CHAPTER 4

RESULTS

4.0 RESULTS

4.1 Field measurements

4.1.1 Physical and chemical parameters

4.1.1.1 Water depth

Water depth of all 12 sampling stations from April to October 1998 are shown in Appendix 2. Most of the stations recorded high water levels in August 1998. Station 3 (Lubuk Pathir) had an overall maximum water depth of 5.40 m. Based on Figure 22a, water depth decreased from April 1998 to May 1998 before gradually increasing to a maximum in August 1998. Water levels then showed a moderate drop and increased slightly in October 1998. Minimum depth was recorded in May/Jun 1998 for most stations while Station 2 (Sungai Tasik) had the minimum depth in April 1998 at 0.88 m. Paya Kelantong had the most shallow level in May/Jun 1998 with a depth of 0.15 m. Due to inaccessibility, data for Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) was not recorded in April 98.

4.1.1.2 Transparency

Measurements of transparency for all stations are shown in Appendix 3. Secchi depth ranged from 0.14 m to 2.19 m. Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) recorded relatively turbid conditions, followed by Station 9 (Sungai Bera 1) and Station 10 (Sungai Bera 2), as compared to the rest of the stations. There were instances where transparency could not be measured with the Secchi disc due to water levels of the substations that were too shallow. In Figure 22b, transparency reading was the highest in June and August 1998. However, it was generally low for most stations in May and September 1998.

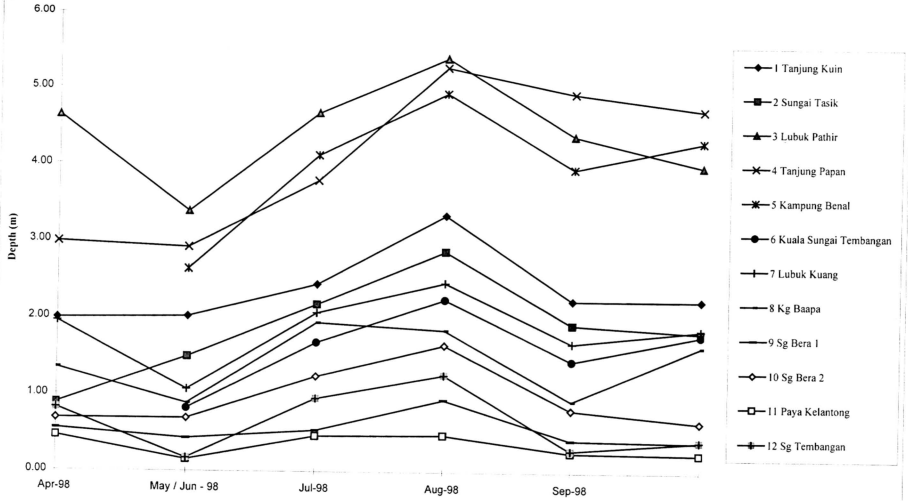


Figure 22a. Measurement of water depth for sampling stations in Tasek Bera (April - October 1998)

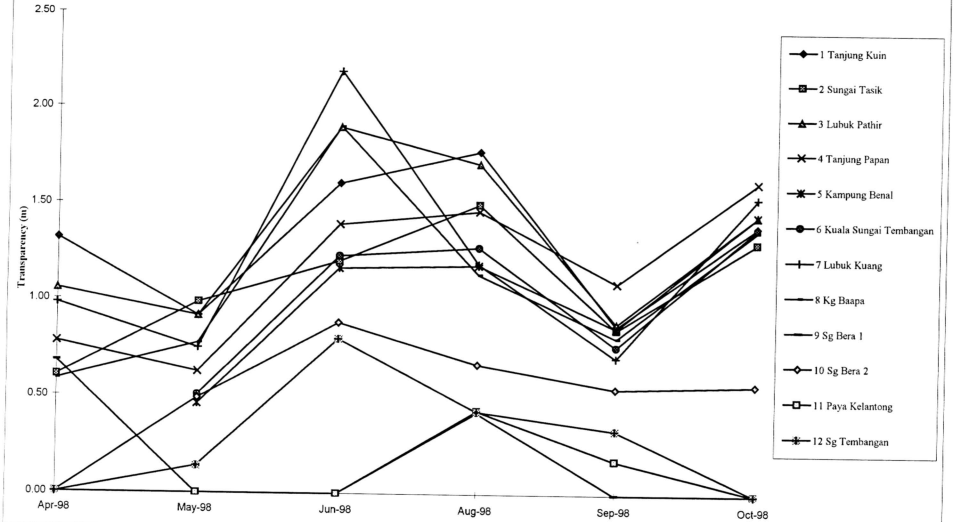


Figure 22b. Measurement of transparency for sampling stations in Tasek Bera (April - October 1998)

4.1.1.3 Conductivity

Data for conductivity are shown in Appendix 4. Figure 22c shows that Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) recorded higher conductivity compared to other stations. The highest conductivity was at Station 11 (Paya Kelantong) in April 1998 which measured at 129.60 $\mu S.cm^{-1}$ while the lowest conductivity measuring at 11.20 $\mu S.cm^{-1}$ was recorded Station 3 (Lubuk Pathir) in May/June 1998.

4.1.1.4 pH

pH measurement are listed in Appendix 5 and ranged from 4.45 to 6.73.The highest pH was recorded at Station 1 (Tanjung Kuin) in April 98 while the lowest was the same station in August 98. Figure 22d showed that pH values for all stations were relatively low in May/June 98 and August 98.

4.1.1.5 Temperature

In Appendix 6, the temperature measurements for all the 12 sampling stations from April to October 1998 ranged between 25.3°C to 33.3°C. Figure 22e shows a pattern of fluctuation in temperature at all the stations. It reached the highest in May/Jun 1998 and dropped in August 1998 before increasing again from September to October 1998.

4.1.1.6 Dissolved oxygen

Dissolved oxygen measurements are listed in Appendix 7. It ranged from 0.40 mgL^{-1} to 5.80 mgL^{-1}. Station 1 (Tanjung Kuin) showed relatively high

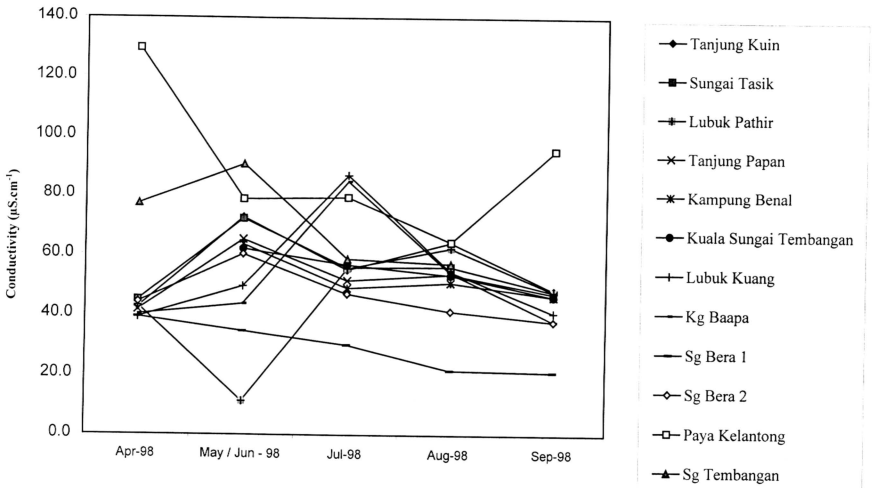


Figure 22c. Measurement of conductivity for sampling stations in Tasek Bera (April - October 1998)

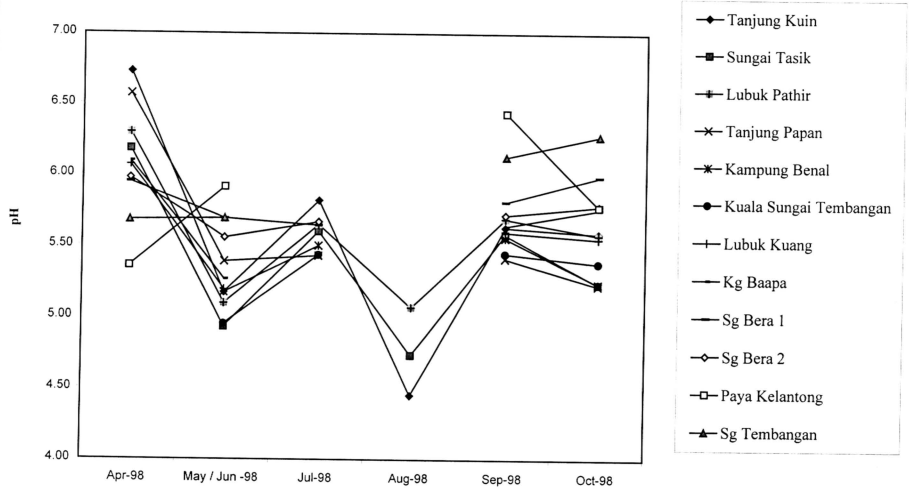


Figure 22d. Measurement of pH for sampling stations in Tasek Bera (April - October 1998)

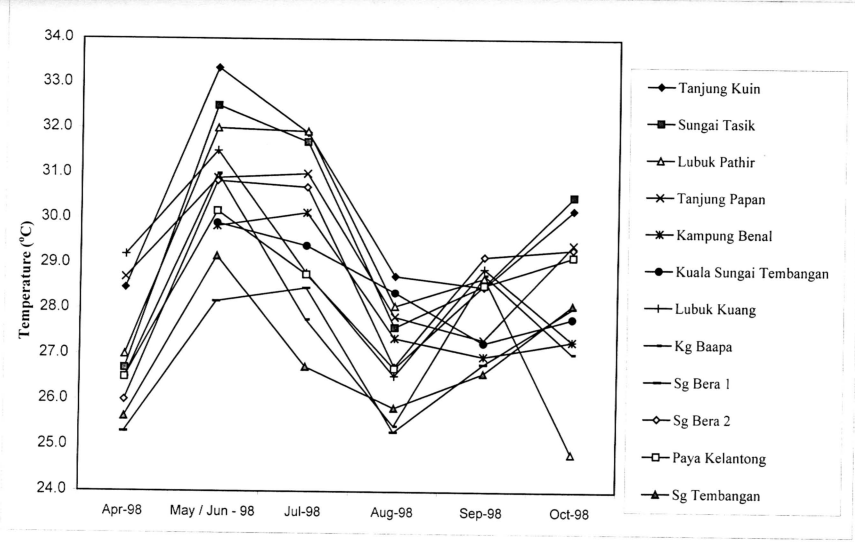


Figure 22e. Measurement of temperature for sampling stations in Tasek Bera (April - October 1998)

dissolved oxygen levels that range from 3.40 mgL^{-1} to 5.80 mgL^{-1}. However, Station 11 (Paya Kelantong) recorded very low readings, ranging from 0.40 mgL^{-1} to 2.7 mgL^{-1}, when compared to other stations. Figure 22f shows that dissolved oxygen level for all stations generally dropped in May/June 1998 and August 1998. Higher levels of dissolved oxygen were recorded in April, July and October of 1998.

4.1.2 Productivity measurements

Appendix 17a-f described the range of primary productivity for all stations from April to October 1998. Gross primary productivity measurements ranged from -0.129 $mgO_2^{-1}L^{-1}h^{-1}$ at Station 1 (Tanjung Kuin) in May/June 1998 to 0.857 $mgO_2^{-1}L^{-1}h^{-1}$ at Station 4 (Tanjung Papan) in August 1998. Data was not available for Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) in April 1998 as the sites were not accessible. Figure 23 shows the primary productivity of sampling stations from April to October 1998. No particular trend was observed among the stations.

In Figure 24, it was noted that Station 8 (Kampung Baapa) and Station 9 (Sungai Bera 1) had relatively higher primary productivity in April 1998. In May/June 1998, only Station 7 (Lubuk Kuang) and Station 4 (Tanjung Papan) had higher primary productivity. In July 1998, only three stations, namely Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir), Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) had very low primary productivity. However, only Station 4 (Tanjung Papan) showed very high reading in August 1998. In September 1998, Station 1 (Tanjung Kuin) and Station 8 (Kampung Baapa) had higher primary productivity. Station 8 (Kampung Baapa) also had high primary productivity in October 1998. Station 1 (Tanjung Kuin), Station 4 (Tanjung Papan), Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) recorded an increase in

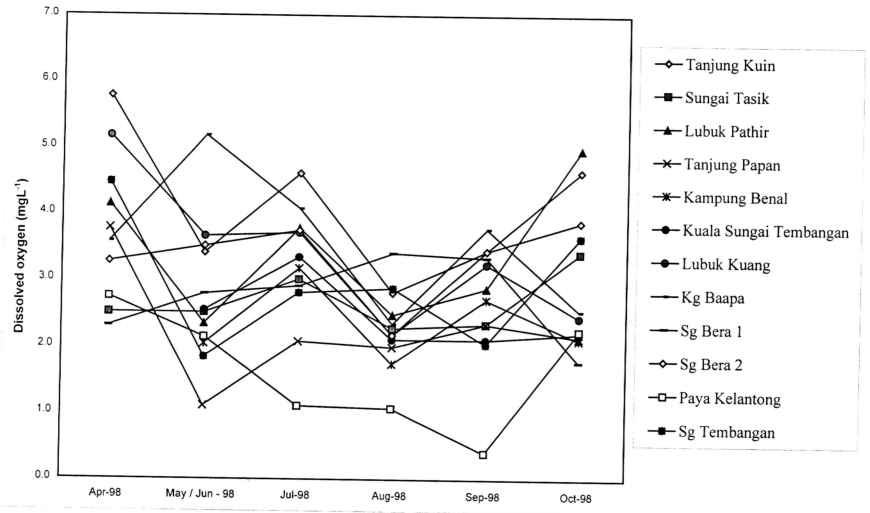


Figure 22f. Measurement of dissolved oxygen for sampling stations in Tasek Bera (April - October 1998)

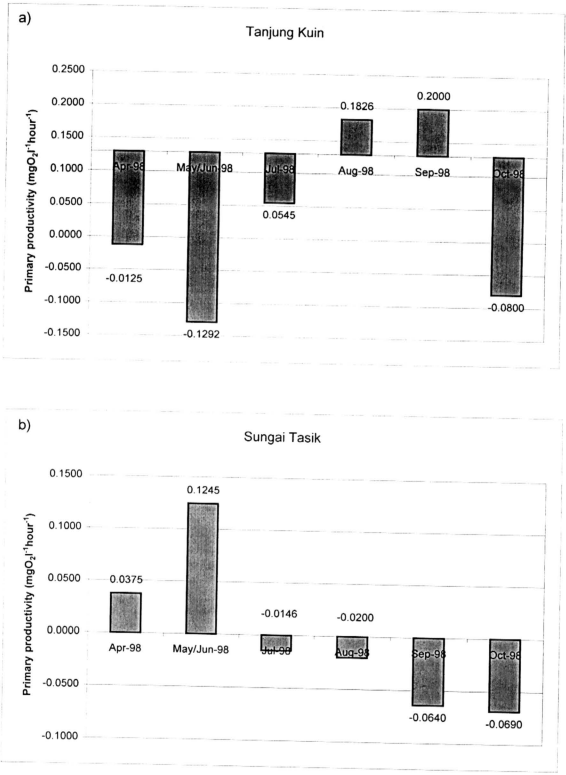
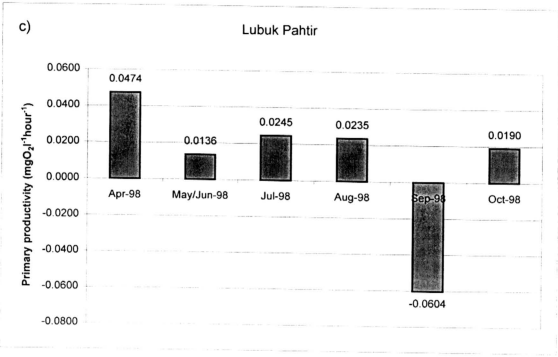


Figure 23. Primary productivity of sampling stations in Tasek Bera (April - October 1998)
a) Tanjung Kuin
b) Sungai Tasik



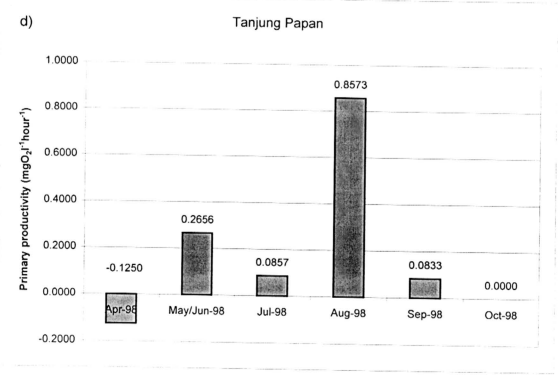
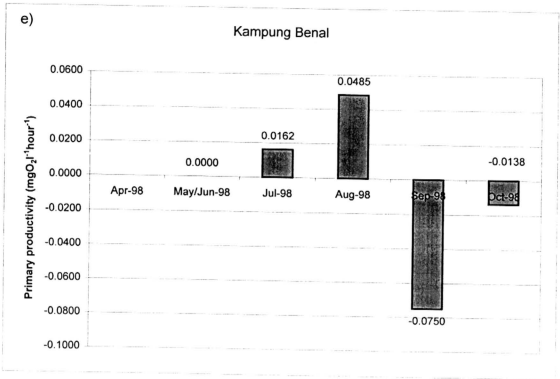


Figure 23. Primary productivity of sampling stations in Tasek Bera (April - October 1998) (continued)
c) Lubuk Pathir
d) Tanjung Papan



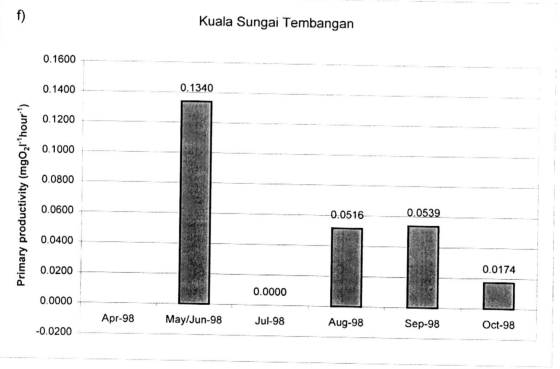
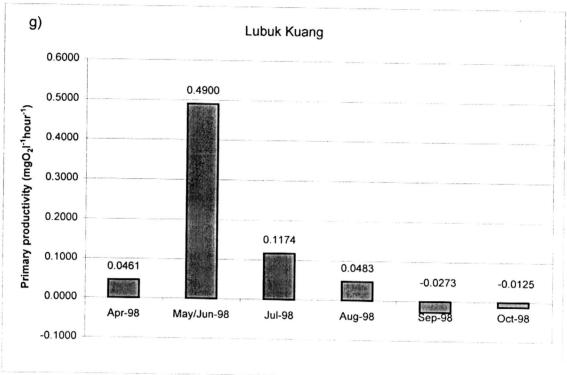


Figure 23. Primary productivity of sampling stations in Tasek Bera (April - October 1998) (continued)
e) Kampung Benal
f) Kuala Sungai Tembangan



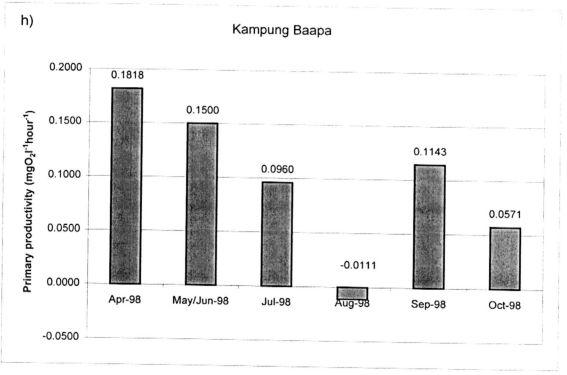
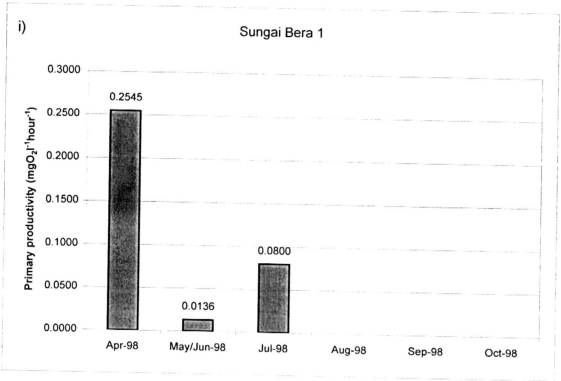


Figure 23. Primary productivity of sampling stations in Tasek Bera (April - October 1998) (continued)
g) Lubuk Kuang
h) Kampung Baapa



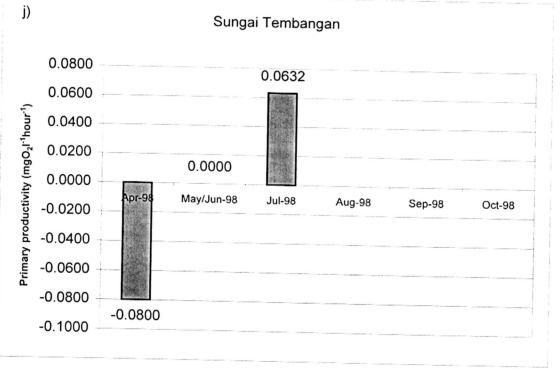
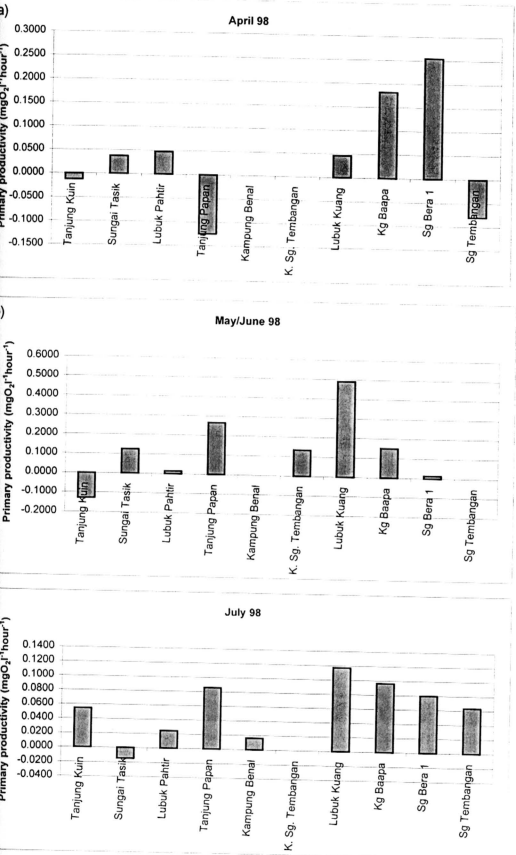
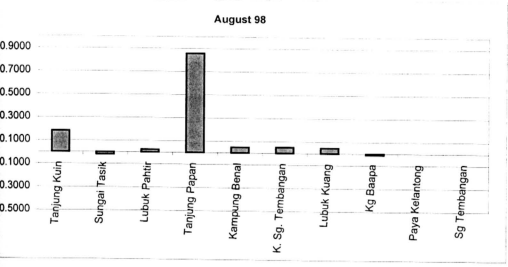
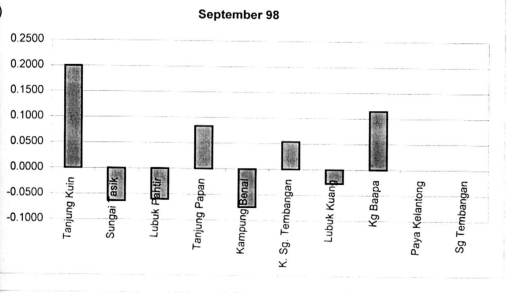


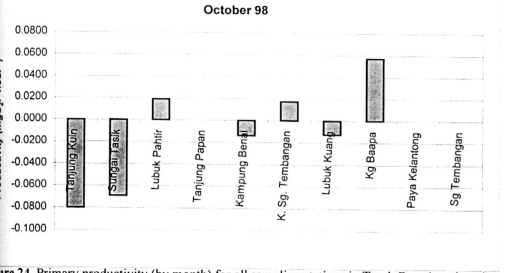
Figure 23. Primary productivity of sampling stations in Tasek Bera (April - October 1998) (continued)
i) Sungai Bera 1
j) Sungai Tembangan



ure 24. Primary productivity (by month) for all sampling stations in Tasek Bera
pril 98
Iay/June 98
ly 98







ure 24. Primary productivity (by month) for all sampling stations in Tasek Bera (continued)
ugust 98
eptember 98
ctober 98

productivity in August 1998. Station 1 (Tanjung Kuin) and Station 6 (Kuala Sungai Tembangan) also recorded an increase in primary productivity during the month of September 1998 in addition to Station 8 (Kampung Baapa). However, Station 4 (Tanjung Papan), Station 8 (Kampung Baapa) and Station 9 (Sungai Bera 1) showed relatively higher primary productivity as compared to the other months.

