

Contents

PART I

General concepts of aquatic ecosystems	1
1 Ecosystem function and management	3
1.1 <i>Ecosystem composition and energy sources</i>	4
1.2 <i>Energy flow and nutrient cycling</i>	5
1.3 <i>Efficiency of energy and nutrient use</i>	8
1.4 <i>Management of ecosystems</i>	10
2 Standing crop, productivity and growth limitation	12
2.1 <i>Pyramid of biomass</i>	12
2.2 <i>Productivity</i>	13
2.3 <i>Efficiency of energy transfer</i>	14
2.4 <i>Population growth and limitation</i>	15
3 Hydrographic characteristics	21
3.1 <i>Types of flow</i>	21
3.2 <i>Boundary layers</i>	23
3.3 <i>Physical factors controlling wastewater distribution</i>	25
3.4 <i>Density effects</i>	25
3.5 <i>Density currents</i>	27
3.6 <i>Thermal properties of lakes</i>	28
3.7 <i>Origin of lakes</i>	28
3.8 <i>Thermal cycle in a typical mid-latitude lake</i>	29
3.9 <i>Classification of lakes by temperature regime</i>	32
3.10 <i>Water movements</i>	36
3.11 <i>Seiches</i>	36
3.12 <i>Surface waves</i>	37
3.13 <i>Wind-driven currents</i>	38

3.14	<i>Tidal effects</i>	39
3.15	<i>Water movements in large lakes</i>	40
3.16	<i>Thermal bar</i>	42
3.17	<i>Measurement of water movements</i>	43
3.18	<i>Dispersal processes</i>	44
3.19	<i>Sedimentation</i>	55
4	Nutrient cycles	56
4.1	<i>Phosphorus</i>	56
4.2	<i>Nitrogen</i>	75
4.3	<i>Sulphur</i>	79
4.4	<i>Carbon</i>	81
5	Characteristics of pollutants	86
5.1	<i>Domestic sources</i>	86
5.2	<i>Urban runoff</i>	89
5.3	<i>Industrial wastes</i>	90
5.4	<i>Agricultural wastes</i>	92
5.5	<i>Biological pollution</i>	93
PART II		
Effects of pollutants in standing water		95
6	Phytoplankton	97
6.1	<i>Seasonal pattern</i>	99
6.2	<i>Population growth kinetics and concept of limitation</i>	100
6.3	<i>Effects of light and mixing</i>	108
6.4	<i>Effects of temperature</i>	128
6.5	<i>Nutrient limitation</i>	136
6.6	<i>Cyanobacterial toxicity</i>	166
6.7	<i>Cyanobacteria and water supplies</i>	172
7	Eutrophication	176
7.1	<i>Definition</i>	176
7.2	<i>Phosphorus mass balance models</i>	177
7.3	<i>Trophic state criteria</i>	186
7.4	<i>Eutrophication of coastal marine waters</i>	210
8	Zooplankton	212
8.1	<i>Population characteristics</i>	212
8.2	<i>Population dynamics</i>	213
8.3	<i>Filtering and grazing</i>	218

8.4	<i>Zooplankton grazing and eutrophication</i>	219
8.5	<i>Trophic cascades</i>	222
8.6	<i>Temperature and oxygen</i>	225
8.7	<i>Invasive, non-native zooplankton</i>	227
9	Macrophytes	228
9.1	<i>Habitats</i>	228
9.2	<i>Significance of macrophytes</i>	229
9.3	<i>Effects of light</i>	232
9.4	<i>Effects of temperature</i>	235
9.5	<i>Effects of nutrients</i>	235
9.6	<i>Nutrient recycling</i>	241
9.7	<i>Alternate stable states</i>	242
9.8	<i>Invasive, non-native macrophytes</i>	246
10	Lake and reservoir restoration	248
10.1	<i>Pre-restoration data</i>	249
10.2	<i>External controls on P</i>	251
10.3	<i>In-lake controls on P</i>	260
10.4	<i>In-lake controls on biomass</i>	265
PART III		
Effects of pollutants in running water		271
11	Periphyton	273
11.1	<i>Significance to productivity</i>	274
11.2	<i>Methods of measurement</i>	276
11.3	<i>Factors affecting growth of periphytic algae</i>	277
11.4	<i>Grazing</i>	296
11.5	<i>Organic nutrients</i>	298
11.6	<i>Periphyton community change as an index of waste type</i>	303
11.7	<i>Effects of toxicants</i>	306
11.8	<i>Nuisance</i>	308
12	Benthic macroinvertebrates	311
12.1	<i>Sampling for benthic macroinvertebrates</i>	313
12.2	<i>Natural factors effecting community change</i>	314
12.3	<i>Oxygen as a factor affecting community change</i>	318
12.4	<i>Temperature</i>	320
12.5	<i>Effect of food supply on macroinvertebrates</i>	326
12.6	<i>Effect of organic matter</i>	327

12.7	<i>Effects of toxic wastes</i>	334
12.8	<i>Suspended sediment</i>	336
12.9	<i>Recovery</i>	338
12.10	<i>Assessment of water quality</i>	339
12.11	<i>Invasive, non-native invertebrates</i>	350
13	Fish	353
13.1	<i>Dissolved oxygen criteria</i>	353
13.2	<i>Temperature criteria</i>	362
13.3	<i>Temperature standards</i>	370
13.4	<i>Comments on standards</i>	371
13.5	<i>Global warming</i>	374
13.6	<i>Toxicants and toxicity</i>	376
13.7	<i>Invasive, non-native fish</i>	397
	Appendices	401
Appendix A	Description of benthic macroinvertebrates and comments on their biology	403
Appendix B	Study questions and answers	406
Appendix C	Glossary	427
	<i>References</i>	440
	<i>Index</i>	494