

Contents

1	Wetland Functioning in Relation to Biodiversity Conservation and Restoration	1
	R. BOBBINK, D.F. WHIGHAM, B. BELTMAN, and J.T.A. VERHOEVEN	
1.1	Introduction	1
1.2	Functioning of Plants and Animals in Wetlands	2
1.3	Biodiversity Conservation and Wetlands	6
1.4	Ecological Restoration of Wetlands	8
1.5	Synthesis	11
	References	12

Section I: Functioning of Plants and Animals in Wetlands

2	Plant Survival in Wet Environments: Resilience and Escape Mediated by Shoot Systems	15
	M.B. JACKSON	
2.1	Introduction	15
2.2	How Excess Water Threatens Plant Life	17
2.2.1	Excluding and Trapping Effects of Water	18
2.2.3	The Energy Crisis	19
2.3	Resilience	19
2.3.1	Oxygen Shortage	19
2.3.2	Shortage of Carbon Dioxide	22
2.4	Escape	26

2.4.1	Aerobic Shoot Extension (the Aerobic Escape)	26
2.4.2	Anaerobic Shoot Extension (the Anaerobic Escape)	29
2.5	Summary	30
	References	32
3	Center Stage: The Crucial Role of Macrophytes in Regulating Trophic Interactions in Shallow Lake Wetlands	37
	R.L. BURKS, G. MULDERIJ, E. GROSS, I. JONES, L. JACOBSEN, E. JEPPESEN, and E. VAN DONK	
3.1	Introduction	37
3.2	Central Position of Aquatic Vegetation	38
3.2.1	Central Themes: Zooplankton Depend on Macrophytes as Habitats	39
3.2.2	Central Themes: Chemical Ecology Spans Trophic Levels . .	42
3.2.3	Central Themes: Impacts of Grazer–Epiphyton Interactions with Macrophytes	45
3.2.4	Central Themes: Prevalance of Fish Influence in Shallow Lakes	49
3.3	In the Wings: Research Areas Worthy of Attention	51
3.3.1	Predictability of Macrophyte Function in Trophic Interactions Across a Climatic Gradient	51
3.3.2	Relative Importance of Chemical Ecology Across Trophic Levels	52
3.3.3	Disproportional Impacts of Certain Invertebrates and Exotic Species	52
3.4	Returning to Center Stage: Macrophytes are Common Players in Trophic Interactions	53
	References	53
4	Biological Invasions: Concepts to Understand and Predict a Global Threat	61
	G. VAN DER VELDE, S. RAJAGOPAL, M. KUYPER-KOLLENAAR, A. BIJ DE VAATE, D.W. THIELTGES, and H.J. MACISAAC	
4.1	Introduction	61
4.2	What is a Biological Invasion?	62
4.3	Impacts of Biological Invasions	63
4.3.1	Ecological Impacts	63
4.3.2	Evolutionary Impacts	64
4.3.3	Economic Impacts	64

Contents	IX
4.3.4 Human Health Impacts	65
4.3.5 Measuring Impacts	65
4.4 Examples of Biological Invasions	66
4.5 Understanding and Predicting Biological Invasions	68
4.5.1 Invading Species Approach	68
4.5.2 Invaded Ecosystem Approach	70
4.5.3 Relationship Between Invader and Invaded Ecosystem (Key-Lock Approach)	77
4.5.4 Invasion Processes Differentiated in Time	79
4.5.5 Comparative Historical Approach	83
4.6 Shadows on the Prospects of Prediction	84
4.7 Conclusion	85
References	85

Section II: Conservation and Management of Wetlands

5 Wetland Conservation and Management: Questions for Science and Society in Applying the Ecosystem Approach	93
E. Maltby	
5.1 Introduction	93
5.2 Wetlands at the Interface	93
5.3 Recognising a New Paradigm in Ecosystem Management	97
5.4 The Ecosystem Approach	97
5.4.1 Principle 1: The Management of Land, Water and Living Resources is a Question of Societal Choice	99
5.4.2 Principle 3: Ecosystem Managers Should Consider the Effects of Their Activities on Adjacent and Other Ecosystems; and Principle 7: The Ecosystem Approach Should be Undertaken at the Appropriate Scale	103
5.4.3 Principle 4: There is a Need to Understand the Ecosystem in an Economic Context	107
5.4.4 Principle 9: Management must Recognise that Change is Inevitable	109
5.4.5 Principle 10: The Ecosystem Approach Should Seek the Appropriate Balance Between Conservation and Use of Biological Diversity	111
5.5 Conclusion	113
References	114

