RESULTS

RESULTS

In this chapter the information on the results obtained after the analysis of samples is enumerated. The samples collected for water analysis were subjected to various analytical procedures and quantitative data were recorded. The data related to biodiversity i.e. species diversity of the flora and fauna were recorded after their collection from various sites. The data compiled for various analyses and treated for monthly, annual or seasonal variations.

Abiotic Parameters:

Water quality analysis for its physical and chemical nature is recorded. Physical factors like surface temperature, electric conductivity, turbidity etc. were collected while chemical factors like pH, Total solids, total hardness, dissolved gases, dissolved salts and heavy metals were analyzed and registered.

Various parameters during these two years were studied for three seasons. The sampling was done at three sites. The seasons were considered as pre-monsoon, monsoon and post-monsoon and the sample collected during the specified time period.

Surface Temperature:

The surface water temperature during sampling from three sampling site was recorded for Site I, Site II, Site III show marked variations depending upon the environmental conditions as well as seasonal variations (Table 4.1).

At site I during first year temperature was recorded lowest 18^0C in December and slightly higher in January, while highest temperature during the year was recorded 32^0C in June and also higher 31^0C in August and 30^0C in July and September. Similarly in second year temperature shows the lowest value of 18^0C in December and highest i.e. 30^0C in April and June. Otherwise during these years minimum temperature was recorded as 18^0C in December 1^{st} year and highest as well (32^0C) in April and June in the same year. The temperature range during the sampling period varies from 20^0C – 29^0C (Fig. 4.1).

At sampling site II during 1^{st} year of sampling temperature was recorded lowest at 16^0C in January and highest was (31^0C) recorded in May, June and September. During 2^{nd} year lowest temperature 20^0C was recorded in February and highest i.e.

Table 4.1 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data

Monthly data :

Temperature of surface water			
Months	**Site-I**	**Site-II**	**Site-III**
N	25	27	28
D	18	20	22
J	19	16	16
F	21	19	22
M	28	27	29
A	28	29	29
M	30	31	28
J	32	31	32
J	30	24	26
A	31	30	31
S	30	31	30
O	29	30	30
N	28	29	29
D	18	25	22
J	20	22	16
F	23	20	17
M	26	26	27
A	30	30	28
M	28	30	30
J	30	31	30
J	28	26	30
A	28	28	27
S	28	28	29
O	24	28	27

Seasonal data:

Season	Years	Sites	Temp
Premonsoon	1ST YEAR	I	30
		II	28
		III	29
	2nd year	I	29
		II	27
		III	28
Monsoon	1st year	I	23
		II	23
		III	22
	2nd year	I	24
		II	22
		III	24
Post monsoon	1st year	I	20
		II	18
		III	20
	2nd year	I	18
		II	18
		III	16

Fig. 4.1 showing monthly variation in the Surface Temperature

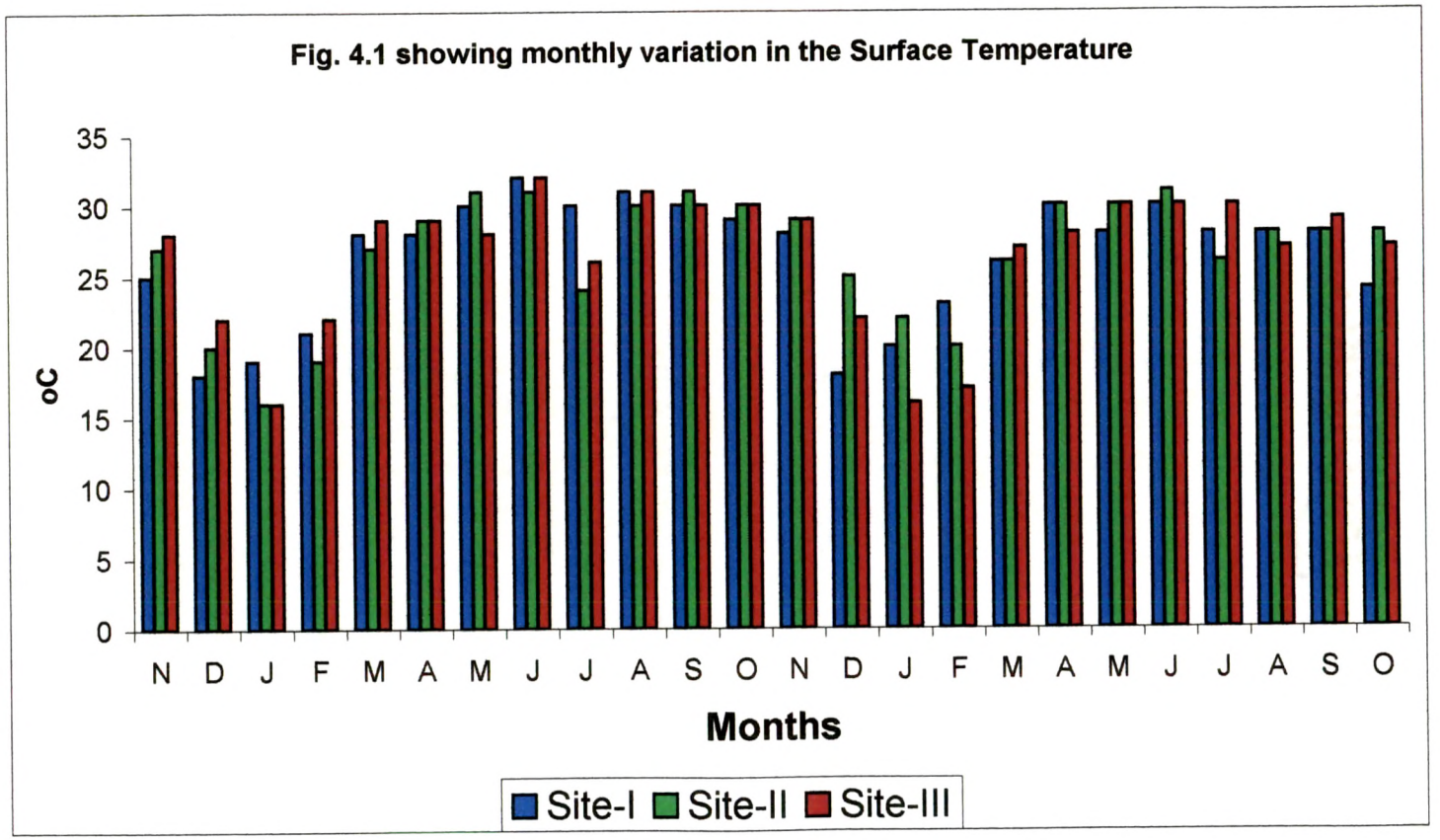
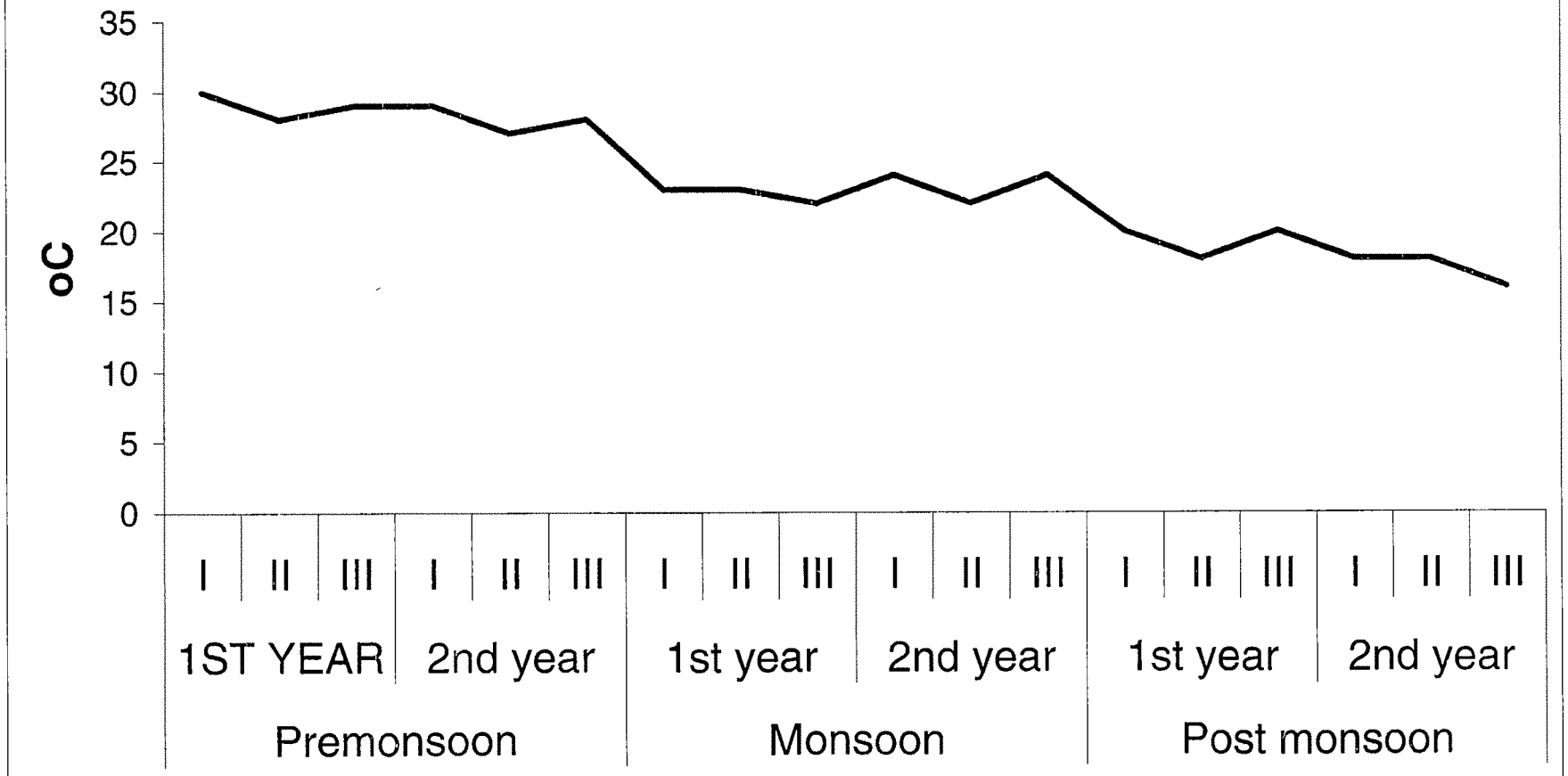


Fig. 4.1 showing seasonal variation in the Surface Temperature



31^{0}C in June and slightly lower as 30^{0}C in April and May. During this period the temperature at site II ranged as 19 ^{0}C – 29^{0}C.

At site III, the trend was observed as lowest 16^{0}C in January and highest was 32^{0}C in June and also 31^{0}C in August and 30^{0}C in September and October of first year. While 2nd year temperature trend shows minimum of 16^{0}C in January and 17^{0}C February and maximum of 30^{0}C in May, June and July. During sampling period at site III temperature range was 22^0 C – 29^{0}C.

Seasonal temperature of the surface water was measured by Alcoholic Centigrade Thermometer and it was found that temperature show seasonal fluctuation depending upon weather as well as atmospheric conditions. The temperature recorded regularly during the two years at selected sites shows the minimum value of temperature 16^{0}C at site III during second year in post monsoon and maximum, 30^{0}C at site I during first year of pre monsoon period. The temperature during other months ranged between 18^{0}C to 29^{0}C during different seasons.

pH:

pH indicates alkaline or acidic nature of the water. pH value shows the following trend at different sites. At site I during 1st year of sampling the pH show minimum value of 6.9 in the

month of June while highest value of pH was observed during December and April i.e.7.7. While otherwise the pH was ranged from 7.1 to 7.5 during this year. In the second year the minimum pH value was observed during July (7.1) and highest value was observed during the month of April i.e. 8.2. During the months of December and January the pH was comparatively higher i.e. alkaline (8.0 and 8.1) respectively. Otherwise pH during 1st year range was 7.1 to 7.7 (Table 4.2).

The values of pH at site II were showing the following trends during these 2 years of sampling. The pH value was found to be minimum during the months of December and April (7.0), while maximum pH was observed during the month of April i.e. 8.4 of 2nd year. The pH value was also supposed to be on higher side even during the month of October (8.0) and March (8.1). Otherwise the pH range was between 7.1 – 7.7.

pH value at site III show the trends as given below during these two years. In 1st year lowest pH value (7.0) was observed during September and highest (8.1) was observed during December. Even higher value was recorded in March i.e. 8.0. The pH during other months ranged from 7.2 to 7.9. During the 2nd year lowest pH value was recorded during the month of February (7.1) and

Table - 4.2 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data

Monthly data :

pH			
Months	**Site-I**	**Site-II**	**Site-III**
N	7.1	7.7	7.5
D	7.7	7	8 1
J	7 2	7.2	7.7
F	7.5	7.1	7.9
M	7.2	7.9	8
A	7.7	7	7.2
M	7.1	7.7	7.4
J	6.9	7.5	7.3
J	7.2	7.1	7.6
A	7.4	7.1	7.9
S	7.3	7.7	7
O	7.4	7.6	7.7
N	7 8	7.2	7.9
D	8.3	7.4	7.8
J	8.1	7	8.6
F	7 4	7.9	7.1
M	7.2	8.1	7.7
A	8.2	8.4	7.9
M	7.7	7.3	8
J	7.5	7.9	8 2
J	7 1	7 5	7.1
A	7.7	7.8	7.5
S	7.7	7.7	7 8
O	7.2	8	8.1

Seasonal data:

Season	Years	Sites	pH
Premonsoon	1st year	I	7.6
		II	7 7
		III	7.3
	2nd year	I	7.7
		II	7 2
		III	7.1
Monsoon	1st year	I	7.6
		II	7.3
		III	7 3
	2nd year	I	7.3
		II	7.1
		III	7 1
Post monsoon	1st year	I	7
		II	7.7
		III	8 1
	2nd year	I	7.7
		II	7 2
		III	7.4

Fig. 4.2 showing monthly variation in the pH of water

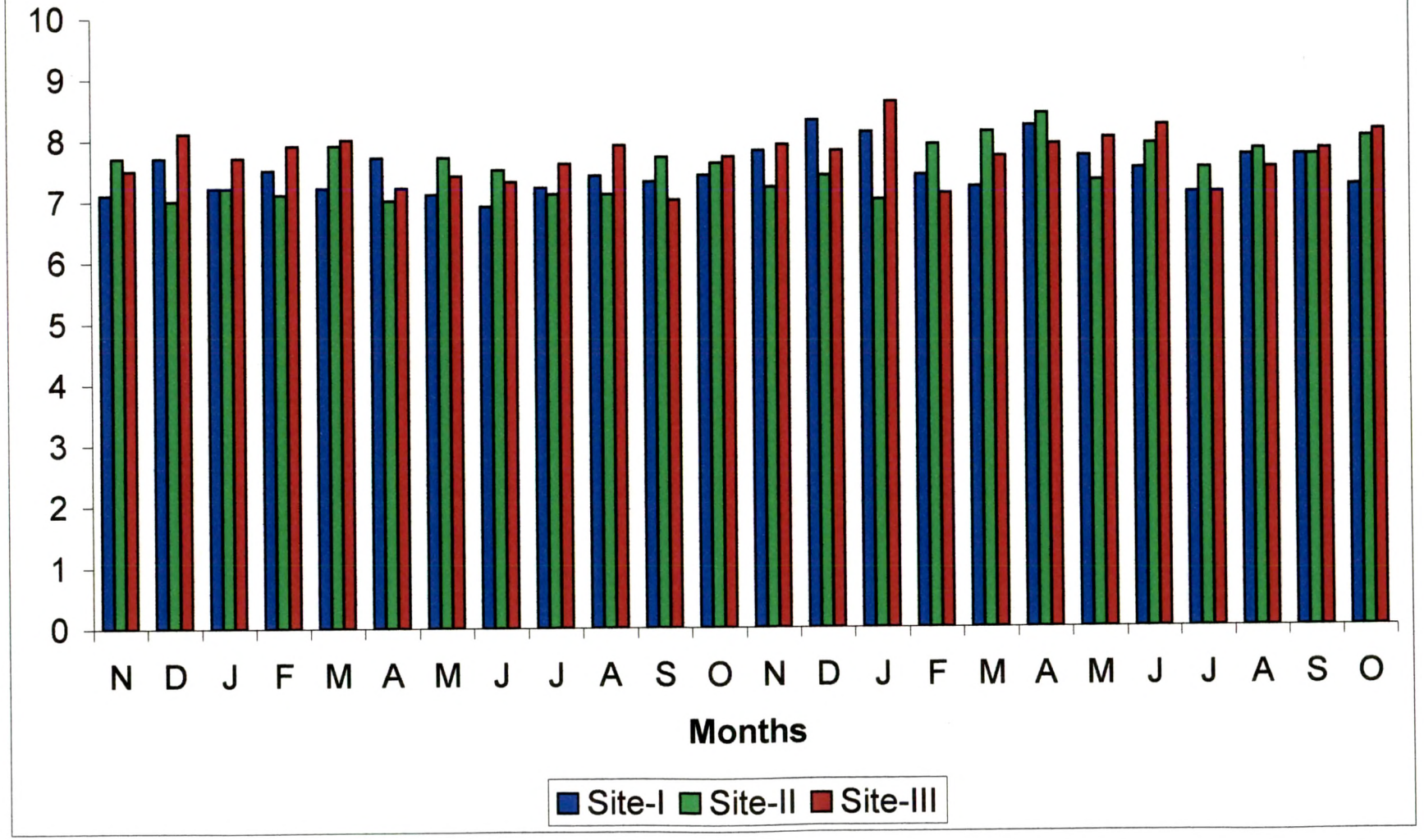
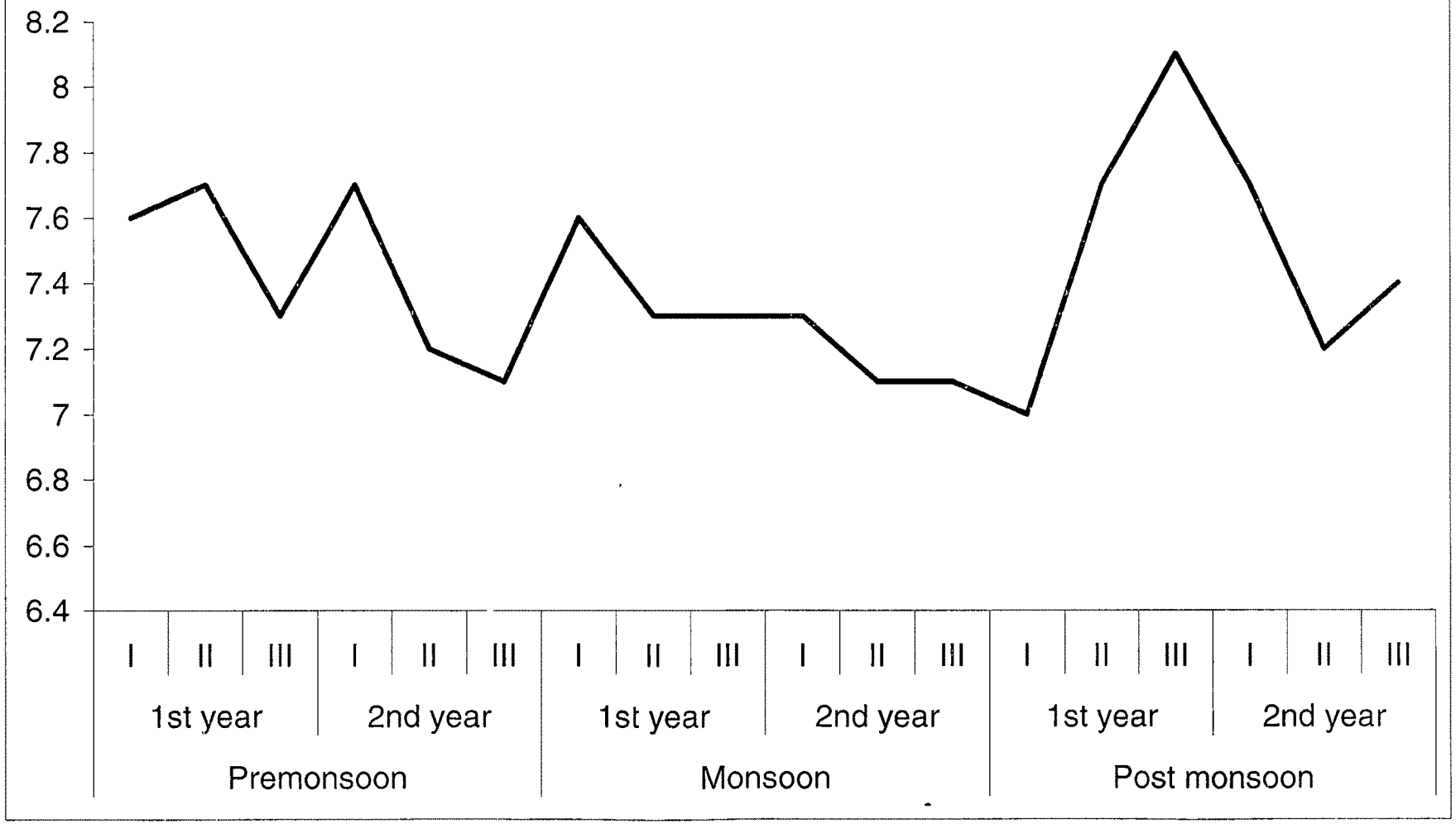


Fig. 4.2 showing seasonal variation in the pH of water



highest in January (8.6). Otherwise during the year value remained in alkaline range was 7.5 to 8.2.

