

6.0 CONCLUSION

Observations for this study are summarised as follows:

1. Water quality had deteriorated since the IBP Project in the 1970s. Low transparency was noted at several sites in the present study due to increased soil erosion and sedimentation following changes in land use pattern in the catchment as more areas were developed into oil palm plantations. In fact, in some areas, plantations encroached right up to the riverbanks. Riverbank erosion is usually aggravated due to removal of riparian vegetation, which functions to maintain bank stability and physically filters run-off and remove coarse sedimentation. Turbid conditions also coincided with low rainfall while increased transparency was noted during high rainfall due to dilution effect. High conductivity was recorded in the present study especially at Station 11 (Paya Kelantong) and Station 12 (Sungai Tembangan) due to fertiliser application and increased leaching of exposed soil areas in the oil palm plantation. Concentrations of dissolved orthophosphate in the present study at Tasek Bera, ranging between 0.000 to 0.009 mgL-1, were found to be much lower as compared to previous studies. In addition, it recorded peak values during the dry season due to mineralisation of decomposing organic matter. However, Pierre and Parker (1927) noted that concentration in the range of 0.01 and 0.1 mgL⁻¹ was common. This is because any phosphorus added as fertiliser or released by decomposition of the organic matter will be immediately converted to one of its insoluble forms. Concentrations of ammoniacal-N were found between four to thirty-six times higher than that of previous studies. Peak values were recorded during both dry and wet seasons; reduction processes during the dry season enhanced the oxidation of nitrogen from nitrate to ammonium while enrichment from the watershed became the contributing factor during wet season. Concentrations of nitrate in the present study were fourteen to eighteen times higher than the previous studies. Peak values were recorded during the wet season. This is because nitrate forms of nitrogen are very soluble. Hence, it is easily dissolved by the rain and carried by the soil solution into the waterways.

2. Multiple regression analysis showed that contribution of dissolved orthophosphate to biotic parameters was not significant. Hence, dissolved orthophosphate was not a limiting factor to biotic parameters in the present study. Ammoniacal-N was also found not to contribute significantly to biotic parameters. However, nitrate contributed significantly to chlorophyll-a levels. Chlorophyll-a levels increased two to four times higher as compared to the previous studies. Nitrate concentrations had also increased in the present study. In addition, pH also contributed significantly to chlorophyll-a levels. This observation is reinforced by various authors who noted that pH affects species composition of phytoplankton especially Chlorophytes such as Ankistrodesmus, Closterium and Chlorella sp. which were reported to dominate in acidic water bodies (pH 4.5). Measurement of photosynthetic production using the light and dark bottle method recorded highly variable readings. Water depth, transparency and temperature were found to contribute significantly to it. Comparison with previous studies was not possible because a different procedure, which was the ¹⁴C method, had been used. However, it was noted that measurement of chlorophyll-a levels was a more reliable method to gauge primary productivity as compared to the photosynthetic production via light and dark bottle method.

3. Number of species identified in the present study (326 species) was almost similar to the total species found (328 species) during the IBP Project. Although Chlorophyta is still the dominant division, a shift of species composition had been observed among the most common phytoplankton recorded. In addition, species unique to Tasek Bera, such as Triploceras splendens Prowse, Micraseterias foliaceae Bail. var spinosa Prowse, Micrasterias alata Wall. f. tumida Prowse and Xanthidium superbum Elfv var. centricornis Prowse, that were identified during the IBP Project were not recorded in the present study. In the present study, Euglenophyta and Pyrrophyta were found to dominate stations that are relatively disturbed by sedimentation or organic pollution while Chlorophyta dominate stations with minimal disturbance. Sorensen's Similarity Coefficient based on species of phytoplankton identified in the present study segregated sampling stations that also coincided with levels of disturbances found at these sampling stations. Conductivity was found to correlate significantly with Shannon-Weiner Index (H'), Margalef's Index (d) and Species Evenness Index (J) in the multiple regression analysis. Although the diversity indices were found to be somewhat informative with regards to the composition of phytoplankton community, they did not provide accurate measures of environmental stress at the sites. Levins (1966) noted the common practice of using a single diversity index to measure the effect of a pollutant upon an algae community and emphasized that many indices are biased in their evaluation of various characteristics of a community. Therefore, it was recommended for a variety of indices to be used in determining whether they all, or at least a majority, indicate similar conditions. The phytoplankton community at all sampling stations were dominated by Chlorophyta except for Station 11 (Paya

