Introduction to the Wetland Book 1: Wetland Structure and Function, Management, and Methods

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Contents

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Abstract

The Wetland Book 1 is designed as a 'first port-of-call' reference work for information on the structure and functions of wetlands, current approaches to wetland management, and methods for researching and understanding wetlands. Contributions by experts summarize key concepts, orient the reader to the major issues, and support further research on such issues by individuals and multidisciplinary teams. *The Wetland Book 1* is organized in three parts - *Wetland structure and function; Wetland management*; and *Wetland methods* - each of which is divided into a number of thematic sections. Each section starts with one or more overview chapters, supported by chapters providing further information and case studies on different aspects of the theme.

Keywords

Wetland structure · Wetland function · Wetland policy · Wetland management · Wetland methods

Introduction

The Wetland Book developed from conversations with the Secretariat of the Ramsar Convention on Wetlands and members of the Convention's Scientific & Technical Review Panel (STRP) on the status and knowledge of wetlands globally, and the need to provide a compilation of wetland information to complement existing, but often scattered sources. *The Wetland Book* is produced as an online and hardcopy publication in two parts, *The Wetland Book:* 1 – Structure and Function, Management, and Methods*;* and 2 – Distribution, Description, and Conservation. The books will support the work of students, transdisciplinary researchers, natural resource managers and agency staff, engineers, planners, policy advisors, NGOs, and environmental consultants.

The Wetland Book 1 is designed as a "first port-of-call" reference work for information on the structure and functions of wetlands, current approaches to wetland management, and methods for researching and understanding wetlands. The contributions by experts aim to summarize key concepts, orient the reader to the major issues, and support further research on such issues by individuals and multidisciplinary teams. Each chapter draws upon multiple sources of information including primary and secondary literature, including publications and reports by government agencies

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and nongovernmental organizations, where appropriate. Chapters are not comprehensively referenced in the style of research papers but rather provide a selection of key sources for finding further information on each topic. Cross-references are provided to help navigate between related chapters in *The Wetland Book*.

Book Structure

The Wetland Book 1 is organized into three parts – *Wetland structure and function; Wetland management;* and *Wetland methods*. Each of these is divided into a number of thematic sections. Each section starts with one or more overview chapters, supported by chapters providing further information and case studies on different aspects of the theme.

For *Wetland structure and function* there are chapters covering: succession (10 chapters); biological adaptations (4); ecological processes and biogeochemistry (7); importance of hydrology to wetlands (8); and landscape ecology (9).

For *Wetland management* there are chapters covering: the international framework (45 chapters); wetland law and policy (42); management of provisioning services (17); management of regulating services (27); management of wetlands for cultural, aesthetic, and associated services (14); and the importance of managing wetland supporting services (6).

For *Wetland methods* chapters cover: wetland delineation and classification (14 chapters); earth observation approaches and their application to wetland ecosystems (17); wetland monitoring and assessment (12); environmental flows (11); wetland management planning (10); wetland restoration and creation (8); environmental impact assessment (9); strategic environmental assessment (3); and economic valuation (6).

The main topic coverage of each part of *The Wetland Book 1* is further summarized below.

Wetland Structure and Function

This part of the Book provides basic information of key importance to the understanding of wetlands. It progresses from large scale ecosystem and landscape concepts to those of a progressively finer scale including biogeochemical, biological, and physiological/anatomical considerations of plants.

Wetland Succession A general chapter on succession, a topic which forms the underpinnings of wetland change and function over time is provided (Middleton 2018) and includes a short chapter on historical ideas of hydrosere (i.e., Clementsian) succession or wetland change over time toward drier land. Later thinking led to the modern Gleasonian perspective, examining the role of disturbance and species life history dynamics in succession. The US $10,000 succession challenge describes the prize offered in the 1950s by the eminent ecologist Frank Egler to anyone who could

demonstrate Clementsian succession leading to a climax community. Although the idea of successional stages leading to a climax community has only weak evidence, the concept is still often used in teaching succession concepts to introductory students of biology (e.g., at high school and first year college level). The debate over the nature of succession (Clementsian vs. Gleasonian) has relevance to more recent discussions of self-design versus designer approaches in restoration practice. A number of specific examples explain how anthropogenic disturbance drives vegetation change, for example cattle grazing in wetlands. Whereas fire can be a natural disturbance in wetlands, the human impacts of drainage, cutting and climate change are creating unnaturally destructive peat fires in swamp forest in South-east Asia. Differences in the succession process are apparent in coastal settings, and comparisons are made with fresher water settings.