During these two years it was found that pH was in alkaline range only at the three sites i.e. site I, site II and site III and it was weakly alkaline (7.1) to slightly strong alkaline (8.6) (Fig.4.2).

pH value for three seasons were recorded to be the lowest of 7.0 at site I during post monsoon in first year while slightly higher (7.1) in pre monsoon at site III for second year and in monsoon at site II and site III of second year. Maximum pH value during the two years of season wise sampling recorded was 8.1 for post monsoon at site III during first year. The pH values fluctuate in between 7.2 to 7.7 during the sampling period at the different sites.

Dissolved Oxygen:

Dissolved Oxygen (DO) content of the water was estimated in the unit of milligram per liter (mg/l). During sampling it showed the following trend (Table 4.3). At Site-I during the 1st years of sampling the minimum value 6.2 of dissolved oxygen was observed in May and maximum 8.7 in March. In 2nd year the oxygen content shows minimum value 5.9 in May and highest

Table - 4.3 : Quantative analysis of Physico - Chemical parameter of water quality, Dissolved Oxygen in water

Monthly data :

Dissolved Oxygen			
Months	**Site-I**	**Site-II**	**Site-III**
N	7 7	6 3	5.9
D	7 2	7	5
J	8 1	5 2	6
F	6 9	6.9	5 1
M	8.7	7.2	4.8
A	6.8	6.7	6 2
M	6.2	5.7	3 95
J	7.7	6	3.2
J	8	5.9	4.8
A	8 1	7.2	5 2
S	8	7 1	5.9
O	7.5	6	6.2
N	7 7	7.55	6.12
D	7.6	7 2	6.9
J	8.3	8.6	5.4
F	8	4.4	5.72
M	7 4	4 9	5.25
A	7.2	6.2	7 15
M	5.9	6.1	5
J	6 7	6 1	3 8
J	8 2	4 5	4 75
A	7.1	5 8	4.3
S	7 8	8.3	5.45
O	8.2	7.3	5.8

Seasonal data:

Season	Years	Sites	DO
Premonsoon	1st year	I	6.1
		II	5.9
		III	3 2
	2nd year	I	6 8
		II	6 6
		III	4.5
Monsoon	1st year	I	7.1
		II	5 8
		III	5.7
	2nd year	I	7.3
		II	6.8
		III	6 2
Post monsoon	1st year	I	6.6
		II	5.9
		III	4.4
	2nd year	I	8 0
		II	6.4
		III	3 9

Fig. 4.3 showing monthly variation in the Dissolved Oxygen in water

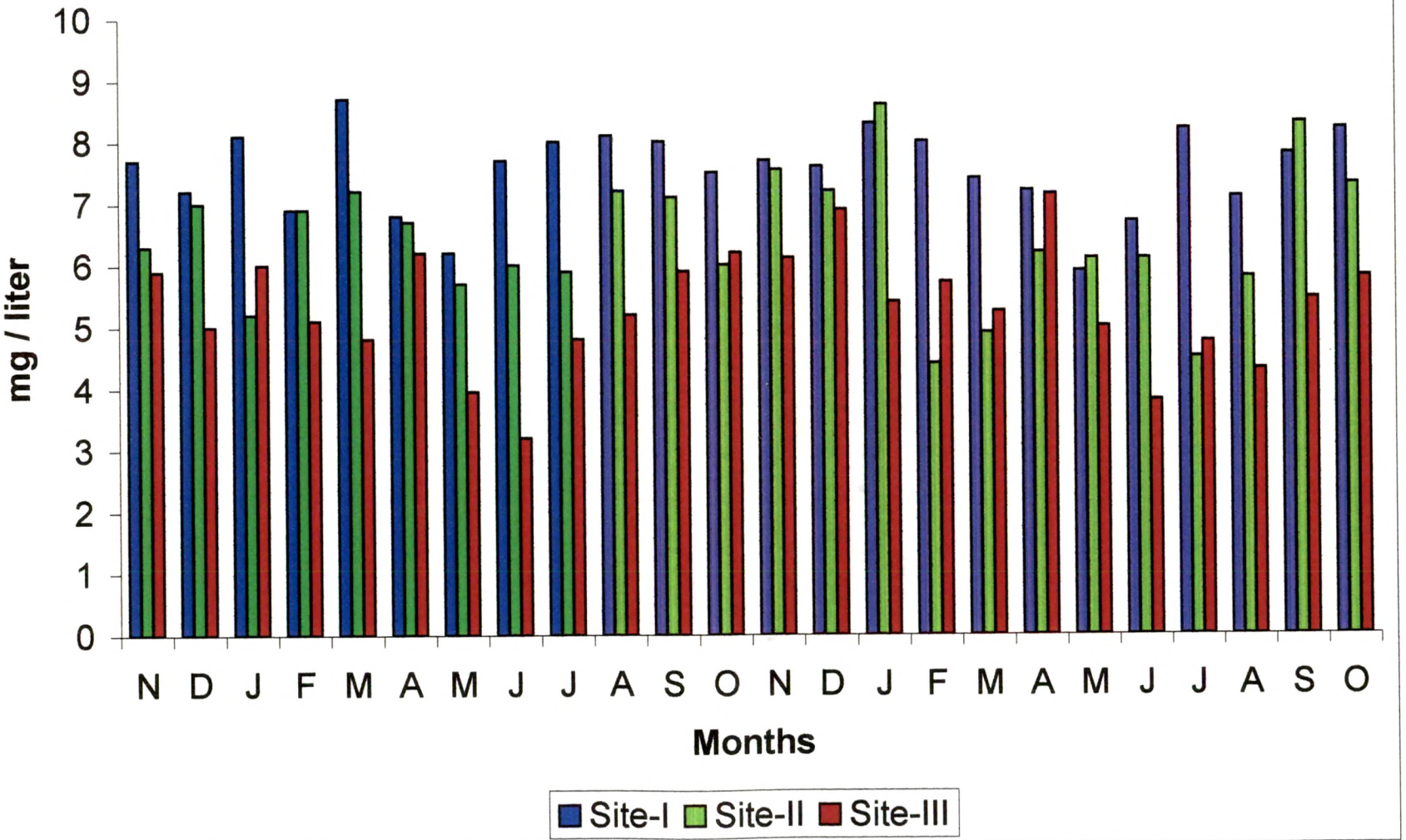
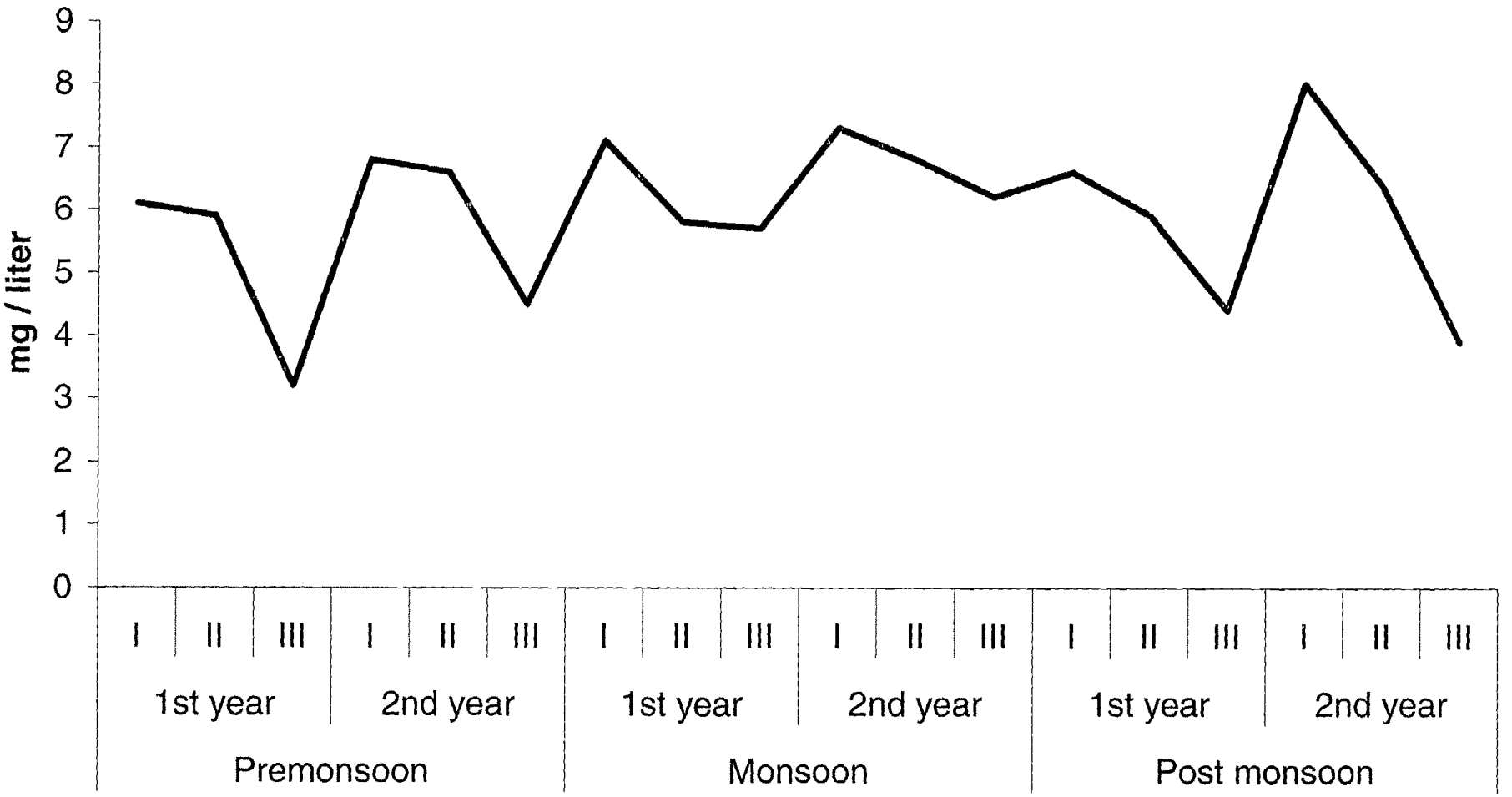


Fig. 4.3 showing seasonal variation in the Dissolved Oxygen in water



value of 8.3 in January. In two years of sampling at site I dissolved oxygen ranged between 6.7 – 8.1 mg/l (Fig.4.3).

At site II during 1st year of sampling low value of dissolved oxygen 5.2 was observed in January and high value of 7.2 was observed in March and August. In 2nd year the sampling showed lower value of 4.4 in February and high value of 8.6 in January. Normally the value of Dissolved Oxygen ranges in these two years between 4.9 to 8.3 mg/l.

At site III during first year the minimum value was 3.2 in June and maximum value 6.2 was detected in April and October. While in 2nd year the value detected was low in June i.e. 3.8 and high of 7.1 in April. So during sampling for these three sites for two years value of Dissolved Oxygen ranged between 3.9 and 7.1 The minimum value on the three sites in two year sampling was 3.2 at site II in June of first year and maximum (8.7) in March at site I during the same year.

Seasonal Analysis of Dissolved Oxygen content of water during three seasons show the minimum value 3.1 at site III during first year in Pre-monsoon while the maximum value of 8.0 was recorded at site I during post monsoon in the second year.

Otherwise for two years the seasonal value of Dissolved Oxygen ranged from 3.9 to 7.1.

Sulphate:

Sulphate content in the water analyses shows the following trends in the samples. At site I during 1st year were recorded minimum of 18.0 in August and maximum 616.0 in February. In 2nd year minimum value was recorded 115 in August and maximum value of sulphate recorded was 485 in June (Table 4.4 and Fig. 4.4).

At site II the value of sulphate during 1st year sampling showed minimum 39.0 in August and maximum 924.0 in May. While in 2nd year minimum sulphate value was observed in August and maximum 895.0 was recorded in June.

At site III the minimum value of sulphate recorded during 1st year sampling was 88 in August and maximum 1010 in December. In 2nd year sulphate value was recorded minimum 300.0 in August and maximum 975 in April. During the two year sampling showed minimum value (18.0) in August of first year at site I and maximum value (1150) in August at site I during second year.

Table - 4.4 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data of Sulphates in water

Monthly data :

Sulphates			
Months	**Site-I**	**Site-II**	**Site-III**
N	285	852	854
D	415	776	1010
J	524	612	648
F	616	854	880
M	502	800	895
A	460	525	725
M	492	924	972
J	312	600	686
J	20	44	105
A	18	39	88
S	232	497	440
O	330	850	914
N	300	850	880
D	295	700	745
J	255	760	840
F	470	712	700
M	285	690	900
A	392	680	975
M	312	824	890
J	485	895	920
J	275	440	475
A	115	215	300
S	350	528	665
O	325	580	670

Seasonal data:

Season	Years	Sites	Sulphate
Premonsoon	1st year	I	97
		II	69
		III	120
	2nd year	I	145
		II	200
		III	132
Monsoon	1st year	I	88
		II	105
		III	140
	2nd year	I	80
		II	110
		III	66
Post monsoon	1st year	I	50
		II	84
		III	34
	2nd year	I	94
		II	102
		III	70

Fig. 4.4 showing monthly variation in the Sulphates in water

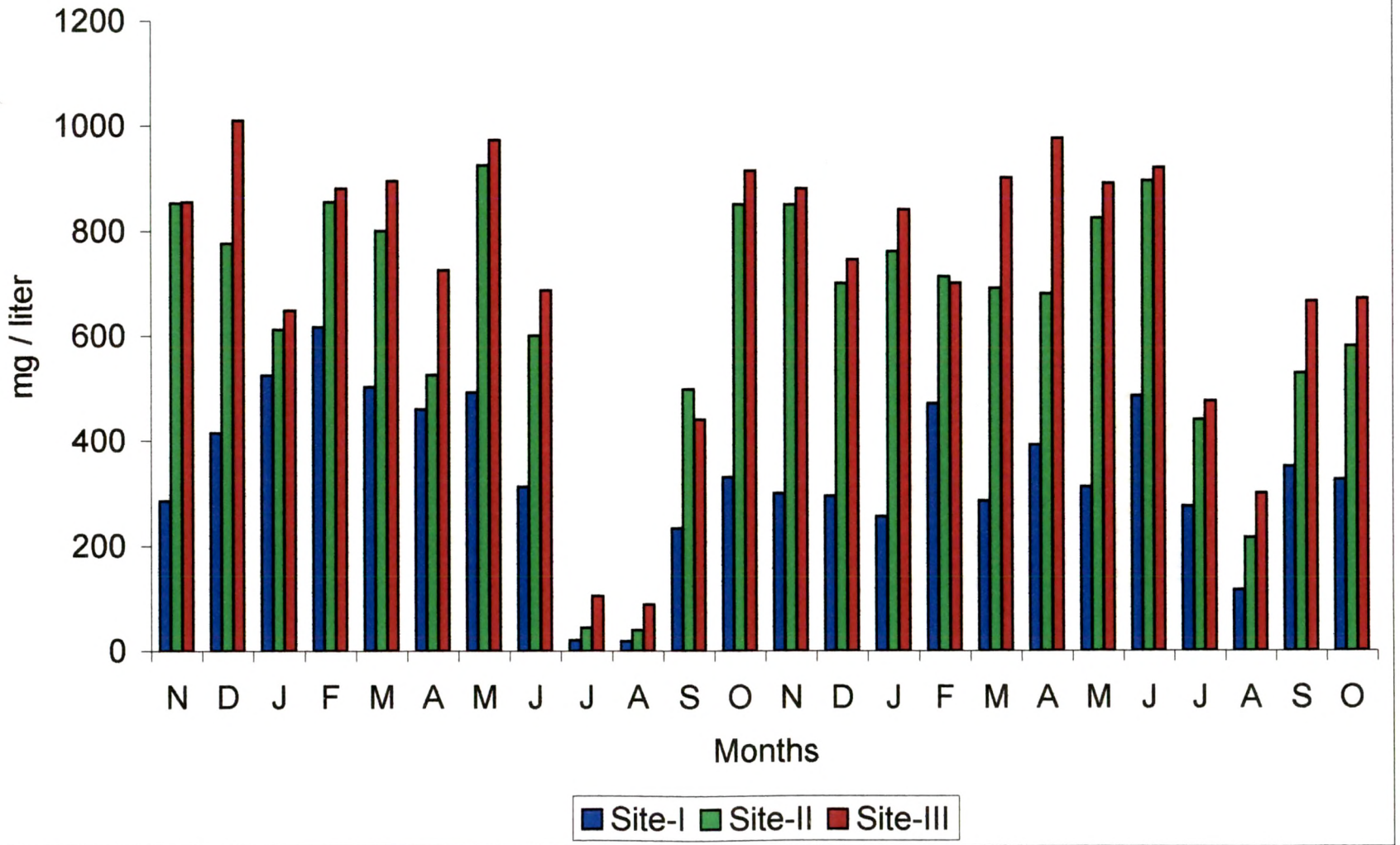
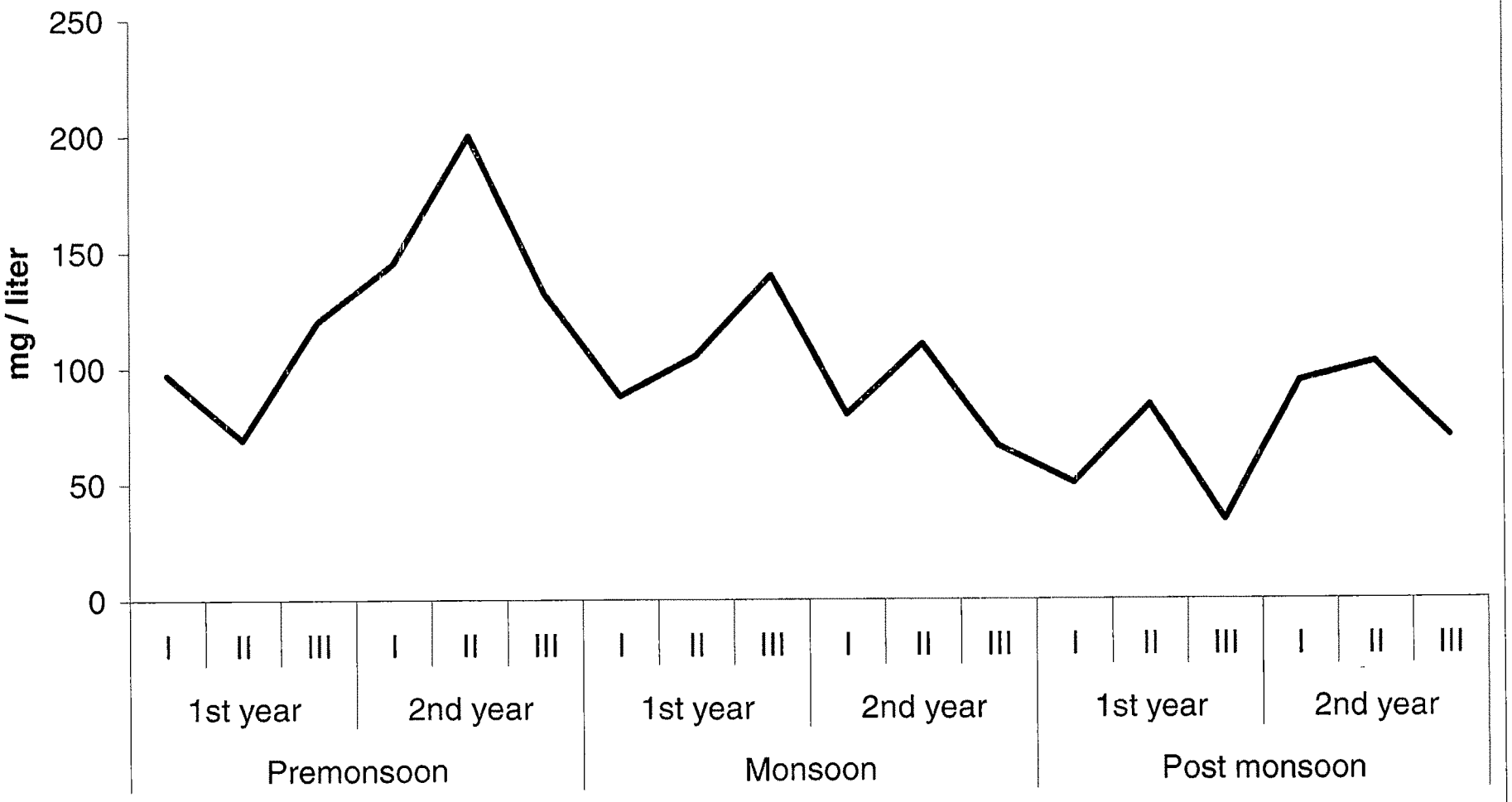


Fig. 4.4 showing seasonal variation in the Sulphates in water



Seasonal Value of sulphate at three sites during 2 years shows variation in the value minimum as 34mg/l site III of first year in post monsoon and maximum of 200mg/l at site II in second year during premonsoon. Sulphate value ranged from 66 to 145 during different season at different site.