4.1.3 Rainfall data in the catchment area

Appendix 18 shows the rainfall data for 1997 and 1998 in several plantations such as Triang Selatan 1, Triang Selatan 2, Bera Selatan 2 and Tembangau 8. These plantations are located in the catchment area around the lake (Figure 2).

The mean total rainfall for these four plantations in 1997 was 1596.50 mm. The wettest months were during March (249.44 mm) to April 1997 (231.75 mm) and November (208.88 mm) to December 1997 (221.25 mm). The driest months were in January (24.60 mm) and August 1997 (37.75 mm). The plantation Bera Selatan 2 had the highest rainfall (1857.00 mm), followed by Triang Selatan 1 (1577.20 mm), Triang Selatan 2 (1496.93 mm) and Tembangau 8 (1424.70 mm).

The mean total rainfall for the plantations in 1998 was 1558.07 mm. The wettest months were in January (161.11 mm), May (160.54 mm), August (167.67 mm) and December of 1998 (301.03 mm). The driest months were March (90.60 mm), April (85.09 mm) and September of 1998 (27.04 mm).

4.1.4 Fertiliser application data from various plantations in the catchment area

Appendix 19 a-d shows the different types of fertiliser loading in Tembangau 8, Triang Selatan 2, Triang Selatan 1 and Bera Selatan 2 in 1998. Data was obtained via interview with plantation managers. Figure 25a to 25d shows the rainfall data for selected plantations and its fertiliser loading from January to December 1998.

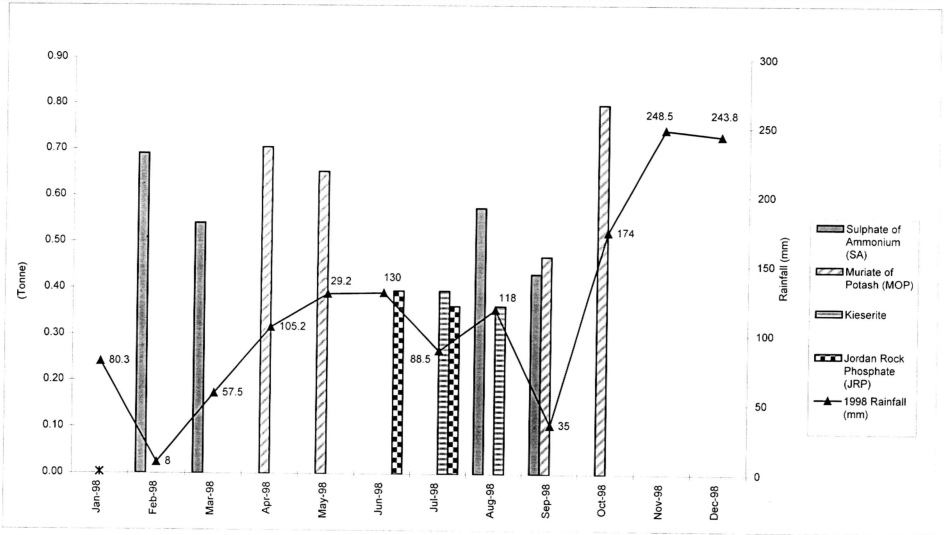


Figure 25a. Rainfall and fertiliser loadings in Tembangau 8 Plantation, Tasek Bera (January - December 1998)

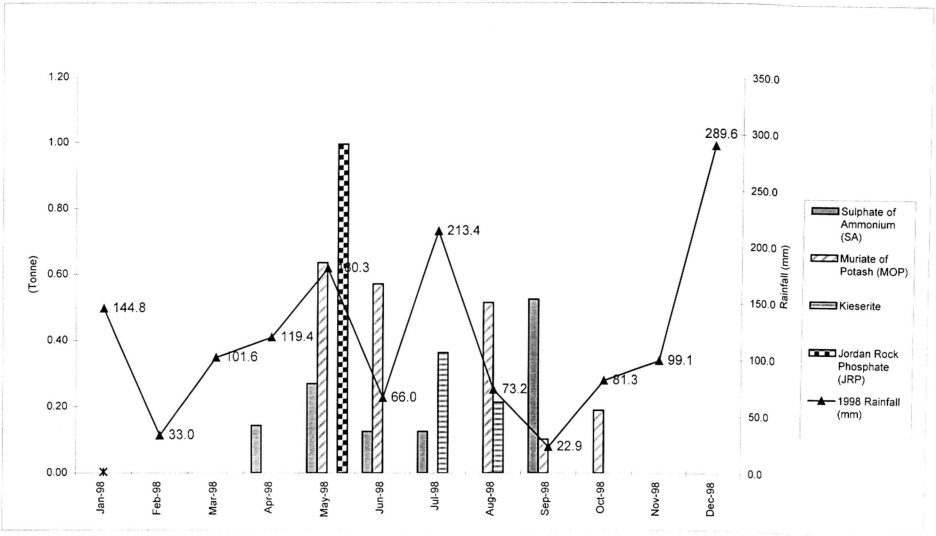


Figure 25b. Rainfall and fertiliser loadings in Triang Selatan 2 Plantation, Tasek Bera (January - December 1998)

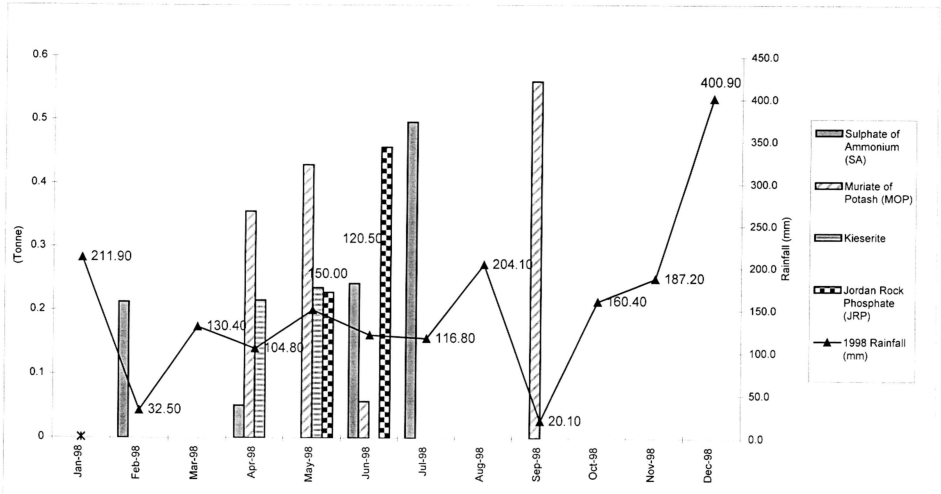


Figure 25c. Rainfall and fertiliser loadings in Triang Selatan 1 Plantation, Tasek Bera (January - December 1998)

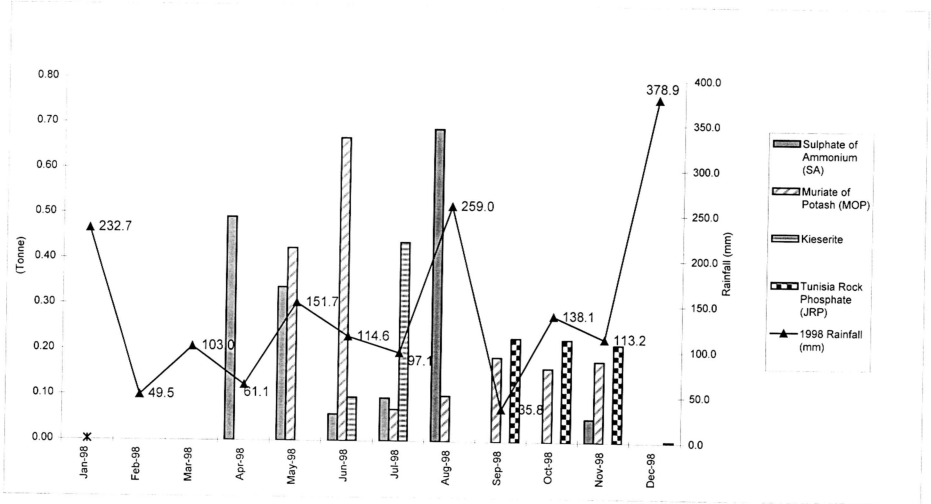


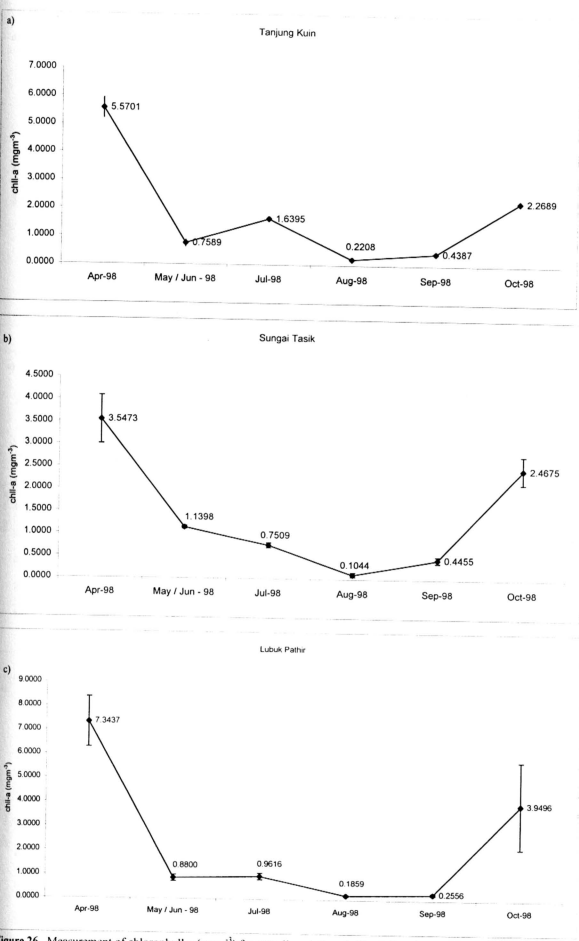
Figure 25d. Rainfall and fertiliser loadings in Bera Selatan 2 Plantation, Tasek Bera (January - December 1998)

4.2 Laboratory measurements

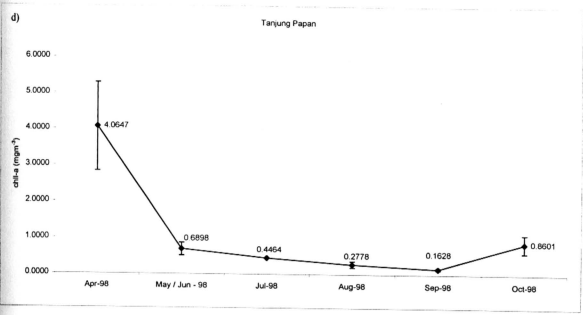
4.2.1 Chlorophyll-a measurements

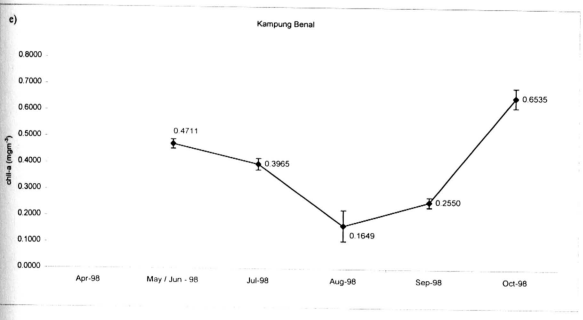
Measurement of chlorophyll-a is shown in Appendix 8. Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) were not accessible in April 1998. Therefore, data on chlorophyll-a for these stations were not available. Concentration of chlorophyll-a ranged from non-detectable to 7.3437 mgm^{-3} at Station 3 (Lubuk Pathir) in April 1998.

In Figure 26, all the stations recorded relatively higher concentration of chlorophyll-a in April 1998. Then, a sudden drop is observed in most stations in May/Jun 1998 where the level remained relatively low until September 1998. Then, a slight increase in Oct 1998 is recorded. The lowest level of chlorophyll-a is in August 1998 for all stations except Station 7 (Lubuk Kuang). Figure 27 shows the chlorophyll-a levels for all stations by month. In April 1998, Station 3 (Lubuk Pathir), Station 7 (Lubuk Kuang) and Station 10 (Sungai Bera 2) showed relatively high chlorophyll-a levels at 7.3437 mgm^{-3}, 5.9786 mgm^{-3} and 6.5362 mgm^{-3} respectively. In May/June 1998 and July 1998, Station 8 (Kampung Baapa) had higher chlorophyll-a levels compared to other stations at 1.8696 mgm^{-3} and 1.7385 mgm^{-3}. In August 1998, Station 7 (Lubuk Kuang) recorded the highest reading (0.6384 mgm^{-3}) among all the stations while Station 11 (Paya Kelantong) had the highest reading (0.9644 mgm^{-3}) in September 1998. In October 1998, Station 3 (Lubuk Pathir), Station 2 (Sungai Tasik) and Station 1 (Tanjung Kuin) had relatively high readings at 3.9496 mgm^{-3}, 2.4675 mgm^{-3} and 2.2689 mgm^{-3} respectively.



igure 26. Measurement of chlorophyll-a (mgm^{-3}) for sampling stations in Tasek Bera(April - October 1998)
) Tanjung Kuin
) Sungai Tasik
) Lubuk Pathir
rror bar denotes standard error





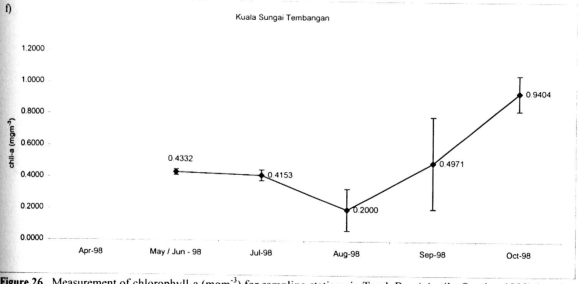
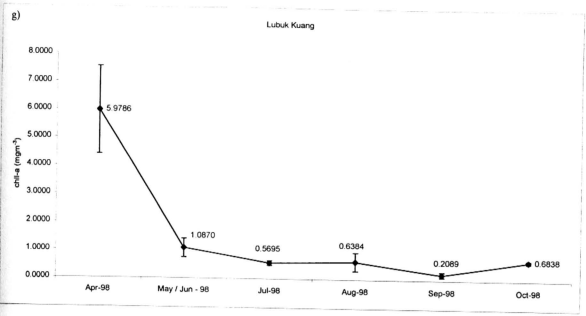
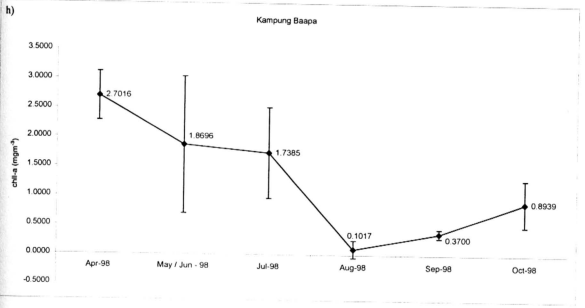


Figure 26. Measurement of chlorophyll-a (mgm^{-3}) for sampling stations in Tasek Bera(April - October 1998) (continued)
d) Tanjung Papan
e) Kampung Benal
f) Kuala Sungai Tembangan
Error bar denotes standard error





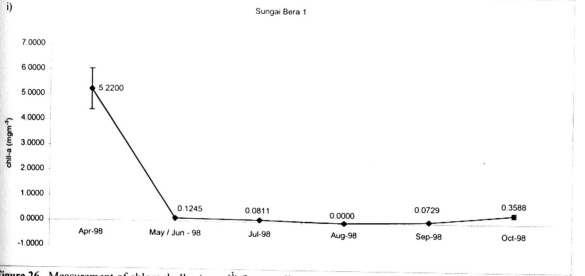
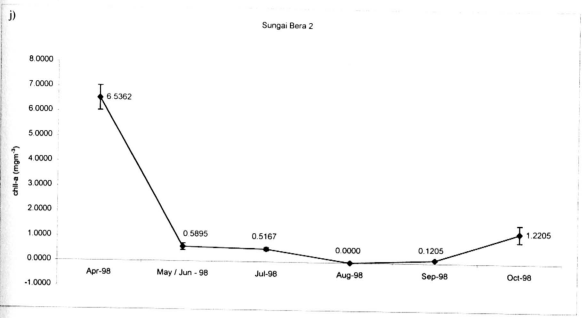


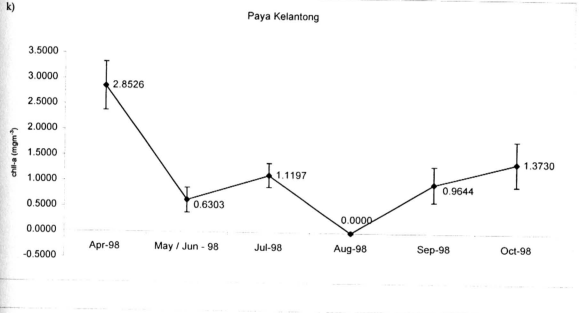
Figure 26. Measurement of chlorophyll-a (mgm^{-3}) for sampling stations in Tasek Bera(April - October 1998) (continued)

) Lubuk Kuang
) Kampung Baapa
Sungai Bera 1
rror bar denotes standard error

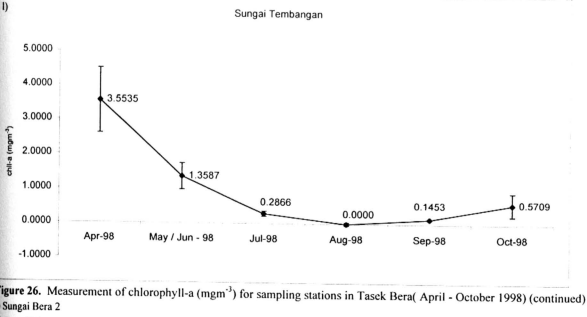
j)



k)



l)



igure 26. Measurement of chlorophyll-a (mgm^{-3}) for sampling stations in Tasek Bera(April - October 1998) (continued)
Sungai Bera 2
) Paya Kelantong
Sungai Tembangan
rror bar denotes standard error

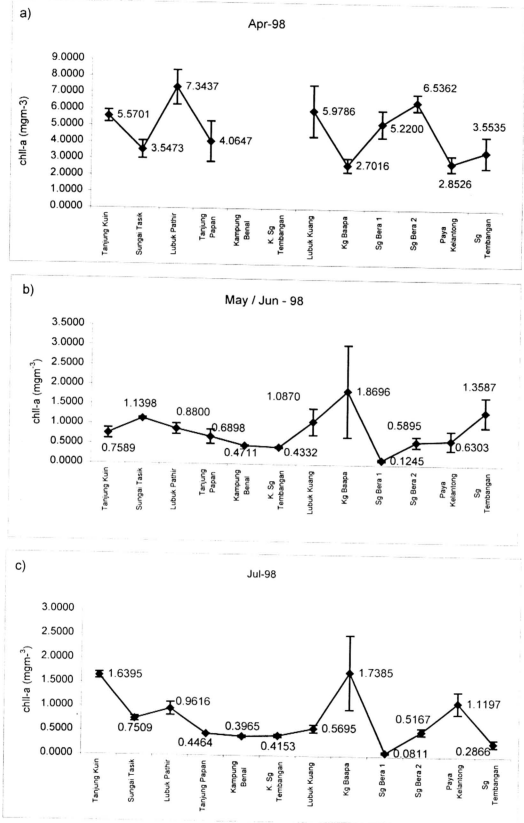


Figure 27. Measurement of chlorophyll-a (mgm^{-3}) by month for all stations in Tasek Bera
a) April 98
b) May/June 98
c) July 98
Error bar denotes standard error

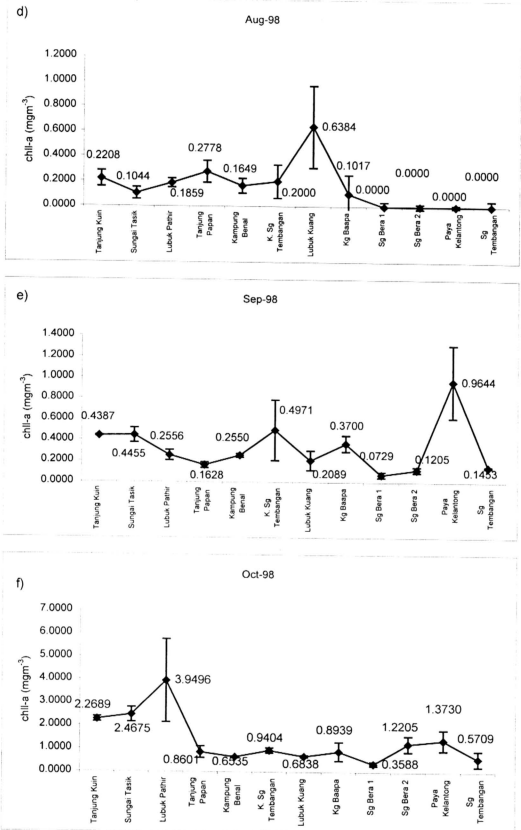


Figure 27. Measurement of chlorophyll-a (mgm^{-3}) by month for all stations in Tasek Bera (continued)
d) August 98
e) September 98
f) October 98
Error bar denotes standard error

4.2.2 Chemical analysis

4.2.2.1 Dissolved orthophosphate

Data for dissolved orthophosphate is listed in Appendix 9. Concentrations ranged from 0.000 to 0.0095 mgL^{-1} at Station 5 (Kampung Benal) in May/Jun 1998.