Landscape Ecology Landscape ecology has emerged relatively recently as a new field in wetland ecology, as broad scale drivers have been increasingly acknowledged as influencing wetland processes (Boudell 2018). Chapters describe various elements of wetland landscape ecology including the concepts of connectivity, corridors, fragmentation, and patch. Process concepts are covered in chapters on disturbance, ecosystem function, and gap and patch dynamics. Species reassembly in riparian and other wetland systems differ because of underlying differences in landscape dynamics in those settings. Practical applications of these concepts are given in chapters on riparian zone buffers, source-sink dynamics, wetland restoration implications, and the heterogeneity of wetland processes as molded by landscape setting. The dynamic nature of wetland processes controlled from a variety of scales lends complexity to the nature of population genetics across wetland landscapes.

Ecological Processes and Biogeochemistry General aspects of chemical transformations in wetlands dictate the nature of other processes (Baldwin 2018). The nature of wetland chemical transformations has important influences on various ecosystem processes, including carbon flux, photosynthesis, primary production, and respiration. Wetland processes related to water quality improvement and habitat support provide vital services to humans, and approaches have been developed to evaluate the economic value of wetlands to human communities. Wetland degradation can negatively impact the extent of ecosystem services provided by wetlands. Therefore, various agencies have implemented programs to better develop policy to protect wetlands including Ecosystem Service Partnerships, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and the Millennium Ecosystem Assessment.

Hydrology for Wetlands: Importance How water dynamics dictate wetland function is described in Rasmussen (2018). These processes play out rather differently in coastal wetlands because of their proximity to the ocean. Due to the complex processes associated with various water inputs and outputs, hydrologic modeling helps frame our basic understanding of wetland hydrology. A specific case of hydrologic dynamics as it relates to treatment performance in constructed wetlands is provided for the Everglades region in Florida, USA.

Biological Adaptations Finer scale considerations of wetlands are summarized, including the anatomical (Seago 2018), morphological (Schaffer 2018), and physiological (Kandalpas 2018) adaptations of plants to life in an aquatic environment. Some aquatic species succeed in environments that terrestrial species would find harsh, by engaging in symbiotic relationships with microbes.

Wetland Management

Information provided on wetland management will be useful to audiences interested in approaches for managing wetlands, including how these approaches have changed over time with the development of international frameworks and newer concepts, such as the developing focus on ecosystem services and the adoption of the 2030 Sustainable Development Goals (SDGs). The importance of legal structures and policy settings is also explored.

Overview of Wetland Management Management of wetlands is complex, needing to address both the pressures imposed on wetlands by wider landscape change as well as more direct *in situ* pressures and measures needed to retain a wetland's natural character and ecosystem services. There is a long history of wetland management, for example to protect favored birds and other species or for fishery, recreational, and other uses. However, in the main, wetland management has not historically been undertaken with conscious efforts to optimize the multiplicity of interconnected ecosystem services providing benefits to diverse sectors of society and underpinning system resilience. Everard (2018a) explores the need for systems scale thinking in wetland management, ensuring that management maximization of single or narrow subsets of benefits does not occur at net cost to wider system functioning and optimization of human well-being across a range of linked ecosystem services.

International Framework for Wetland Conservation and Wise Use Such is the importance of wetlands and their ecosystem services that they are the subject of a wide range of international conventions and agreements and others mechanisms for protection and positive management (reviewed by Gardner 2018). These include biodiversity-related conventions, of which the Ramsar Convention on Wetlands is an international exemplar (Davidson 2018). The multiple values they provide to society also mean that wetlands have been a focus of the Convention on Biological Diversity, as well as making important contributions towards achieving global biodiversity targets.