Phosphate:

In the samples collected in first and second year at different selected sites the phosphate content variation was estimated and recorded in the unit of milligram per liter (mg/l) (Table 4.5 and Fig 4.5).

Minimum value of phosphate at site I during first year shows .18 in August and maximum value 1.94 in November. While in second year minimum value 0.18 in September and maximum 1.35 was observed in May.

Similarly at site II first year minimum value was 0.46 in February, 0.47 in June while maximum was 2.30 in May. During second year the minimum value (0.74) in September and maximum value of 2.64 in May and slightly lower i.e. 2.60 in April.

At site III the phosphate during first year showed low value of 0.59 in February and high value of 4.76 in April. Second year the

Table - 4 5 · Quantative analysis of Physico - Chemical parameter of water quality, Monthly and seasonal data. Phosphates in water

Monthly data :

Phosphates			
Months	**Site-I**	**Site-II**	**Site-III**
N	1.94	1 05	1.96
D	0 75	1 94	3 82
J	0 66	1.54	2
F	0.45	0 46	0.59
M	1 3	1	1 26
A	0 6	1.88	4 76
M	0.94	2 3	2 52
J	0.37	0 47	0.96
J	0 42	0.56	1 25
A	0 18	1.68	2 6
S	0.35	0.8	1.18
O	0 89	2.12	2 24
N	0 95	1.24	1 84
D	1.05	2 25	2.52
J	0.86	2.1	2 75
F	0 44	1.18	1 38
M	0.62	1 2	1.29
A	1.26	2.6	3 72
M	1.35	2.64	3 25
J	0.9	1 8	1.86
J	0.32	1 52	2 15
A	0.42	1.36	1.96
S	0 18	0 74	1.48
O	0.36	0 96	1.2

Seasonal data:

Season	Years	Sites	Phosphate
Premonsoon	1st year	I	2 24
		II	2 6
		III	3 38
	2nd year	I	1 94
		II	0 86
		III	1.5
Monsoon	1st year	I	1.18
		II	1 68
		III	0 49
	2nd year	I	0 96
		II	1 24
		III	0 8
Post monsoon	1st year	I	1 6
		II	1 46
		III	2 2
	2nd year	I	0.88
		II	3 42
		III	3 1

Fig. 4.5 showing monthly variation in the Phosphates in water

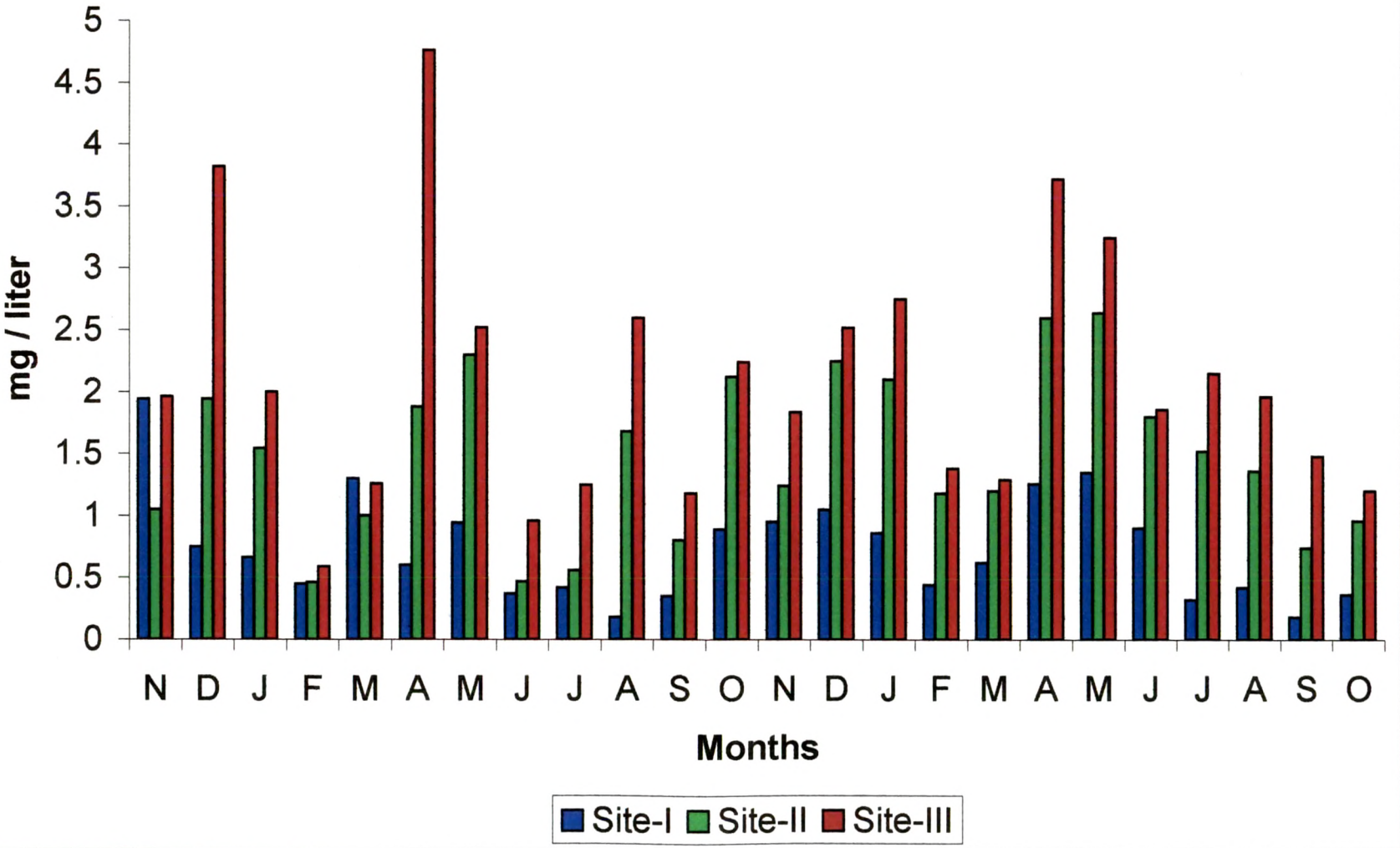
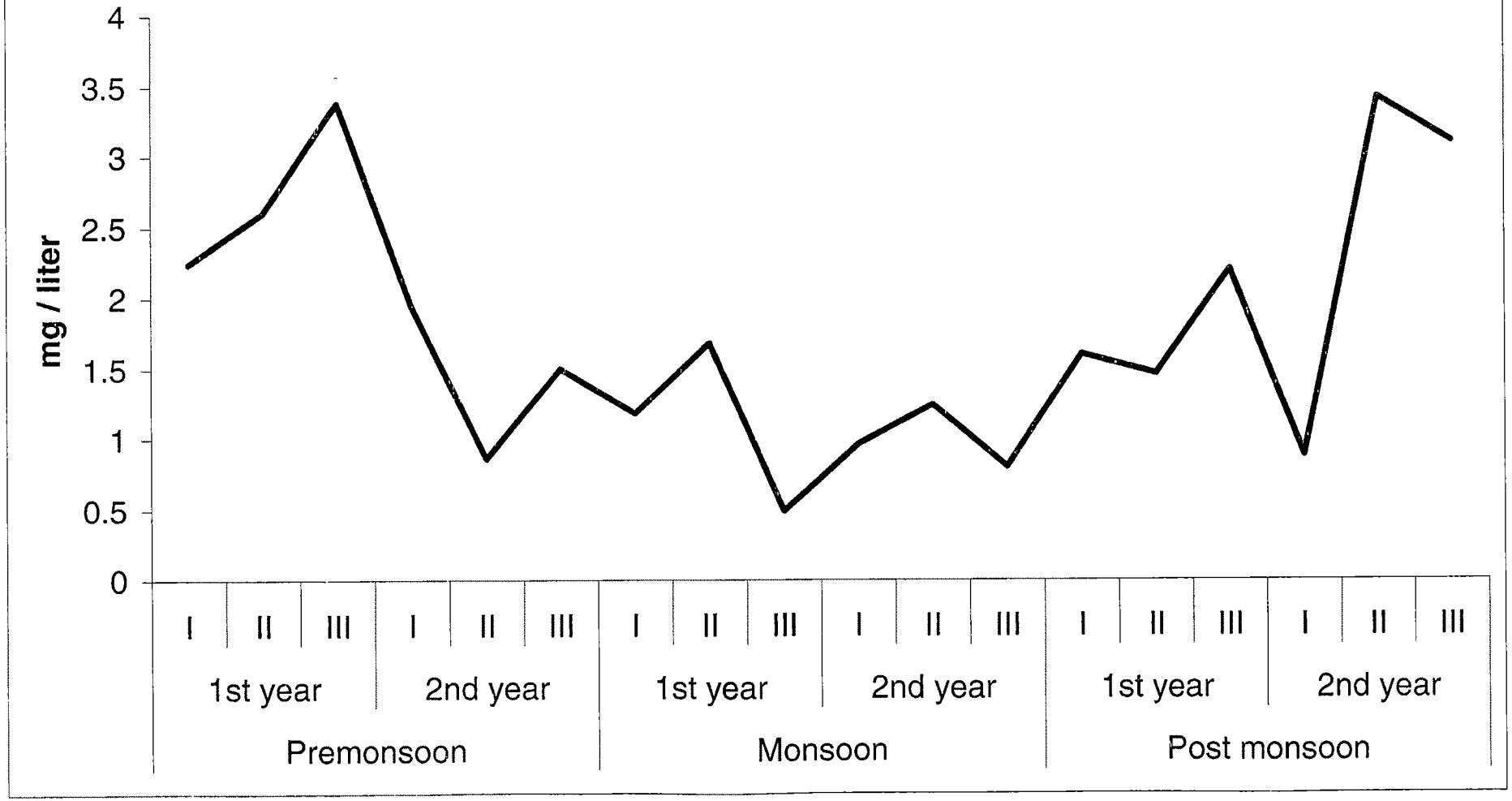


Fig. 4.5 showing seasonal variation in the Phosphates in water



low value of phosphate was (1 2) in October and high value (3.72) was recorded in April.

Otherwise during these two years the value of phosphate ranged between 0.3 at site I of second year and 3.82 at site III of first year.

Seasonal values of phosphate during different seasons for 2 years show minimum value of 0.49 at site III during 1st year in monsoon and maximum value 3.42 during 2nd year post monsoon at site II was recorded.

Chlorides:

Water sample collected for two years for the chloride content in water regularly from the study sites and estimated in mg/l (Table 4.6 and Fig 4.6).

At site I during first year the chloride showed minimum value (3.9) in August and maximum (2620) in November. In second year the minimum value recorded was 297 in August and maximum was 2240 in January. At site II the chloride content lowest value was 700 in August and highest value of 3986 in November. In second year the low value (490) in July and high value (2756) was observed in December.

Table - 4.6 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data of Chlorides in water

Monthly data :

Chlorides			
Months	**Site-I**	**Site-II**	**Site-III**
N	2620	3986	4015
D	2212	2324	2530
J	770	1260	1572
F	750	970	1026
M	1280	1722	2020
A	1600	1765	1995
M	558	889	1275
J	542	848	980
J	670	750	1079
A	390	700	740
S	1670	2426	2590
O	1050	1870	2212
N	1670	2440	2640
D	1530	2756	3350
J	2240	2660	2860
F	1078	1815	1050
M	580	1035	1470
A	612	1002	1320
M	1842	2550	2930
J	1008	1460	1760
J	385	490	630
A	297	560	1642
S	1200	1805	3855
O	1060	1675	1808

Seasonal data:

Season	Years	Sites	Chloride
Premonsoon	1st year	I	375
		II	528
		III	26
	2nd year	I	184
		II	612
		III	218
Monsoon	1st year	I	416
		II	400
		III	16
	2nd year	I	286
		II	302
		III	202
Post monsoon	1st year	I	470
		II	360
		III	14
	2nd year	I	236
		II	320
		III	23

Fig. 4.6 showing monthly variation in the Chloride in water

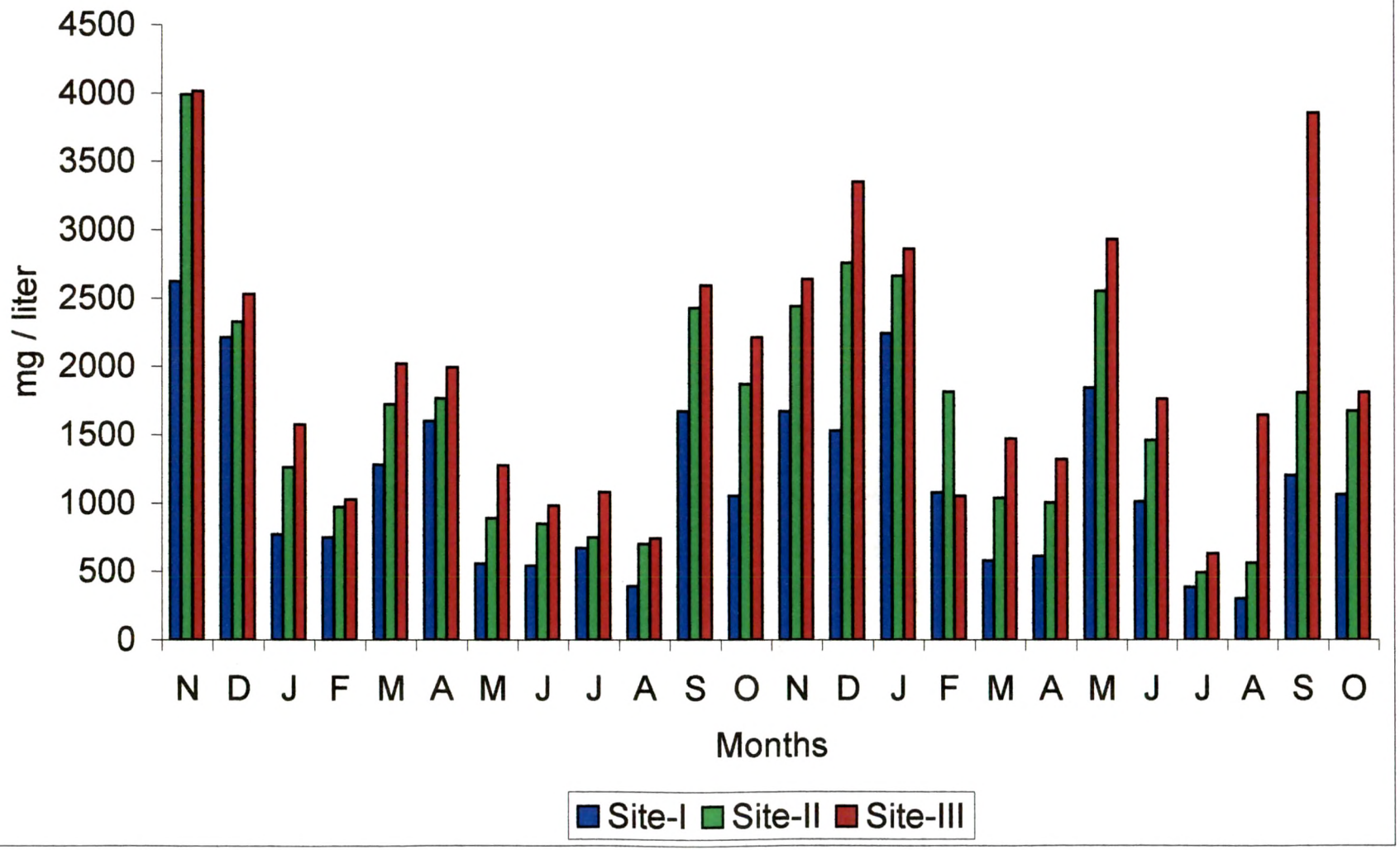
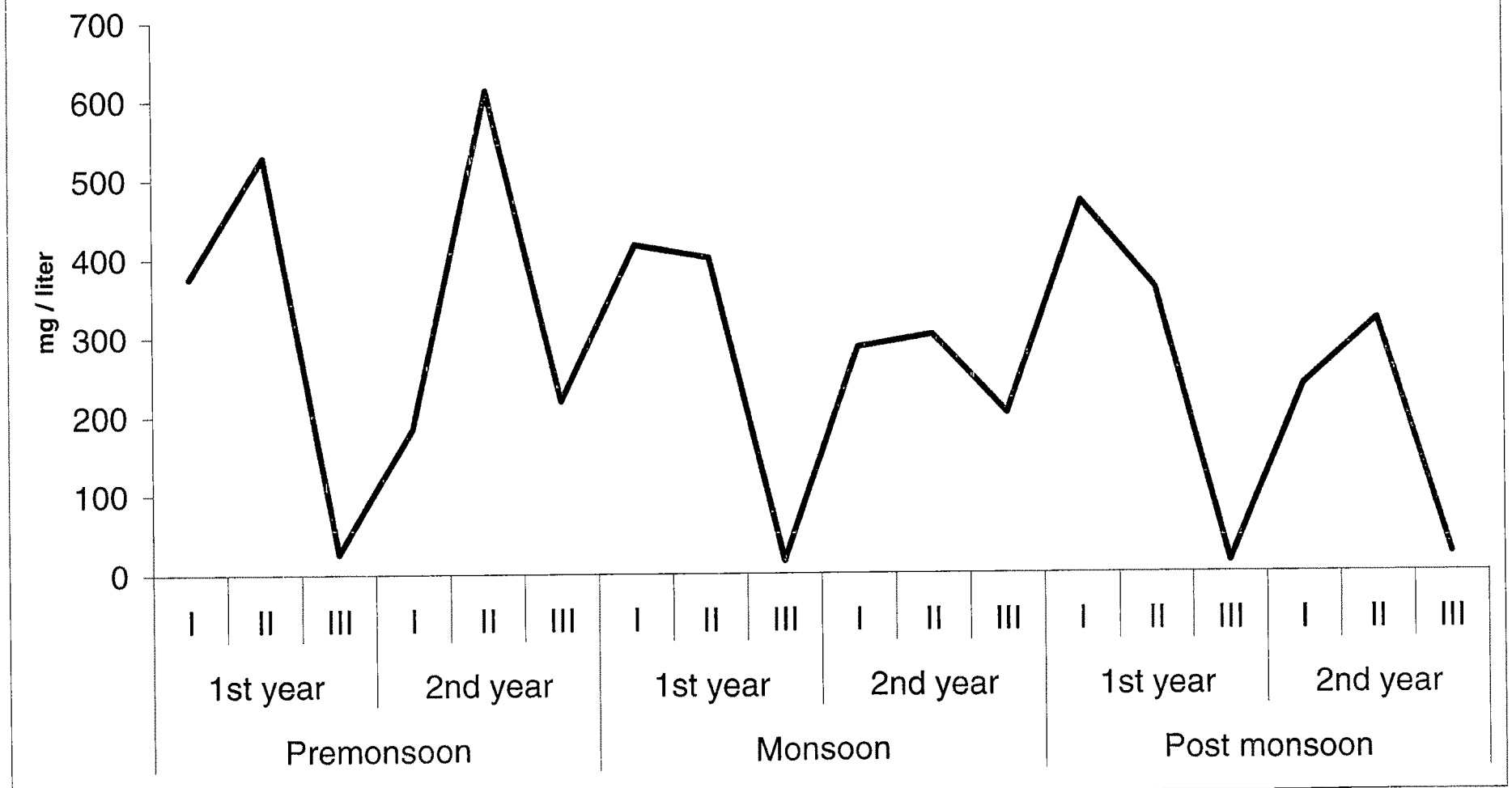


Fig. 4.6 showing seasonal variation in the Chloride in water



At site III similarly the low value during first year was detected as 740 mg/l in August and maximum of 4015 in November While second year chloride content were low (630) in July and high (3855) in September. During the two year sampling the chloride contents in water sample ranged from 297 at site I for second year and 4015 at site III for first year.

The chloride contents of water sample during pre monsoon, monsoon and post monsoon season for 2 years show minimum value of chloride 14 mg/l at site III in post monsoon of first year and maximum of 528 mg/l in pre monsoon at site II during first year.

Nitrates:

Water sample shows nitrate content in sample for the specified time period at selected sites as mentioned below. At site I nitrate value for first year was minimum of (0.25) in February and maximum of (6.65) in July and (6.26) in June. The value minimum of 0.5mg/l and maximum of 0.66 mg/l in August was recorded. At site II the minimum value was 1.14 and maximum value was 16.3 in August and 14.8 in July of first year and minimum value (2.5) in May and maximum (9.6) in July of second year (Table 4.7 and Fig. 4.7).