With the exception of Station 1 (Tanjung Kuin), the rest of the stations showed a similar trend from April to August 1998 in terms of fluctuation of concentrations. Figure 28 shows that dissolved orthophosphate levels were high in April 1998 for most of the stations followed by a drastic drop in May/June 1998 and reached a minimum in July 1998. Gradual increase was recorded from August 1998 onwards up to October 1998. As for Station 1 (Tanjung Kuin), dissolved orthophosphate level was low in April 1998, increased markedly in May/June 1998 and August 1998, after which it showed a sudden decrease in September 1998.

In Figure 29, Station 4 (Tanjung Papan) had relatively high concentrations (0.0028 mgL^{-1}) of dissolved orthophosphate in April 1998 while Station 5 (Kampung Benal) had the highest concentration (0.0095 mgL^{-1}) in May/June 98. However, Station 1 (Tanjung Kuin) had relatively high concentrations throughout the month of July (0.0016 mgL^{-1}), August (0.0065 mgL^{-1}) and September 98 (0.0019 mgL^{-1}) compared to the other stations. In October 1998, measurement of dissolved orthophosphate was relatively higher in Station 1 (Tanjung Kuin) and Station 8 (Kampung Baapa).

4.2.2.2 Ammoniacal-nitrogen

Data for ammoniacal-nitrogen is shown in Appendix 10. Concentrations ranged from 0.000 to 2.9132 mgL^{-1} at Station 5 (Kampung Benal) in August 1998.

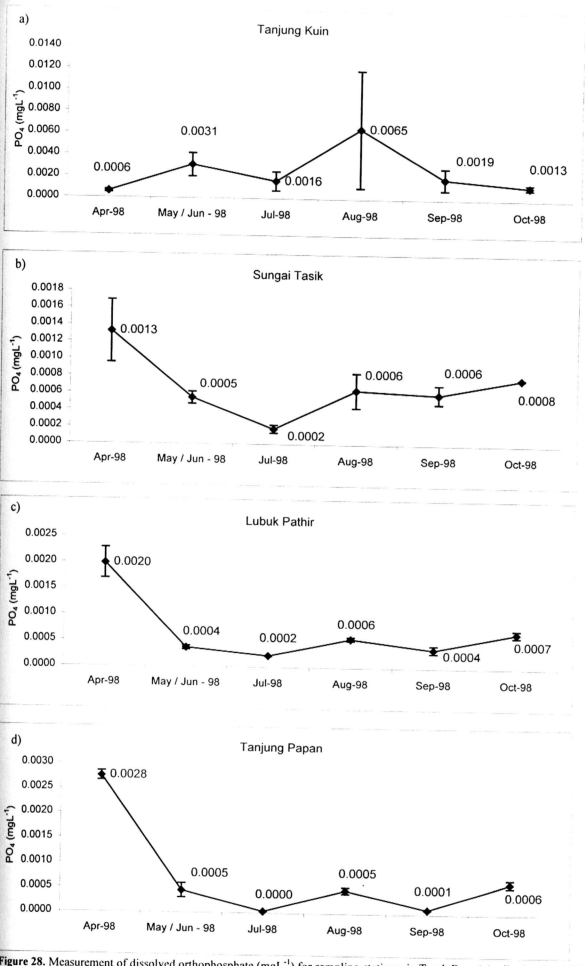
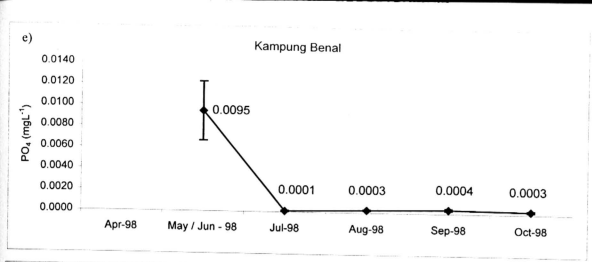
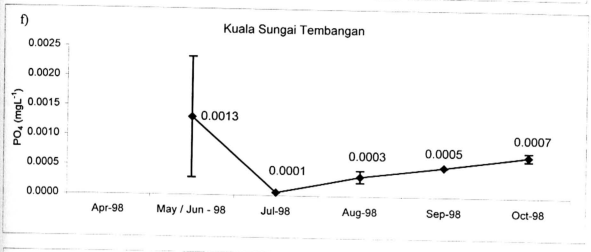


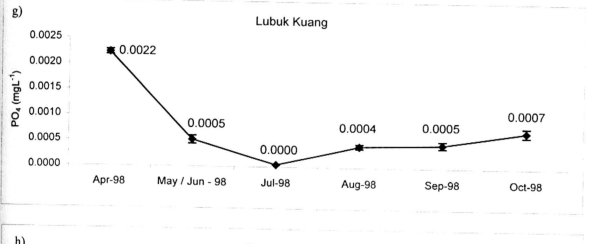
Figure 28. Measurement of dissolved orthophosphate (mgL^{-1}) for sampling stations in Tasek Bera (April - October 1998)

a) Tanjung Kuin
b) Sungai Tasik
c) Lubuk Pathir
d) Tanjung Papan

Error bar denotes standard error







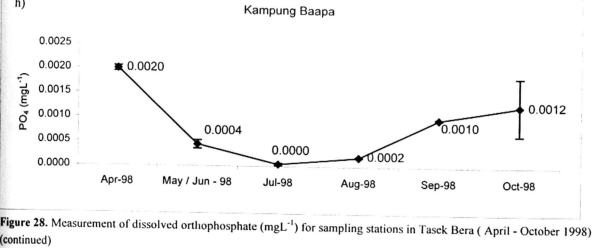


Figure 28. Measurement of dissolved orthophosphate (mgL^{-1}) for sampling stations in Tasek Bera (April - October 1998) (continued)

e) Kampung Benal
f) Kuala Sungai Tembangan
g) Lubuk Kuang
h) Kampung Baapa
Error bar denotes standard error

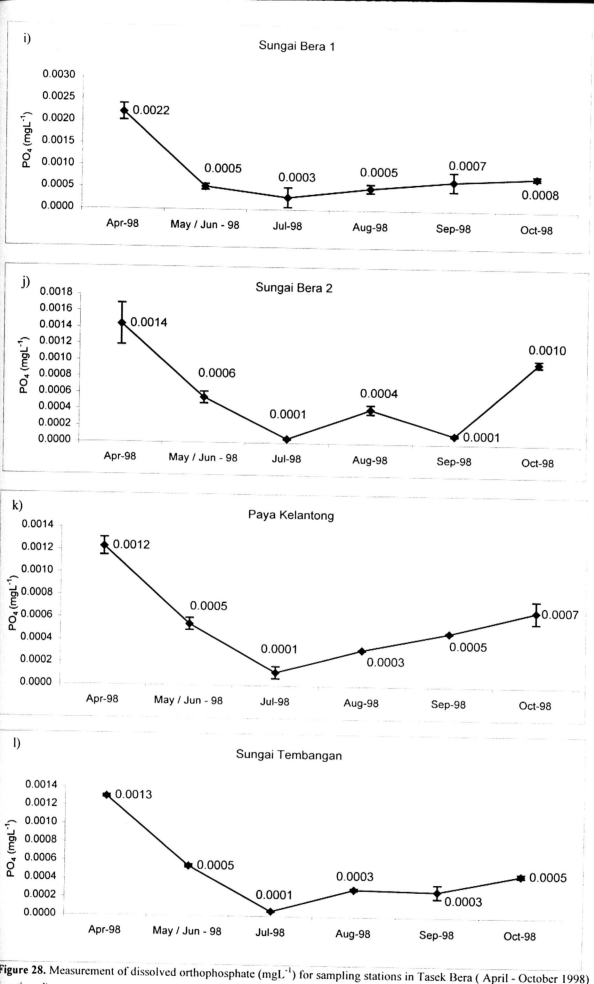


Figure 28. Measurement of dissolved orthophosphate (mgL^{-1}) for sampling stations in Tasek Bera (April - October 1998) (continued)

) Sungai Bera 1
) Sungai Bera 2
) Paya Kelanrong
) Sungai Tembangan
Error bar denotes standard error

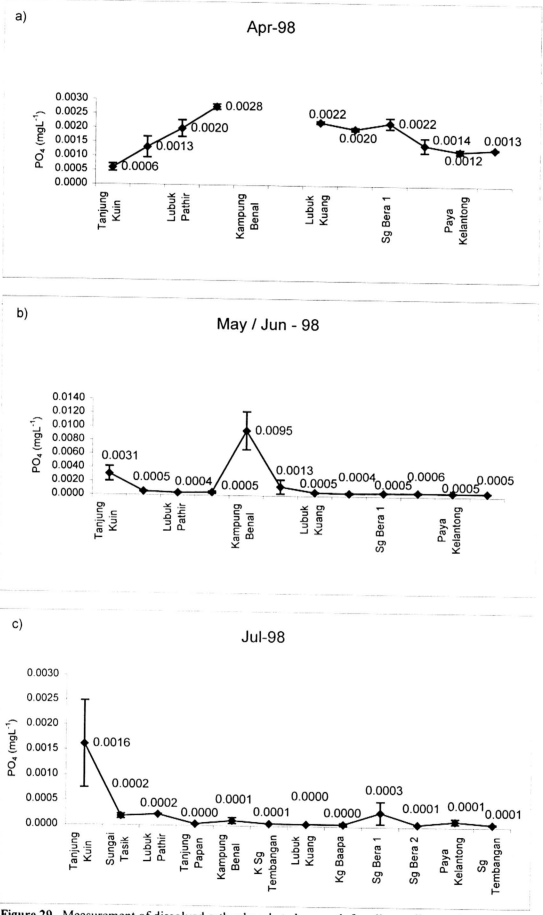
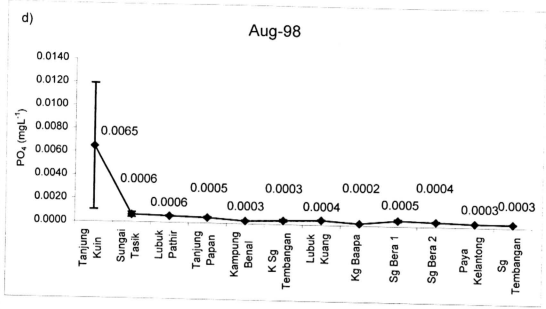
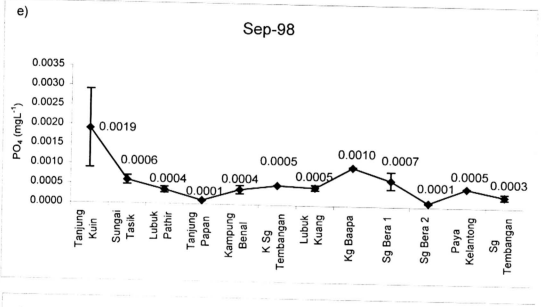


Figure 29. Measurement of dissolved orthophosphate by month for all sampling stations in Tasek Bera
a) April 1998
b) May/June 1998
c) July 1998
Error bar denotes standard error





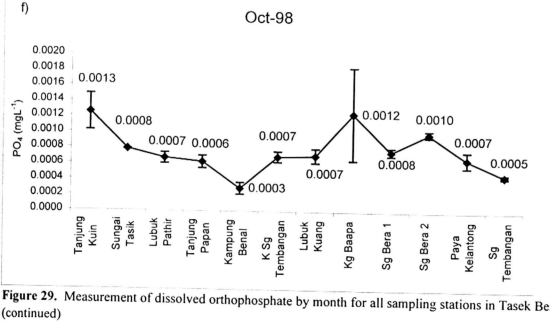


Figure 29. Measurement of dissolved orthophosphate by month for all sampling stations in Tasek Bera (continued)
d) August 1998
e) September 1998
f) October 1998
Error bar denotes standard error

In general, all stations with the exception of Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) which were not accessible in April 1998 had low concentrations of ammoniacal-nitrogen,

Based on Figure 30, a similar trend in fluctuation was noted at Station 1 (Tanjung Kuin), Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir), Station 4 (Tanjung Papan), Station 5 (Kampung Benal), Station 6 (Kuala Sungai Tembangan) and Station 9 (Sungai Bera 1) where concentrations of ammoniacal-nitrogen peaked in May/June 1998 and August 1998 but dropped quite markedly in July 1998 and September 1998.

Figure 30 also showed that the remaining five stations, namely Station 7 (Lubuk Kuang), Station 8 (Kampung Baapa), Station 10 (Sungai Bera 2), Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) had relatively low concentrations of ammoniacal-nitrogen from April to July 1998. A sudden increase was recorded in August 1998.

In Figure 31, Station 1 (Tanjung Kuin) and Station 2 (Sungai Tasik) recorded relatively high concentrations of ammoniacal-nitrogen at 0.1477 mgL^{-1} and 0.1326 mgL^{-1} respectively. However, in May/June 1998 and July 1998, Station 1 (Tanjung Kuin), Station 4 (Tanjung Papan) and Station 6 (Kuala Sungai Tembagan) showed relatively high readings as compared to the other stations. In August 1998, Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir), Station 5 (Kampung Benal), Station 7 (Lubuk Kuang) and Station 10 (Sungai Bera 2) had among the highest readings, ranging from 2.4234 mgL^{-1} to 2.9132 mgL^{-1}. In September 1998, only Station 12 (Sungai Tembangan) had the highest reading at 1.9823 mgL^{-1}. In October 1998, Station 1 (Tanjung Kuin), Station 7 (Lubuk Kuang) and Station 11 (Paya Kelantong) had relatively higher readings.

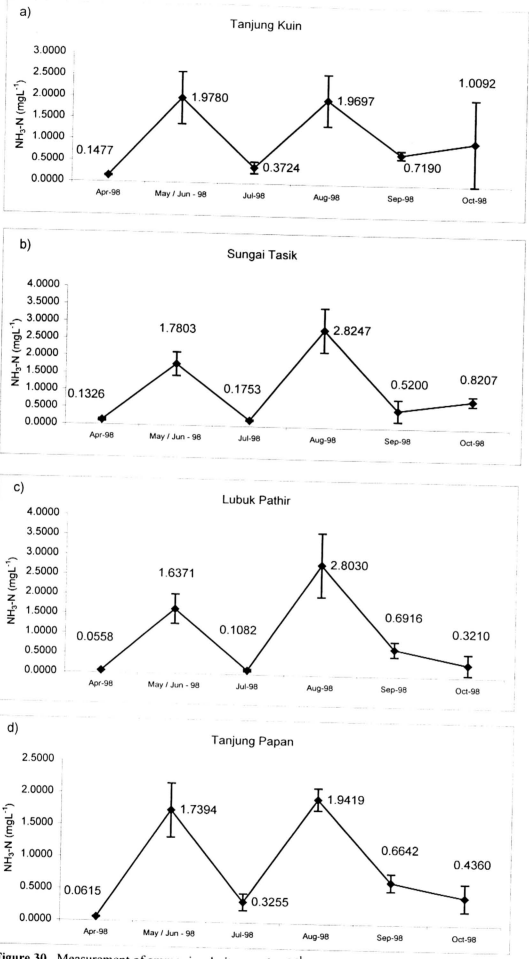


Figure 30. Measurement of ammoniacal nitrogen (mgL^{-1}) for sampling stations in Tasek Bera (April - October 1998)

a) Tanjung Kuin

b) Sungai Tasik

c) Lubuk Pathir

d) Tanjung Papan

Error bar denotes standard error

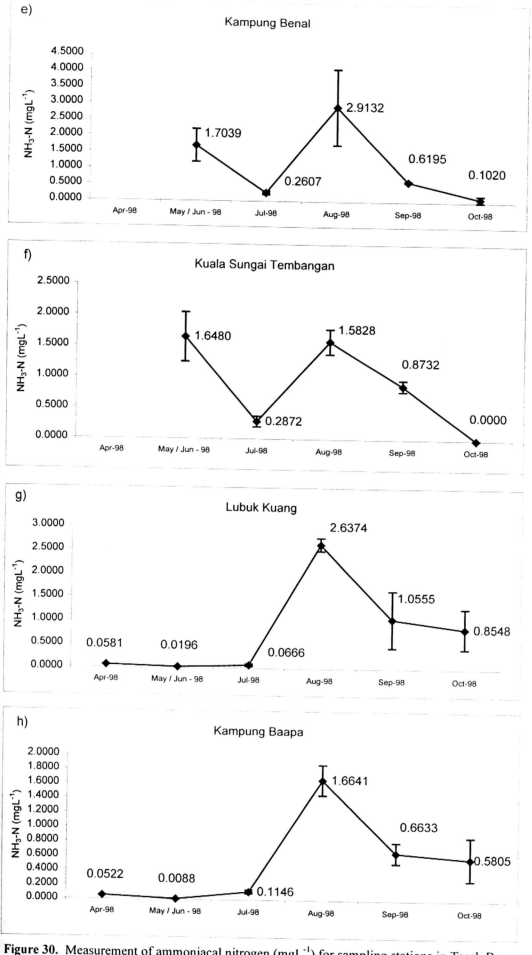


Figure 30. Measurement of ammoniacal nitrogen (mgL^{-1}) for sampling stations in Tasek Bera (April - October 1998) (continued)

e) Kampung Benal

f) Kuala Sungai Tembangan

g) Lubuk Kuang

h) Kampung Baapa

Error bar denotes standard error

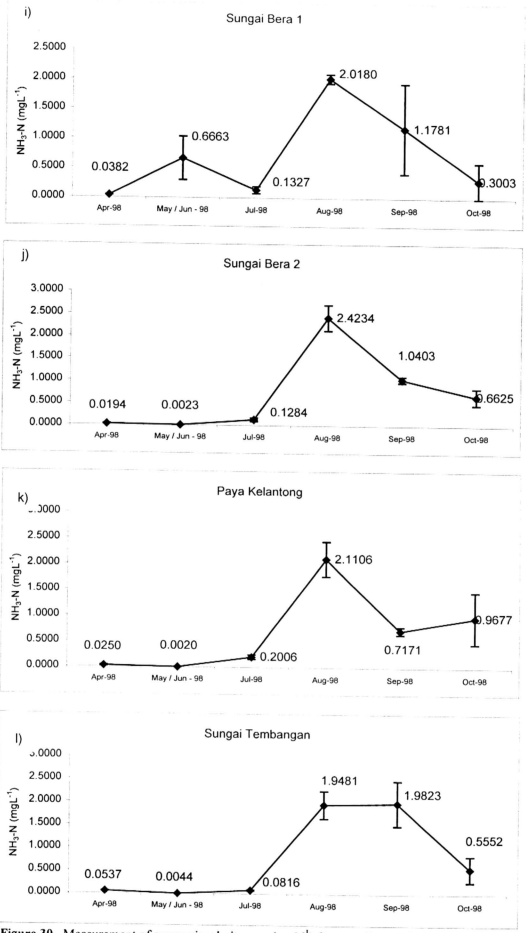


Figure 30. Measurement of ammoniacal nitrogen (mgL^{-1}) for sampling stations in Tasek Bera (April - October 1998) (continued)
i) Sungai Bera 1
j) Sugnai Bera 2
k) Paya Kelantong
l) Sungai Tembangan
Error bar denotes standard error

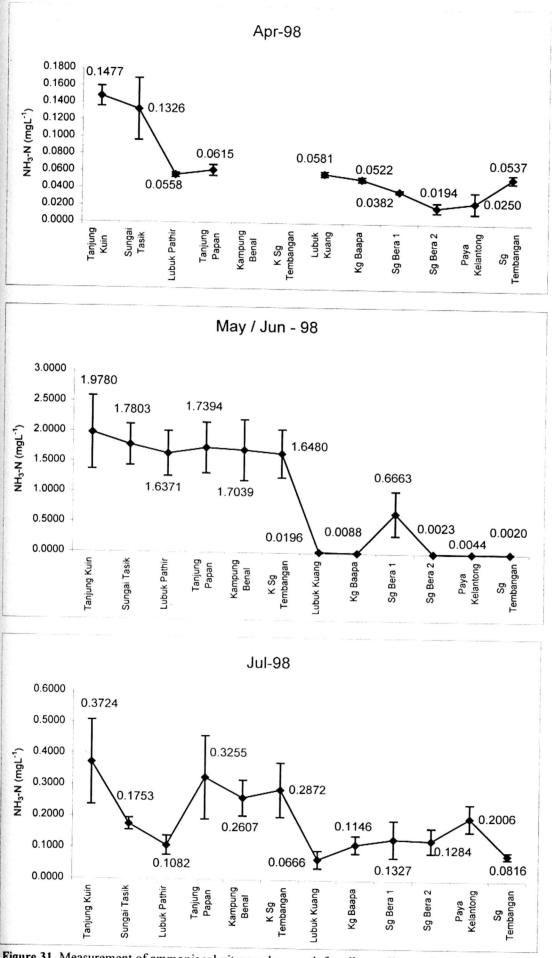
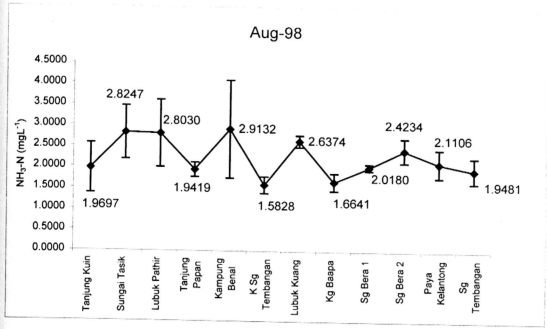
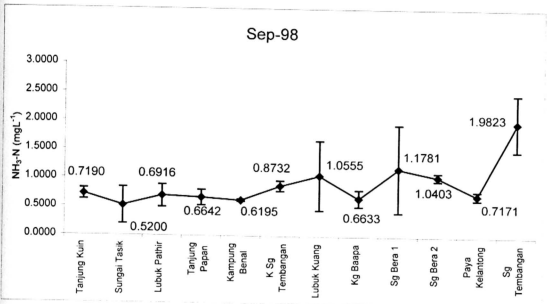


Figure 31. Measurement of ammoniacal nitrogen by month for all sampling stations in Tasek Bera
a) April 1998
b) May/June 1998
c) July 1998
Error bar denotes standard error





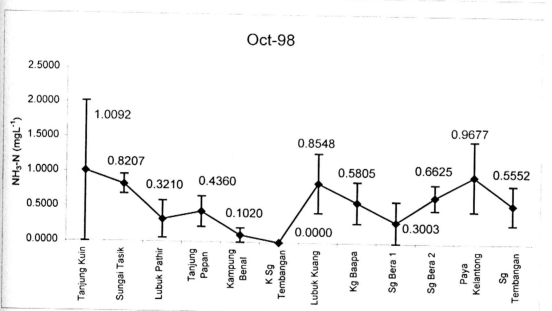


Figure 31. Measurement of ammoniacal nitrogen by month for all sampling stations in Tasek Bera (continued)

d) August 1998

e) September 1998

f) October 1998

Error bar denotes standard error

4.2.2.3 Nitrate

Data for nitrate concentration for every station from April to October 1998 is shown in Appendix 11. Concentrations ranged from 0.000 mgL^{-1} (not detectable) to 5.600 mgL^{-1} at Station 11 (Paya Kelantong) in August 1998.

