Chapter 3: Assessing and Measuring Wetland Hydrology

Donald O. Rosenberry and Masaki Hayashi

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Abstract Virtually all ecological processes that occur in wetlands are influenced by the water that flows to, from, and within these wetlands. This chapter provides the "how-to" information for quantifying the various source and loss terms associated with wetland hydrology. The chapter is organized from a water-budget perspective, with sections associated with each of the water-budget components that are common in most wetland settings. Methods for quantifying the water contained within the wetland are presented first, followed by discussion of each separate component. Measurement accuracy and sources of error are discussed for each of the methods presented, and a separate section discusses the cumulative error associated with determining a water budget for a wetland. Exercises and field activities will provide hands-on experience that will facilitate greater understanding of these processes.

3.1 Introduction

The physical, biological, and chemical properties of a wetland all are greatly influenced by water and chemical fluxes, both to and from the wetland, as well as the temporal variability of these fluxes. Therefore, hydrologic processes are central to the character and features of a wetland and to virtually everything that occurs surrounding and within a wetland basin. A question occasionally posed by wetland scientists is whether a wetland "has hydrology." This terminology likely stems from

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a need to determine whether a landscape has characteristics of a wetland setting for regulatory or protection purposes. Hydrology is basically the study of water as it is distributed over, on, and within the earth. All landscapes, and particularly wetlands, have hydrologic properties that are an integration of all the water-related characteristics and processes that occur there. Wetland hydrology encompasses study of the distribution and flow of all water that is added to, lost from, or stored in a wetland.

A wetland is a portion of a landscape that is wet for a period sufficiently long that physical, chemical and biological conditions are indicative of a wet setting. Wetlands occur in a wide range of settings where geological and hydrological processes enhance the accumulation and retention of water (Winter 1988). Water, therefore, is present at or just beneath land surface at a substantial percentage of the time in wetland settings. Given that water is integral to wetland settings, an overarching challenge in determining the type or persistence or quality of a particular wetland setting is to determine the relative contributions of the various components of wetland hydrology (i.e., precipitation or evapotranspiration or surface-water inputs or groundwater inputs or overland flow). A water-budget approach for making this determination is perhaps the best way to categorize and describe the wide range of wetland types that exist in the world (Winter and Woo 1990; Winter 1992) and is the perspective from which this chapter is presented.

3.2 Wetland Hydrology from the Perspective of a Water Budget

Knowledge and understanding of the storage and mass balance of water and chemicals is critical to understanding a wetland ecosystem. This includes quantifying all of the sources, losses, and changes in storage in the wetland. Simply determining the relative magnitude of various hydrologic components can largely determine a wetland type. For example, surface water may be the dominant source and sink of water and solutes for a riparian wetland whereas overland flow and evapotranspiration may dominate in a prairie wetland. One will have greatly different water chemistry and biogeochemical processes than the other, all because of the relative mix of sources and sinks of water and chemicals.

Wetland stage is an integrated response to all source- and sink-terms in a hydrologic budget. It also incorporates temporal variability in the balance of all hydrologic fluxes and is, therefore, strongly linked to wetland hydroperiod and wetland hydrodynamics, both of which are important to most disciplines that encompass wetland science (Euliss et al. 2004). Wetland stage and volume can also provide a direct and often sensitive response when climate change may be affecting the relative magnitude and importance of specific hydrologic components.

For these reasons and more, an accounting of hydrologic components of a wetland water budget should be one of the first items on a wetland-scientist's agenda (LaBaugh 1986). Preliminary estimates of the relative volume associated with each hydrologic component is often a valuable first step. These estimates will allow attention to be

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