Table - 4.7 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data

Monthly data :

Nitrate			
Months	**Site-I**	**Site-II**	**Site-III**
N	0.56	4.52	10.7
D	0.33	2.45	4.2
J	2 25	4 4	6 25
F	0.25	1 8	2 4
M	0.28	1 96	3
A	1.12	1 34	1.28
M	0 54	1 14	1 08
J	6.26	8.16	7.1
J	6 65	14 8	21.8
A	8 9	16.3	14 7
S	1 48	2 8	2.6
O	0.42	3 76	4
N	0.62	2.95	3.72
D	1.32	3	4
J	0.95	2.67	4.25
F	2 37	6 25	6.5
M	1.28	2 84	3.15
A	0 95	3	4 25
M	0.62	2 5	2 24
J	1.2	1.75	3.75
J	4.2	9.6	12 7
A	6.6	7 7	9 8
S	0.86	1 75	3.6
O	0.5	2 6	1 86

Seasonal data:

Season	Years	Sites	Nitrates
Premonsoon	1st year	I	10
		II	3.4
		III	3
	2nd year	I	6 4
		II	2.2
		III	403
Monsoon	1st year	I	10.7
		II	2.4
		III	3.6
	2nd year	I	6.9
		II	209
		III	4.8
Post monsoon	1st year	I	5 2
		II	4
		III	3
	2nd year	I	3 6
		II	2.5
		III	7 7

Fig. 4.7 showing monthly variation in the Nitrate in water

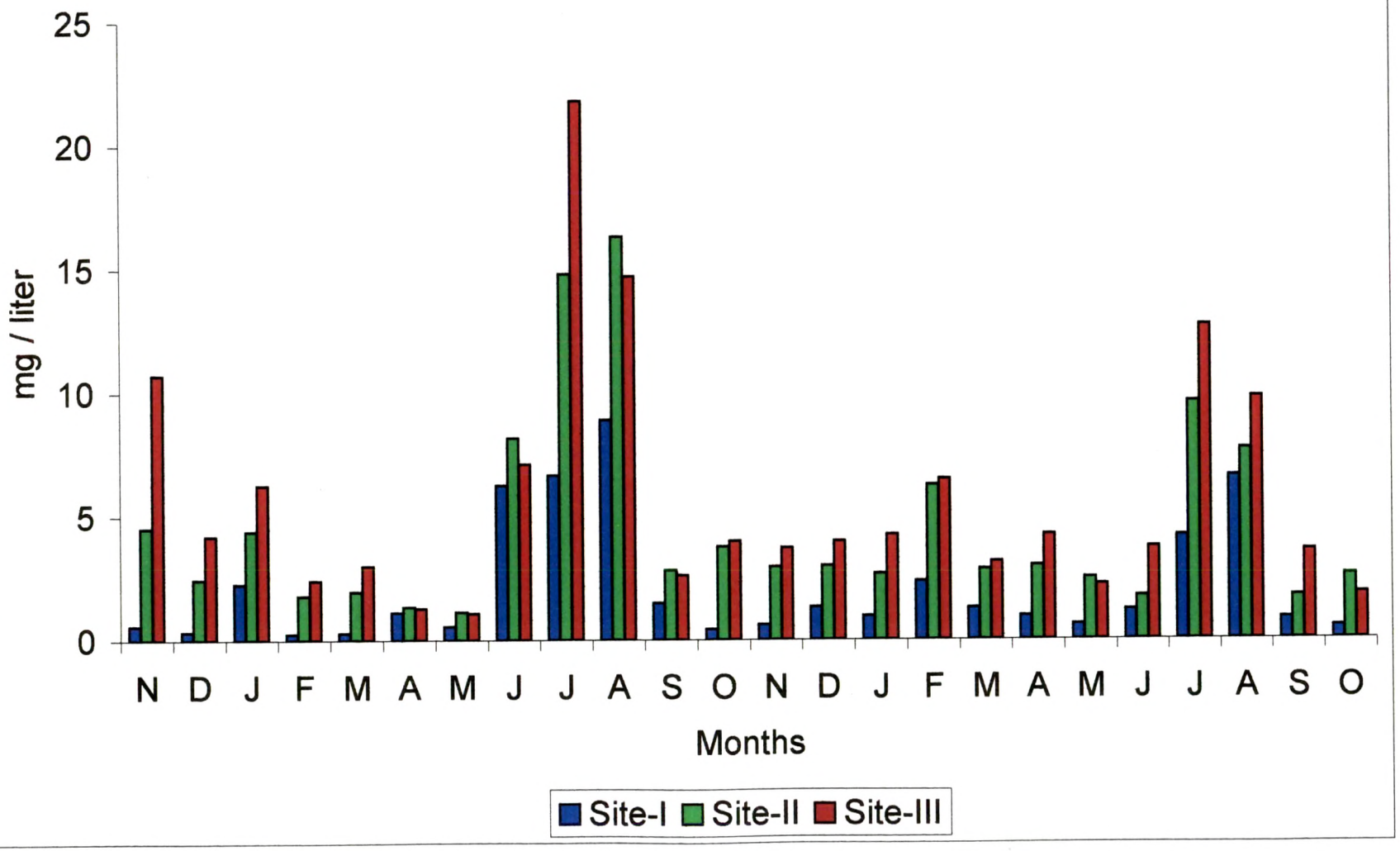
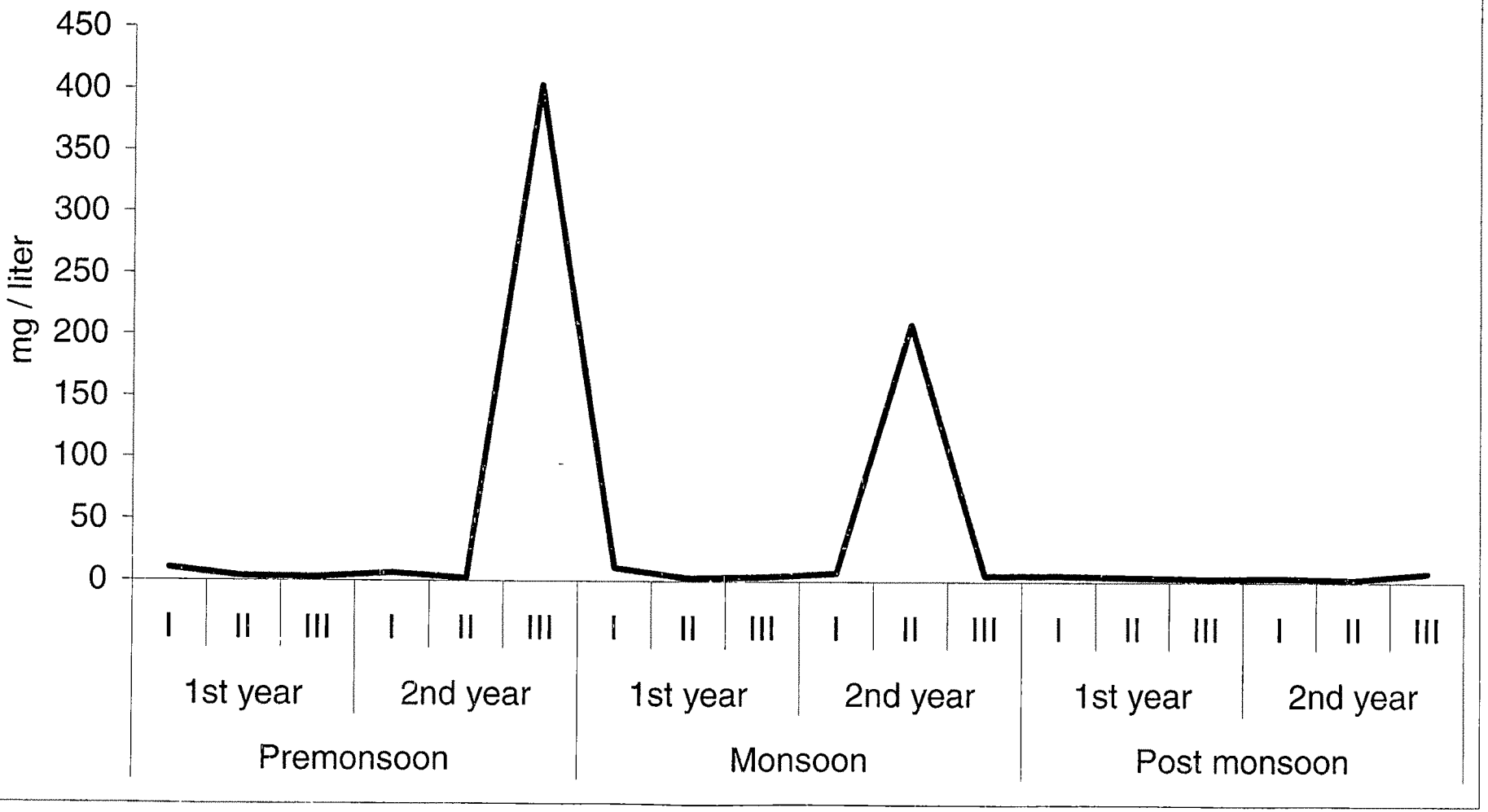


Fig. 4.7 showing seasonal variation in the Nitrate in water



At site III for nitrate minimum value in first year 1.08 in May and Maximum 21.8 in July and second year minimum 1.86 in October and maximum 12.7 in July was recorded.

Like wise seasonal value of nitrates contents in water the value recorded for the specified period and locations was as minimum of 2.2 at site II for second year during pre-monsoon and maximum of 403 at site III in 2nd year during monsoon.

Ammonical Nitrogen:

Site I the Ammonical Nitrogen content in water during first year show minimum value of 26 in February to maximum value of 155 in October. During the second year the minimum value was 80mg/l in January and 82 mg/l a bit higher in September and high value of 115 mg/l was recorded in August (Table 4.8 and Fig 4.8). At site II the values of Ammonical Nitrogen in first year sample show minimum amount of 38 mg/l in April and maximum value of 167 in July. During second year the low value of 68 in April and high value of 126 was recorded in June. At site III the value of lowest 75 in February and highest of 182 in July was recorded during first year. Next year lowest value was (95) in January and highest (155) in May.

Table - 4 8 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data

Monthly data :

Ammonical Nitrogen			
Months	**Site-I**	**Site-II**	**Site-III**
N	105	88	114
D	120	112	136
J	94	110	148
F	26	68	75
M	70	76	108
A	42	38	95
M	125	116	136
J	120	118	155
J	148	167	182
A	136	160	177
S	95	92	128
O	155	140	162
N	116	110	140
D	115	94	128
J	80	70	95
F	102	102	126
M	89	100	132
A	108	68	102
M	90	125	155
J	106	126	142
J	103	100	138
A	115	112	150
S	82	78	102
O	100	102	115

Seasonal data:

Season	Years	Sites	NH3N
Premonsoon	1st year	I	52
		II	130
		III	152
	2nd year	I	66
		II	110
		III	160
Monsoon	1st year	I	62
		II	66
		III	122
	2nd year	I	90
		II	102
		III	180
Post monsoon	1st year	I	68
		II	110
		III	118
	2nd year	I	82
		II	125
		III	170

Fig. 4.8 showing monthly variation in the Ammonical nitrogen

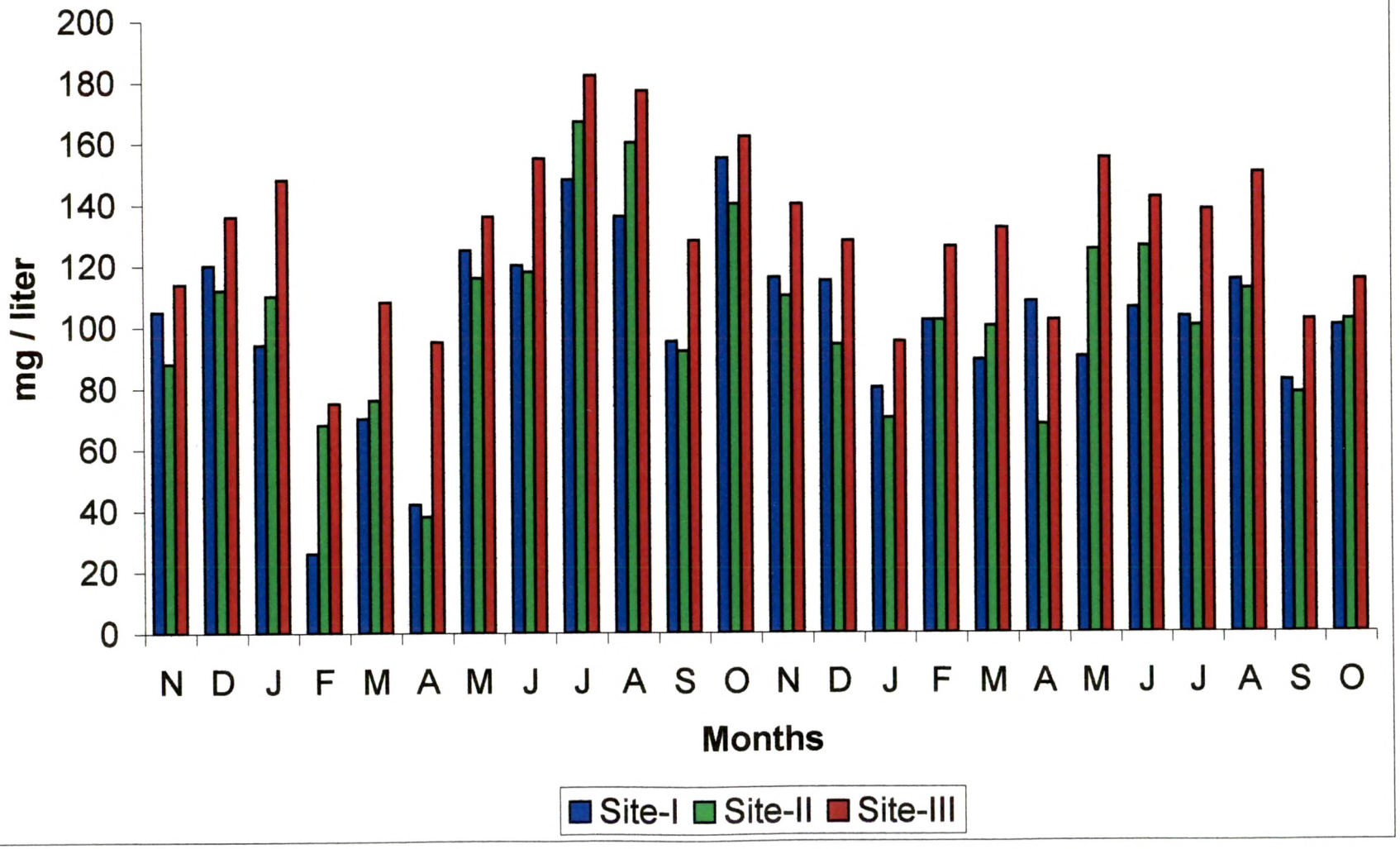
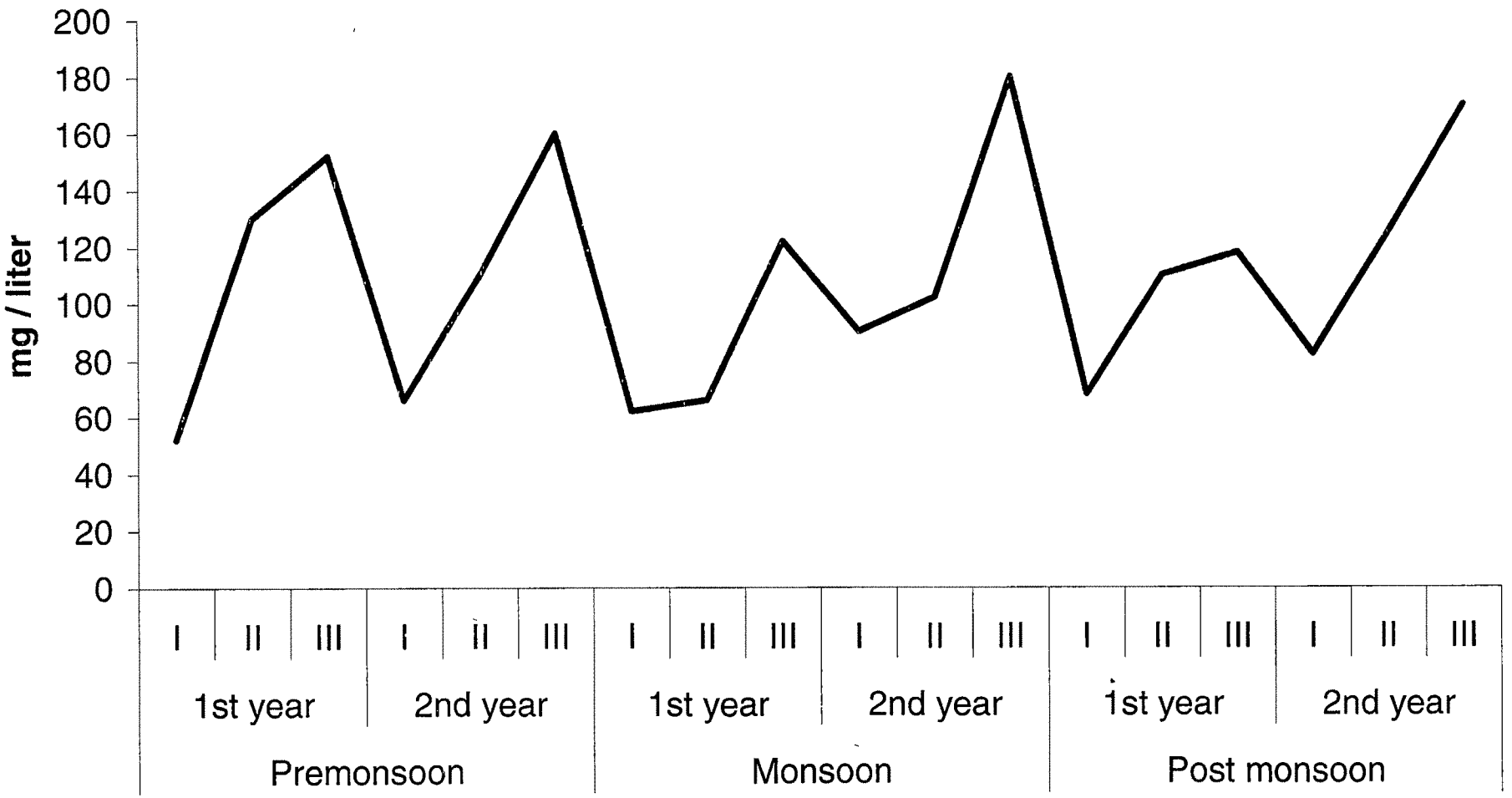


Fig. 4.8 showing seasonal variation in the Ammonical nitrogen



During first year Ammonical Nitrogen value at three site was 26 mg/l in February at site I and maximum (182) in July at site III and during second year minimum value was (68) in April at site II and maximum. (155) in May at site III was recorded.

Ammonical Nitrogen value was recorded as 52 mg/l at site I in pre monsoon during first year and maximum of 180 mg/l at site III during second year in monsoon. Otherwise it ranged between 62 to 170 mg/l during different seasons.

Carbonates:

Carbonate content in water show the following maximum and minimum trend during sampling for two years from the selected sites (Table 4.9).

At site I carbonate show minimum value of 1.0 in April, May and August and Maximum value of 12.0 in December. Carbonate were altogether absent in sample collected in July. Second year the sample showed minimum value of 1.0 in May and July. Maximum value of 18.0 was observed in December. Carbonates content in water was absent in September during second year (Fig 4.9).