In Figure 32, seven stations, namely Station 1 (Tanjung Kuin), Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir), Station 6 (Kuala Sg. Tembangan), Station 7 (Lubuk Kuang), Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) recorded a marked increase of nitrate concentration in August 1998. However, the maximum reading for Station 4 (Tanjung Papan) was in July 1998 while Station 9 (Sungai Bera 1) was in September 1998. The rest of the stations consisting of Station 5 (Kampung Benal), Station 8 (Kampung Baapa) and Station 10 (Sungai Bera 2) recorded its maximum reading in October 1998.

Figure 33 shows the nitrate concentrations for all 12 stations by month. Station 4 (Tanjung Papan), Station 8 (Kampung Baapa) and Station 10 (Sungai Bera 2) were relatively high in April 1998. In May/June 1998, Station 2 (Sungai Tasik), Station 4 (Tanjung Papan) and Station 7 (Lubuk Kuang) recorded higher values than the other stations. However, concentration at Station 10 (Sungai Bera 2) dropped to 0.000 mgL^{-1} from 0.3397 mgL^{-1} as compared to the previous month. In July 1998, Station 4 (Tanjung Papan) recorded a very high concentration of nitrate (0.7400 mgL^{-1}). Station 11 (Paya Kelantong) showed a very high value (5.600 mgL^{-1}) as compared to other stations in August 1998, followed by Station 3 (2.1500 mgL^{-1}). On the other hand, Station 1 (Tanjung Kuin) and Station 9 (Sungai Bera 1) recorded high nitrate concentrations in September 1998. In October 1998, however, higher nitrate concentrations had been noted at Station 3 (Lubuk Pathir) and Station 10 (Sungai Bera 2).

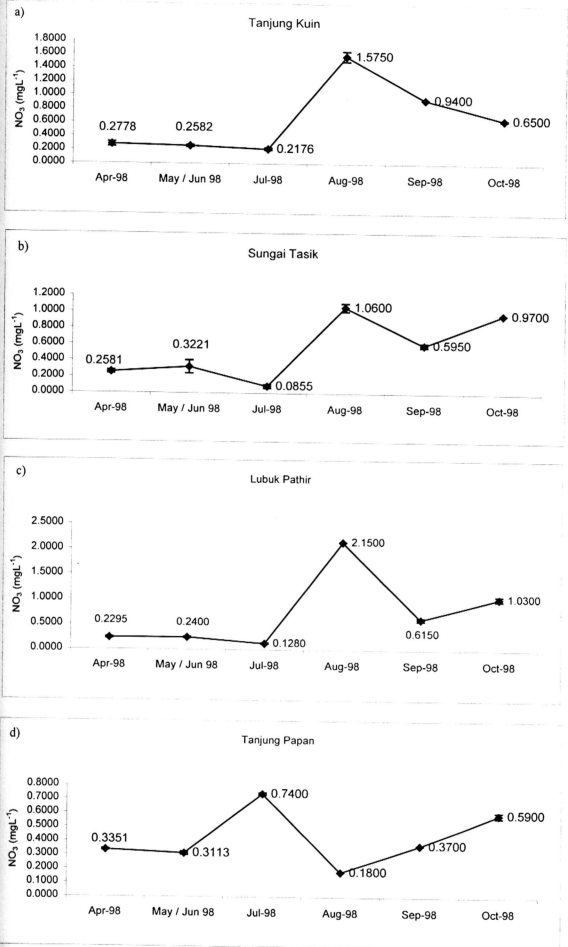
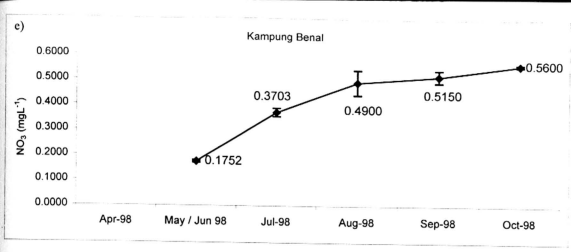
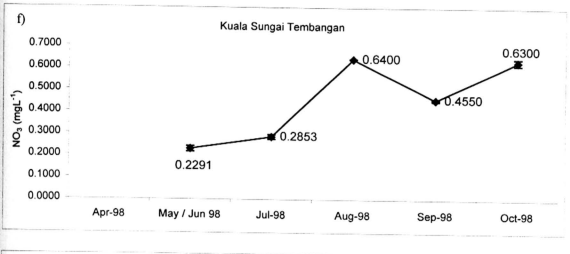
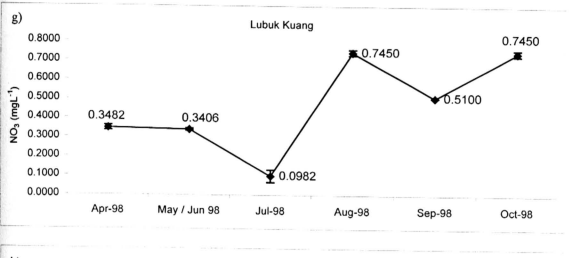


Figure 32. Measurement of nitrate for sampling stations in Tasek Bera (April - October 1998)
a) Tanjung Kuin
b) Sungai Tasik
c) Lubuk Pathir
d) Tanjung Papan
Error bar denotes standard error







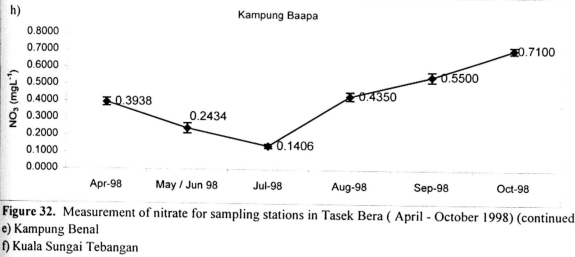


Figure 32. Measurement of nitrate for sampling stations in Tasek Bera (April - October 1998) (continued)
e) Kampung Benal
f) Kuala Sungai Tebangan
g) Lubuk Kuang
h) Kampung Baapa
Error bar denotes standard error

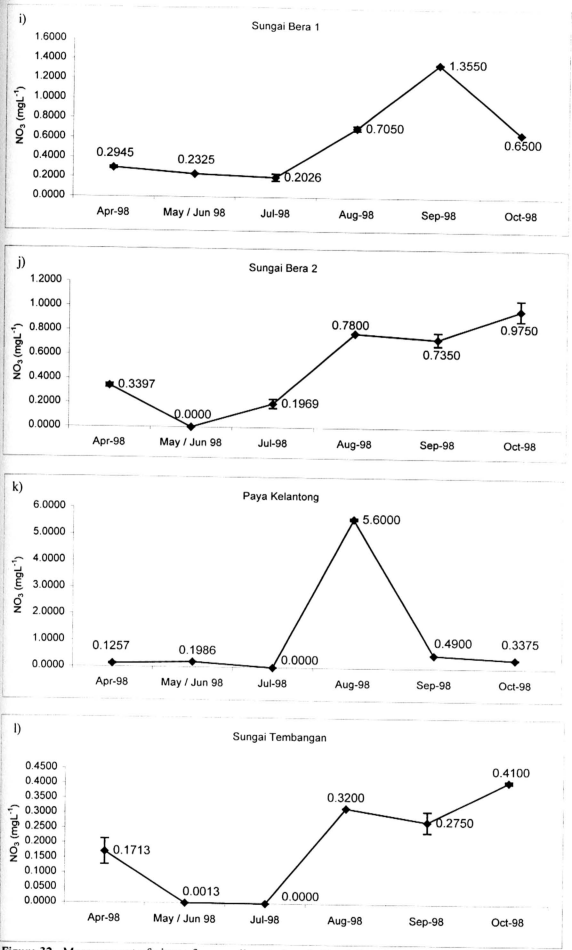


Figure 32. Measurement of nitrate for sampling stations in Tasek Bera (April - October 1998) (continued)
i) Sungai Bera 1
j) Sungai Bera 2
k) Paya Kelantong
l) Sungai Tembangan
Error bar denotes standard error

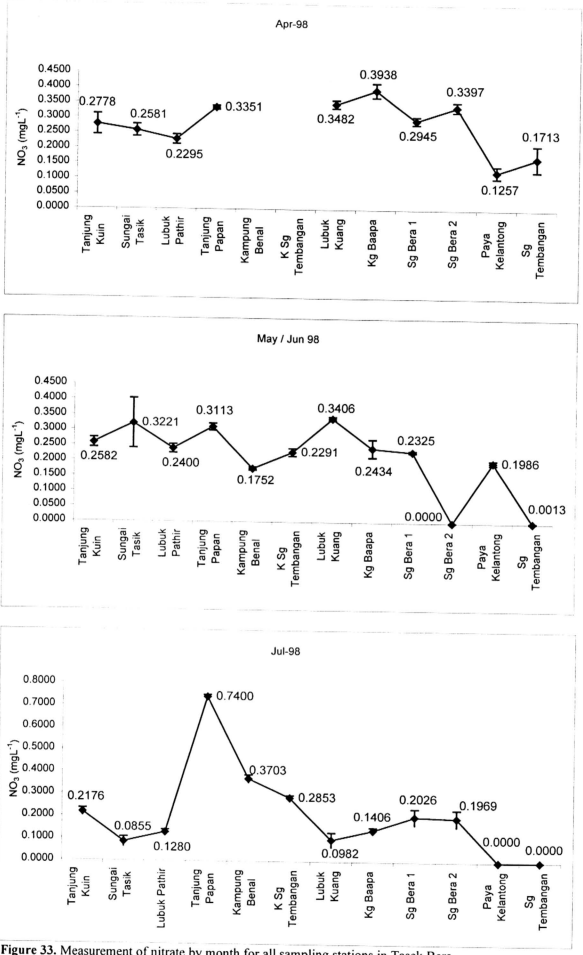
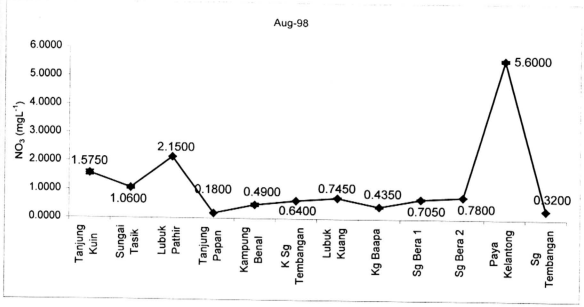
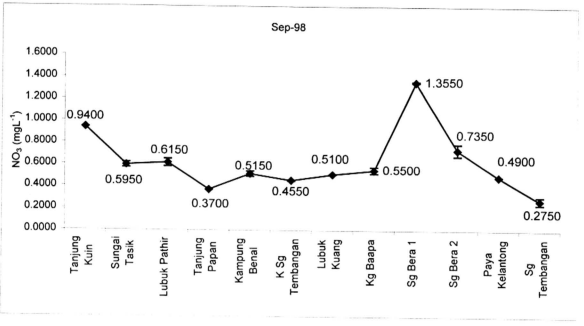


Figure 33. Measurement of nitrate by month for all sampling stations in Tasek Bera
a) April 1998
b) May/June 1998
c) July 1998
Error bar denotes standard error





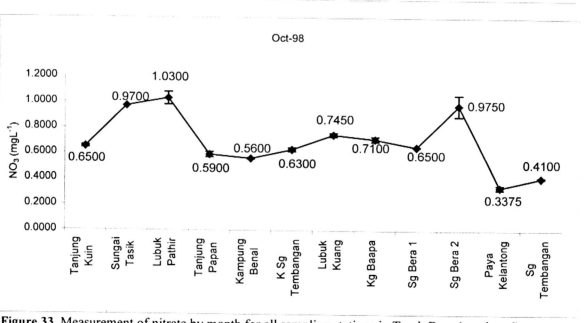


Figure 33. Measurement of nitrate by month for all sampling stations in Tasek Bera (continued)
d) August 1998
e) September 1998
f) October 1998
Error bar denotes standard error

4.2.3 Microscopic identification and quantification of phytoplankton

4.2.3.1 Checklist of phytoplankton and abundance

A total of 326 species were recorded including 42 unidentified species (Table 11). This consisted of 150 species of Chlorophyta, 90 species of Chrysophyta, 36 species of Euglenophyta, three species of Pyrrhophyta, three species of Xanthophyta and two species of Cyanophyta.

Cell density ranged from 192 cells.L^{-1} for *Golenkinia radiata* in Station 6 (Kuala Sungai Tembangan) to 380916 cells.L^{-1} for *Arthrodesmus octocornis* in Station 1 (Tanjung Kuin). Station 3 (Lubuk Pathir), Station 1 (Tanjung Kuin) and Station 2 (Sungai Tasik) had the highest total number of cells.L^{-1}.

The most commonly found species are *Arthrodesmus octocornis* (Figure 34), *Cosmarium asphaerosporum* (Figure 35), *Staurastrum tetracerum* (Figure 36), *Rhizosolenia sp.* (Figure 37) and *Dinobryon sertularia* (Figure 38).

Appendix 16 shows the phytoplankton count of all stations from April to September 1998. Phytoplankton cell counts by sampling stations is displayed in Figure 39. All stations, except Station 6 (Kuala Sungai Tembangan) and Station 11 (Paya Kelantong), showed a similar trend where the cell count was very high in April 1998 but decreased significantly in the following months. Data was not available for Station 5 (Kampung Benal) and Station 6 (Kuala Sungai Tembangan) for the month of April 1998 as the sites could not be accessed. Station 6 had relatively uniform counts throughout May/June till August 1998 but dropped in September 1998. Station 11 (Paya Kelantong) also had nearly uniform counts throughout April to July 1998 but dropped in August and September 1998. Figure 40 shows the phytoplankton cell counts by month. Station 3 (Lubuk Pathir) recorded the highest cell counts throughout April to September 1998 except in July 1998 where Station 1 (Tanjung Kuin) had the highest count.

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Division	**Chlorophyta**												
Class :	Chlorophyceae												
Order :	Chlorococcales												
Family :	Characiaceae												
	Schroederia spiralis (Printz) Korschikoff	2083	1900	6250	1042								
	Schroederia setigera (Schroed.) Lemmermann		1042										
Family :	Coelastraceae												
	Coelastrum astroideum De Notaris			1042				1042					
	Coelastrum polychordum (Korschikoff) Hindak	858											
	Coelastrum reticulatum (Dangeard) Senn	2083											
Family :	Dictyosphaeriaceae												
	Dictyosphaerium pulchellum Wood			1042		1042							
	Dictyosphaerium tetrachotomum Printz							1683					
Family :	Hydrodictyaceae												
	Pediastrum duplex Meyen	3808	7292	7342		838	1042	1042			5533		
	Pediastrum duplex var. gracillimum West & West	608	3667	1042									
	Pediastrum simplex (Meyen) Lemmermann			1042									
Family :	Micratiniaceae												
	Golenkinia radiata Chodat	3125	3125	3417	1042		192				2658	1042	
Family :	Radiococcaceae												
	Coenocyctis subcylindrica Korschikoff	1042						13050					
	Coenocystis planctonica Korschikoff	2459	14467	1709		1042	1042	1517					
Family :	Oocystaceae												
	Ankinstrodesmus densus Korschikoff						1042						
	Ankistrodesmus falcatus (Corda) Ralfs	1042											
	Chlorella sp. Beyerinck	29208	10367	28533	31575			20517			2083	16667	
	Chodatella citriformis Snow									1333			
	Closteriopsis microporum Lemmermann				433								
	Closteriopsis morus Lemmermann	1042	1042	2083							1042		

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Oocystaceae												
	Franceia ovalis (France) Lemmermann	6250	4917	4167	4367						1042		1042
	Franceia aranea (Behre) Fott									1667			
	Kirchneriella dianae (Bohlin) Comas			1042							1042	1042	
	Monoraphidium dybowskii (Wołoszynska) Hindak & Komarkova-Legnerova	1042											
	Monoraphidium mirabile (W & G.S. West) Pankow						1042						
	Monoraphidium pusillum (Printz) Komarkova-Legnerova												
	Siderocelis ornata Fott (Fott)	10417		3125	2083		3125			5834		4167	
	Tetraedron hastatum (Schmidle) Lemmermann								1042				
	Tetraedron trigonum (Nag.) Hansgirg	1042											
Family :	Scenedesmaceae												
	Crucigenia quadrata Morren				3125								
	Didymocystis bicellularis (Chodat) Komarek		850			471							
	Pectodictyon pyramidale Akiyama & Hirose								1617				
	Scenedesmus acutiformis Schroeder			2000		471							
	Scenedesmus armatus (Chod) G.M. Smith					1042							
	Scenedesmus bicaudatus (Hansging) Chodat			1042									
	Scenedesmus bijuga (Turp) Lagerheim		3308	2167									
	Scenedesmus disciformis (Chodat) Fott & Komarek										558		
	Scenedesmus quadricauda (Turp.) Brebisson	1042	4334	2833	1108			1042	1667				
	Tetrastum glabrum (Roll) Ahlstrom and Tiffany	8000	7792	12483						1667	14550		
Order :	Tetrasporales												
Family :	Palmellaceae												
	Sphaerocystis schroeteri Chodat	1042						1517					
Order :	Ulotrichales												
Family :	Ulotrichaceae												
	Ulothrix sp. Kutzing						1042						
Order :	Volvocales												
Family :	Chlamydomonaceae												
	Chlamydomonas sp. Ehrenberg	1042			1042			1042	454				

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Volocaceae												
	Eudorina elegans Ehrenberg	2084	1500	667	1025		1042	3367					
	Pandorina morum Bory		750		1025			31300					
	Gonium pectorale Mueller			1042									
	Gonium sociale (Duj) Warming		1042										
Order :	Zygnematales												
Family :	Desmidiaceae												
	Arthrodesmus incus W & G.S. West	5209	7585	4767						2667	2083		
	Arthrodesmus octocornis Ehrenberg	380916	234550	340017	1025	1042					213750		
	Arthrodesmus ralfsii W. West			3125		471							
	Arthrodesmus validus Scott & Groenblad						1042						
	Closterium dianae Ehrenberg							1933					
	Closterium sp. 1								1783				
	Closterium abruptum (Lyngb.) Brebisson					1879		1042			2875		2083
	Closterium acutum Brebisson	2083	858	1709			192		1042			513	
	Closterium archerianum Cleve				1042								
	Closterium cornu Ehrenberg		1083	4567					3767				
	Closterium gracile Brebisson	5933	3492	11942	2359		2083		1683		3125	1042	3563
	Closterium juncidum Roy			1083	2483	471	1042	1933				1554	458
	Closterium kutzingii Brebisson	1650	3434			1042					1833		
	Closterium limneticum Lemmermann	52841	29092	69684	3175	1042	1042	1042		1042	47467	3125	1042
	Closterium littorale Gay					1042			1042				
	Closterium macilentum Brebisson				1042		479	342	1783				
	Closterium moniliferum Brebisson												1042
	Closterium navicula (Breb) Lutkem							375					
	Closterium parvalum W & G.S. West			1042									
	Closterium peracerosum Gay					1042							
	Closterium praelongum West				1042			1042				1042	
	Closterium pusillum Hantzsch							4167		1042			
	Closterium sp. 2												1042
	Closterium sp. 3										1833		
	Closterium sp. 4							1042					