6	Wetlands in the Tidal Freshwater Zone	117
	A. BARENDREGT, D.F. WHIGHAM, P. MEIRE, A.H. BALDWIN, and S. VAN DAMME	
6.1	Characteristics of Tidal Freshwater Wetlands	117
6.2	Human Activities	121
6.2.1	Historical Development	121
6.2.2	Water Quality Changes	122
6.3	Biological Variation Within the Freshwater Tidal Ecosystem	122
6.3.1	Vegetation Zonation	123
6.3.2	The Vegetation of European Tidal Freshwater Wetlands . . .	124
6.3.3	The Vegetation of North American Tidal Freshwater Wetlands	126
6.3.4	Wildlife	131
6.3.5	Fish Species	131
6.3.6	Other Biota	132
6.4	Chemical and Physical Processes: the Wetland as a Filter . .	134
6.5	Restoration and Future Outlook	138
6.5.1	Europe	138
6.5.2	United States	140
6.6	Conclusions	141
	References	142
7	Biodiversity in European Shallow Lakes: a Multilevel–Multifactorial Field Study	149
	L. DE MEESTER, S. DECLERCK, J.H. JANSE, J.J. DAGEVOS, R. PORTIELJE, E. LAMMENS, E. JEPPESEN, T. LAURIDSEN, K. SCHWENK, K. MUYLEAERT, K. VAN DER GUCHT, W. VYVERMAN, G. ZWART, E. VAN HANNEN, P.J.T.M. VAN PUIJENBROEK, J.M. CONDE-PORCUNA, P. SÁNCHEZ-CASTILLO, J. VANDEKERKHOVE, and L. BRENDONCK	
7.1	Introduction	149
7.2	Lake Selection	151
7.3	Sampling and Analysis	153
7.4	Lake Characteristics	154
7.5	Multidimensionality of System-Wide Biodiversity	157
7.6	Macrophytes and Nutrient Concentrations	158
7.7	Model and Expert Tools	159
7.7.1	Approach	159
7.7.2	PCLake	160

Contents	XI
7.7.3	The Expert System BASIS 164
7.7.4	Combined Models; and PCLake and BASIS as Management Tools 164
7.8	Synthesis: Policy Implications of the Results 165
References 166
8	River Basin Management to Conserve Wetlands and Water Resources 169
	J. PITTOCK, B. LEHNER, and L. LIFENG
8.1	Introduction 169
8.2	Systematically Prioritising Wetland Conservation: Freshwater Ecoregion Conservation 172
8.2.1	Freshwater Ecoregions 172
8.2.2	Planning Conservation of Freshwater Ecoregions 172
8.2.3	Rapid Assessment of Watersheds and Landscapes in Data-Short River Basins 175
8.3	Using Treaties to Conserve Wetlands and River Basin 176
8.3.1	The Ramsar Convention on Wetlands 176
8.3.2	Convention on Biological Diversity 178
8.3.3	European Union's Water Framework Directive 178
8.4	Poverty Reduction Through Wetlands Conservation 180
8.4.1	Yangtze River and Dongting Lake 180
8.4.2	Xipanshanzhou Polder 181
8.4.3	Quinshan Polder and Lessons Learned 182
8.5	Conservation and Wise Use of Wetlands: a Regional Partnership Approach 182
8.5.1	Ramsar Convention and Regional Initiatives 183
8.5.2	MedWet – The Mediterranean Wetlands Initiative 184
8.5.3	Great Asian Mountains Wetlands 185
8.6	Target-Driven Wetland Conservation: Lessons from WWF's Program FY99–FY04 187
8.6.1	Target 1: Protect and Sustainably Manage 250×10^6 ha of Freshwater Ecosystems Worldwide 187
8.6.2	Target 2: Restore and Conserve Ecological Processes in More Than 50 River or Lake Basins 189
8.6.3	Target 3: Best Practices in Water management are Adopted in Key Water-Using Sectors 192
8.7	Conclusion 193
References 194

9 Aspects of Adaptive Management of Coastal Wetlands: Case Studies of Processes, Conservation, Restoration, Impacts and Assessment 197
 P.E.R. DALE, M.B. DALE, J. ANOROV, J. KNIGHT, M.C. MINNO,
 B. POWELL, R.C. RAYNIE, and J.M. VISSER