Wetlands also have significant international ramifications, both as transboundary systems and as networks of habitats vital for migratory species. For this reason, a range of transnational and regional legal frameworks has been established, particularly with respect to integrated management of migratory bird flyways (Davidson and Stroud 2018). Regional legal frameworks have also been developed for the

comanagement of significant international and interregional wetlands such as Lake Chad and the Murray-Darling Basin, Australia.

Significant implications for wetland management also arise from global challenges such as climate change and the commitment by UN signatories to the 2030 Sustainable Development Goals (SDGs).

A range of nongovernmental organizations (NGOs), institutions, and programs, across a range of scales, have particular focal interests in wetland conservation and management including, for example, BirdLife International, the International Crane Foundation, the International Peat Society, the Society of Wetland Scientists and Wetlands International. Some institutions have government backing and support for significant wetland rehabilitation programs, such as South Africa's national wetland rehabilitation program called *Working for Wetlands*.

Wetland Law and Policy Wetland management needs and initiatives have given rise to a diversity of wetland law and policies (Gardner and Finlayson 2018), including a wide range of national wetland policies (Bonells 2018). These policies encompass a range of principles including "no net loss," different types of permit schemes, the "avoid-mitigate-compensate" sequence and mitigation banking. Management tools such as Environmental Impact Assessments and Strategic Environmental Assessments support impact assessment and mitigation measures.

Economic values as well as diverse non-market benefits associated with wetland ecosystem services mean that management occurs within economic, ecological, and social contexts. Economic incentives may be significant for the nonregulatory conservation and management of wetlands (Watts and Everard 2018). Financial exchanges may have a role to play in incentivizing land owners to retire land or to manage in ecosystem-sensitive ways; examples include the US Conservation Reserve Program and the Payments for Ecosystem Services (PES) approaches. Establishment of national wetland policies is a strategic priority for signatories to the Ramsar Convention. Consequently, many countries have developed wetland policies and examples are described from Australia, Ghana, Chile, and the USA.

Management of Provisioning Services Management of wetlands for provisioning ecosystem services can encompass a diversity of outputs (Everard 2018b) including, for example, wetland food (such as lake bed cropping), reed products, traditional medicines, and salt production.

Management of Regulating Services Wetland management for regulatory services (McInnes 2018) also encompasses a diversity of benefits including support of insect pollinators, climate regulation, coastal protection, and urban wastewater management.

Management of Cultural Services Cultural services as foci for wetland management (Papayannis and Pritchard 2018) cover a diversity of benefits such as protection of archaeological resources, religious interests, educational resources (including visitor centers), and inspiration for the arts.

Importance of managing wetland supporting services Often overlooked, certainly by traditional economic assessment as they are not directly "consumed" in the economy, management of wetlands for their supporting services is essential for maintaining ecosystem integrity, functioning, and a reliable flow of other services (Everard 2018c). These services include nutrient cycling, biodiversity support, and generation of soils.

Wetland Methods

This part of the Book will be useful to a diverse audience. For those who work with wetlands, it can serve as an entry point to more detailed technical publications on the practical application of these methods. For students and decision makers, it will support a broad understanding of how wetlands are measured, mapped, and valued; how changes in wetlands can be assessed; and how planning for management and protection can be improved.

Wetland Delineation and Classification With the introduction of formal protection of wetlands by means of policies and laws, the need for formal delineation, mapping, and inventory arose. Tiner (2018) describes how this is done in the USA, a country with one of the longest traditions in wetland identification and delineation. Three types of indicators (on hydrophytic vegetation, hydric soil, and wetland hydrology) can be used to characterize wetlands. Aerial photography and, more recently, geographical information systems and satellite imagery play a large role in incorporating these indicators into the maps of wetlands.

Another need arising from formal protection and management procedures is the classification of wetlands (Gerbeaux et al. 2018). A variety of classification systems for wetlands has evolved, based on different characteristics of the wetland such as soil or vegetation type, geomorphology or nutrient status. Several chapters present different classification systems for specific types of wetlands (e.g., coastal wetlands, peatlands, and estuaries) or for specific countries (e.g., Brazil, Canada, India, South Africa, and the USA). A separate chapter describes the Ramsar Convention's classification system.