Table - 4.9 Quantative analysis of Physico - Chemical parameter of water quality, Monthly and seasonal data

Monthly data :

Carbonates			
Months	**Site-I**	**Site-II**	**Site-III**
N	9	16	22
D	12	16	18
J	8	14	20
F	4	6	10
M	2	2	8
A	1	3	4
M	1	0	4
J	4	10	12
J	0	3	6
A	1	3	4
S	1	0	4
O	6	10	12
N	9	19	20
D	18	20	26
J	10	12	14
F	4	10	16
M	5	6	10
A	4	8	12
M	1	5	6
J	8	12	18
J	1	4	8
A	2	5	6
S	0	5	19
O	12	20	24

Seasonal data:

Season	Years	Sites	CO3
Premonsoon	1st year	I	12
		II	20
		III	8
	2nd year	I	22
		II	28
		III	12
Monsoon	1st year	I	9
		II	18
		III	3
	2nd year	I	20
		II	3
		III	8
Post monsoon	1st year	I	12
		II	22
		III	26
	2nd year	I	4
		II	12
		III	13

Fig. 4.9 showing monthly variation in the Carbonates in water

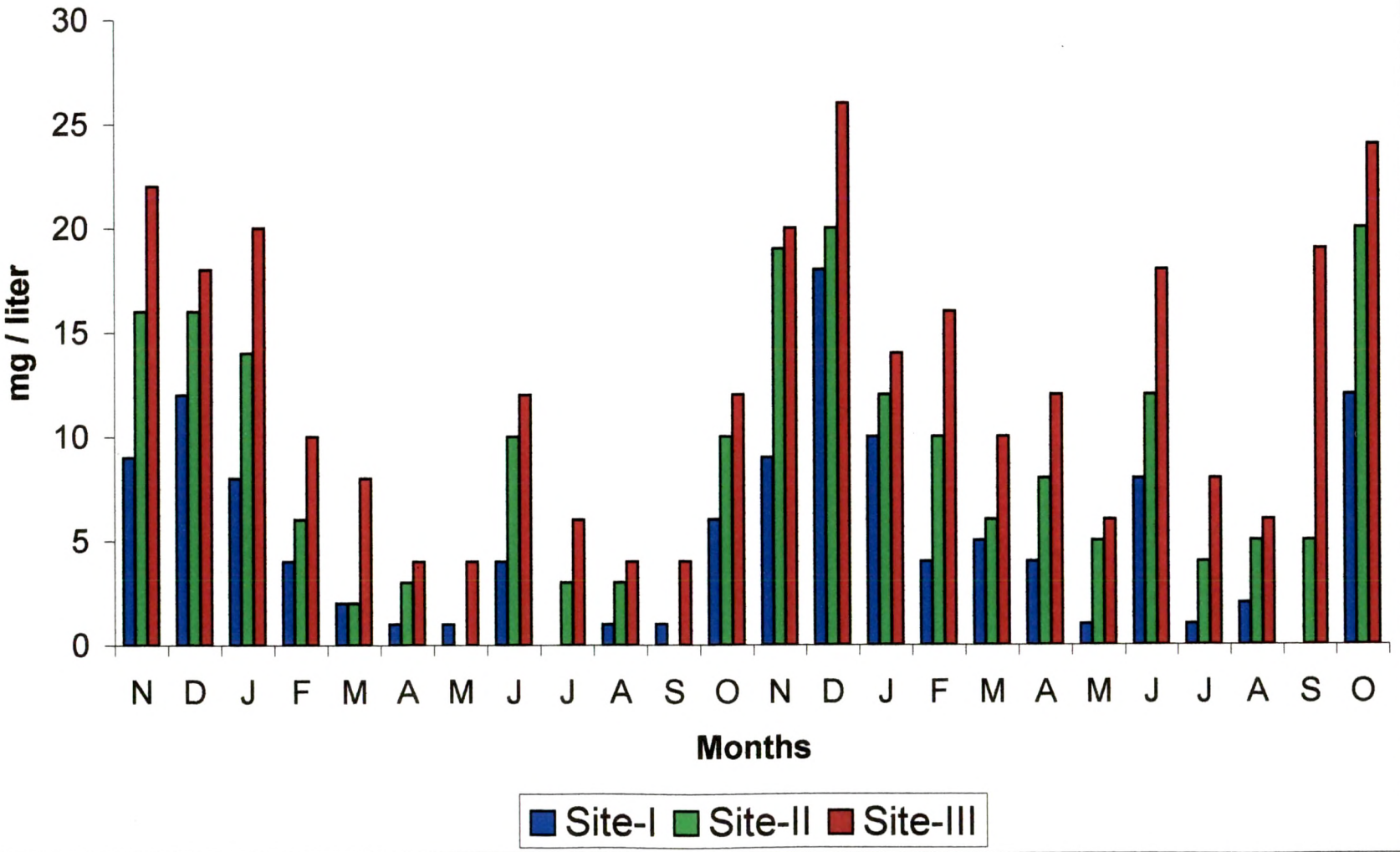
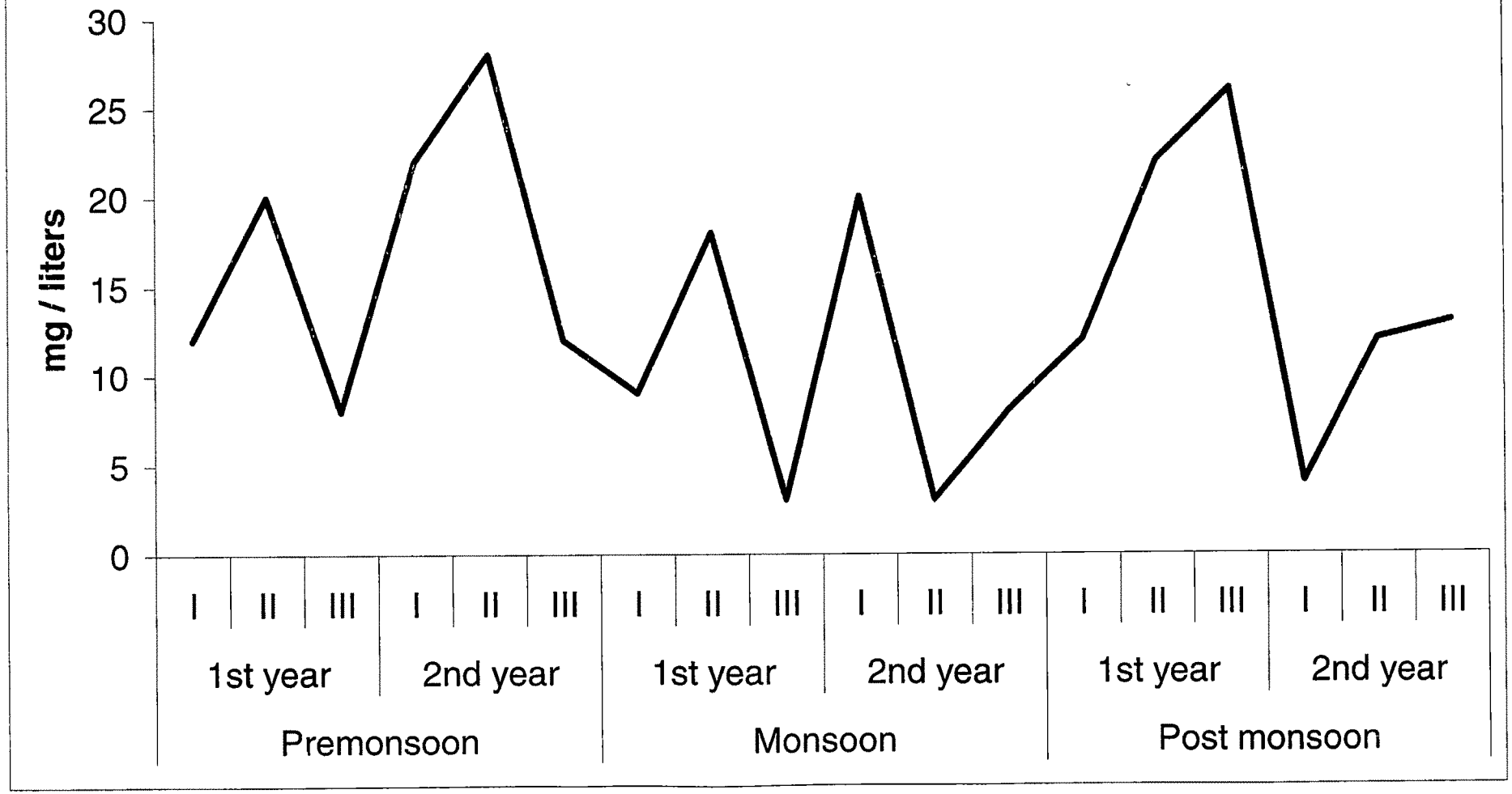


Fig. 4.9 showing seasonal variation in the Carbonates in water



At site II during 1st year sample analysis shows absence of carbonates in May and September and high value was detected in November & December (16.0). While during second year the minimum value (4.0) in July and maximum value (20.0) was observed in December and October Slightly lower than high value i.e. 19.0 was observed in November.

At site III the trend of carbonate value observed for 2 years are given here. The first year shows minimum carbonates value of 4.0 in April and maximum value of 22 in November and during second year the minimum value of 6.0 was in May and August and Maximum value of 26 was recorded in December. While no carbonate contents were detected in July first year and September second year at site I, In May and September of first year at site II.

Carbonates value recorded seasonally for 2 years show the trend as minimum 3.0 mg/l at site III in monsoon of 1st year and also 3 at site II in monsoon of second year, while maximum of 28mg/l site II second year in pre monsoon and slightly low as 26 mg/l at site III in post monsoon of first year. Carbonate ranged between 8 to 22 mg/l at other places during different season.

Bicarbonates:

The bicarbonates at different sites for two year period show the following trends of minimum and maximum value at sites selected for study (Table 4.10).

The bicarbonate show minimum value of 11 in April during 1st year and maximum value of 89.0 was recorded in July, while second year minimum value at site I during second year show minimum value (14) in July of second year and maximum value (96) in March of second year was recorded (Fig 4.10).

At site II the value of bicarbonate was recorded minimum i.e. 22 in April first year and maximum value of 114 in March during first year. Like wise the second year the minimum value of 30 was recorded in July and maximum value was recorded as 118 mg/l.

At site III the bicarbonate value during first year sampling show minimum value 44 in April while maximum value 129 in February first year and like wise minimum 56 in July and maximum 140 in June during second year of study period.

Seasonal Analysis of bicarbonate at the selected sites during three season monitoring regularly show minimum bicarbonate

Table - 4 10 · Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data

Monthly data :

Bi-carbonates			
Months	**Site-I**	**Site-II**	**Site-III**
N	21	42	58
D	24	38	50
J	33	57	68
F	64	112	129
M	48	86	104
A	11	22	44
M	28	56	62
J	60	110	120
J	89	104	118
A	67	96	102
S	30	52	76
O	46	92	112
N	69	94	102
D	60	77	92
J	42	77	88
F	38	79	90
M	96	114	126
A	37	74	100
M	40	72	82
J	75	118	140
J	14	30	56
A	16	38	85
S	32	86	106
O	19	48	68

Seasonal data:

Season	Years	Sites	HCO3
Premonsoon	1st year	I	42
		II	96
		III	120
	2nd year	I	28
		II	88
		III	76
Monsoon	1st year	I	100
		II	36
		III	112
	2nd year	I	34
		II	64
		III	129
Post monsoon	1st year	I	55
		II	28
		III	78
	2nd year	I	18
		II	48
		III	85

Fig. 4.10 showing monthly variation in the Bicarbonates in water

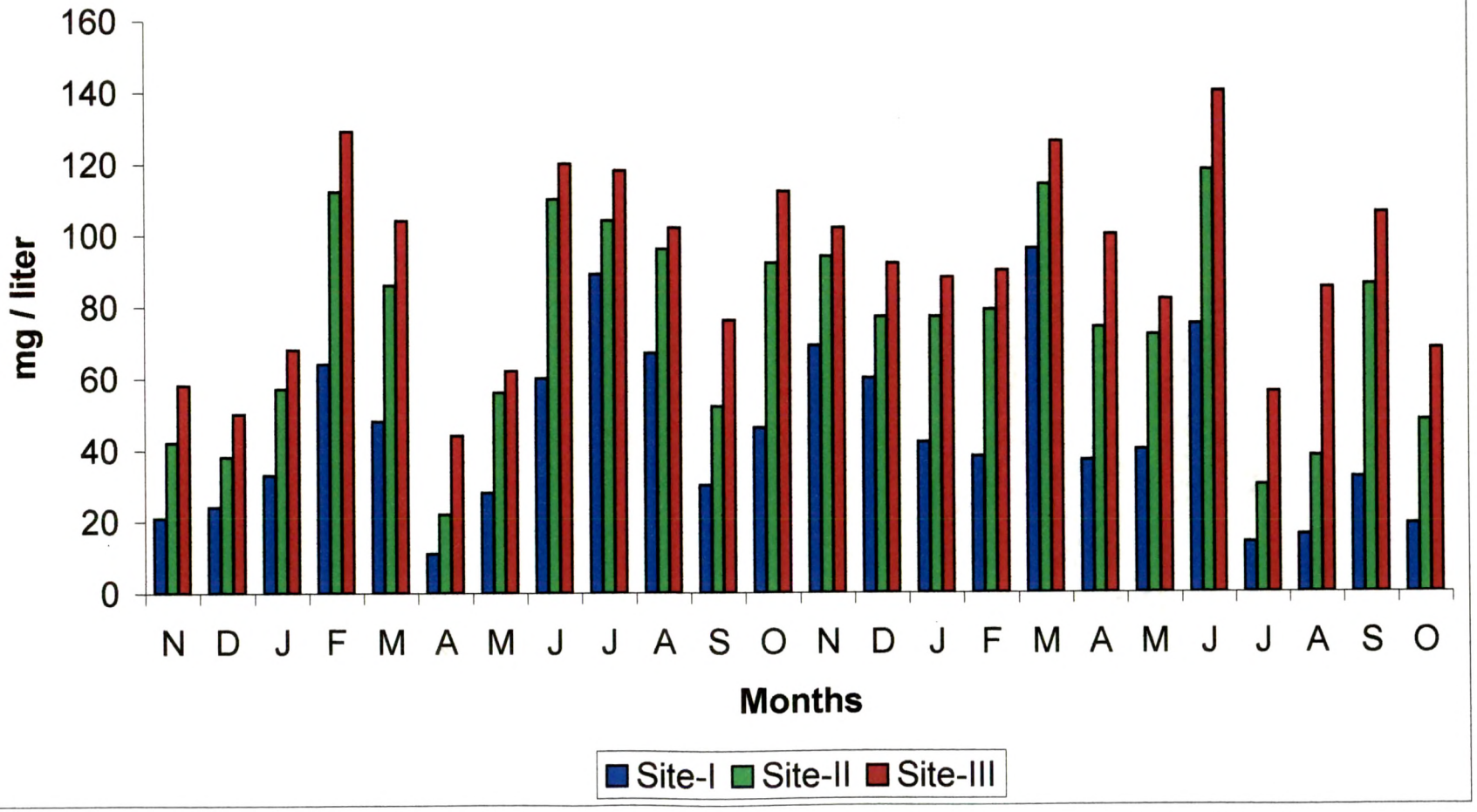
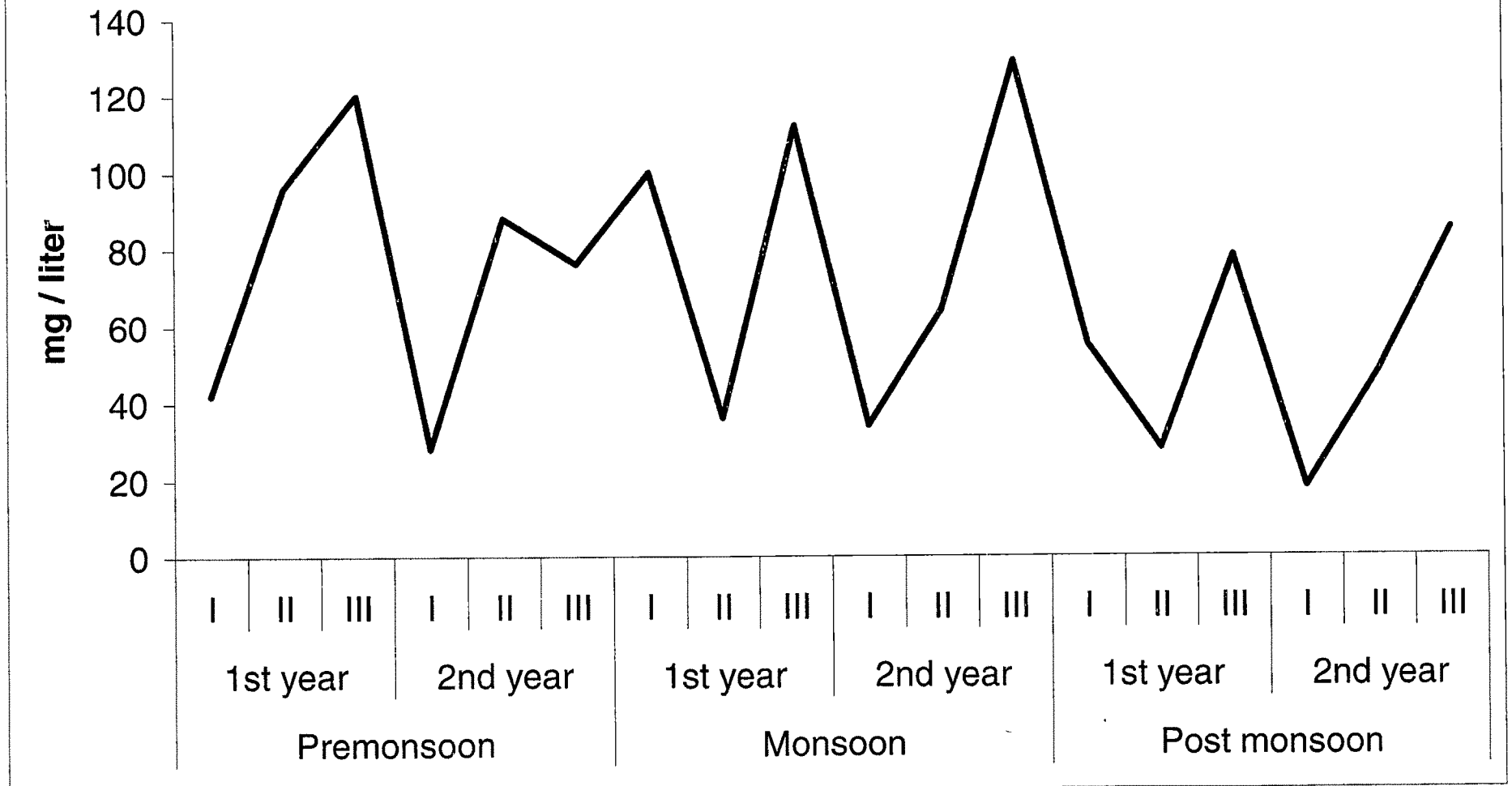


Fig. 4.10 showing seasonal variation in the Bicarbonates in water



content in river water as 18 mg/l at site I during second year in post monsoon and maximum value of 129 mg/l at site III during monsoon in second year.

Chemical Oxygen Demand:

The Chemical Oxygen Demand (COD) value in sample collected during sampling period and analysis show the various trend (Table 4.11 and Fig.4.11). The values of COD at site I in first year the low value of 12 in March and high value of 102 in November recorded. For second year COD lowest value was 14 mg/l in May and highest value was 150 mg/l in October. At site II the value of COD during first year was 17 in June and high value of 150 in January and a bit low of 149 in October were recorded. During second year low COD value (16) in May and high (155) in October was recorded. At site III in the first year COD value was 28 in September and high of 172 in January and little low as 170 in October and next year the lowest (28) and highest 173 were recorded in October.

Over all the COD value ranged from 12 to 173 at site I, II and III during the study period.