9.1 Introduction 197

9.2 Diverse Tools to Identify Processes and Long-Term Changes 200

9.2.1 Geomorphic Evolution and Vegetation History 201

9.2.2 Human Modification of Carbrook Wetlands 203

9.2.3 Conclusion 205

9.3 Managing for Conservation: Monitoring Ecological Changes in Coastal Wetlands in Northeast Florida, USA 205

9.3.1 Approach 206

9.3.2 Environmental Characteristics 206

9.3.3 Conclusion 209

9.4 Managing for Restoration: a Multi-Scale Adaptive Approach in Restoring Coastal Wetlands in Louisiana, USA 209

9.4.1 Approach 210

9.4.2 Lessons Learned 210

9.4.3 Program Recommendations 213

9.4.4 Conclusion 214

9.5 Managing the Environment to Reduce Insect Pests: a Multivariate Approach to Assess Impacts of Disturbance on Saltmarsh Processes in Subtropical Australia 214

9.5.1 Approach 215

9.5.2 Conclusion 216

9.6 Use of Remote Sensing to Monitor Hydrologic Processes in Mangrove Forests and to Integrate Across the Adaptive Management Framework 217

9.6.1 Approach 217

9.6.2 Conclusions 219

References 220

Section III: Wetland Restoration and Creation

10	Contrasting Approaches to the Restoration of Diverse Vegetation in Herbaceous Wetlands	225
	A.M. BOERS, C.B. FRIESWYK, J.T.A. VERHOEVEN, and J.B. ZEDLER	
10.1	Introduction	225
10.2	Restoration Contexts	228
10.2.1	Restoration Targets	230
10.3	Discouraging Undesirable Species	230
10.3.1	Undesirable Invaders	231
10.3.2	Controlling Invasives	233
10.3.3	Minimizing Eutrophication	233
10.3.4	Establishing Appropriate Hydrology	235
10.4	Encouraging Desirable Species	235
10.4.1	Site Modifications	236
10.4.2	Natural Recruitment	237
10.4.3	Sowing Seed	238
10.4.4	The Decision to Plant	240
10.4.5	Suitable Sources for Propagules	241
10.5	Emerging Principles	242
	References	243
11	Fen Management and Research Perspectives: An Overview	247
	B. MIDDLETON, A. GROOTJANS, K. JENSEN, H. OLDE VENTERINK, and K. MARGÓCZI	
11.1	Introduction	247
11.2	Hydrological Systems of Fens	249
11.2.1	Large and Small Hydrological Systems	250
11.2.2	Natural Fens Can Be Very Stable	251
11.2.3	Hydrochemical Processes Stabilizing the Biodiversity of Fens	253
11.3	Eutrophication in Fens	254
11.3.1	Change in Management	254
11.3.2	Change in Nutrient Budgets	254
11.3.3	Internal Eutrophication	256
11.4	Seed Bank and Seed Dispersal	258

11.4.1	Seed Banks	259
11.4.2	Seed Dispersal	260
11.5	Fen Restoration: An Example From Hungary	260
11.5.1	Introduction	260
11.5.2	Destruction and Restoration of a Fen System in Hungary . .	261
11.5.3	Monitoring and Evaluation of the Created Wetland	262
11.6	Concluding Remarks	263
	References	265
12	Social Learning in Wetland Development	269
	E. VAN SLOBBE, E. D. MORRIS, N. RÖLING, R. TORENBEEK, K. BROKER, and H. HEERING	
12.1	Introduction	269
12.2	Socio-Technical Characteristics of Wetlands	270
12.3	Different Perspectives on Planning	273
12.4	Social Learning as Part of a Mix of Governance Approaches	275
12.5	Social Learning in Wetland Development	277
12.6	Conclusions	281
	References	282
13	Eco-Hydrological Functioning of the Biebrza Wetlands: Lessons for the Conservation and Restoration of Deteriorated Wetlands	285
	M.J. WASSEN, T. OKRUSZKO, I. KARDEL, J. CHORMANSKI, D. SWIATEK, W. MIODUSZEWSKI, W. BLEUTEN, E.P. QUERNER, M. EL KAHLOUN, O. BATELAAN, and P. MEIRE	
13.1	Introduction	285
13.2	General Characteristics of the Biebrza Valley	287
13.2.1	Introduction	287
13.2.2	Geomorphology, Lithology, and Geo-Hydrology	287
13.2.3	Vegetation	289
13.2.4	Birds and Mammals	290
13.3	Hydrology of the Biebrza Valley	290
13.3.1	Surface Water: Hydrography and Hydrology	290
13.3.2	Groundwater	292
13.3.3	Flooding	292

Contents	XV
13.3.4 Drainage	294
13.4 Relation Between Hydrology and Vegetation Zoning	297
13.5 Productivity and Nutrient Limitation of Marsh and Fen Vegetation	301
13.6 Discussion and Conclusions	304
References	307
Subject Index	311