Earth Observation Methods for Wetlands In this section earth observation approaches, and their application to wetland ecosystems, are covered. An overview is given by Lucas (2018a). Since the 1970s, sensors operating in the visible and infrared regions of the electromagnetic spectrum (e.g., the Landsat satellites) have provided valuable imagery for characterization of wetlands and their dynamics. More recently, sensors in the thermal and especially the microwave region of the spectrum have also become important, especially because the latter (e.g., Synthetic Aperture Radar, SAR) can observe changes in water dynamics regardless of cloud cover or overhanging canopies. Separate chapters provide more in-depth insights into different sensor types (Lucas and Costa 2018) and the electromagnetic spectrum (Lucas 2018b) and into the use of remote sensing for observing water persistence

and duration (Milne 2018). Other chapters focus on remote sensing applications for a variety of wetland types (arctic and boreal wetlands, tropical forest wetlands, seagrasses, mangroves, peat swamps, subtropical wetlands, temperate bogs, mires, and fens) and human activities related to wetlands (aquaculture, agriculture).

Wetland Monitoring and Assessment One of the assumptions of protection and management is that information on the state of the wetland, and especially on the characteristics of the ecosystem which are part of management objectives, is available. This leads to the need for monitoring and assessment of wetlands (Stratford 2018a). Different types of assessment (hydrological, biological, functional, integrated, and vulnerability assessment) are discussed. While assessment is often a "snapshot" observation, monitoring (Stratford 2018b) provides more long-term data on the changes of the wetland, often based on very specific monitoring objectives (e.g., related to pressures on the ecosystem or to the effectiveness of management measures).

Environmental Flows The extraction of water from aquifers, rivers, lakes, and other wetlands for human use and the observed impact on ecosystems have led to the realization that there is a trade-off between the quality of ecosystems and the benefits of water for humans. The environmental flows concept is introduced by Acreman and Arthington (2018) and deals not only with the quantity of water available for ecosystems but also with water quality and the timing of flows. This is a complex issue, as it involves the challenge of determining the water requirements of the ecosystems, the practical questions around safeguarding these flows, as well as the policies and management strategies needed for implementing them. Subsequent chapters discuss various frameworks developed over the past decade for quantifying and realizing environmental flow regimes with examples of their implementation, and place the environmental flow concept within the context of integrated water resources management.

Wetland Management Planning As a result of increasing awareness of the importance of wetlands, and supported by the Ramsar Convention, increasing numbers of countries have formulated and adopted wetland conservation policies (see chapters in the "Wetland Law and Policy" part). The impact and effectiveness of such policies depend crucially on how they are translated into actual management on the ground. For this, management planning is extremely important. Alexander (2018) introduces the planning process which starts with the formulation of a clear vision and objectives, and participation of all involved in the wetland site. Other chapters discuss the planning process and which tools can be used. Emphasis is on adaptive management which allows frequent reassessment of objectives and actions to adjust the process to changing circumstances and needs. A separate chapter covers approaches to increase the capacity of countries to implement the management planning process, and several case studies are presented to support this topic.

Restoration and Creation of Wetlands Sometimes it is not possible to protect wetlands from degradation or destruction, and increasingly efforts are being made

to restore degraded wetlands and even create new ones. Moreno-Mateos (2018) shows that, although restoration cannot bring back the original ecosystem, it is possible to restore some of the important ecosystem functions and services that the original wetland system provided. Restoration can lead to artificial new wetland ecosystems ("constructed wetlands"), to brand new natural wetlands which are allowed to develop independently ("created wetlands"), or to the recovery of existing wetlands from earlier anthropogenic impact. Chapters discuss the ecosystem aspects of restoration (e.g., water quality, succession and plant communities, carbon and nutrient cycling), policy-related topics, and the economics of wetland restoration.