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Zygnematales												
Family :	Desmidiaceae												
	Closterium stridatum Ehrenb.								1042				
	Closterium subreniforme Nordst						1042						
	Closterium tumidum Johnson								1042				
	Closterium ulna Focke								2084		2083		
	Closterium venus Kutz		1042						1042				
	Cosmarium askenasyi Schm.								1683				
	Cosmarium asphaerosporum Nordst	3125	102700	206192	1042								
	Cosmarium circulare Rinsch		858	1333				3033	1042				
	Cosmarium connatum Breb			1042							3917		
	Cosmarium contractum Kirchner			4333									
	Cosmarium germinatum Lundell					1042							
	Cosmarium moniliforme (Turp.) Ralfs	1042											
	Cosmarium obsoletum (Hantzsch) Reinsch		750										
	Cosmarium phaseolus Boldt				1042	1513	192				83767		
	Cosmarium sp. 1						1042				1833		
	Cosmarium sp. 2							1517					
	Cosmarium sp. 3			1042									
	Cosmarium sphaerosporum					1042		2083					
	Cosmarium sportella Brebisson												
	Cosmarium tinctum Ralfs	4167	1900	10000	3467			2058			2083		
	Cosmarium undulatum Wittr	1042			2083								
	Euastrum elegans Kutzing	3833	1042						2083		2083		
	Euastrum sinuosum Lenor					1042							
	Euastrum zygodon Ehr								1042				
	Gonatozygon brebissonii De Bary		1083					2083					
	Gonatozygon Kinahani (Arch.) Rabenhorst	1042	1042		4605	3496	1233	5683	21708			1042	2083
	Gonatozygon montaenium DeBary	1042	2084		1042		3125	2458	4167		2083	1042	
	Gonatozygon pilosum Wolle	2084		2083	2083	2554	7292	2850	2146		1042	2596	
	Hyalotheca dissiliens (Smith) Brebisson				1042								1042
	Hyalotheca sp. Ehrenberg				1042								
	Micrasterias radiosa Ralfs							375					

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Zygnematales												
Family :	Desmidiaceae												
	Netrium oblongum (De Bary) Luetkamueller	8333	1042		6526	1308	2083	3550	4808	2350	1042	3125	
	Netrium sp. Nageli								1783				
	Pleurotaenium sp. Nageli							2558					
	Pleurotaenium subcoronulatum (Turner)						1042						
	Spondylosium javanicum (Gutw.) Gronblad							5050					
	Staurastrum sp. 1									1042			
	Staurastrum aculiferum (West) Anders										1617		
	Staurastrum apiculatum Breb			4333	2217								
	Staurastrum arachne W. and G.S. West	4517	1717	1842									
	Staurastrum arctiscon (Ehr.) Lund		1042	1042		421							
	Staurastrum astrias	708											
	Staurastrum avicula Breb			667									
	Staurastrum chaeloceras (Shrod.) G.M. Smith	1750	4900	5234						2350	6000		
	Staurastrum cingulum Scott & Gronblad		1792										
	Staurastrum diptilum Nordstedt	20442	19933	53225		471		12200	513		46858		
	Staurastrum elongatum	1417									4167		
	Staurastrum furcatum (Ehr.) Breb.		733										
	Staurastrum gladiosum Turner			1175	1042								
	Staurastrum gracile Ralfs								1042				
	Staurastrum hexacerum (Ehren.) Wittrock			667									
	Staurastrum limneticum G.M. Smith		1500	1175		1042	1379				2083		
	Staurastrum manfeldii Schumacher	4166		1042									
	Staurastrum obiculare Roy et Biss			3217									
	Staurastrum paradox		14583										
	Staurastrum paradoxum Meyen	33675	27600	38208	1025		3125	2725			19833		
	Staurastrum pentacerum (Wolle) G.M. Smith	2083		9533				1042			1042		
	Staurastrum pseudopelagicum W & G.S. West	1350		1083									
	Staurastrum sp. 2	1042											
	Staurastrum sp. 3		1042										
	Staurastrum sp. 4				1042								
	Staurastrum sp. 5						479						

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Zygnematales												
Family :	Desmidiaceae												
	Staurastrum sp. 6												
	Staurastrum sp. 7		1042								1833		
	Staurastrum sp. 8			1083									
	Staurastrum sp. 9							1042					
	Staurastrum sp. 10		1500										
	Staurastrum sp. 11										2083		
	Staurastrum sp. 12										1617		
	Staurastrum subcriciatum Cooke & Wille	1417	858	2350									
	Staurastrum tetracerum Ralfs	118400	91117	183617	2217	1042		1683	1042		98642		
	Staurastrum Tohopekaligense W & G.S.W.	1042	1042										
	Staurastrum triangularis	20666	29609	63766	1042	2083	1042	1042					
	Staurastrum zonatum Borges	1042	3550	4167			1042	2083			31083		
	Straurastrum clevei (Wittr.) Roy et Biss	708											
	Triploceras gracile Bailey					471							
	Xanthidium hastiferum Turner		758								1833		
Division	**Chrysophyta**												
Class :	Bacillariophyta												
Order :	Achnanthales												
Family :	Achnanthaceae												
	Achnanthes chilensis Reimer						1042					13542	
	Achnanthes sp. Bory	1042	1042										
	Rhoicosphenia curvata (Kutz) Grun			1042	1042			3125					
Order :	Epithemiales												
Family :	Epithemiaceae												
	Ephithemia zebra (Grun.) A. Mayer											529	

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Eunotiales												
Family :	Eunotiaceae												
	Eunotia arcus Ehrenberg				1042								
	Eunotia elegans Oestrup						1042						
	Eunotia glacialis Meister							375					
	Eunotia lunaris Grun.								8417			3125	
	Eunotia microcephala Kraske										1042		
	Eunotia quarternaria Ehrenberg					1042			1042				
	Eunotia robusta Ralfs												
	Eunotia serra (Ehr) Patrick						1042		1042				
	Eunotia sp. 1								1042				
	Eunotia sp. 2						1042						
	Eunotia sp. 3										1042		
	Eunotia sp. 4								3300				
	Eunotia sp. 5								1042				
	Eunotia sp. 6								1042				
	Eunotia tridon Ehrenberg								4850				
	Eunotia zygodon Ehrenberg								6667				
Order :	Eupodiscales												
Family :	Coscinodiscaceae												
	Melosira sp. Agardh					1042							
	Stephanodiscus sp. Ehrenberg	3542			2050								3125
Order :	Fragilariales												
Family :	Diatomaceae												
	Diatoma sp. DeCandolle	1042											
	Diatoma vulgare Bary				4167				4167		1042		
Family :	Fragilariaceae												
	Asterionella formosa Hassal								1683				
	Asterionella sp. Hassal			2083				1042					
	Fragilaria construens (Ehrenberg) Grunow			4167	4475	10888	7292	15625	23429	2804	1042		

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Fragilariaceae												
	Fragilaria intermedia Grunow							1933	5208				
	Fragilaria sp. 1			1175	2955		1042	9642	21075	1042	458	3604	3125
	Fragilaria sp. 2					23958							
	Fragilaria sp. 3						1042	2083					
	Fragilaria sp. 4							1042	2083				
	Fragilaria vaucheriae (Kutz) Grun	1083											
	Fragilaria vulgaris								2083				2083
	Synedra rumpens Kutz								3125				4167
	Synedra sp. 1								2083				
	Synedra sp. 2								7033				
Family :	Tabellariaceae												
	Tabellaria fenastrata (Lung.) Kutzing						192		1042				
	Tabellaria sp.					3125							
Order :	Naviculales												
Family :	Cymbellaceae								1042				
	Cymbella tumidula Grunow												
	Cymbella turgida (Greg) Cleve	1042											
Family :	Naviculaceae												
	Amphiphora costata (Kutz.) Husedt			1042									
	Frustulia vulgaris Thwaites	3101	1042	7558	7196	5208	671	7292	15663	1042	2083	2083	6250
	Frustulia rhomboides (Her.) de Toni							5283	12850		2083		
	Gomphonema contrictum (Ehr.) Cleve				1042								
	Gomphonema gracile Ehrenberg						1042						
	Navicula cryptocephala Kutz					942							
	Navicula elegans W. Smith										1042	1042	
	Navicula placenta Ehr.								2083	2083		1042	1042
	Navicula radiosa (Breb) Cleve		1042		1042			4167	2083			1042	
	Navicula sp. 1	1042											
	Navicula sp. 2		1717										

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Naviculaceae												
	Navicula sp. 3		1042										
	Navicula sp. 4				1317								
	Navicula sp. 5						1042						
	Navicula sp. 6											2083	
	Navicula sp. 7										1042		
	Navicula sp. 8										2083		
	Navicula sp. 9			1175									
	Navicula sp. 10				1042								
	Navicula sp. 11							1517					
	Navicula sp. 12								1042				
	Navicula viridis (Kutz) Cleve	1650		667	4167	888	388					2083	
	Neidium bisulcatum (Schy. & Meyer) Reimer								1783				
	Pinnularia sp. 1				438								
	Pinnularia biceps Gregory	1042		1042									
	Pinnularia latevittata Cleve @ *macilenta* Ehr								1783				
	Pinnularia sp. 2											2083	
	Pinnularia sp. 3		1042										
	Pinnularia sp. 4								1042				
	Pinnularia sp. 5							1042					
	Pinnularia streptoraphe Cleve							342					
	Pinnularia viridis (Nitz) Hustedt					471							
	Pleurosigma strigosum W. Smith	608											
	Stauroneis phoenicentrum Hustedt								3467				
Order :	Nitzschiales												
Family :	Nitzschhiaceae												
	Nitzschia sp. 1								1783				
	Nitzschia sp. 2	1042											
	Nitzschia sp. 3												8333
	Nitzschia sp. 4				2083								
	Nitzschia sp. 5		1042										
	Nitzschia subtilis Grunow				1042								
	Nitzschia thermalis Kutzing					1042							

Phytoplankton abundance (cells/L) at sampling stations 1 to 12 in Tasek Bera (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Rhizosoleniales												
Family :	Rhizosolenials												
	Rhizosolenia sp. Ehrenberg	64584	88542	292375									
Order :	Surirellales												
Family :	Surirellaceae												
	Surirella biseriata (W Smith) Hust								1042				
Class :	Chrysophyceae												
Order :	Ochromonales												
Family :	Dinobryonaceae												
	Dinobryon sertularia Ehrenberg	115266	103583	168742	5100	7292	5400	6908	1042	1042	21813	1042	1042
Family :	Synuraceae												
	Mallomonas splendens (G.S. West) Playfair	37784	12775	15634	6688	4167	11233	3125	2725	5058	7292	2083	
	Mallomonas fresenii Kent	2084	1042	3125	4167			2083					
	Mallomonas sp. Perty						1042						458
	Mallomonas tonsurata Teiling									1333			
Order :	Rhyzochrysidales												
Family :	Rhizochrysidaceae												
	Rhizochrysis limnetica G.M. Smith	7266	6108	1042	2083	1042	338				1017		
Division	**Cyanophyta**												
Class :	Cyanophyceae												
Order :	Oscillatoriales												
Family :	Oscillatoriaceae												
	Oscillatoria sp. Vaucher				1042								
	Phormidium sp. Kutzing										2083		2083
Division	**Euglenophyta**												
Class :	Euglenophyceae												
Order :	Euglenales												
Family :	Euglenaceae												
	Euglena acus Ehrenberg				1042			3767		4000		5208	

Table 11. Phytoplankton abundance (cells.L^{-1}) at sampling stations 1 to 12 in Tasek Bera (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Division	**Euglenophyta**												
Class :	Euglenophyceae												
Order :	Euglenales												
Family :	Euglenaceae												
	Euglena adhaerens Matvienko												2083
	Euglena caudata Hubner								1783			3125	
	Euglena deses Ehrenberg								1783				
	Euglena ehrenbergii Thompson				1042	1042							1042
	Euglena hemichromata Skuja				5267							8333	
	Euglena proxima Dangeard							3867					
	Euglena sciotensis Lackey								1042				
	Euglena sp. 1		3033	1250		3125	1042	3124	1042	9163	7292	4713	1042
	Euglena sp. 2												8333
	Lepocinclis fusiformis (Carter) Lemmermann		5208		1025								
	Lepocinclis gracilicauda Deflandre							9375					
	Lepocinclis ovum (Ehr.) Lemmermann					1042						11458	
	Lepocinclis sp. Perty											529	
	Phacus acuminatus Stokes								4167				
	Phacus circulatus Pochmann		1042		1042				2083				
	Phacus cylindraceus Popova			1042									
	Phacus longicauda (Ehr.) Dujardin	2083								1042			4167
	Phacus obolus Pochman		1042			1042	1042	5208	4850			6250	5208
	Phacus raciborskii Drezepolski							1042					
	Phacus sp. Dujardin		2083	2083									
	Phacus suecius Lemmermann								1042				
	Phacus tripteris Dujardin	1042	850									1042	
	Stombomonas rotunda (Playfair) Deflandre									2667			
	Strombomonas napiformis (Playfair) Deflandre											2083	
	Trachelomonas abrupta Swirenko				1108								
	Trachelomonas acutum	2083											
	Trachelomonas armata (Ehrenberg) Stein	1350										8333	1042
	Trachelomonas armatum		858										
	Trachelomonas bacillifera Playfair											9375	
	Trachelomonas gibberosa Playfair									3333			

Table 11. Phytoplankton abundance (cells.L^{-1}) at sampling stations 1 to 12 in Tasek Bera (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Division	**Euglenophyta**												
Class :	Euglenophyceae												
Order :	Euglenales												
Family :	Euglenaceae												
	Trachelomonas rotunda Swirenko							1042					
	Trachelomonas sp. 1		5208	7292	433	12500		12450			2083	16667	
	Trachelomonas sp. 2					5208	192	4167				2083	
	Trachelomonas sp. 3								8550	6250	87567	14038	4167
	Trachelomonas volvocina Ehrenberg	117491	59334	88484	75941	8333	17708	25342	17875	68721	59479	80158	33021
Division	**Pyrrhophyta**												
Class :	Dinophyceae												
Order :	Peridiniales												
Family :	Peridiniaceae												
	Peridinium aculiferum Lemmermann	118734	37475	216108	44591	12500	13542	43042	32492		6250	8333	56688
	Peridinium inconspicuum Lemmermann							4167					
	Peridinium sp. Ehrenberg			11459	5208	3125		2083	1042				1042
Division	**Xanthophyta**												
Class :	Xanthophyceae												
Order :	Heterococcales												
Family :	Mischococcaceae												
	Peroniella planktonica G.M. Smith				3125	5208							
												37500	3125
Family :	Pleurochloridaceae												
	Asterogloea gelatinosa Pascher				1317								
Order :	Mischococales												
Family :	Scidiaceae												
	Ophiocytium capitatum Wolle			1042									
TOTAL		1254089	1001502	1955086	287915	144696	107985	330454	292785	130574	827933	292610	166065

Figure 34. Phytoplankton common in Tasek Bera : *Arthrodesmus octocornis* (0.4 μm)

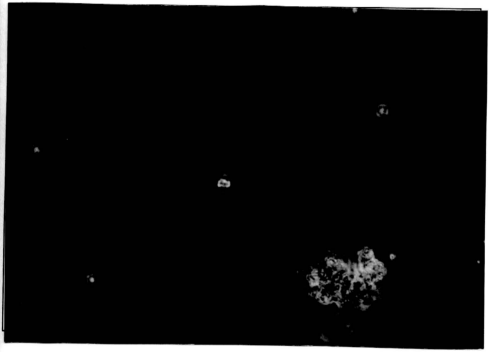


Figure 35. Phytoplankton common in Tasek Bera : *Cosmarium aspherosporum* (0.2 μm)

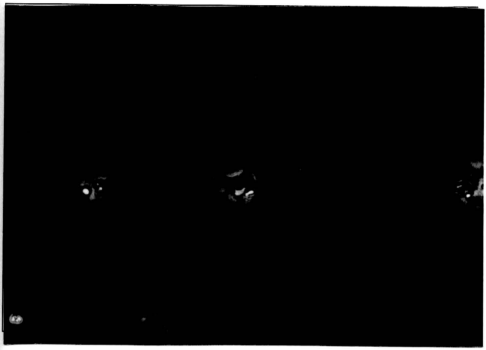


Figure 36. Phytoplankton common in Tasek Bera :
Staurastrum tetracerum (0.9 μm)

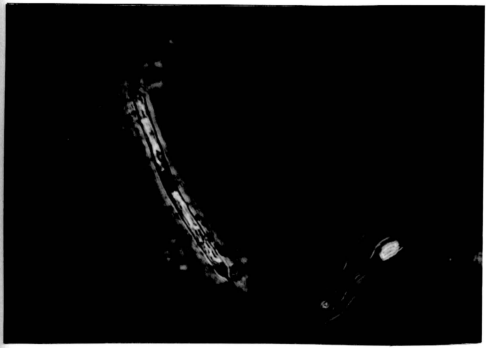


Figure 37. Phytoplankton common in Tasek Bera : *Rhizosolenia* sp. (2.2 μm)

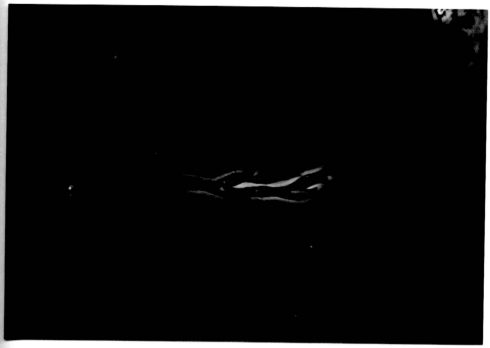


Figure 38. Phytoplankton common in Tasek Bera :
Dinobryon sertularia (2.5 µm)

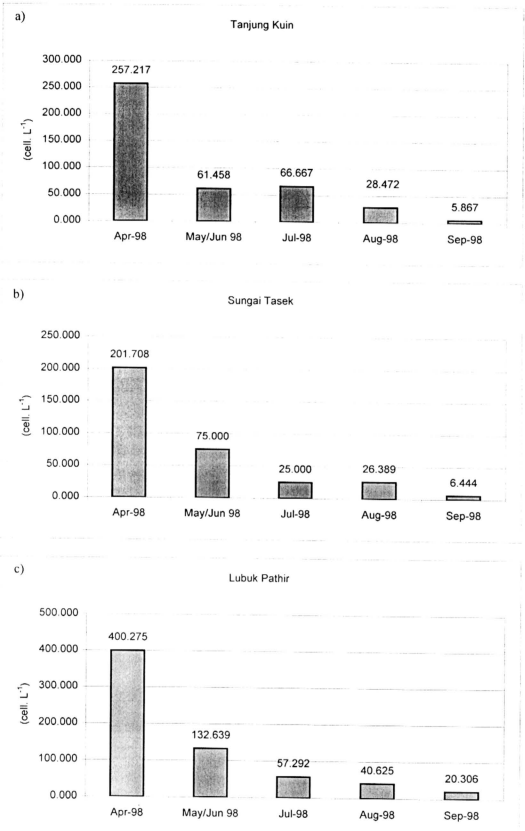
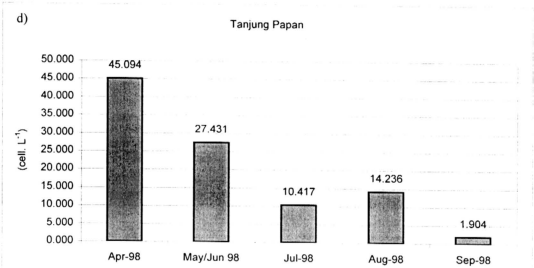
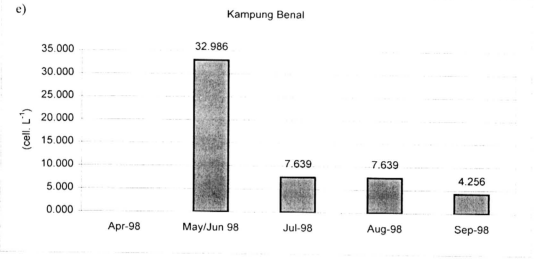


Figure 39. Phytoplankton cell count for sampling stations in Tasek Bera (April - September 1998)
a) Tanjung Kuin
b) Sungai Tasik
c) Lubuk Pathir





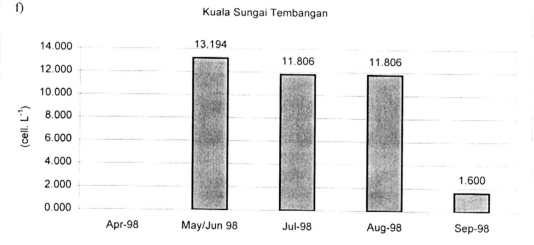


Figure 39. Phytoplankton cell count for sampling stations in Tasek Bera (April - September 1998) (continued)
d) Tanjung Papan
e) Kampung Benal
f) Kuala Sungai Tembangan

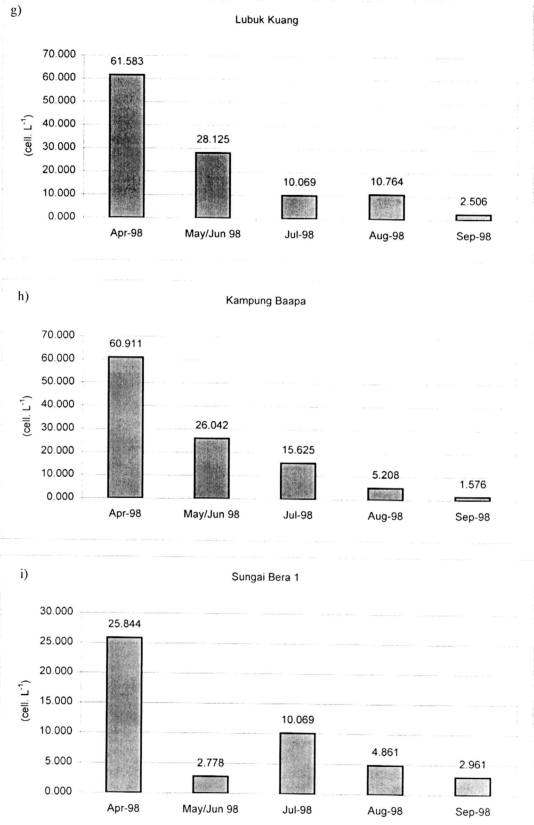


Figure 39. Phytoplankton cell count for sampling stations in Tasek Bera (April - September 1998) (continued)
g) Lubuk Kuang
h) Kampung Baapa
i) Sungai Bera 1