Seasonal Value of Chemical Oxygen demand for two years record show minimum COD value (16) at site II during second

Table - 4.11 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data of Chemical Oxygen Demand in water

Monthly data :

Chemical Oxygen Demand			
Months	**Site-I**	**Site-II**	**Site-III**
N	102	142	156
D	66	68	95
J	100	150	172
F	32	55	62
M	12	28	48
A	55	92	102
M	24	38	55
J	16	17	32
J	44	66	108
A	102	130	155
S	19	26	28
O	98	149	170
N	118	136	140
D	114	129	138
J	90	100	112
F	104	149	162
M	65	98	140
A	34	42	66
M	14	16	28
J	39	61	70
J	102	122	142
A	40	46	60
S	29	48	69
O	150	155	173

Seasonal data:

Season	Years	Sites	COD
Premonsoon	1st year	I	176
		II	112
		III	142
	2nd year	I	190
		II	84
		III	156
Monsoon	1st year	I	22
		II	76
		III	80
	2nd year	I	34
		II	164
		III	72
Post monsoon	1st year	I	24
		II	28
		III	33
	2nd year	I	30
		II	16
		III	28

Fig. 4.11 showing monthly variation in the Chemical Oxygen Demand of water

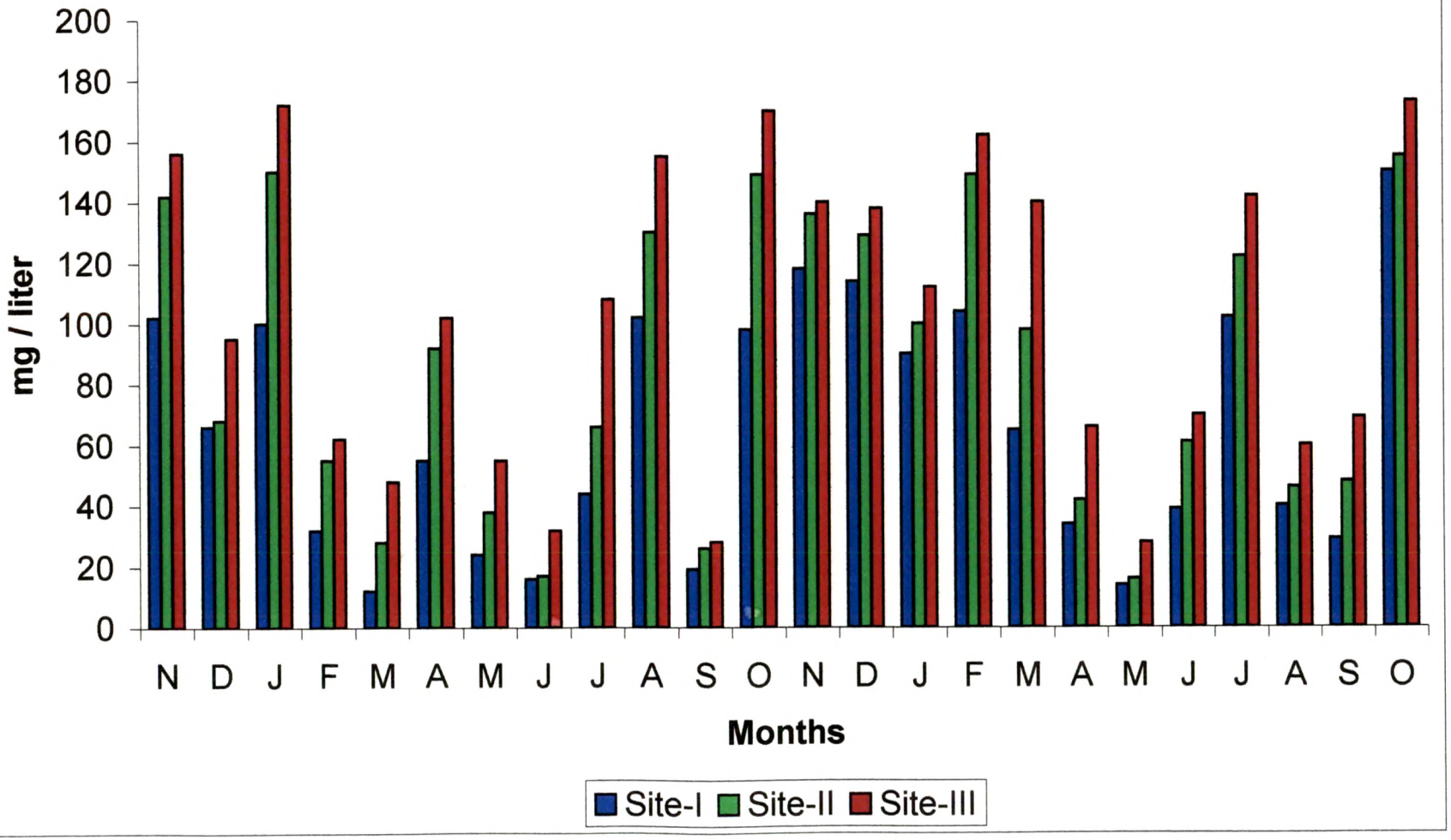
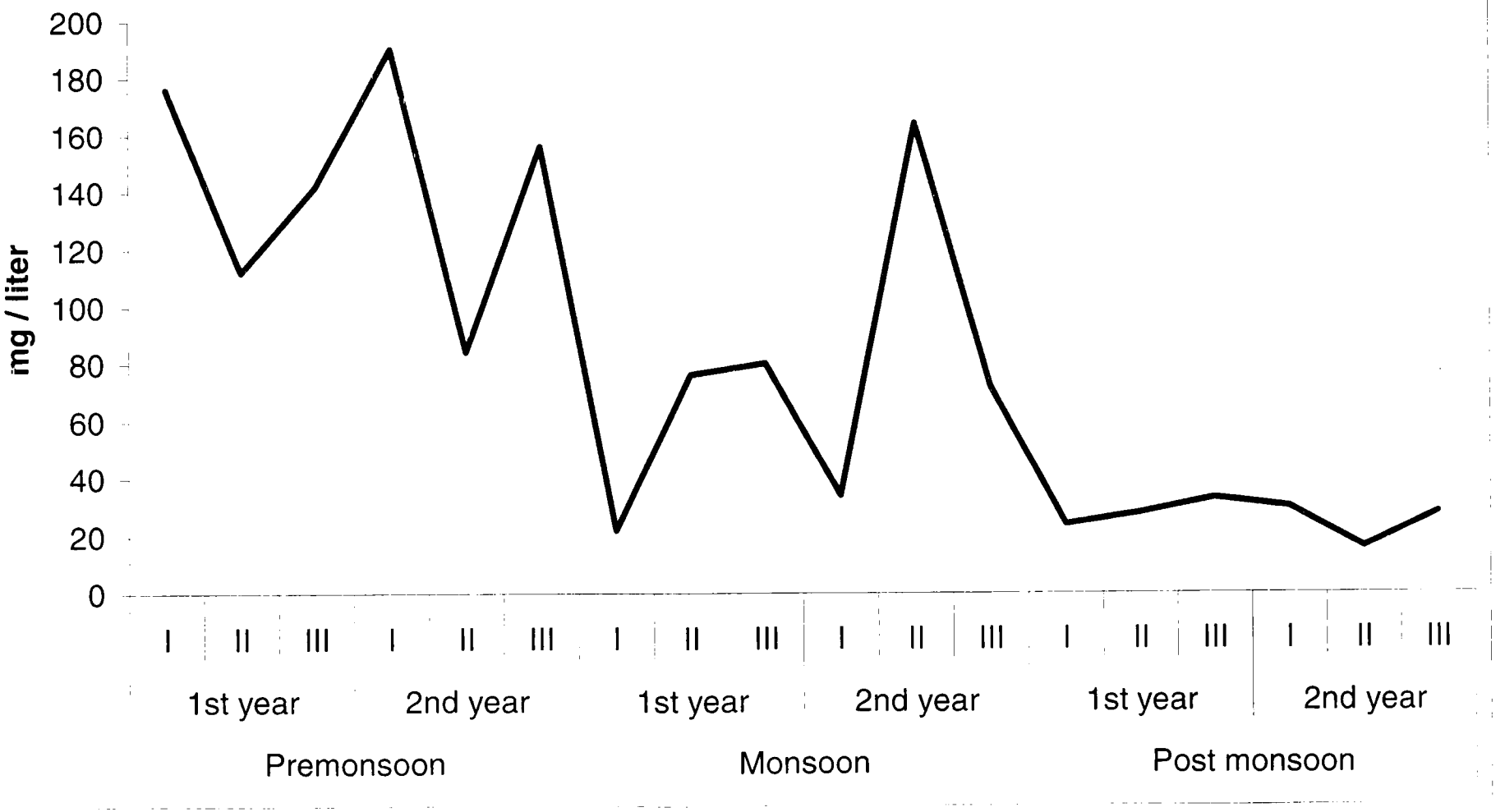


Fig. 4.11 showing seasonal variation in the Chemical Oxygen Demand of water



year in post monsoon and maximum (190) at site I during second year in pre monsoon.

Total Hardness:

Total Hardness is due to Ca++ and Mg++ ions in water. The total hardness during sampling analysis shows the minimum and maximum values of the ions (Table 4.12). At site I during first year the total hardness of water show minimum value of 120 in August and maximum value of 680 in May. Next year minimum value of total hardness was 185 in September and maximum value 750 in October was recorded (Fig 4.12).

At site II the total hardness value for two year sampling showed the trend as low value (96) in July while high value (712) was observed in March. Second year the low value of (185) in September and high value (750) was recorded in October. At site III the total hardness low value of 139 in July and high value of 770 in October was recorded. Next year at site III the low value of total hardness was 210 in July and high value was 850 mg/l recorded in March and October.

The two year sample shows that the total hardness value ranges between 96 in July at site II first year to 850 site III in March and October second year.

Table - 4 12 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data Hardness of water

Monthly data :

Total Hardness			
Months	**Site-I**	**Site-II**	**Site-III**
N	520	351	475
D	582	602	658
J	550	550	585
F	628	695	725
M	656	712	748
A	410	552	424
M	680	404	538
J	416	240	340
J	130	96	139
A	120	128	216
S	199	299	376
O	695	670	770
N	640	610	645
D	528	499	620
J	530	525	556
F	350	326	475
M	645	746	850
A	520	600	668
M	472	582	612
J	416	348	420
J	200	192	210
A	295	339	485
S	185	185	225
O	750	750	850

Seasonal data:

Season	Years	Sites	Total Hardness	Ca++ Hardness	Mg++ Hardness
Premonsoon	1st year	I	406	160	246
		II	580	228	352
		III	252	112	140
	2nd year	I	368	172	196
		II	358	148	210
		III	194	82	112
Monsoon	1st year	I	352	144	208
		II	376	160	216
		III	112	72	40
	2nd year	I	476	196	280
		II	430	210	220
		III	230	112	118
Post monsoon	1st year	I	460	166	294
		II	420	160	260
		III	140	72	68
	2nd year	I	288	168	120
		II	235	102	133
		III	230	148	82

Fig. 4.12 showing monthly variation in the Total Hardness of water

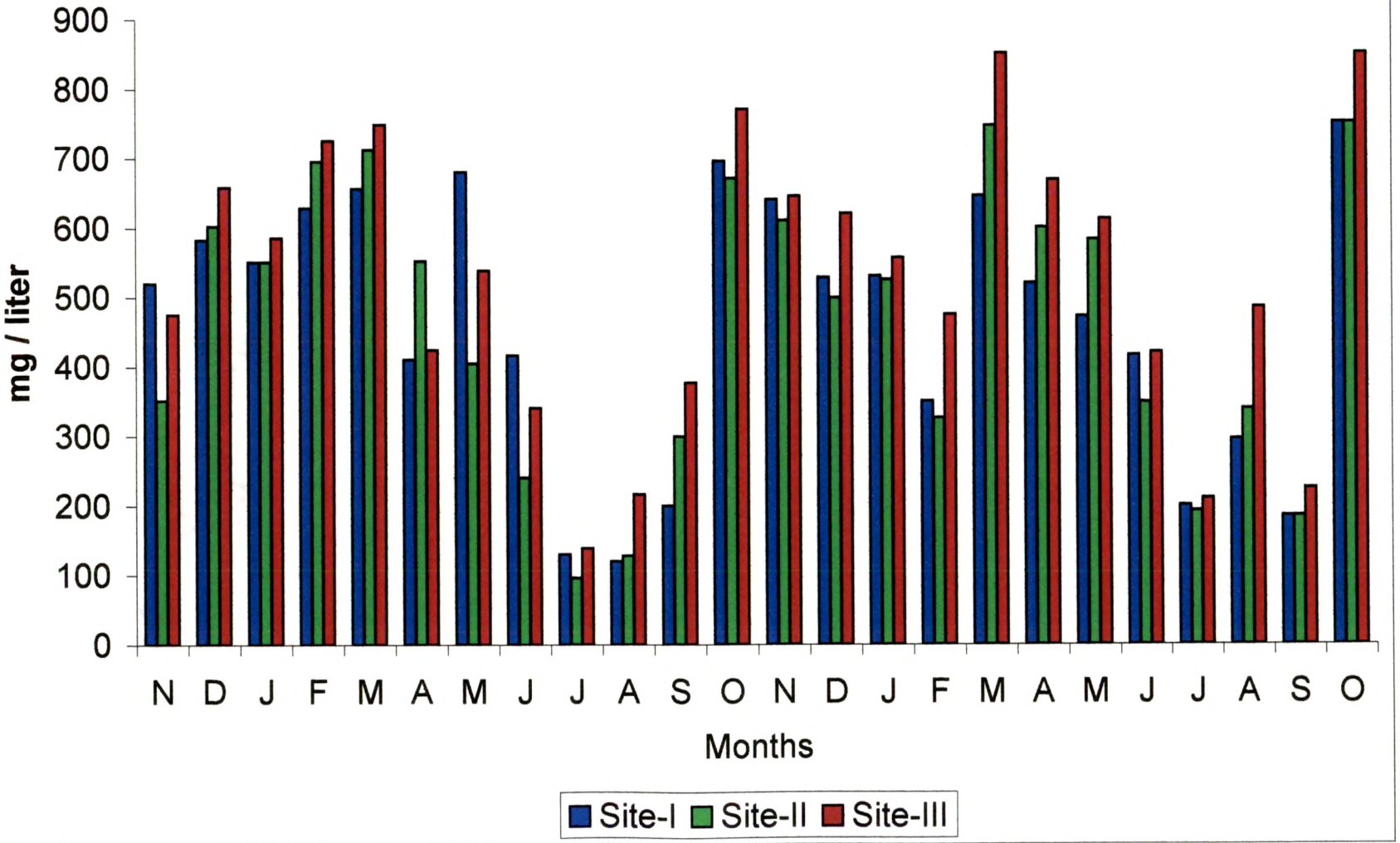
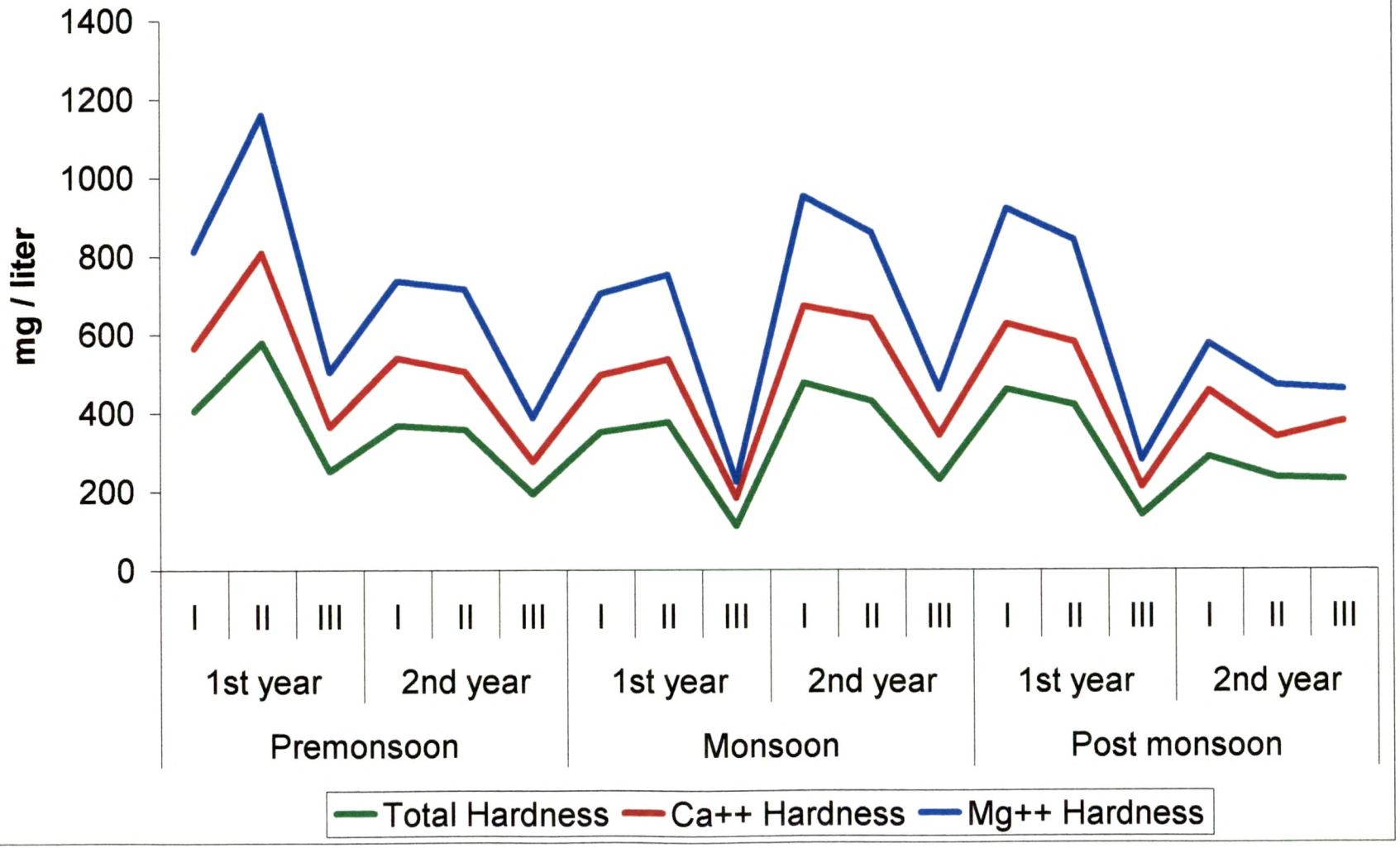


Fig. 4.12 showing seasonal variation in the Hardness of water



Total hardness recorded seasonally shows the minimum value (112) at site III during monsoon in first year and maximum was recorded (580) at site II during first year in premonsoon period Total hardness otherwise ranged between 140 mg/l to 476 mg/l during two years of sampling.

Ca++ Hardness:

In Calcium hardness (Table 4.12 and Fig. 4.12) minimum value (72) was recorded at site III monsoon and site III post monsoon first year while maximum (228) at site II pre monsoon first year.

Mg++ Hardness:

The low value of magnesium hardness (Table 4.12 and Fig. 4.12) was recorded during first year in monsoon at site III while maximum value of Mg++ hardness (352) was recorded at site II in premonsoon during first year. While otherwise it ranged between 82 to 210 mg/l.

Total Solids:

During sampling period at three sites the total solids value variation was observed. At site I the first year total solid value minimum of 630 in April and maximum of 1600 in August was recorded and second year minimum value of 610 in March and

maximum values of 2540 in July were recorded. At site II for the two years data minimum value of 665 in April and maximum of 2800 in January of first year and minimum of 740 in January and maximum of 3010 in July second year were recorded. At site III values for two years the low value of total solids 1205 mg/l in August and maximum value of 2680 mg/l in June of first year, while minimum value as 895 in January and maximum of 2450 in October was recorded during second year (Table 4.13 and Fig. 4.13).

The total solids value (Fig. 4.13) ranged in two years at three sites show minimum of 630 in April site 1 first year and maximum 3010 at site II in July second year.

The two years regular sample collection and analysis during different seasons and different site the value of total solid was 268mg/l at site III during first year in monsoon was recorded, while maximum value 1572 was recorded at site II in first year during pre monsoon. Otherwise it range between 297 and 1512 during other months of different season.

Total solid are the sum total of suspended solid (Fig. 4.13) and total dissolved solids (Fig. 4.13). For the suspended solids minimum value of 12 at site II during monsoon first year and

Table - 4.13 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data of TS of water

Monthly data :

Total Solids			
Months	**Site-I**	**Site-II**	**Site-III**
N	975	1470	1550
D	1200	1875	1366
J	1090	2800	1895
F	748	1600	1852
M	1215	2310	2025
A	630	665	974
M	960	1450	1680
J	1280	1865	2680
J	1485	1880	1925
A	1600	1790	1205
S	1224	1712	1884
O	1015	1189	1396
N	1120	1990	1264
D	1705	1854	1425
J	880	740	895
F	908	1250	1264
M	610	1785	1030
A	1015	1508	664
M	1118	1310	1395
J	1766	1995	2205
J	2540	3010	2010
A	1340	1756	1264
S	1680	2082	2160
O	1925	2325	2450

Seasonal data:

Season	Years	Sites	SS	TDS	TotalSolid
Premonsoon	1st year	I	184	1048	1232
		II	40	1532	1572
		III	1008	376	1384
	2nd year	I	220	670	890
		II	330	1180	1510
		III	380	990	1370
Monsoon	1st year	I	58	1228	1286
		II	12	1304	1316
		III	68	200	268
	2nd year	I	66	680	746
		II	176	844	1020
		III	85	375	460
Post monsoon	1st year	I	40	620	660
		II	226	1286	1512
		III	34	263	297
	2nd year	I	92	712	804
		II	144	1208	1352
		III	102	718	820