Environmental Impact Assessment for Wetlands Human development and economic activities create pressures on nature that, through the years, have led to the degradation and destruction of ecosystems all over the world. Concerns over negative impacts on the environment (including wetlands) in the 1960s led to the development of Environmental Impact Assessment (EIA) as a process to influence decision-making about development projects and to mitigate negative effects on not only ecosystems but also on society in a broader sense. Slootweg (2018a) introduces EIA and its development, including how it plays a role in policy and practice for wetland protection and conservation. In the following chapters, the various stages in the EIA process (screening, scoping, assessment and evaluation, reporting, and decision making) are explained further. Separate chapters are devoted to mitigation and to health and social impact assessment, as well as to the vital need for the participation of stakeholders in the EIA process.

Strategic Environmental Assessment for Wetlands While the EIA process is usually applied at the project level, Strategic Environmental Assessment (SEA) has been developed as a set of tools to identify and address the environmental and social impacts of higher-level initiatives such as policies and programs. SEA became important in the 1980s and 1990s, and Slootweg (2018b) describes its importance for wetlands, as demonstrated by the fact that EU member states have had since 2006 a legal obligation to apply SEA to their development plans and programs. Further chapters discuss the background and scope of the SEA process, including what is needed to implement the SEA process effectively for improved and more integrated decision-making for wetlands and their resilience.

Economic Valuation of Wetlands One of the topics that has received a lot of attention during the last decade is the economic valuation of ecosystems. Propelled by initiatives such as the Millennium Ecosystem Assessment and the "*The Economics of Ecosystems and Biodiversity*" (TEEB) economic valuation of ecosystem services has become part of the mainstream in policy and decision-making for wetlands. Kumar (2018) explains the background principles of economic valuation and highlights some of the challenges, e.g., of upscaling of values obtained from limited studies and uncertainty related to the limitations of the methods used for valuation. Subsequent chapters deal with the total economic value of wetlands and

provide more details on the different valuation methods. Two separate chapters discuss market-based and policy-based instruments to incorporate the economic value of wetlands in policies for wetland conservation and protection. A final chapter presents a number of examples of wetland valuation studies.

References

Acreman MC, Arthington AH. Environmental flows – overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Alexander M. Wetland management planning – overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Baldwin D. Chemical transformations in wetlands. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Bonells M. National wetland policies: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Boudell J. Landscape ecology of wetlands: overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Davidson NC. Biodiversity-related conventions and initiatives relevant to wetlands. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Davidson NC, Stroud DA. Waterbird flyways – and the history of international co-operation for waterbird conservation. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Everard M. Systems scale thinking for wetland management. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018a.

Everard M. Management of provisioning services: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018b.

Everard M. Importance of managing wetland supporting services: overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018c.

Gardner R. International conventions framework and drivers: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Gardner R, Finlayson CM. Wetland law and policy: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Gerbeaux P, Finlayson CM, van Dam AA. Classifying wetlands: concepts and principles. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Kandalepas D. 2018. Symbioses in wetland plants. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Kumar R. Economic valuation of wetlands, overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Lucas R, Costa M. Remote sensing instruments: sensor types relevant to wetlands. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Lucas R. Earth observation methods for wetlands – overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018a.

Lucas R. The electromagnetic spectrum: relevance to wetlands. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018b.

McInnes RJ. Management of regulating services: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Middleton B. Succession in wetlands. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht (The Netherlands): Springer; 2018.

Milne A. Remote sensing of water in wetlands: persistence and duration. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Moreno-Mateos D. Wetland restoration and creation: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Papayannis T, Pritchard D. Cultural aspects of wetland management: overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Rasmussen T. Wetland hydrology. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Schaffer G. Wetland plant morphology. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Seago J. Anatomy of wetland plants. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Slootweg R. Environmental impact assessment for wetlands, overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018a.

Slootweg R. Strategic environmental assessment for wetlands, overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018b.

Stratford CJ. Wetland assessment, overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018a.

Stratford CJ. Monitoring of wetlands, overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018b.

Tiner RW. Wetland delineation: an overview. In: Finlayson CM, Middleton B, McInnes JR, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.

Watts WD, Everard M. Economic incentives for the non-regulatory conservation and management of wetlands: an overview. In: Finlayson CM, Middleton B, McInnes RJ, Everard M, Irvine K, van Dam AA, Davidson NC, editors. The Wetland Book. 1: Wetland structure and function, management, and methods. Dordrecht: Springer; 2018.