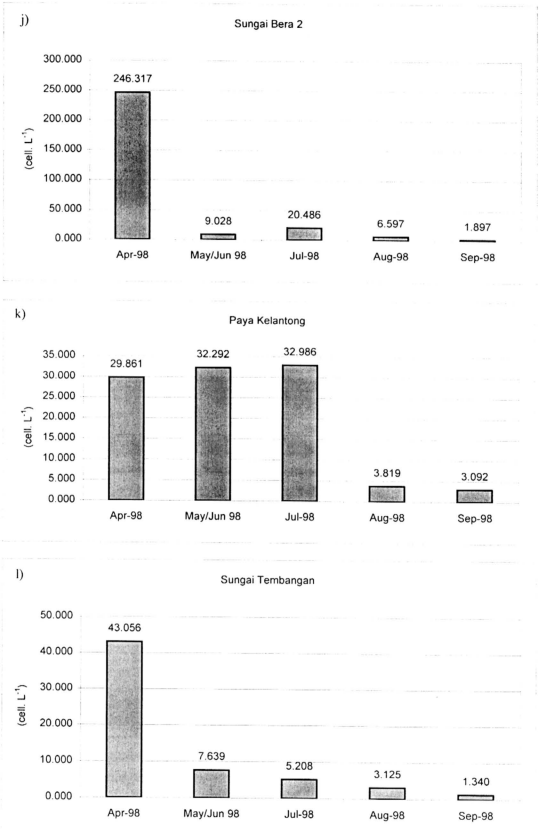


Figure 39. Phytoplankton cell count for sampling stations in Tasek Bera (April - September 1998) (continued)
j) Sungai Bera 2
k) Paya Kelantong
l) Sungai Tembangan

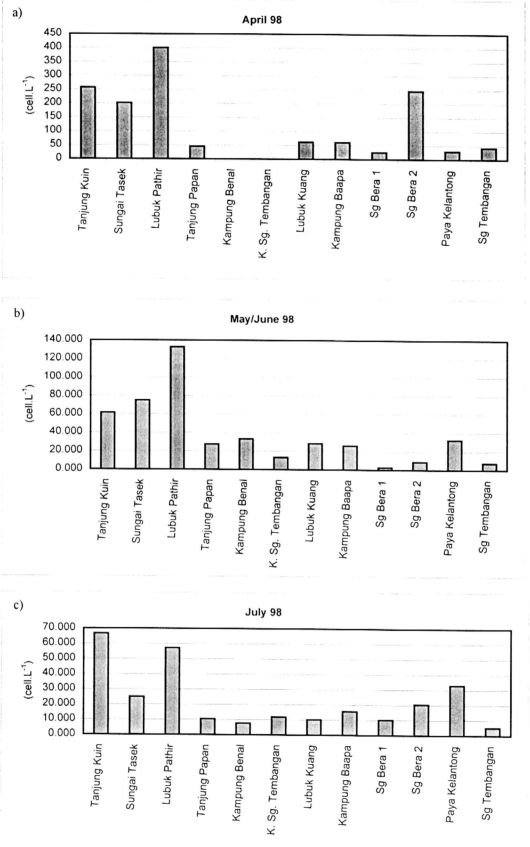


Figure 40. Phytoplankton cell counts by month for all sampling stations in Tasek Bera
a) April 1998
b) May/June 1998
c) July 1998

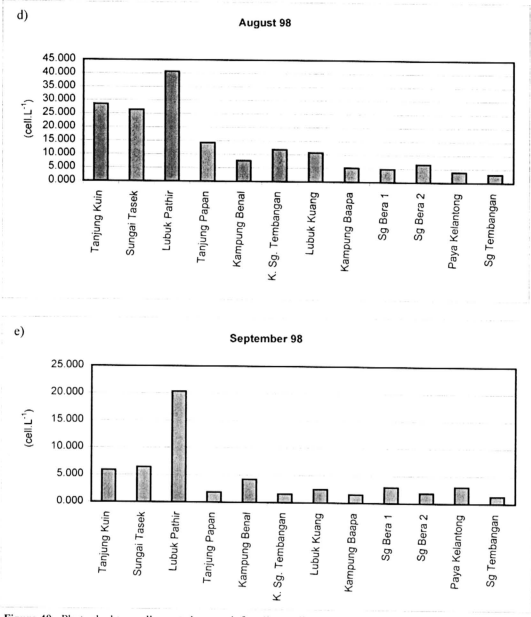


Figure 40. Phytoplankton cell counts by month for all sampling stations in Tasek Bera (continued)
d) August 1998
e) September 1998

4.2.3.2 Frequency (%) of phytoplankton

The frequency (%) values for each phytoplankton species at all stations from April to September 98 are found in Table 12. It ranged from 0.05% to 52.6%. *Arthrodesmus octocornis* occurred with the highest frequency in Station 1 (Tanjung Kuin) at 30.4%, Station 2 (Sungai Tasik) at 23.4%, Station 3 (Lubuk Pathir) at 17.4% and Station 10 (Sungai Bera 2) at 25.8%. *Trachelomonas volvocina* occurred with the highest frequency in Station 4 (Tanjung Papan) at 26.4%, Station 6 (Kuala Sungai Tembangan) at 16.4%, Station 9 (Sungai Bera 1) at 52.6% and Station 11 (Paya Kelantong) at 27.4%. *Peridinium aculiferum* were found in the highest frequency at Station 7 (Lubuk Kuang) at 13%, Station 8 (Kampung Baapa) at 11.1% and Station 12 (Sungai Tembangan) at 34.1%. *Fragilaria* sp. was found with the highest frequency in Station 5 (Kampung Benal) at 16.6%.

4.2.3.3 Diversity indices

Appendix 12 shows the Shannon-Weiner diversity index (H' value) of the phytoplankton for the 12 stations from April to September 1998. It ranged from 0.0000 to 1.6726.

In Figure 41, stations that showed little fluctuation in the H' value include Station 5 (Kampung Benal), Station 6 (Kuala Sungai Tembangan) and Station 7 (Lubuk Kuang). However, Station 1 (Tanjung Kuin), Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir), Station 4 (Tanjung Papan), Station 10 (Sungai Bera 2), Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) showed slight increase in the H' value from April to August before decreasing in September 1998. Station 8 (Kampung Baapa) and Station 9 (Sungai Bera 1) recorded decreasing H' value from April to September 1998.

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Division	**Chlorophyta**												
Class :	Chlorophyceae												
Order :	Chlorococcales												
Family :	Characiaceae												
	Schroederia spiralis (Printz) Korschikoff	0.1661	0.1897	0.3197	0.3619								
	Schroederia setigera (Schroed.) Lemmermann		0.1040										
Family :	Coelastraceae												
	Coelastrum astroideum De Notaris			0.0533				0.3153					
	Coelastrum polychordum (Korschikoff) Hindak	0.0684											
	Coelastrum reticulatum (Dangeard) Senn	0.1661											
Family :	Dictyosphaeriaceae												
	Dictyosphaenium pulchellum Wood			0.0533		0.7201							
	Dictyosphaenium tetrachotomum Printz							0.5093					
Family :	Hydrodictyaceae												
	Pediastrum duplex Meyen	0.3036	0.7281	0.3755		0.5791	0.9649	0.3153			0.6683		
	Pediastrum duplex var. gracillimum West & West	0.0485	0.3662	0.0533									
	Pediastrum simplex (Meyen) Lemmermann			0.0533									
Family :	Micratiniaceae												
	Golenkinia radiata Chodat	0.2492	0.3120	0.1748	0.3619		0.1778				0.3210	0.3561	
Family :	Radiococcaceae												
	Coenocystis subcylindrica Korschikoff	0.083						3.949					
	Coenocystis planctonica Korschikoff	0.196	1.445	0.087		0.720	0.965	0.459					
Family :	Oocystaceae												
	Ankinstrodesmus densus Korschikoff						0.965						
	Ankistrodesmus falcatus (Corda) Ralfs	0.083											
	Chlorella sp Beyerinck	2.329	1.035	1.459	10.967			6.209			0.252	5.696	
	Chodatella citriformis Snow									1.021			
	Closteriopsis microporum Lemmermann				0.150								
	Closteriopsis morus Lemmermann	0.083	0.104	0.107							0.126		

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Oocystaceae												
	Franceia ovalis (France) Lemmermann	0.498	0.491	0.213	1.517						0.126		0.627
	Franceia aranea (Behre) Fott									1.277			
	Kirchneriella dianae (Bohlin) Comas			0.053									
	Monoraphidium dybowskii (Woloszynska) Hindak & Komarkova-Legnerova										0.126	0.356	
	Monoraphidium mirabile (W & G.S. West) Pankow	0.083											
	Monoraphidium pusillum (Printz) Komarkova-Legnerova						0.965						
	Siderocelis ornata Fott (Fott)	0.831		0.160	0.723		2.894			4.468		1.424	
	Tetraedron hastatum (Schmidle) Lemmermann								0.356				
	Tetraedron trigonum (Nag.) Hansgirg	0.083											
Family :	Scenedesmaceae												
	Crucigenia quadrata Morren				1.085								
	Didymocystis bicellularis (Chodat) Komarek		0.085			0.326							
	Pectodictyon pyramidale Akiyama & Hirose								0.552				
	Scenedesmus acutiformis Schroeder			0.102		0.326							
	Scenedesmus armatus (Chod) G.M. Smith					0.720							
	Scenedesmus bicaudatus (Hansging) Chodat			0.053									
	Scenedesmus bijuga (Turp) Lagerheim		0.330	0.111									
	Scenedesmus disciformis (Chodat) Fott & Komarek										0.067		
	Scenedesmus quadricauda (Turp.) Brebisson	0.083	0.433	0.145	0.385			0.315	0.569				
	Tetrastum glabrum (Roll) Ahlstrom and Tiffany	0.638	0.778	0.638						1.277	1.757		
Order :	Tetrasporales												
Family :	Palmellaceae												
	Sphaerocystis schroeteri Chodat	0.083						0.459					
Order :	Ulotrichales												
Family :	Ulotrichaceae												
	Ulothrix sp. Kutzing						0.965						
Order :	Volvocales												
Family :	Chlamydomonaceae												
	Chlamydomonas sp. Ehrenberg	0.083			0.362			0.315	0.155				

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Volvocaceae												
	Eudorina elegans Ehrenberg	0.166	0.150	0.034	0.356		0.965	1.019					
	Pandorina morum Bory		0.075		0.356			9.472					
	Gonium pectorale Mueller			0.053									
	Gonium sociale (Duj) Warming		0.104										
Order :	Zygnematales												
Family :	Desmidiaceae												
	Arthrodesmus incus W & G.S. West	0.415	0.757	0.244						2.043	0.252		
	Arthrodesmus octocornis Ehrenberg	30.374	23.420	17.391	0.356	0.720					25.817		
	Arthrodesmus ralfsii W. West			0.160		0.326							
	Arthrodesmus validus Scott & Groenblad						0.965						
	Closterium dianae Ehrenberg							0.585					
	Closterium sp. 1								0.609				
	Closterium abruptum (Lyngb.) Brebisson					1.299		0.315			0.347		1.254
	Closterium acutum Brebisson	0.166	0.086	0.087			0.178		0.356			0.175	
	Closterium archerianum Cleve				0.362								
	Closterium cornu Ehrenberg		0.108	0.234					1.287				
	Closterium gracile Brebisson	0.473	0.349	0.611	0.819		1.929		0.575		0.377	0.356	2.146
	Closterium juncidum Roy			0.055	0.862	0.326	0.965	0.585				0.531	0.276
	Closterium kutzingii Brebisson	0.132	0.343			0.720					0.221		
	Closterium limneticum Lemmermann	4.213	2.905	3.564	1.103	0.720	0.965	0.315		0.798	5.733	1.068	0.627
	Closterium littorale Gay					0.720			0.356				
	Closterium macilentum Brebisson				0.362		0.444	0.103	0.609				
	Closterium moniliferum Brebisson												0.627
	Closterium navicula (Breb) Lutkem							0.113					
	Closterium parvalum W & G.S. West			0.053									
	Closterium peracerosum Gay					0.720							
	Closterium praelongum West				0.362			0.315				0.356	
	Closterium pusillum Hantzsch							1.261		0.798			
	Closterium sp. 2												0.627
	Closterium sp. 3										0.221		
	Closterium sp. 4							0.315					

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Zygnematales												
Family :	Desmidiaceae												
	Closterium stridatum Ehrenb.								0.356				
	Closterium subreniforme Nordst						0.965						
	Closterium tumidum Johnson								0.356				
	Closterium ulna Focke								0.712		0.252		
	Closterium venus Kutz		0.104						0.356				
	Cosmarium askenasyi Schm.								0.575				
	Cosmarium asphaerosporum Nordst	0.249	10.255	10.546	0.362								
	Cosmarium circulare Rinsch		0.086	0.068				0.918	0.356				
	Cosmarium connatum Breb			0.053							0.473		
	Cosmarium contractum Kirchner			0.222									
	Cosmarium germinatum Lundell					0.720							
	Cosmarium moniliforme (Turp.) Ralfs	0.083											
	Cosmarium obsoletum (Hantzsch) Reinsch		0.075										
	Cosmarium phaseolus Boldt				0.362	1.046	0.178				10.118		
	Cosmarium sp. 1										0.221		
	Cosmarium sp. 2						0.965						
	Cosmarium sp. 3							0.459					
	Cosmarium sphaerosporum			0.053									
	Cosmarium sportella Brebisson					0.720		0.630					
	Cosmarium tinctum Ralfs	0.332	0.190	0.511	1.204			0.623			0.252		
	Cosmarium undulatum Wittr	0.083			0.723								
	Euastrum elegans Kutzing	0.306	0.104						0.711		0.252		
	Euastrum sinuosum Lenor					0.720							
	Euastrum zygodon Ehr								0.356				
	Gonatozygon brebissonii De Bary		0.108					0.630					
	Gonatozygon Kinahani (Arch.) Rabenhorst	0.083	0.104		1.599	2.416	1.142	1.720	7.414			0.356	1.254
	Gonatozygon montaenium DeBary	0.083	0.208		0.362		2.894	0.744	1.423		0.252	0.356	
	Gonatozygon pilosum Wolle	0.166		0.107	0.723	1.765	6.753	0.862	0.733		0.126	0.887	
	Hyalotheca dissiliens (Smith) Brebisson				0.362								0.627
	Hyalotheca sp. Ehrenberg				0.362								
	Micrasterias radiosa Ralfs							0.113					

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Zygnematales												
Family :	Desmidiaceae												
	Netrium oblongum (De Bary) Luetkamueller	0.664	0.104		2.267	0.904	1.929	1.074	1.642	1.800	0.126	1.068	
	Netrium sp.								0.609				
	Pleurotaenium sp.							0.774					
	Pleurotaenium subcoronulatum (Turner)						0.965						
	Spondylosium javanicum (Gutw.) Gronblad							1.528					
	Staurastrum sp. 1									0.798			
	Staurastrum aculiferum (West) Anders										0.195		
	Staurastrum apiculatum Breb			0.222	0.770								
	Staurastrum arachne W. and G.S. West	0.360	0.171	0.094									
	Staurastrum arctiscon (Ehr.) Lund		0.104	0.053		0.291							
	Staurastrum astrias	0.056											
	Staurastrum avicula Breb			0.034									
	Staurastrum chaetoceras (Shrod.) G.M. Smith	0.140	0.489	0.268						1.800	0.725		
	Staurastrum cingulum Scott & Gronblad		0.179										
	Staurastrum diptilum Nordstedt	1.630	1.990	2.722		0.326		3.692	0.175		5.660		
	Staurastrum elongatum	0.113									0.503		
	Staurastrum furcatum (Ehr.) Breb.		0.073										
	Staurastrum gladiosum Turner			0.060	0.362								
	Staurastrum gracile Ralfs								0.356				
	Staurastrum hexacerum (Ehren.) Wittrock			0.034									
	Staurastrum limneticum G.M. Smith		0.150	0.060		0.720	1.277				0.252		
	Staurastrum manfeldii Schumacher	0.332		0.053									
	Staurastrum obiculare Roy et Biss			0.165									
	Staurastrum paradox		1.456										
	Staurastrum paradoxum Meyen	2.685	2.756	1.954	0.356		2.894	0.825			2.395		
	Staurastrum pentacerum (Wolle) G.M. Smith	0.166		0.488				0.315			0.126		
	Staurastrum pseudopelagicum W & G.S. West	0.108		0.055									
	Staurastrum sp. 2	0.083											
	Staurastrum sp. 3		0.104										
	Staurastrum sp. 4				0.362								
	Staurastrum sp. 5						0.444						

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Zygnematales												
Family :	Desmidiaceae												
	Staurastrum sp. 6										0.221		
	Staurastrum sp. 7		0.104										
	Staurastrum sp. 8			0.055									
	Staurastrum sp. 9							0.315					
	Staurastrum sp. 10		0.150										
	Staurastrum sp. 11										0.252		
	Staurastrum sp. 12										0.195		
	Staurastrum subcriciatum Cooke & Wille	0.113	0.086	0.120									
	Staurastrum tetracerum Ralfs	9.441	9.098	9.392	0.770	0.720		0.509	0.356		11.914		
	Staurastrum Tohopekaligense W & G.S.W.	0.083	0.104										
	Staurastrum triangularis	1.648	2.956	3.262	0.362	1.440	0.965	0.315					
	Staurastrum zonatum Borges	0.083	0.354	0.213			0.965	0.630			3.754		
	Straurastrum clevei (Wittr.) Roy et Biss	0.056											
	Triploceras gracile Bailey					0.326							
	Xanthidium hastiferum Turner		0.076								0.221		
Division	**Chrysophyta**												
Class :	Bacillariophyta												
Order :	Achnanthales												
Family :	Achnanthaceae												
	Achnanthes chilensis Reimer						0.965					4.628	
	Achnanthes sp. Bory	0.083	0.104										
	Rhoicosphenia curvata (Kutz) Grun			0.053	0.362			0.946					
Order :	Epithemiales												
Family :	Epithemiaceae												
	Ephithemia zebra (Grun.) A. Mayer											0.181	

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Eunotiales												
Family :	Eunotiaceae												
	Eunotia arcus Ehrenberg				0.362								
	Eunotia elegans Oestrup						0.965						
	Eunotia glacialis Meister							0.113					
	Eunotia lunaris Grun.								2.875			1.068	
	Eunotia microcephala Kraske										0.12586		
	Eunotia quarternaria Ehrenberg					0.720			0.356				
	Eunotia robusta Ralfs												
	Eunotia serra (Ehr) Patrick						0.965		0.356				
	Eunotia sp. 1								0.356				
	Eunotia sp. 2						0.965						
	Eunotia sp. 3										0.12586		
	Eunotia sp. 4								1.127				
	Eunotia sp. 5								0.356				
	Eunotia sp. 6								0.356				
	Eunotia tridon Ehrenberg								1.657				
	Eunotia zygodon Ehrenberg								2.277				
Order :	Eupodiscales												
Family :	Coscinodiscaceae												
	Melosira sp. Agardh					0.720							
	Stephanodiscus sp. Ehrenberg	0.282			0.712								1.882
Order :	Fragilariales												
Family :	Diatomaceae												
	Diatoma sp. DeCandolle	0.083											
	Diatoma vulgare Bary				1.447				1.423		0.126		
Family :	Fragilariaceae												
	Asterionella formosa Hassal								0.575				
	Asterionella sp. Hassal			0.107				0.315					
	Fragilaria construens (Ehrenberg) Grunow			0.213	1.554	7.525	6.753	4.728	8.002	2.147	0.126		

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Family :	Fragilariaceae												
	Fragilaria intermedia Grunow							0.585	1.779				
	Fragilaria sp. 1			0.060	1.026		0.965	2.918	7.198	0.798	0.055	1.232	1.882
	Fragilaria sp. 2					16.557							
	Fragilaria sp. 3						0.965	0.630					
	Fragilaria sp. 4							0.315	0.711				
	Fragilaria vaucheriae (Kutz) Grun	0.086											
	Fragilaria vulgaris								0.711				1.254
	Synedra rumpens Kutz								1.067				2.509
	Synedra sp. 1								0.711				
	Synedra sp. 2								2.402				
Family :	Tabellariaceae												
	Tabellaria fenastrata (Lung.) Kutzing						0.178		0.356				
	Tabellaria sp. Ehrenberg					2.160							
Order :	Naviculales												
Family :	Cymbellaceae												
	Cymbella tumidula Grunow								0.356				
	Cymbella turgida (Greg) Cleve	0.083											
Family :	Naviculaceae												
	Amphiphora costata (Kutz.) Husedt			0.053									
	Frustulia vulgaris Thwaites	0.247	0.104	0.387	2.499	3.599	0.621	2.207	5.350	0.798	0.252	0.712	3.764
	Frustulia rhomboides (Her.) de Toni							1.599	4.389		0.252		
	Gomphonema contrictum (Ehr.) Cleve				0.362								
	Gomphonema gracile Ehrenberg						0.965						
	Navicula cryptocephala Kutz					0.651							
	Navicula elegans W. Smith										0.126	0.356	
	Navicula placenta Ehr.								0.711	1.595		0.356	0.627
	Navicula radiosa (Breb) Cleve		0.104		0.362			1.261	0.711			0.356	
	Navicula sp. 1	0.083											
	Navicula sp. 2		0.171										