Fig. 4.13 showing monthly variation in the Total Solids in water

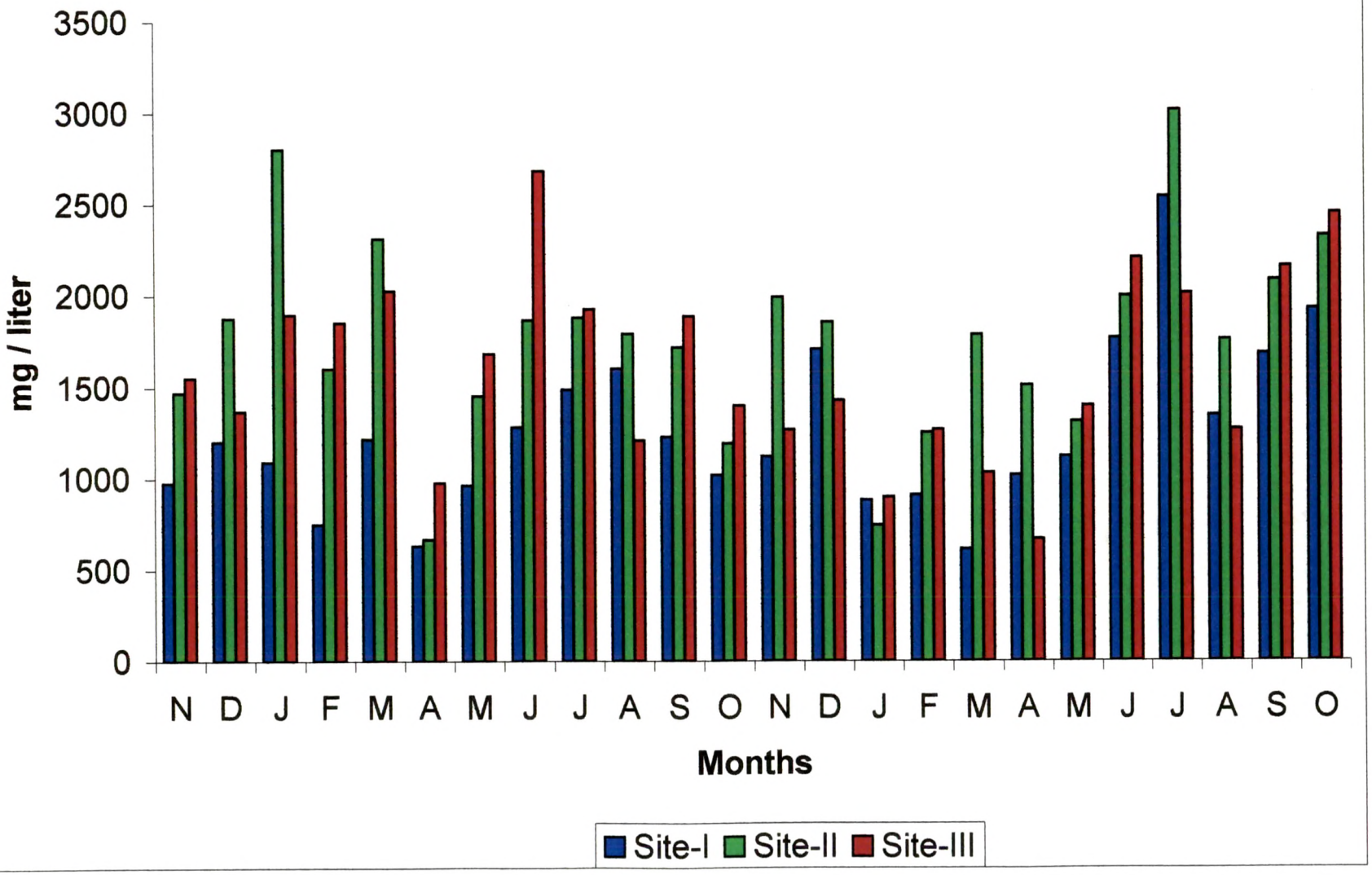
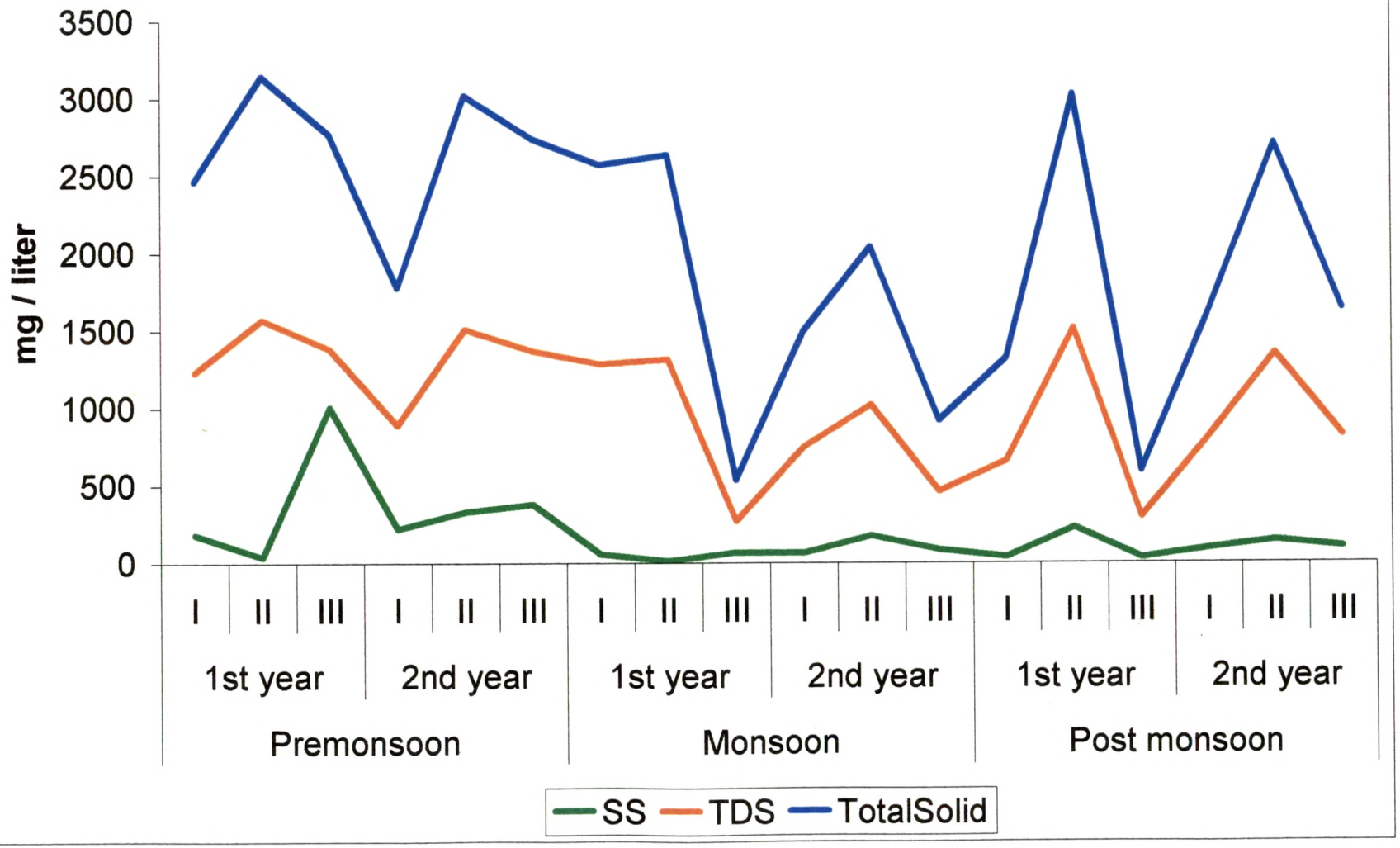


Fig. 4.13 showing seasonal variation in the Solids in water



maximum value of 1008 at site III during first year Pre monsoon and maximum of 380 at site III during 2nd year monsoon period. Likewise total dissolved solids had low value of 200 at site I during monsoon of first year and maximum value of Total solids recorded was 1532 at site II in pre monsoon during first year.

Cobalt:

Cobalt content (Table 4.14) in water sample was mostly absent or non traceable for most of the months, but the traced amount of cobalt in two year sample show minimum value of 0.01 to maximum of 0.02 at site I and of 0.01 to 0.06 at site II and of 0.01 to 0.10 at site III.

Copper:

Metallic content of copper (Table 4.15) in water sample during the sampling period shows different results at the various sites. At site I the value of copper was 0.01 in March first year and December second year. Other wise it was non traceable in other month. At site II copper was non traceable except 0.01 in February and October and 0.03 in March. Similarly next year 0.01 in January, February and September and 0.03 in December was recorded. At site III the values of copper shows minimum of 0.01 in April and September, and maximum of 0.04

Table - 4.15 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data of Copper in water

Monthly data :

Copper			
Months	**Site-I**	**Site-II**	**Site-III**
N	NT	NT	NT
D	NT	NT	NT
J	NT	NT	NT
F	NT	0.01	0.02
M	0.01	0.03	0.04
A	NT	NT	0.01
M	NT	NT	NT
J	NT	NT	NT
J	NT	NT	NT
A	NT	NT	NT
S	NT	NT	0.01
O	NT	0.01	0 02
N	NT	NT	NT
D	0.01	0.03	0.06
J	0.01	0.01	0.02
F	NT	0.01	0.02
M	NT	NT	NT
A	NT	NT	NT
M	NT	NT	0.01
J	NT	NT	NT
J	NT	NT	NT
A	NT	NT	NT
S	NT	0.01	0 02
O	NT	NT	NT

Seasonal data:

Season	Years	Sites	Cu++
Premonsoon	1st year	I	NT
		II	NT
		III	NT
	2nd year	I	0.2
		II	0 08
		III	0 01
Monsoon	1st year	I	NT
		II	0.14
		III	0 02
	2nd year	I	0 02
		II	0.1
		III	0.14
Post monsoon	1st year	I	Trace
		II	NT
		III	NT
	2nd year	I	NT
		II	0 2
		III	0 09

in March first year. In second year the copper value of 0.01 in May and 0.06 in December was recorded otherwise for many months it was non traceable in the water sample.

Copper in water sample for three season at three site mostly was not traced while traced value ranged between lowest of 0.01 to highest of 0.20 during different season and different locations.

Iron:

Iron content in sample was not traceable in any month at site I during the sampling period. At site II during first year it show value low of 0.02 in November while high of 0.4 in June was recorded and during second year (0.02) in June and (0.12) in March and October. At site III lowest value was 0.01 in August, while highest was 0.48 in June. In second year low (0.02) in August and high (0.24) in November was recorded. It was non traceable for 5 month during the period (Table 4.16).

Iron content recorded varies between minimum 0.02 to maximum 0.28 during different seasons.

Table - 4 16 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data of Iron in water

Monthly data :

Iron			
Months	**Site-I**	**Site-II**	**Site-III**
N	0.09	0 02	NT
D	0.02	NT	NT
J	NT	NT	NT
F	0 12	0.29	NT
M	0 28	0.22	NT
A	0.14	0 1	NT
M	NT	NT	NT
J	0.48	0 4	NT
J	0.03	0.2	NT
A	0.01	NT	NT
S	10	NT	NT
O	0 26	0 21	NT
N	0 24	0.06	NT
D	0 15	NT	NT
J	0 1	NT	NT
F	NT	0.09	NT
M	NT	0 12	NT
A	0 21	0 09	NT
M	0.16	NT	NT
J	0 04	0.02	NT
J	0 04	NT	NT
A	0 02	NT	NT
S	NT	NT	NT
O	0 18	0 12	NT

Seasonal data:

Season	Years	Sites	Iron
Premonsoon	1st year	I	0 28
		II	0.09
		III	0 36
	2nd year	I	0 02
		II	0 04
		III	0 02
Monsoon	1st year	I	0 23
		II	0 18
		III	0.18
	2nd year	I	0 1
		II	0 09
		III	NT
Post monsoon	1st year	I	NT
		II	NT
		III	NT
	2nd year	I	0 18
		II	0 08
		III	0 22

Zinc:

Zinc content in water sample was observed and was mostly found absent in all samples except for few months during the sampling period.

The Zinc was minimum (0.01) in January and maximum (0.14) in March at site I during first year. It was absent in June, July both years and October first year and January, February, second year. At site II minimum value of Zinc in first year was 0.02 in July and maximum value of zinc was 0.22 in December. Zinc was absent in the sample in June and October 1st year. At site III Zinc was absent in June and October 1st year and otherwise show low content (0.06) in July and high (0.27) in March and (0.25) in September. While during second year low value of 0.04 in January and high value of 0.32 in April was traced while Zinc was not traced in June sample.

Zinc content seasonally in water ranged between minimum of 0.02 to maximum of 0.35. For many months it was not traceable even (Table 4.17).

Table - 4.17 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and seasonal data of Zinc in water

Monthly data :

Zinc			
Months	**Site-I**	**Site-II**	**Site-III**
N	0.04	0.13	0.17
D	0.06	0.22	0.3
J	0.01	0.05	0.07
F	0 08	0.16	0.19
M	0.14	0.21	0.27
A	0.06	0.16	0.18
M	0 04	0.08	0.12
J	NT	NT	NT
J	NT	0.02	0.06
A	0 02	0.07	0.1
S	0.11	0.18	0 25
O	NT	NT	NT
N	0.04	0.09	0.14
D	0.12	0.2	0.22
J	NT	0.02	0.04
F	NT	0 04	0.1
M	0.12	0.2	0.25
A	0.16	0.28	0.32
M	0.06	0 12	0.26
J	NT	0 07	NT
J	NT	0.03	0.08
A	0.06	0 12	0.16
S	0 03	0.1	0.18
O	0.02	-4.59	0.1

Seasonal data:

Season	Years	Sites	Zinc
Premonsoon	1st year	I	0.07
		II	0.3
		III	0.02
	2nd year	I	0.02
		II	0.1
		III	0.02
Monsoon	1st year	I	0.09
		II	0 14
		III	NT
	2nd year	I	NT
		II	0.04
		III	0.03
Post monsoon	1st year	I	NT
		II	0.2
		III	NT
	2nd year	I	0.1
		II	0 35
		III	0.15

Electrical Conductivity:

Electrical conductivity (EC) parameter of water was analyzed seasonally (Table 4.18). Electrical conductivity of water of river Narmada during the sampling period for two years shows remarkable variation during different season at different site. The lowest value of the electrical conductivity recorded during study period was 302 at site III during first year in monsoon, while highest value of electrical conductivity was recorded 2500 at site II first year during pre monsoon. Electrical conductivity during these two year ranged between 322 to 1970 (Fig.4.14).Post monsoon values of electrical conductivity for two years at different sites usually shows comparatively low as compared to pre monsoon and monsoon period.

not tally with figure

Turbidity:

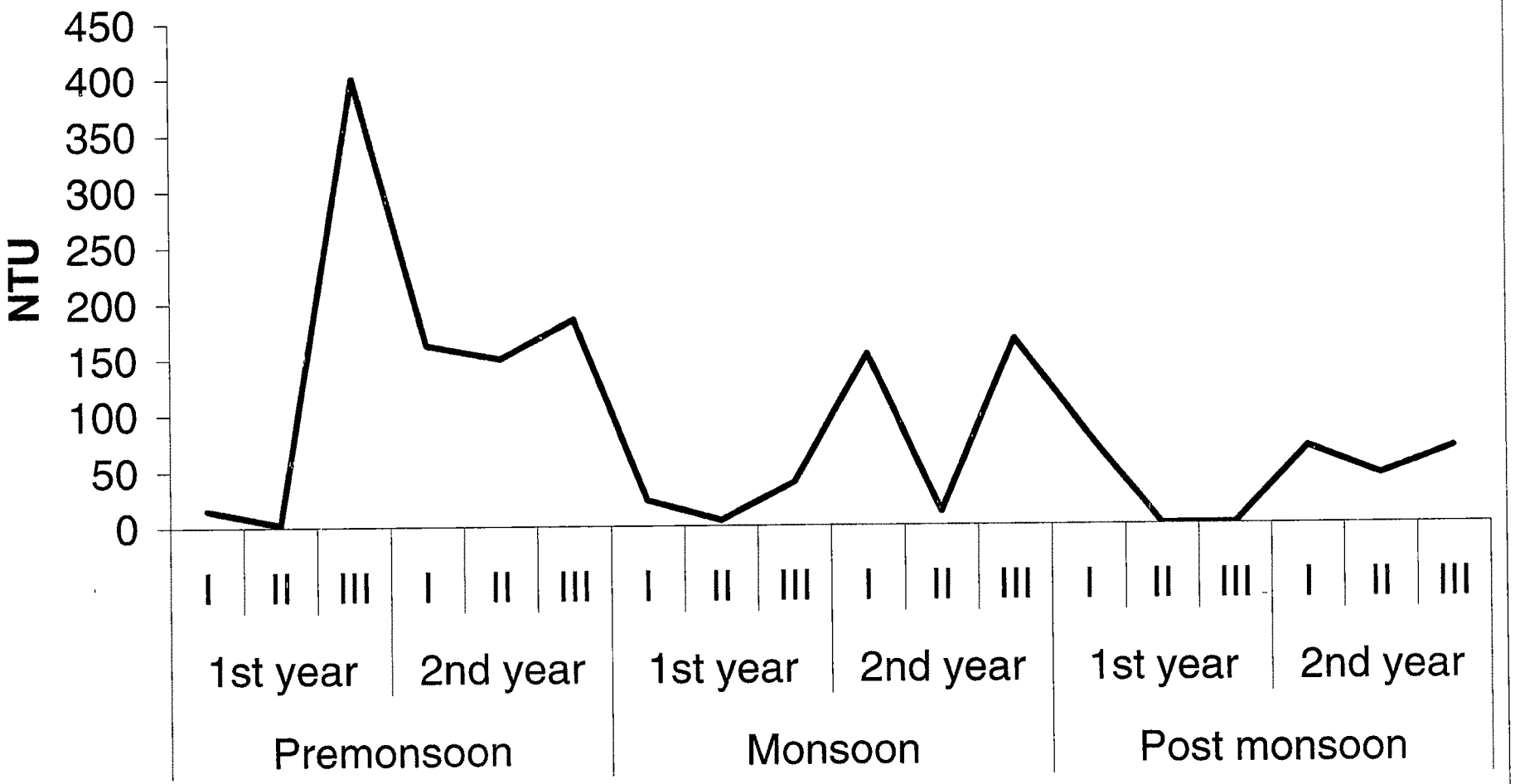
The turbidity (Table 4.19 and Fig. 4.15) of river water was monitored regularly for two years. The value observed during the sampling period was found to be the lowest of 0.18 at site II during first year in post monsoon period and highest of 400 at site III same year in pre monsoon period. Otherwise turbidity was found to be on higher side during monsoon period as compared to pre monsoon and post monsoon period. The

Table - 4.18 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data

Seasonal data:

Season	Years	Sites	Electrical Conductivity
Premonsoon	1st year	I	1861
		II	2500
		III	465
	2nd year	I	1060
		II	1820
		III	660
Monsoon	1st year	I	1832
		II	1945
		III	302
	2nd year	I	1400
		II	1454
		III	650
Post monsoon	1st year	I	1257
		II	1970
		III	322
	2nd year	I	500
		II	1270
		III	780

Fig. 4.15 showing seasonal variation in the Turbidity in water



turbidity value of river water fluctuated between 0.30 to 185 NTU.

Total Alkalinity:

Total alkalinity parameter (Table 4.20 and Fig. 4.16) on the three sites during sampling period was recorded regularly. The total alkalinity show the minimum value of 70mg/l at site I during second year in post monsoon and maximum value of 520 was recorded at site I during first year post monsoon. Pre monsoon period otherwise show higher value of total alkalinity as recorded during analysis of the water sampling during different seasons.

Silicates:

Silicate contents of the river water showed minimum value of 2.0 at site II during 1st year pre monsoon and maximum of 34.0 at site I of first year during pre monsoon. During post monsoon slightly lower than the highest value of 32.0 recorded at site III in first year

Biotic Parameters:

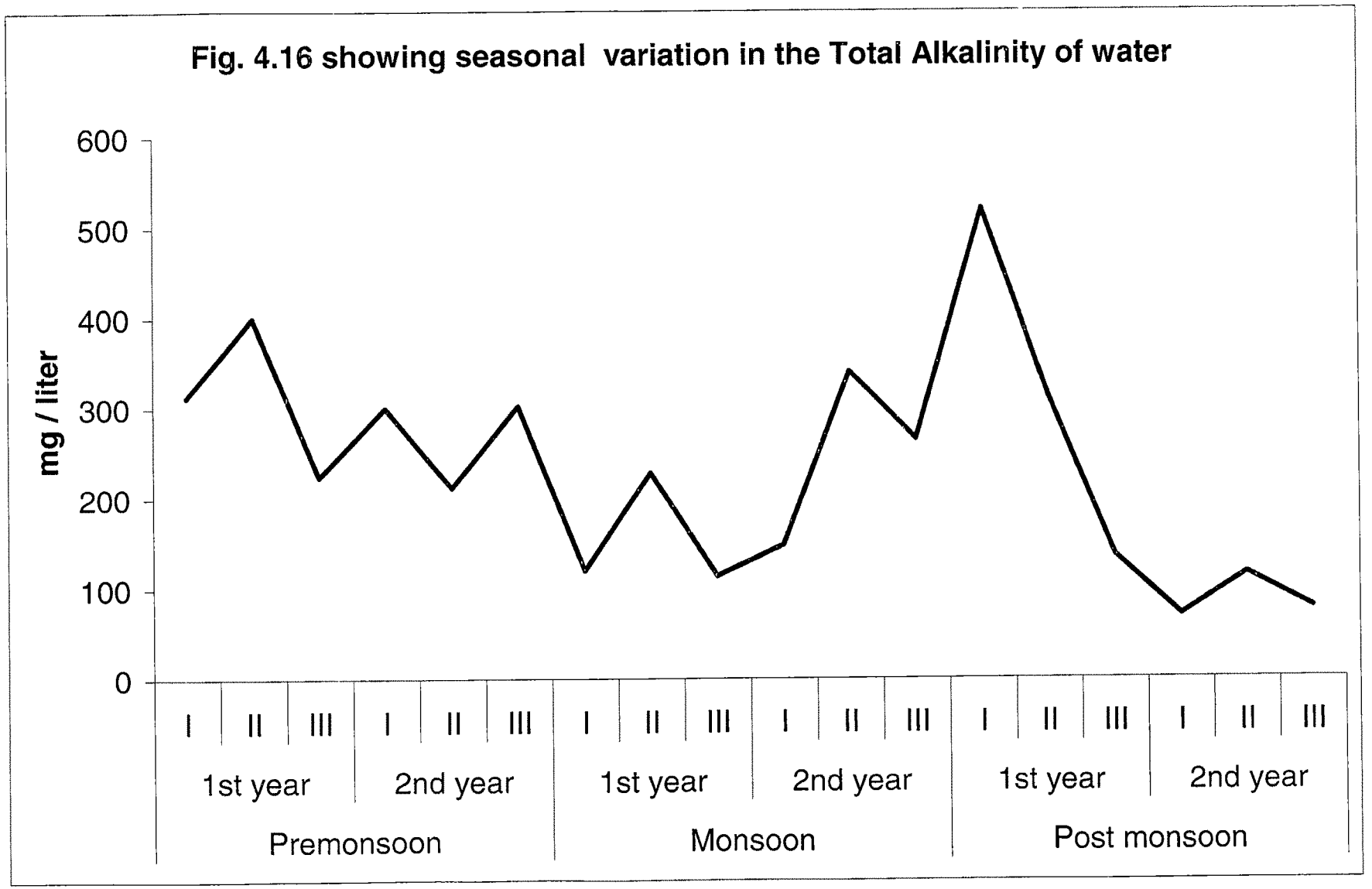
An ecosystem is a dynamic relationship between abiotic and biotic parameters. Every parameter has its dependence on each

Table - 4.20 : Quantative analysis of Physico - Chemical parameter of water quality, Monthly and Seasonal data : Total Alkalinity

Monthly data :

Season	Years	Sites	Total Alkalinity
Premonsoon	1st year	I	312
		II	400
		III	224
	2nd year	I	300
		II	212
		III	302
Monsoon	1st year	I	120
		II	228
		III	114
	2nd year	I	148
		II	340
		III	265
Post monsoon	1st year	I	520
		II	312
		III	136
	2nd year	I	70
		II	116
		III	78

Fig. 4.16 showing seasonal variation in the Total Alkalinity of water



other. Abiotic factors largely control the biotic environment of any ecosystem. Here in this riverine ecological work along with abiotic factor, i.e. the water. biotic factor in the form of biodiversity analysis is carried out. The biotic component is elaborately analyzed for phytoplankton, aquatic flora, zooplankton and other fauna. The River Narmada is known for its fisheries aspects; hence the same is analyzed thoroughly.

