SPRING 2011

WATERSHED SCIENCE BULLETIN

AWSPs
Association of Watershed & Stormwater Professionals

Journal of the Association of Watershed & Stormwater Professionals

A program of the Center for Watershed Protection, Inc.

Integrating Climate Change Science into Watershed and Stormwater Management

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Watershed Science Bulletin (ISSN: 2156-8545) is the journal of the Association of Watershed and Stormwater Professionals (AWSPs), and is published semi-annually by the Center for Watershed Protection, Inc. (CWP).

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MISSION: The mission of the *Watershed Science Bulletin* (the *Bulletin*) is to synthesize research and experience from the numerous disciplines that inform watershed management and transmit this valuable information to researchers, regulators, practitioners, managers, and others working to protect and restore watersheds everywhere.

POSTMASTER: Please send address changes to the Watershed Science Bulletin address listed above.

SUBSCRIPTIONS AND BACK ISSUES: Subscription is included for AWSPs members as part of member dues. The subscription rate for nonmembers is $89/year. Single copies and back issues can be purchased for $49 each. For a complete listing of back issues or to purchase a subscription, please visit www.awsps.org.

SUBMISSION: To submit an article, please visit www.awsps.org.

Graphic Design by Down to Earth Design, LLC (d2edesign.com)

Copyediting by Elizabeth Stallman Brown

Printed by the YGS Group, York, PA.

Cover photo courtesy of Lori Lilly,
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This photo was taken along Young's Bay estuary in Astoria, OR. The Young's Bay estuary is a component of the Columbia River estuary, a nationally significant estuary in the northwest corner of Oregon that supports some of the largest anadromous fish runs in the world and provides unique habitat for sensitive and endangered species.

Recommendations for Developing Saltmarsh Buffer Widths as Sea Levels Rise

The Delaware Inland Bays are three shallow coastal lagoons of great recreational and ecological importance to the state and region. Their 777 km^2 (300 mi^2) mixed-use watershed contributes excess nutrients that have eutrophied the 78 km^2 (30 mi^2) estuary (Figure 1). Acting to moderate the effects of this pollution are approximately 4,000 ha (10,000 acres) of saltmarsh that define the boundary between the land and the Bays. Because these signature ecosystems of the estuary are critical to maintaining water quality and aquatic life, their protection is of the highest priority for the Delaware Center for the Inland Bays National Estuary Program (the Center). Now more than ever, meeting the Center's conservation and management plan goal of maximum protection for saltmarshes is dependent on an understanding of marsh response to rising seas.

Figure 1. Aerial photograph of the connection between the Indian River Bay, a temperate coastal lagoon, and the Atlantic Ocean. (Photograph by Chris Bason)

Figure 2. Tidewater inundates a residential lot for sale in a study development during a nor'easter in the Indian River Bay watershed, Delaware. This illustrates that wide buffers can protect homeowners as well as marshes. (Photograph by Chris Bason)

Rising sea levels press marsh boundaries landward over adjacent uplands, while at the same time marsh edges are eroded by wave action to become shallow bay bottom. The net result is the inland migration of a marsh system observable over a human lifetime. Maximizing future marsh acreage under conditions of rising sea level requires unobstructed pathways for saltmarsh migration.

Construction adjacent to marshes can act as a barrier to marsh migration; such construction became increasingly common during the past two decades. From 1992 to 2007, development within the Inland Bays' watershed increased by 67 km^2 (26 mi^2) or 57%, with much construction occurring adjacent to tidal areas.

Recognizing that an existing County wetland buffer ordinance was inadequate and unenforced, the Center developed recommendations for enhanced buffers between marshes and new development. This work was part of a complete set of recommendations for a water quality buffer system submitted for consideration to the State of Delaware in 2008 during the development of the pollution control strategy (PCS) for the Bays. The PCS was designed to reduce nitrogen and phosphorus loads to the Bays from 40% to 85%, in accordance with established total maximum daily load regulations.

The Center's recommendations for saltmarsh buffers were based on research by the University of Delaware's Wendy Carey, who estimated rates of marsh migration by interpreting aerial photography over the period 1944–1989. During this period, the tidal prism of the estuary's inlet to the ocean increased by nearly five times as a result of scouring caused by its earlier stabilization with rock jetties. This created higher high tides at the landward boundary of marshes, which probably added to the effect of regional sea level rise on the landward migration of marshes.

Marsh migration rates varied based on the slope of the adjacent lands, with marshes next to gradually sloping lands (≤ 0.08 rise over run) migrating an average of 1.7 m (5.7 ft) per year, and those next to steeply sloping lands (> 0.08 rise over run) 0.3 m (1.1 ft) per year. The Center converted the rates to the number of years it would take for marshes to migrate across buffers of different widths and slopes (Table 1); the resulting values thus function as simple planning horizons for effective buffers.

Through a GIS-based exercise, the Center evaluated the impact of the recommended buffer widths on randomly selected development project parcels proposed to the State. The percentage of developable land for a project that the most protective saltmarsh buffers encompassed ranged from less than 1% to 64% (Figure 2). This, predictably, was dependent on the amount of saltmarsh in or adjacent to the development and the slope of the uplands adjacent to the marshes.

Overall, the work illustrated (1) the surprising speed at which marsh systems can move across the Mid-Atlantic coastal plain, where rates of sea level rise are relatively high; (2) how buffer widths that maximize pollutant removal in coastal plain freshwater streams (between 24 to 46 m, or 80 to 150 ft) may provide only a few years of protection for many saltmarshes; and (3) that development site design would have to change significantly to accommodate marsh migration for low-elevation sites with gradual slopes.

The results of this analysis were influential in the decision by the State of Delaware to assume regulation of saltmarsh buffers for new major subdivisions under the Inland Bays PCS in 2008. However, the State decided not to define the width of buffers based on the provided migration rates of marshes, but instead included an option intended to offer flexibility for developers whereby they could choose to establish either 100 foot or 50 foot salt marsh buffers dependent on the level of stormwater quality management practices incorporated on the subdivision.

In 2010, researchers at the University of Delaware began a new remote sensing study of marsh change that will include refinement of estimated migration rates by sampling an expanded number of marshes. The study, expected to be completed by 2013, will also examine changes in the rate of marsh change over time (including changes since the previous analysis) and explore potential relationships between marsh migration rates and both climate and development. Historical aerial photography and satellite imagery will be used in the analysis.

List of Sources

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For More Information

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Table 1. The average number of years it would take for marshes to migrate across buffers of different widths by the slope of the buffer for two of Delaware's Inland Bays. (A gradual slope is defined as ≤ 0.08, and a steep slope is > 0.08). Data are derived from migration rates estimated for the period 1944–1989.

	Rehoboth Bay		Indian River Bay	
Buffer Width m (ft)	Gradual Slope	Steep Slope	Gradual Slope	Steep Slope
15 (50)	10	35	8	61
23 (75)	14	52	12	91
31 (100)	19	69	17	122
61 (200)	38	139	33	244
91 (300)	57	208	49	366
122 (400)	76	278	66	488
152 (500)	95	347	82	610