Kelantong), which was dominated by Euglenophyta. In the present study, trophic states of a particular water body based on chlorophyll-a was one level lower as compared to classification based on algal numbers. This was attributed by the fact that measurement based on chlorophyll-a accounts only for Chlorophyta while algal numbers encompassed all the other divisions of phytoplankton. However, it is noted that counting is a laborious task compared to measurement of chlorophyll-a. In cluster analysis, biotic parameters such as chlorophyll-a, Shannon-Weiner Index (H' value), Margalef's Index (d value), Species Evenness Index (J value), cell counts and primary productivity generally segregated sampling stations into representative groups according to level of disturbance. Groupings based on abiotic parameters did not attain very clear segregation. In terms of biological indicators, genera such as Euglena and Trachelomonas were useful for indicating organic pollution in the water body. Chlorophyll-a level was preferred to photosynthetic production in measurement of primary productivity in water body. Algal cell counts provided better indication to trophic levels in water body as compared to chlorophyll-a. However, diversity indices provided an insight to the community structure of phytoplankton but its values are somewhat varied to provide clear indication on levels of disturbance at sampling stations. Dominance of Chlorophyta, particularly desmids, showed that water body in Tasek Bera is acidic in nature.

4. Since most of the catchment area of Tasek Bera was immensely developed into oil palm and rubber plantations, eutrophication problems due to fertiliser run-off, pollution from pesticides and sedimentation due to soil erosion in exposed soil areas in agricultural plots have been identified as factors influencing water quality. Point source pollution included sewage from Semelai settlement as well as the resort area, oil pollution from outboard engines and synthetic chemicals used in fish poisoning. Fires set by the Semelai to clear Pandanus stands that choke navigation channels, facilitate turtle hunting and lowland forest clearing for shifting cultivation were known to cause progressive replacement of swamp forest with open water habitats and Pandanus-Lepironia swamps. Furtado and Mori (1982) suggested that Tasek Bera and its catchment be conserved an aboriginal area, national monument and nature reserve, with controlled exploitation and development of natural resources. A buffer zone was also proposed at vulnerable areas in the catchment. Following the designation of Tasek Bera as Malaysia's first Ramsar site, the Pahang State Government implemented the Integrated Management of Tasek Bera in 1996 with technical assistance from Wetlands International - Asia Pacific and fundings from Danish Cooperation for the Environment and Development (DANCED). This had led to the Ramsar site with an area of 31,120 ha being gazetted under the National Forestry Act as a Forest Reserve and an area of 77,380 ha which is mostly agricultural plantations constituting the buffer zone. The Ramsar site had been identified under the Bera District Structure Plan as an area for conservation and recreation while the restricted development of agricultural land, environmental protection and water catchment were proposed in the buffer zone. The Pahang State Director of Forest was responsible for the administration of the site while the Department of Wildlife and National Parks was the lead management agency. The Ministry of Science, Technology and the Environment is the national administrative authority for the Ramsar Convention.

5. The Tasek Bera Integrated Management Plan (1999 – 2004) acknowledged several challenges faced including manpower and resources, logistical as well as legal constraints. A management zoning approach was recommended where zones were identified for permitted activities, incompatible activities and activities requiring management approval. However, there is no legal status governing the zones at present and it is of high priority that the management zoning plan be incorporation into law. Active local community participation had been recognised as an important element in site management. It was noted that the Buffer Zone lies beyond the boundary of the current Ramsar Site and its management is not within the scope of the management plan. However, recommendations were stated for maintenance and rehabilitation of existing areas of natural habitats, improved soil protection measures, improved water quality and reduced input of chemical. Development for tourism sector also should be limited to the Buffer Zone.