Floral Component:

Aquatic flora analyzed here in two respects i.e. the phytoplankton and the aquatic vegetation or aquatic weeds. Phytoplankton were represented by four groups, viz. Bacilariophyceae, Chlorophyceae, Cyanophyceae, and Euglenophyceae. Diversity study reveals common planktonic forms present at different sites of sampling (Table 4.21). Annual average percentage composition of various groups of phytoplankton at different sites was studied (Fig. 4.17). At site I, Bacilariophyceae and Euglenophyceae were dominant with 35% contribution of each group. Chlorophyceae and Euglenophyceae with 30% share of each was observed at site II, where Bacilariophyceae contributed 25%. Planktonic forms representing Chlorophyceae and Cyanophyceae were about

Table 4.21: Types of phytoplankton recorded from various sites.

Type of phytoplankton	Genera recorded
Bacilariophyceae (Diatoms)	Asterionella Cocconeis Cosinodiscus Cymbella Fragilaria Navicula Melosira Pinnularia Rizosolenia Synedra
Chlorophyceae (Green algae)	Chlorella Eudorina Pediastrum Pandorina Spirogyra
Cyanophyceae (Blue-green algae)	Anabaena Glaeotricnia Microsystis Oscillatoria Trycodesmium
Euglenophyceae	Euglena

Fig. 4.17 showing percent value of Phytoplankton at Site I

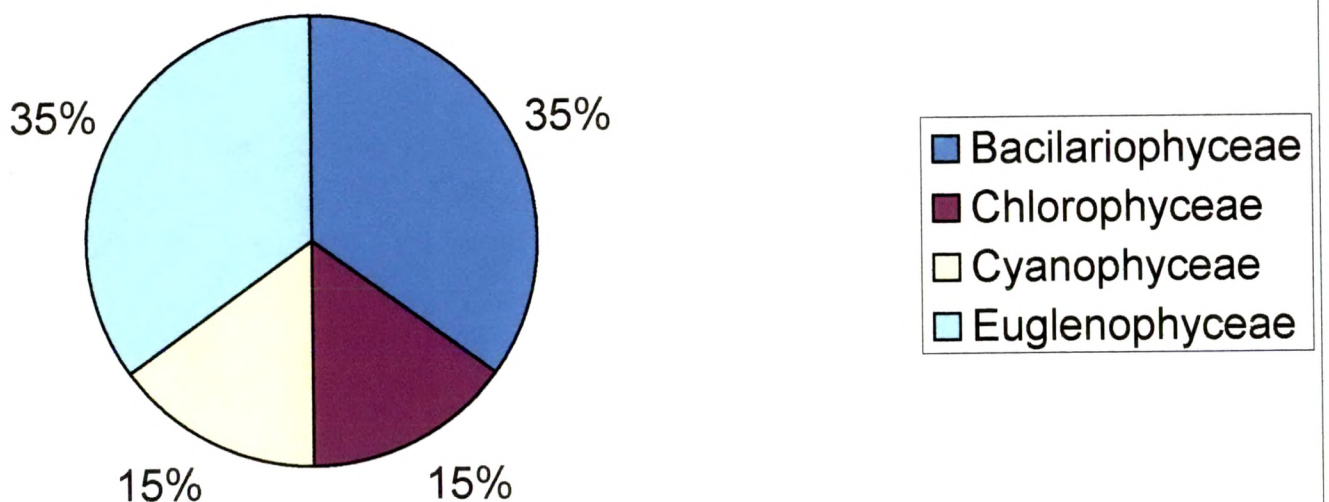


Fig. 4.17 showing percent value of Phytoplankton at Site II

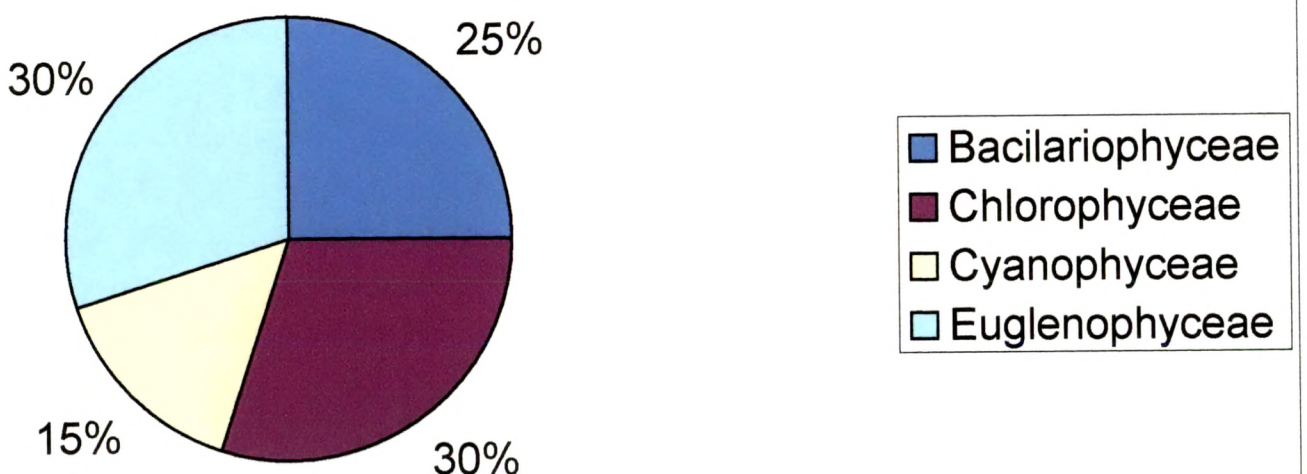
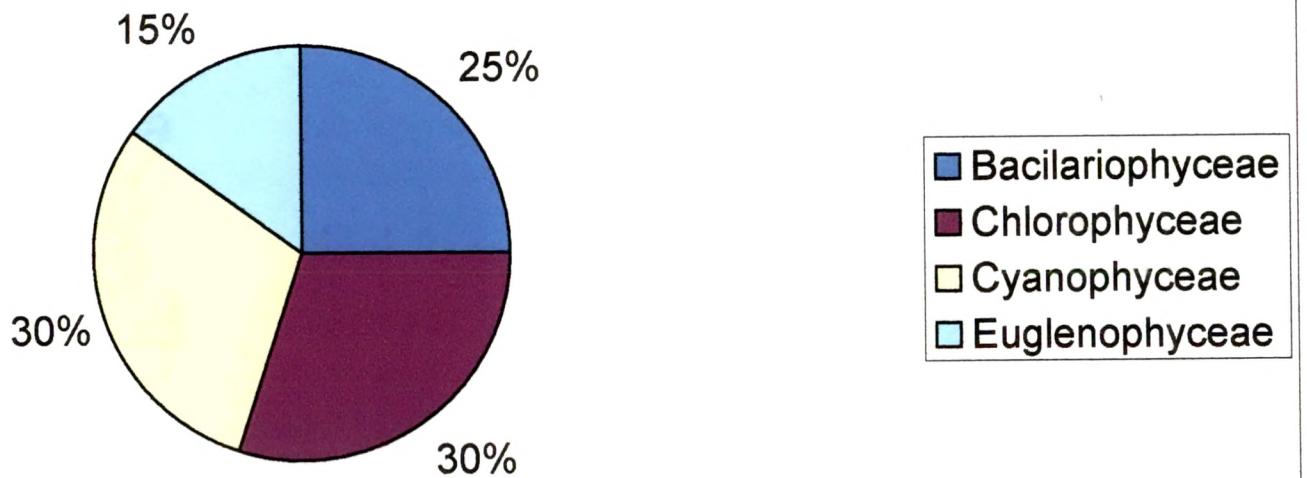


Fig. 4.17 showing percent value of Phytoplankton at Site III



30% each recorded from site III. At site III, second dominant group was Bacilariophyceae (25%).

Aquatic weeds of several varieties were found in the river water. Such weeds as per their location of occurrence and existence in the river water strata were listed in to different categories (Table 4.22). In general aquatic weeds (Plate 1) like Hydrilla, Valesneria, Chara, Nymphea, Pistia, Typha etc. were commonly found in the study area. During complete annual cycle their overall density was roughly recorded for various sites. It was observed that at site I marginal weeds and submerged weeds were lesser in density compared to other two sites. At site II most of all variety of weeds were present, however, submerged (Hydrilla, Valesnaria) and floating weed (Pistia and Nymphea) were of high amount. Site III, was represented by abundant algal matter but floating weeds were of very less amount.

Faunal Component:

Along with variety plant matter in an aquatic ecosystem, diversity of aquatic animals also is of great importance. This floral and faunal diversity together maintains the ecosystem in balance. The faunal component is represented by several different aquatic animals. Moreover riverine segment which was under study area has salinity influence also, hence stenohaline

Table 4.22: List of the commonly occurring Hydrophytes (Aquatic weeds)

A: Diversity general

1) Spirogyra
2) Nitella
3) Chara
4) Lemna
5) Pistia
6) Salvinia
7) Nymphaea
8) Myriophyllum
9) Typha
10) Vallisneria
11) Hydrilla
12) Utricularia
13) Ceratophyllum
14) Marsillia
15) Jussiaea

B: Zonal status – specific

Type of plants	Species recorded
Free floating plant	Eichornia crassipes Lemna paucicostata
Submerged plants	Ceratophyllum demersum Hydrilla verticillata Ottelia alismoides Potamogeton spp. Vallisneria spiralis
Rooted floating plants (leaved macrophytes)	Ipomoea aquatica Nelumba nucifera Nymphoides indicum Pistia spp.
Emergent plants	Polygonum glaqbrum Sagittaria sagittifolia Typha angustata

Plate - 1

and euryhaline type of animals were present. Zooplankton presence makes the main representation of fauna. However, other varieties of animals from invertibrata and chordata groups are of equal importance as diversity component. Ichthyofauna and other economically important animals represented here establishes link between ecological and economical exploration of the riverine ecosystem,

Zooplankton:

Quite a large variety of zooplanktons were found present in the study area (Table 4.23). These planktonic forms were represented mainly from major phyla like Protozoa and Arthropoda and minor phyla like Rotifera and were dominating the planktonic diversity. Few varieties of representing different groups of animals were denoted as miscellaneous group.

Annual average percentage of zooplankton from different sites revealed different forms in their density attributed to water quality. At site I, Protozoan and Arthropods were of nearly equal composition but Rotifers were comparatively more (Fig 4.18). Protozoans were more in percent composition at site II, whereas, other groups were arthropods and rotifers in decline manner. Site III is representing average percent composition of

Table 4.23: List of plankton recorded at the study Sites.

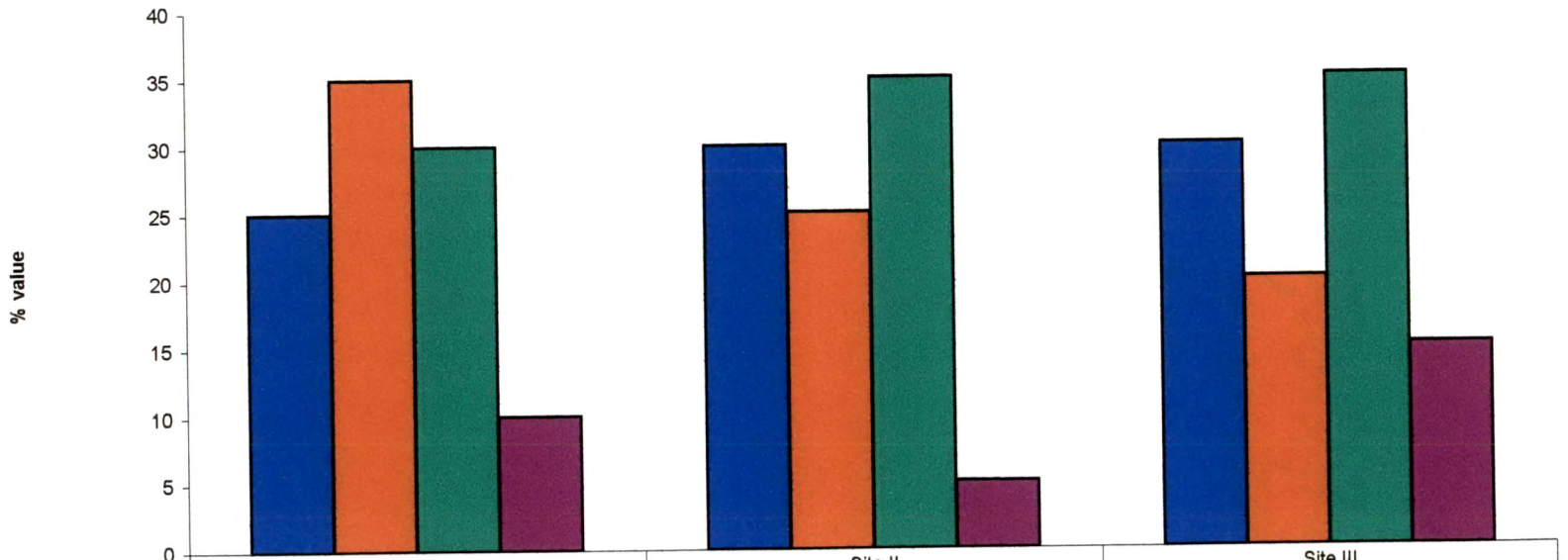
Phylum	Class	Genus
Protozoa	Mastigophora	Euglena
		Volvox
	Rhizopoda	Rhabdonella
		Saccammina
		Tretmophalus
		Polystomella
		Globigerina
		Textularia
	Lobosa	Arcella
		Diffugia
	Ciliata	Stentor
		Vorticella
	Nematoda	Adenophorea
		Rhabdolaimus
	Trematoda	Larval stage
	Rotifera	Seisonidea
		Philodina
		Rotaria
	Monogononta	Brachionus
		Notholca
		Kerallatella
		Diplois
		Epiphanes
		Cephalodella
		Sacridium
		Asplanchna
		Harringia
		Ploesoma
		Polyarthra
		Triarthra

Table 4.23: (Contd..)

Phylum	Class	Genus
Annelida	Polychaeta	Larval stage
Arthropoda	Mandibulata	Chydorus Eurycercus Daphnia Simocephalus Scapholebris Cerriodaphnia Moina Diphanosoma Macrothrix Cypris Potamocypris Calanus Pseudocalanus Limnocalanus Centrophages Eurytemora Cyclops Mesocyclop Microcyclops Tigriopus Euterpina Acartia
	Malacostraca	Laraval stage
	Insecta	Cranefly larva Tendipes Corynoneura Chaborus pupa Mosquito larva Ceratopogon Baetis nymph Coelon nymph
	Acarina	Hygrobates Megapus Neumania

Figure showing percentage representation of various zooplankton at different sampling sites

Fig. 4.18 showing percentage composition of Zooplankton at various sites.



	Site I	Site II	Site III
Protozoa	25	30	30
Rotifera	35	25	20
Arthropoda	30	35	35
Miscillaneous	10	5	15

all the three groups; however arthropods and rotifers were comparatively more. Significant presence of variety of dinoflagellates at site II and site III may be due to more quantity of phytoplankton. Arthropods were represented by variety of copepods and calanids.

General Fauna:

The river Narmada is habitat for large variety of aquatic fauna, (Table 4.24) represent the fauna other than classified as zooplankton. The diversity of such animals spreads along the invertebrates to vertebrates among small sized animals variety of larval forms of major phyla representatives were also recorded. Zoo-benthic forms of phylum Porifera and Cnidaria were less in number; only at site I few sponges were observed. Hydra was recorded from dense vegetation of site II. During high tide and post monsoon very few members of Syphanophores were observed as pelagic forms. Very few members Nemertine worms were recorded from sand and mud bank of site I. From this saline intrusion zone at few places Sagitta a Chaetognath was aslo observed. The site II was loaded with high density of nematode worms. Within dense vegetation and algal bed several gastropods were observed. Other than gastropods like

Table 4.24: List of animals recorded from sampling sites.

Several other animals were found as nektons and benthos. They are as follows:

Fresh water sponges

Hydra

Nematode worms, (parasitic worms also)

Fresh water leech (parasite on fish)

Argulus – Fish louse

Macrobrachium rosenbergii – Giant Fresh water Prawn

Macrobrachium malcomsonii - Prawn

Sagitta - Chaetognatha

Bivalves

Planorbis, Limnea and few other Gastropods

Common **Insects of their life forms:**

Limnometra, Notonecta, Ranatra, Diplonychus, Lithocerus

Cybister, Hydaticus, Dincutes, Hydrophilus, Regimbartia, Sternolophus

Nymphs of Dragon fly, Damsal fly, Larva and Pupa of Mosquitoes

Chironomus larva.

Several varieties of fishes (separate table)

Turtles

Crocodiles

Water birds and fowls (migratory also)

Planorbis, Lamnea few bivalve forms were also recorded from site I, II and site III. At site II and site III, larval forms like wriggler larva of mosquito, Chironomus larva, Glochidium larvae were present. Nymphs and naiads of few insects were found present as aquatic forms from site II. Vertebrate forms were abundantly represented as fishes. Several variety of commercially economical and non-commercial variety of fishes was found in the waters of Narmada (Table 4.25). Very few variety of anuran were recorded from this region, however during early post-monsoon time, tadpole larvae of frog were commonly observed in the water near the seashore area. From, Reptiles, turtles were very common at all the sites, but were more common in the lower reaches of site II. Crocodiles were reported from river Narmada, however during this study period and within this area we have never come across any Crocodile. Avifauna depending on aquatic flora and fauna were recorded from this study area.

Fishery of Narmada:

River Narmada is a largest river of Gujarat State. The study area is partly fresh water zone and partly saline influenced zone, hence allows variety of euryhaline fishes to dwell in this area. This area is quite known for two major fisheries, the fresh water

Table 4.25: List of fishes of river Narmada:

1) Tor tor
2) Labeo fimbriatus
3) Labeo calbasu
4) Labeo bata
5) Labeo dyochelius
6) Labeo gonius
7) Cirrhinus mrigala
8) Cirrhinus reba
9) Puntius sarana
10) Puntius stigma
11) Catla catla
12) Rita pavimantata
13) Rita buchnani
14) Mystus singhala
15) Mystus aor
16) Mystus cavasius
17) Wallago attu
18) Clupisoma garua
19) Ompok bimaculatus
20) Channa punctatus
21) Channa macrocephalus
22) Channa stiatus
23) Mastacembalus armatus
24) Notopterus notopterus
25) Tenulisa illisa.

prawn fishery and the Palva (Hilsa) fishery Both these fishery are on organized level and contributor in the economy of the Gujarat State. Several fishing centers are located on both sides of river Narmada and especially in this study zone. More number of such fishing centers is on the northern bank of the river. Comparatively very less contribution has been recorded from riverine source to the fish catch of Gujarat state however; the maximum of this is contributed from river Narmada. Commercial variety of fishes are usually caught during post monsoon and by Gola net or cast net. Catamaran type of conventional boat is used as craft. The study area itself is the largest breeding ground for Scampi - *Macrobrachium rosenbergii.* Spent prawns are usually caught from site I and site II. Site III and its northern belt is real nursery ground for scampi larvae. Post larvae are traditionally caught by scoop nets from Jhanor area, which is just north to site III. These post larvae are marketed for stocking in fresh water ponds for cultivation

Plate - 2