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Naviculales												
Family :	Naviculaceae												
	Navicula sp. 3		0.104										
	Navicula sp. 4				0.457								
	Navicula sp. 5						0.965						
	Navicula sp. 6											0.712	
	Navicula sp. 7										0.126		
	Navicula sp. 8										0.252		
	Navicula sp. 9			0.060									
	Navicula sp. 10				0.362								
	Navicula sp. 11							0.459					
	Navicula sp. 12								0.356				
	Navicula viridis (Kutz) Cleve	0.132		0.034	1.447	0.614	0.359					0.712	
	Neidium bisulcatum (Schy. & Meyer) Reimer								0.609				
	Pinnularia sp. 1				0.152								
	Pinnularia biceps Gregory	0.083		0.053									
	Pinnularia latevittata Cleve								0.609				
	Pinnularia sp. 2											0.712	
	Pinnularia sp. 3		0.104										
	Pinnularia sp. 4								0.356				
	Pinnularia sp. 5							0.315					
	Pinnularia streptoraphe Cleve							0.103					
	Pinnularia viridis (Nitz) Hustedt					0.326							
	Pleurosigma strigosum W. Smith	0.048											
	Stauroneis phoenicentrum Hustedt								1.184				
Order :	Nitzschiales												
Family :	Nitzschhiaceae												
	Nitzschia sp. 1								0.609				
	Nitzschia sp. 2	0.083											5.018
	Nitzschia sp. 3												
	Nitzschia sp. 4				0.723								
	Nitzschia sp. 5		0.104										
	Nitzschia subtilis Grunow				0.362								
	Nitzschia thermalis Kutzing					0.720							

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Order :	Rhizosoleniales												
Family :	Rhizosolenials												
	Rhizosolenia sp. Ehrenberg	5.150	8.841	14.955									
Order :	Surirellales												
Family :	Surirellaceae												
	Surirella biseriata (W Smith) Hust								0.356				
Class :	Chrysophyceae												
Order :	Ochromonales												
Family :	Dinobryonaceae												
	Dinobryon sertularia Ehrenberg	9.191	10.343	8.631	1.771	5.040	5.001	2.090	0.356	0.798	2.635	0.356	0.627
Family :	Synuraceae												
	Mallomonas splendens (G.S. West) Playfair	3.013	1.276	0.800	2.323	2.880	10.402	0.946	0.931	3.874	0.881	0.712	
	Mallomonas fresenii Kent	0.166	0.104	0.160	1.447			0.630					
	Mallomonas sp. Perty						0.965						0.276
	Mallomonas tonsurata Teiling									1.021			
Order :	Rhyzochrysidales												
Family :	Rhizochrysidaceae												
	Rhizochrysis limnetica G.M. Smith	0.579	0.610	0.053	0.723	0.720	0.313				0.123		
Division	**Cyanophyta**												
Class :	Cyanophyceae												
Order :	Oscillatoriales												
Family :	Oscillatoriaceae												
	Oscillatoria sp. Vaucher				0.362								
	Phormidium sp. Kutzing										0.252		1.254
Division	**Euglenophyta**												
Class :	Euglenophyceae												
Order :	Euglenales												
Family :	Euglenaceae												
	Euglena acus Ehrenberg				0.362			1.140		3.063		1.780	

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Division	**Euglenophyta**												
Class :	Euglenophyceae												
Order :	Euglenales												
Family :	Euglenaceae												
	Euglena adhaerens Matvienko												1.254
	Euglena caudata Hubner								0.609			1.068	
	Euglena deses Ehrenberg								0.609				
	Euglena ehrenbergii Thompson				0.362	0.720							0.627
	Euglena hemichromata Skuja				1.829							2.848	
	Euglena proxima Dangeard							1.170					
	Euglena sciotensis Lackey								0.356				
	Euglena sp. 1		0.303	0.064		2.160	0.965	0.945	0.356	7.017	0.881	1.611	0.627
	Euglena sp. 2												5.018
	Lepocinclis fusiformis (Carter) Lemmermann		0.520		0.356								
	Lepocinclis gracilicauda Deflandre							2.837					
	Lepocinclis ovum (Ehr.) Lemmermann					0.720						3.916	
	Lepocinclis sp. Perty											0.181	
	Phacus acuminatus Stokes								1.423				
	Phacus circulatus Pochmann		0.104		0.362				0.711				
	Phacus cylindraceus Popova			0.053									
	Phacus longicauda (Ehr.) Dujardin	0.166								0.798			2.509
	Phacus obolus Pochman		0.104			0.720	0.965	1.576	1.657			2.136	3.136
	Phacus raciborskii Drezepolski							0.315					
	Phacus sp. Dujardin		0.208	0.107									
	Phacus suecius Lemmermann								0.356				
	Phacus tripteris Dujardin	0.083	0.085									0.356	
	Stombomonas rotunda (Playfair) Deflandre									2.043			
	Strombomonas napiformis (Playfair) Deflandre											0.712	
	Trachelomonas abrupta Swirenko				0.385								
	Trachelomonas acutum	0.166											
	Trachelomonas armata (Ehrenberg) Stein	0.108										2.848	0.627
	Trachelomonas armatum		0.086										
	Trachelomonas bacillifera Playfair											3.204	
	Trachelomonas gibberosa Playf @ Strombomonas girardiana									2.553			

Table 12. Frequency (%) of phytoplankton for sampling station 1 to 12 in Tasek Bera (April - October 1998) (continued)

		Stations											
		1	2	3	4	5	6	7	8	9	10	11	12
Division	**Euglenophyta**												
Class :	Euglenophyceae												
Order :	Euglenales												
Family :	Euglenaceae												
	Trachelomonas rotunda Swirenko							0.315					
	Trachelomonas sp. 1		0.520	0.373	0.150	8.639		3.768			0.252	5.696	
	Trachelomonas sp. 2					3.599	0.178	1.261				0.712	
	Trachelomonas sp. 3								2.920	4.787	10.577	4.798	2.509
	Trachelomonas volvocina (9a May) Ehrenberg	9.369	5.925	4.526	26.376	5.759	16.399	7.669	6.105	52.630	7.184	27.394	19.884
Division	**Pyrrhophyta**												
Class :	Dinophyceae												
Order :	Peridiniales												
Family :	Peridiniaceae												
	Peridinium aculiferum Lemmermann	9.468	3.742	11.054	15.488	8.639	12.541	13.025	11.098		0.755	2.848	34.136
	Peridinium inconspicuum Lemmermann							1.261					
	Peridinium sp. Ehrenberg			0.586	1.809	2.160		0.630	0.356				0.627
Division	**Xanthophyta**												
Class :	Xanthophyceae												
Order :	Heterococcales												
Family :	Mischococcaceae												
	Peroniella planktonica G.M. Smith				1.085	3.599							
												12.816	1.882
Family :	Pleurochloridaceae												
	Asterogloea gelatinosa Pascher				0.457								
Order :	Mischococcales												
Family :	Scidiaceae												
	Ophiocytium capitatum Wolle			0.053									
	TOTAL	1	1	1	1	1	1	1	1	1	1	1	1

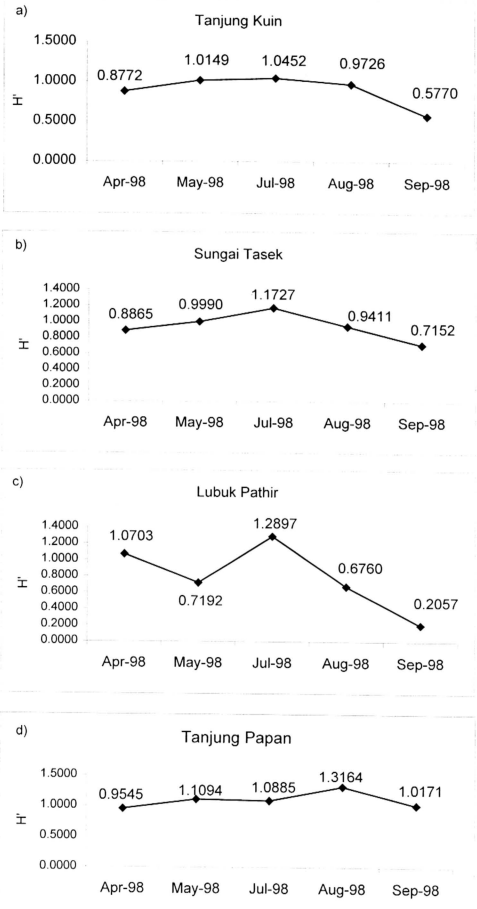
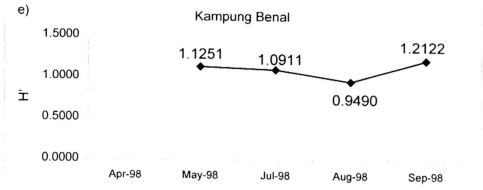
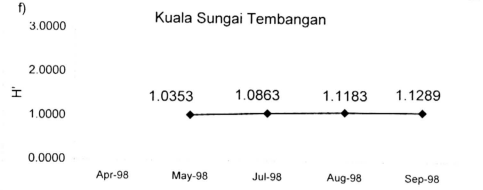


Figure 41. Shannon-Weiner Diversity Index (H') for phytoplankton at Tasek Bera (April - September 1998)
a) Tanjung Kuin
b) Sungai Tasik
c) Lubuk Pathir
d) Tanjung Papan





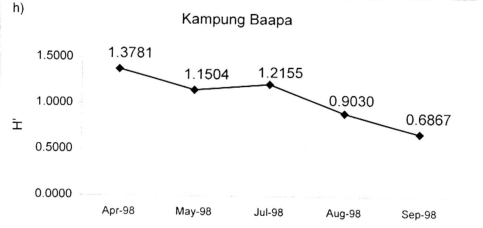
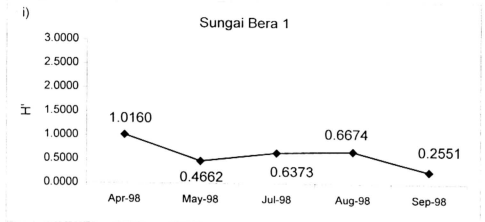
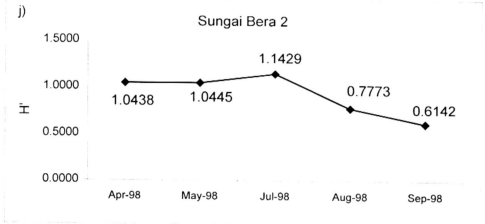
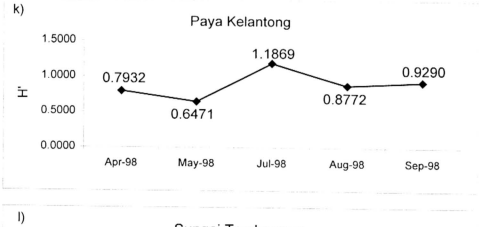


Figure 41. Shannon-Weiner Diversity Index (H') for phytoplankton at Tasek Bera (April - September 1998) (continued)
e) Kampung Benal
f) Kuala Sungai Tembangan
g) Lubuk Kuang
h) Kampung Baapa







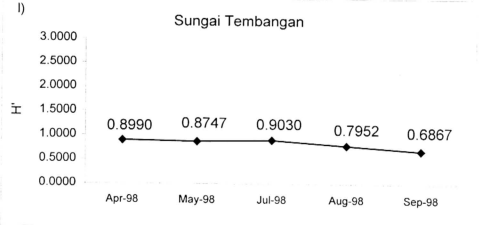


Figure 41. Shannon-Weiner Diversity Index (H') for phytoplankton at Tasek Bera (April - September 1998) (continued)
i) Sungai Bera 1
j) Sungai Bera 2
k) Paya Kelantong
l) sungai Tembangan

Figure 42 shows the H' value for all stations by month. In general, Station 7 (Lubuk Kuang) and Station 8 (Kampung Baapa) had relatively high H' values from April to September 1998. However, Station 4 (Tanjung Papan) had the highest H' value in August 1998. Station 9 (Sungai Bera 1) showed relatively low H' values throughout April to September 1998. Station 3 (Lubuk Pathir) also had low H' values in May, August and September 1998.

Appendix 13 shows the Margalef's Species Index (d) for phytoplankton for all stations from April to September 98. It ranged from 0.0355 to 0.8125. In Figure 43, the Margalef's Species Index gradually increased and reached a maximum value in September 1998 at Station 1 (Tanjung Kuin), Station 4 (Tanjung Papan), Station 6 (Kuala Sungai Tembangan), Station 7 (Lubuk Kuang). However, the d value at Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir), Station 5 (Kampung Benal) and Station 7 (Lubuk Kuang) reached a peak in July 1998 while Station 8 (Kampung Baapa), Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) recorded a peak in August 1998.

Figure 44 showed the d value for all stations by month. Station 3 (Lubuk Pathir) had relatively low d value from April to September 1998 while Station 11 (Paya Kelantong) showed low values from April to July 1998. Station 4 (Tanjung Papan) and Station 5 (Kampung Benal) had relatively high d values from July to September 1998.

Appendix 14 showed the Equitability or Species Evenness Index (J) for all stations from April to September 1998. Species Evenness Index (Equitability) for phytoplankton ranged from 0.1278 to 0.4278.

Most stations showed a general increase in J value from April to September 1998 (Figure 45). However, Station 3 (Lubuk Pathir), Station 7 (Lubuk Kuang) and Station 9 (Sungai Bera 1) recorded a drastic drop from August to September 1998.

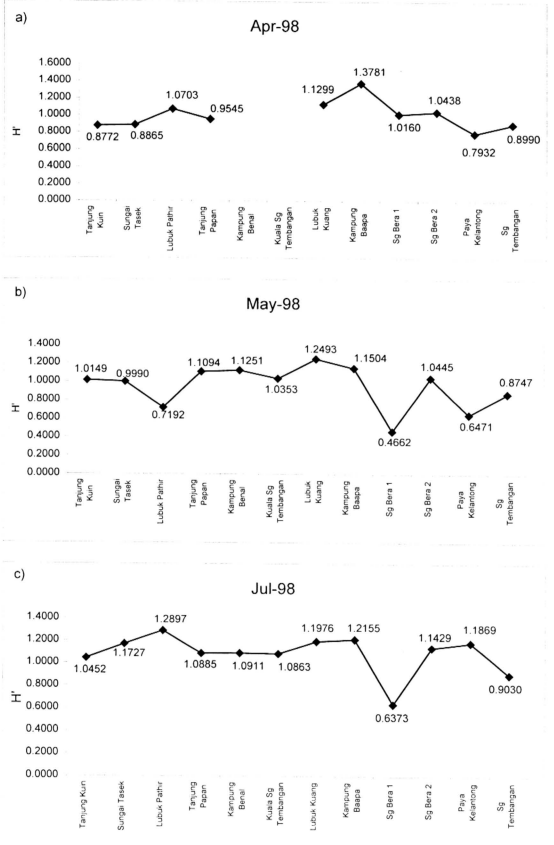
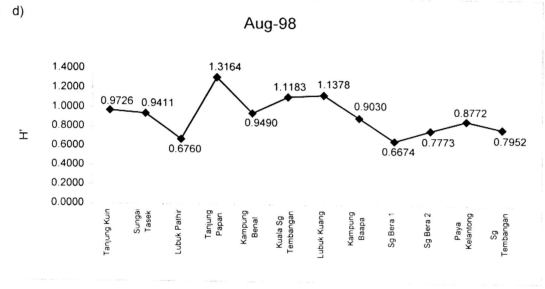


Figure 42. Shannon-Weiner Diversity Index of phytoplankton in Tasek Bera
a) April 1998
b) May 1998
c) July 1998

d)



e)

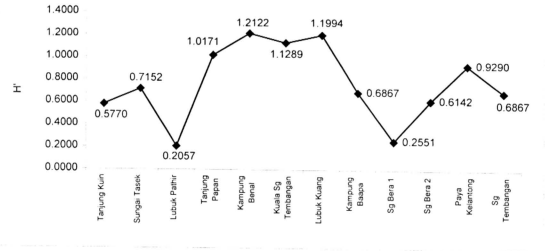


Figure 42. Shannon-Weiner Diversity Index of phytoplankton in Tasek Bera (continued)
d) August 1998
e) September 1998

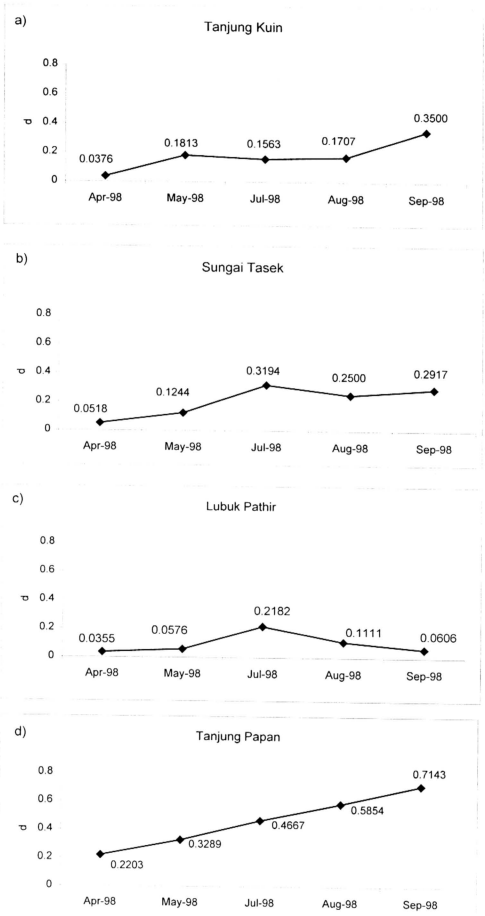
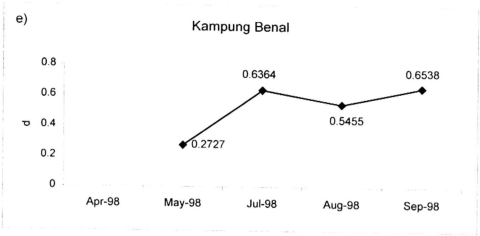
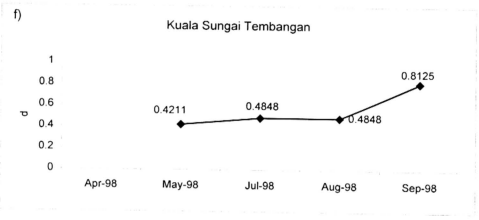
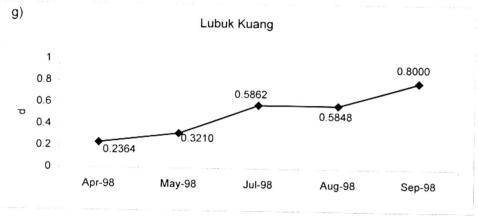


Figure 43. Margalef's Species Index (d) for phytoplankton in Tasek Bera (April - September 1998)
a) Tanjung Kuin
b) Sungai Tasek
c) Lubuk Pathir
d) Tanjung Papan







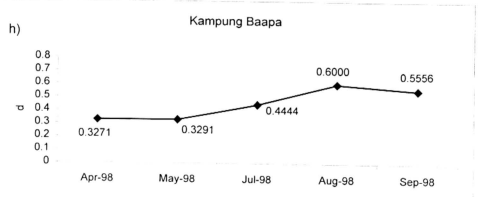
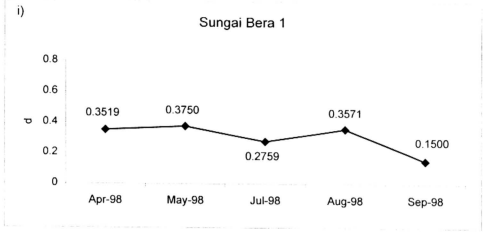
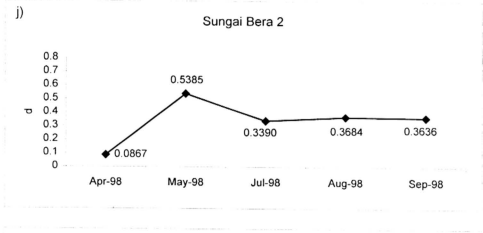
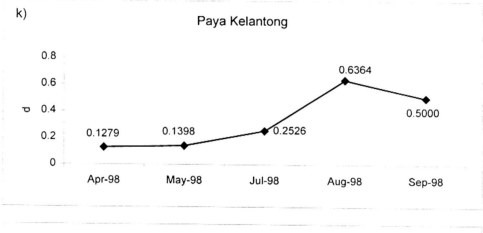


Figure 43. Margalef's Species Index (d) for phytoplankton in Tasek Bera (April - September 1998) (continued)
e) Kampung Benal
f) Kuala Sungai Tembangan
g) Lubuk Kuang
h) Kampung Baapa







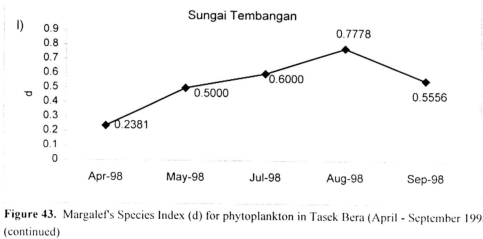


Figure 43. Margalef's Species Index (d) for phytoplankton in Tasek Bera (April - September 1998) (continued)
i) Sungai Bera 1
j) Sungi Bera 2
k) Paya Kelantong
l) Sungai Tembangan

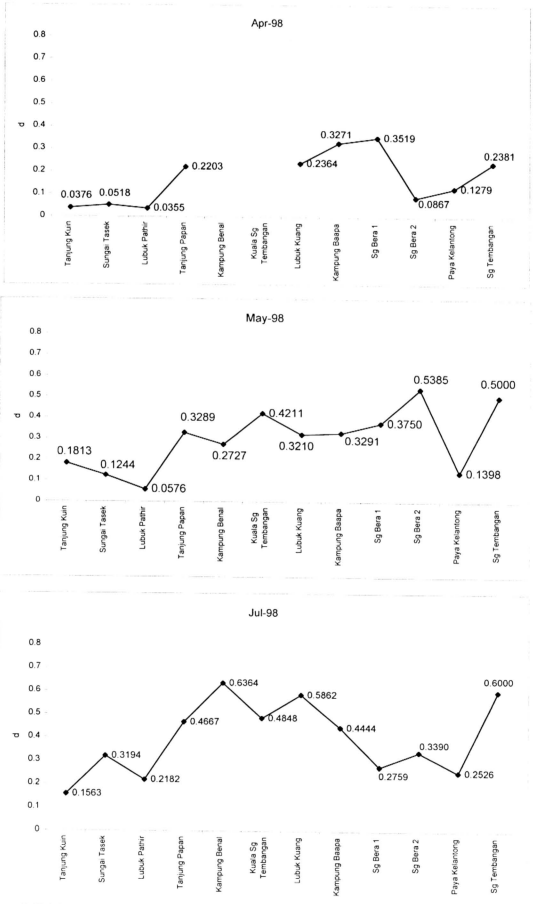


Figure 44. Margalef's Species Index (d) of phytoplankton in Tasek Bera
a) April 1998
b) May 1998
c) July 1998

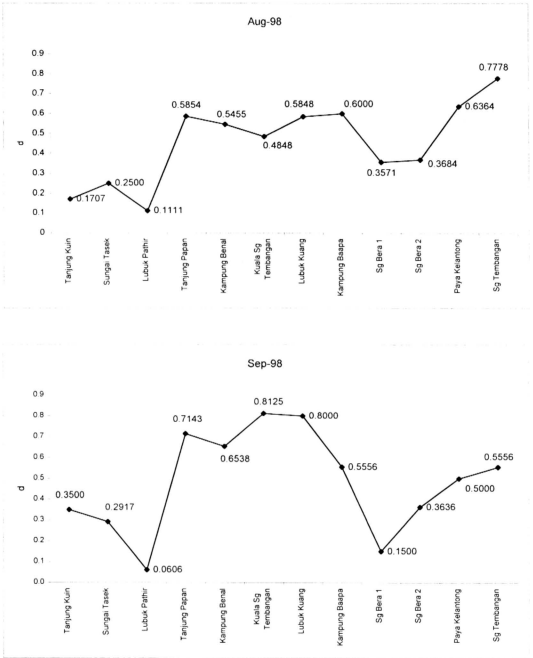


Figure 44. Margalef's Species Index (d) of phytoplankton in Tasek Bera (continued)
d) August 1998
e) September 1998

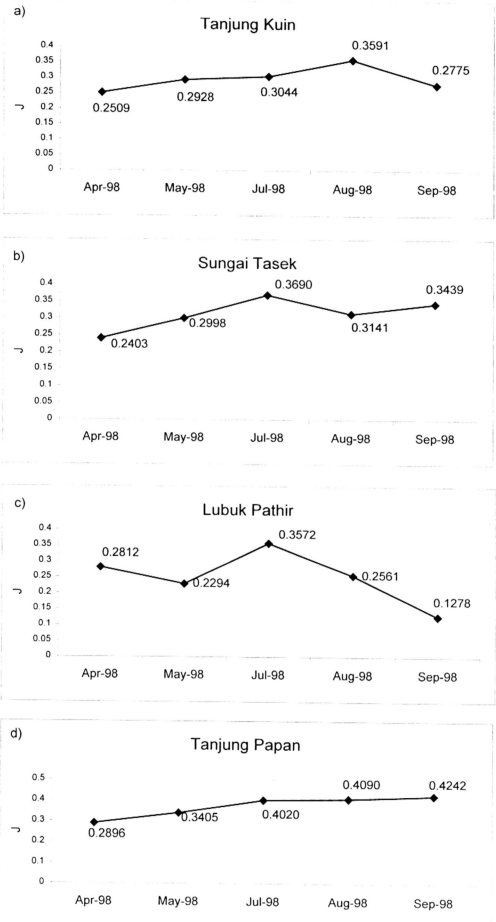
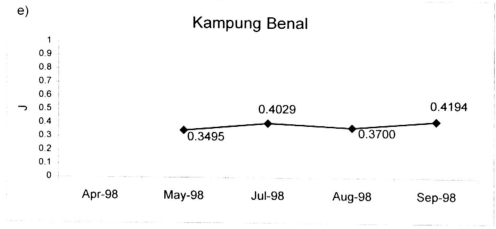
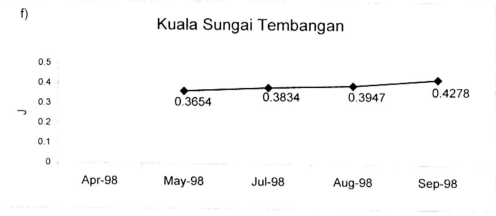
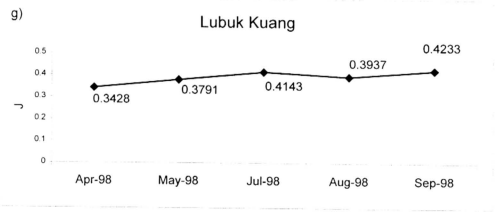


Figure 45. Equitability or Species Evenness (J) for phytoplankton in Tasek Bera (April - September 1998)
a) Tanjung Kuin
b) Sungai Tasek
c) Lubuk Pathir
d) Tanjung Papan







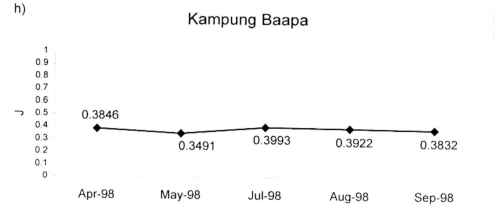


Figure 45. Equitability or Species Evenness (J) for phytoplankton in Tasek Bera (April -September 1998) (continued)
e) Kampung Benal
f) Kuala Sungai Tembangan
g) Lubuk Kuang
h) Kampung Baapa

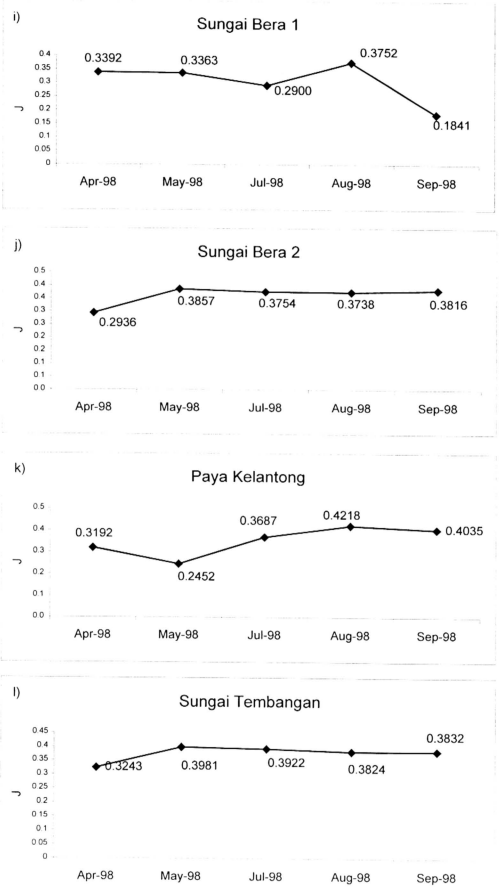


Figure 45. Equitability or Species Evenness (J) for phytoplankton in Tasek Bera (April - September 1998) (continued)
i) Sungai Bera 1
j) Sungai Bera 2
k) Paya Kelantong
l) Sungai Tembangan

In Figure 46, J value for all stations are displayed by month. Five stations, namely Station 4 (Tanjung Papan), Station 5 (Kampung Benal), Station 6 (Kuala Sungai Tembangan), Station 7 (Lubuk Kuang) and Station 8 (Kampung Baapa) had relatively high J values throughout April to September 1998. However, the J value for Station 7 (Lubuk Kuang) dropped drastically in September 1998.

4.2.3.4 Sorensen's Similarity Coefficient

In the present study, the list of phytoplankton species found at each of the 9 stations is analysed using Sorensen's Similarity Coefficient. Sorensen's Similarity Coefficient, ranging from 17.11 to 55.78% is shown in Appendix 15. The stations that are most dissimilar are :

Station	Index (%)
Station 1 (Tanjung Kuin) and Station 8 (Kampung Baapa)	17.11
Station 3 (Lubuk Pathir) and Station 12 (Sungai Kelantong)	19.30
Station 1 (Tanjung Kuin) and Station 12 (Sungai Kelantong)	19.42

The stations that are most similar are :

Station	Index (%)
Station 1 (Tanjung Kuin) and Station 3 (Lubuk Pathir)	55.78
Station 1 (Tanjung Kuin) and Station 2 (Sungai Tasek)	52.41
Station 2 (Sungai Tasek) and Station 3 (Lubuk Pathir)	51.28

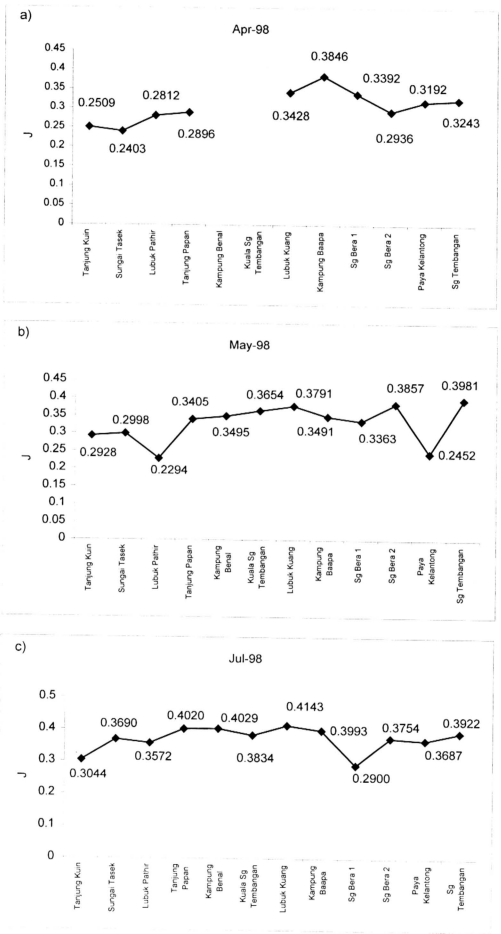


Figure 46. Equitability or Species Evenness for phytoplankton in Tasek Bera
a) April 1998
b) May 1998
c) July 1998

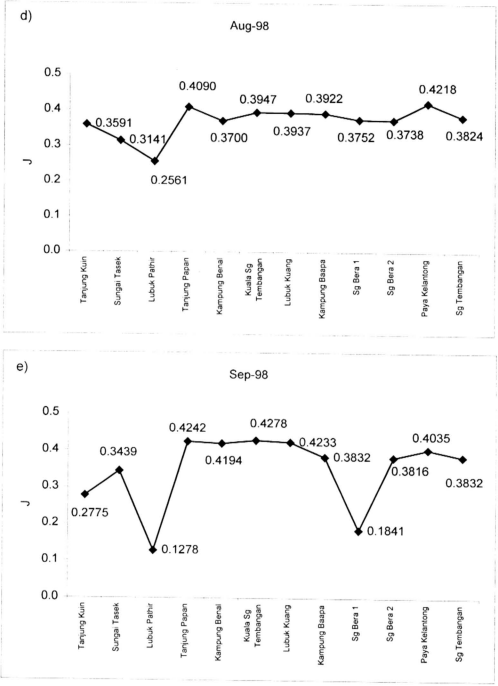


Figure 46. Equitability or Species Evenness for phytoplankton in Tasek Bera (continued)
d) August 1998
e) September 1998

The checklist in Appendix 20, Appendix 21 and Table 13 for several studies of phytoplankton diversity in Tasek Bera, when analysed using Sorensen's Similarity Coefficient, showed the difference in species composition that was observed in various period of studies. Table 13 shows the Sorensen's Similarity Coefficient for the analyses, ranging from 7.89% to 12.18%.

4.3 Data analysis

4.3.1 Statistical analysis

4.3.1.1 Two-way ANOVA

A Two-way analysis of variance was used to assess difference in environmental parameters and biotic parameters : i) of all the twelve stations; ii) among different sampling occasions (April to October 1998).

The Newman Keuls test was used to trace the significant difference resulting from the interaction of sampling occasions and stations for environmental parameters and for biological parameters such as chlorophyll-a, cell count, productivity and diversity of phytoplankton in Tasek Bera.

The ANOVA results, show : i) no significance difference ($p>0.05$) in environmental and biotic parameters among sampling stations with the exception of primary productivity and transparency (Appendix 22).

Primary productivity was found to be significantly different among the stations ($p=0.0006$). Transparency was also significantly different among stations ($p=0.0009$). However, chlorophyll-a levels ($p = 0.8681$), H' values ($p = 0.9995$), d values ($p = 0.9995$), J values ($p = 0.9995$), phytoplankton cell count ($p = 0.9995$), depth of station ($p = 0.5220$), conductivity ($p = 0.9982$), pH ($p = 0.7207$), temperature ($p = 0.5375$), dissolved oxygen ($p = 0.5432$), orthophosphate ($p =$

Table 13. Sorensen's Similarity Coefficient (%) for phytoplantonkton diversity based on different studies in Tasek Bera.

Survey	1	2	3
1		7.89	12.18
2	7.89		9.94
3	12.18	9.94	

Source of checklist for phytoplankton :

1 = Studies by Furtado and Mori (1982)

2 = Studies by Phang and Murugadas (1997)

3 = Present study (1998)

0.5374), ammoniacal-nitrogen (p = 0.5331), nitrate (p = 0.5387) were not significantly different among all the stations.

ii) no significant difference (p>0.05) in the environmental and biotic parameters among sampling occasions with the exception of chlorophyll-a levels, H' values, phytoplankton cell count, conductivity and pH (Appendix 23).

Chlorophyll-a levels (p = 0.0064), H' values (p = 0.0000), d values (0.0000), J values (0.0000), phytoplankton cell count (p = 0.0000), conductivity (p = 0.0000) and pH (p = 0.0000) were significantly different among sampling occasions. However, primary productivity (p = 0.0858), depth of station (p = 0.0662), transparency (p = 0.1391), temperature (p = 0.0654), dissolved oxygen (p = 0.0617), orthophosphate (p = 0.0646), ammoniacal nitrogen (p = 0.0713) and nitrate (p = 0.0667) were not significantly different among sampling occasions.

4.3.3.2 Multiple regression

In multiple regression analysis, biotic parameters observed at Tasek Bera during the study period, such chlorophyll-a concentration, cell count, productivity and diversity of phytoplankton were treated as dependent variables while the other environmental parameters were treated as independent variables. This was to investigate which of the environmental parameters were more effective and contributed more to the biotic parameters. The results of the multiple regression analysis are summarised in Table 14. The parameters, which have a contribution to biotic parameters, are indicated using * in the tables.

Table 14. Results of the multiple regression analysis showing the important parameters contributing to the biotic parameters observed at Tasek Bera (Apr – Oct 1998).

Parameters	Chlorophyll-a		H' value		d value		J value		Cell counts		Primary productivity	
	Contribution	P-level	Contribution	P-level	Contribution	P-level	Contribution	P-level	Contribution	P-level	Contribution	P-level
Depth											*	0.037259
Transparency											*	0.000042
Conductivity			*	0.000000	*	0.000000	*	0.000000	*	0.000000		
pH	*	0.000005										
Temperature											*	0.036060
Dissolved oxygen												
Dissolved orthophosphate												
Ammoniacal-nitrogen												
Nitrate	*	0.000020										

Note : * = contributes ($P<0.05$) to biotic parameters observed at Tasek Bera during study period (April – October 1998).

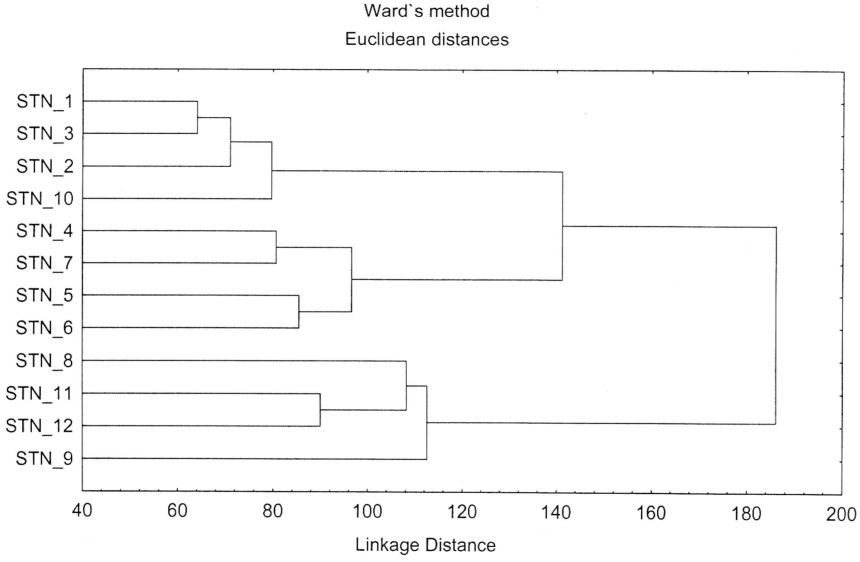
4.3.3.3 Cluster analysis

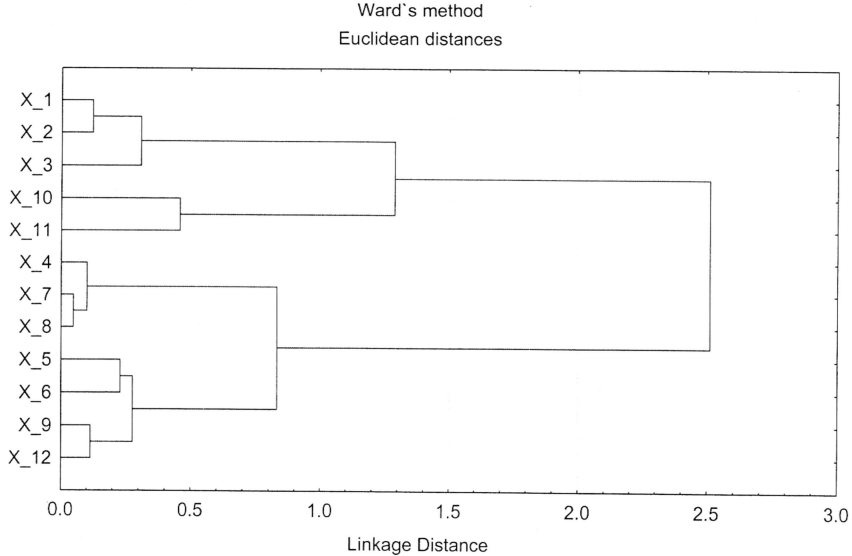
Cluster analysis was used to segregate sampling stations based on biotic parameters as well as environmental parameters.

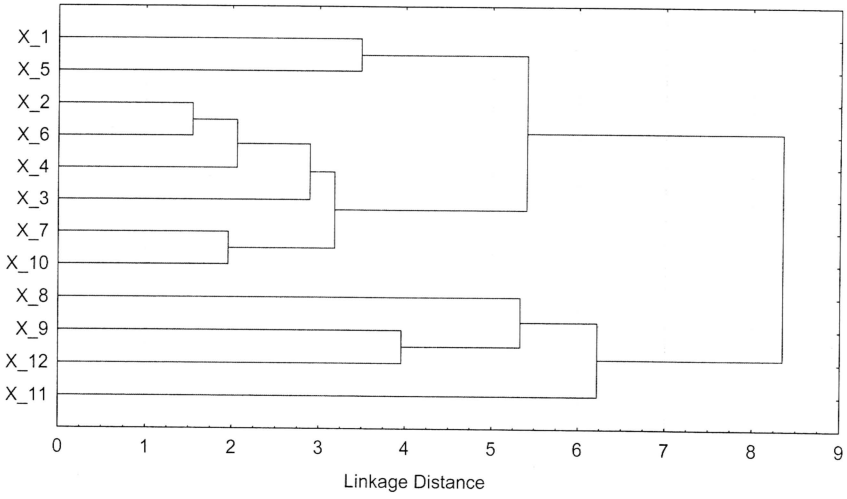
Sorensen's Index of Similarity was calculated based on the species of phytoplankton identified at each sampling station and used in cluster analysis (Figure 47). Three main clusters were identified. The first cluster representing less disturbed sites consisted of Station 1 (Tanjung Kuin), Station 3 (Lubuk Pathir), Station 2 (Sungai Tasik) and Station 10 (Sungai Bera 2). The second cluster were moderately disturbed sites which consisted of Station 4 (Tanjung Papan), Station 7 (Lubuk Kuang), Station 5 (Kampung Benal) dan Station 6 (Kuala Sungai Tembangan). The third cluster consisted of more polluted sites, namely Station 8 (Kampung Baapa), Station 11 (Paya Kelantong), Station 12 (Sungai Tembangan) and Station 9 (Sungai Bera 1).

Figure 48 shows the result of cluster analysis based on biotic parameters which consists of cell counts, productivity, H' value, d value and J value. Four main clusters were identified. The first cluster consists of Station 1 (Tanjung Kuin), Station 2 (Sungai Tasik), Station 3 (Lubuk Pathir). The second cluster consists of Station 10 (Sungai Bera 2) and Station 11 (Paya Kelantong). The third cluster consists of Station 4 (Tanjung Papan), Station 7 (Lubuk Kuang) and Station 8 (Kampung Baapa). The last cluster consists of Station 5 (Kampung Benal), Station 6 (Kuala Sungai Tembangan), Station 9 (Sungai Bera 1) and Station 12 (Sungai Tembangan).

Figure 49 shows that result of cluster analysis based on environmental parameters which consists of depth, transparency, conductivity, pH, temperature, dissolved oxygen, orthophosphate, ammoniacal-nitrogen and nitrate. Three clusters


Tree Diagram for 12 Variables
Ward`s method
Euclidean distances
STN_1
STN_3
STN_2
STN_10
STN_4
STN_7
STN_5
STN_6
STN_8
STN_11
STN_12
STN_9
40
60
80
100
120
140
160
180
200
Linkage Distance


Tree Diagram for 12 Cases
Ward`s method
Euclidean distances
X_1
X_2
X_3
X_10
X_11
X_4
X_7
X_8
X_5
X_6
X_9
X_12
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Linkage Distance


Tree Diagram for 12 Cases
Ward`s method
Euclidean distances
X_1
X_5
X_2
X_6
X_4
X_3
X_7
X_10
X_8
X_9
X_12
X_11
0
1
2
3
4
5
6
7
8
9
Linkage Distance

are identified. The first cluster consists of Station 1 (Tanjung Kuin) and Station 5 (Kampung Benal). The second cluster consists of Station 2 (Sungai Tasik), Station 3 (Lubuk Pahtir), Station 4 (Tanjung Papan), Station 6 (Kuala Sungai Tembangan), Station 7 (Lubuk Kuang) and Station 10 (Sungai Bera 2). The third cluster consists of Station 8 (Kampung Benal), Station 9 (Sungai Bera 1), Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan).