Takeaways

- Beaver dominated landscape
- Sedimentation rates low
- Majority of non-arboreal plants were wetland species
- Design systems that mimic pre-colonial systems – wet and marshy

Estuaries and Coasts
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PERSPECTIVE

Historical Land Use, Nitrogen, and Coastal Eutrophication: A Paleoecological Perspective

Grace S. Brush

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Abstract Organisms and chemicals preserved in sediment cores from the Chesapeake estuary in mid-Atlantic USA are consistent with a precolonial landscape covered with a diversity of forests and marshes, large and small. During the past 300 years, many of the wetlands have been drained, and the landscape was converted to agricultural fields and urban and suburban development. During this time, sources of nitrogen have diversified, and loadings have increased. Since precolonial time, the mesohaline estuary has become increasingly eutrophic and anoxic. Estuaries and coastal regions throughout the world have experienced similar conditions in their recent history. These changes are recorded in Chesapeake sediment cores by increases in ragweed pollen, dry taxa, sedimentation rates, nitrogen influxes, and a major change in estuarine autotrophs from benthic to planktonic. In many areas, attempts to reverse estuarine eutrophication and anoxia have centered on restoring streams and riparian areas and reducing fertilizer use on agricultural lands. However, data from soils and historical reports and the paleoecological record suggest that to reduce the effects of modern nitrogen inputs, it may be necessary to locate and enhance denitrifying areas throughout the watershed.

Keywords Estuary · Landscape · Paleoecology · Nitrogen fixation · Eutrophication · Anoxia · Denitrification

G. S. Brush (✉)
Johns Hopkins University,
Baltimore, MD 21218, USA
e-mail: gbrush@jhu.edu

Introduction

An important and largely unanswered question in many coastal areas throughout the world is how can aquatic ecosystems be restored to functionally coupled autotrophic detrital food webs, where inorganic material is converted to organic by primary producers, used by consumers, and converted back to inorganic by decomposers and recycled to primary producers. The large coastal shellfish and fishery resource, which has provided food for much of the world's human populations, has been greatly reduced as excess nutrients and over-harvesting have altered energy flows through aquatic food webs. Excess nitrogen is a major cause of ecosystem deterioration both on land and in water and is particularly difficult to amend due to multiple sources, the complexity of nitrogen transformations, and the necessity of anaerobic conditions for its return to the atmosphere as elemental nitrogen, via denitrification (e.g., Vitousek et al. 1997; Galloway et al. 2004; Seitzinger et al. 2006). In this discussion, I concentrate on the Chesapeake Bay, a large estuary on the Atlantic coast of USA (Fig. 1). I use the stratigraphic record of organisms and materials preserved in Chesapeake Bay sediments spanning 1,000 to 14,000 years, along with available historical records (past 300 years; Fig. 2) to trace the history of changes associated primarily with nitrogen loadings into the estuary since precolonial time. I briefly review the known history of coastal eutrophication and deterioration worldwide. And finally, based on the historical and paleoecological records, I propose that a significant reduction in nitrogen both on the land and in the estuary can be accomplished most effectively by multiple denitrifying processors, both natural and engineering, positioned throughout the watershed.

Takeaways

- Increase carbon availability in the flow path
- Slow water velocity – increase contact time
- Increase topographic complexity – maximize surface area to volume
- Increase connection between stream and adjacent floodplain
- Enhance hyporheic exchange

STREAM RESTORATION STRATEGIES FOR REDUCING RIVER NITROGEN LOADS

Laura S. Craig[1], Margaret A. Palmer[1, 2], David C. Richardson[1], Solange Filoso[2], Emily S. Bernhardt[3], Brian P. Bledsoe[4], Martin W. Doyle[5], Peter M. Groffman[6], Brooke A. Hassett[3], Sujay S. Kaushal[7], Paul M. Mayer[8], Sean M. Smith[9], and Peter R. Wilcock[9]

[1]University of Maryland, College Park, MD; [2]University of Maryland Center for Environmental Science-Chesapeake Biological Laboratory, Solomons, MD; [3]Duke University, Durham, N.C.; [4]Colorado State University, Fort Collins, CO; [5]University of North Carolina, Chapel Hill, NC; [6] Institute for Ecosystem Studies, Millbrook, NY; [7]University of Maryland Center for Environmental Science-Appalachian Laboratory, Frostburg, MD; [8] U.S. Environmental Protection Agency, Ada, OK; [9]Johns Hopkins University, Baltimore, MD

ABSTRACT

Despite decades of work implementing best management practices to reduce the movement of excess nitrogen (N) to aquatic ecosystems, the amount of N moving down streams and rivers remains high in many watersheds. During this same time period, stream restoration has become increasingly popular, yet efforts to quantify N-removal benefits are only just beginning. Natural resource managers are asking scientists to use the best available knowledge to provide advice for maximizing chances of reducing the downstream flux of N. We propose a framework for prioritizing restoration sites that involves identifying where potential N loads are large due to sizeable sources and efficient delivery to streams, and when the majority of N is exported. Small streams (1^{st}-3^{rd} order) with considerable loads delivered during low to moderate flows offer the greatest opportunities for N removal. We suggest approaches that increase in-stream carbon availability, contact between the water and benthos, and connections between streams and adjacent terrestrial environments. Because of uncertainties concerning the magnitude of N reduction possible, approaches should be tested in various landscape contexts, and until more is known, stream restoration alone is not appropriate for compensatory mitigation and should be considered complementary to land-based best management practices.

Takeaways

- Mill dams ubiquitous throughout the region

- Heavy sedimentation rates coincided with post settlement land use changes

- Dam breaches lead to incision, bank erosion and increased suspended sediment

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Anthropocene streams and base-level controls from historic dams in the unglaciated mid-Atlantic region, USA

By Dorothy Merritts[1,*], Robert Walter[1], Michael Rahnis[1], Jeff Hartranft[2], Scott Cox[2], Allen Gellis[3], Noel Potter[4], William Hilgartner[5], Michael Langland[6], Lauren Manion[1], Caitlin Lippincott[1], Sauleh Siddiqui[1], Zain Rehman[1], Chris Scheid[1], Laura Kratz[1], Andrea Shilling[1], Matthew Jenschke[1], Katherine Datin[1], Elizabeth Cranmer[1], Austin Reed[1], Derek Matuszewski[1], Mark Voli[1], Erik Ohlson[1], Ali Neugebauer[1], Aakash Ahamed[1], Conor Neal[1], Allison Winter[1] and Steven Becker[1]

[1]*Department of Earth and Environment, Franklin and Marshall College, PO Box 3003, Lancaster, PA 17604-3003, USA*
[2]*PA Department of Environmental Protection, Rachel Carson State Office Building, 400 Market Street, Harrisburg, PA 17101, USA*
[3]*US Geological Survey, 5522 Research Park Drive, Baltimore, MD 21228, USA*
[4]*Department of Earth Sciences, Dickinson College, Carlisle, PA 17013-2896, USA*
[5]*Engineering Programs for Professionals, The Johns Hopkins University, Baltimore, MD 21218, USA*
[6]*US Geological Survey, 215 Limekiln Road, New Cumberland, PA 17070, USA*

Recently, widespread valley-bottom damming for water power was identified as a primary control on valley sedimentation in the mid-Atlantic US during the late seventeenth to early twentieth century. The timing of damming coincided with that of accelerated upland erosion during post-European settlement land-use change. In this paper, we examine the impact of local drops in base level on incision into historic reservoir sediment as thousands of ageing dams breach. Analysis of lidar and field data indicates that historic milldam building led to local base-level rises of 2–5 m (typical milldam height) and reduced valley slopes by half. Subsequent base-level fall with dam breaching led to an approximate doubling in slope, a significant base-level forcing. Case studies in forested, rural as well as agricultural and urban areas demonstrate that a breached dam can lead to stream incision, bank erosion and increased loads of suspended sediment, even with no change in land use. After dam breaching, key predictors of stream bank erosion include number of years since dam breach, proximity to a dam and dam height. One implication of this work is that conceptual models linking channel condition and sediment yield exclusively with modern upland land use are incomplete for valleys impacted by milldams.

*Author for correspondence (dorothy.merritts@fandm.edu).

One contribution of 13 to a Theme Issue 'The Anthropocene: a new epoch of geological time?'.

Takeaways

- Contemporary upland sediment is a significant contribution to overall sediment supply
- Supports sediment storage along the flow path
- Difficult to demonstrate that any particular investment will achieve the desired result

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Upland sediment supply and its relation to watershed sediment delivery in the contemporary mid-Atlantic Piedmont (U.S.A.)

S.M.C. Smith [a,*], P.R. Wilcock [b]

[a] University of Maine, School of Earth and Climate Sciences, Bryand Global Science Center, Orono, ME 04473, USA
[b] Johns Hopkins University, Department of Geography and Environmental Engineering, 3400 North Charles Street, Ames Hall 313, Baltimore, MD 21218, USA

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A B S T R A C T

We use sediment accumulation in ponds and reservoirs to examine upland sediment sources and sinks in the Piedmont physiographic region of Maryland, USA. In zero-order and first-order watersheds, sediment yield is greatest from suburban land cover, followed by agriculture and forest. The idea that sediment yield is small from mature suburban development appears to not be correct. First-order channel enlargement is an important sediment source, causing sediment yield to increase from zero-order to first-order watersheds. Nonchannel sources provide one-third to two-thirds of the upland sediment load.

Long-term sediment accumulation in a reservoir at fifth-order indicates that cumulative sediment load from upland areas is reduced by one-quarter by net valley bottom sedimentation. If upland supply exceeds the load delivered from a watershed, sediment must accumulate along valley bottoms. In our study watershed, net sedimentation rate (sedimentation less erosion) averaged over valley bottom area is 2.6 mm/y, a value that is similar to independent direct measurements of sedimentation and erosion in a nearby watershed. Evaluation of the relative contributions to sediment mass balance of upland supply, valley bottom sedimentation and erosion, and watershed delivery indicates that, if valley-bottom rates of sedimentation exceed erosion as indicated by recent studies, then the proportion of watershed sediment delivery derived from stream banks is necessarily small.

Although sediment yield estimated from stream gage records is similar in magnitude to that from ponds for watersheds smaller than 20 km^2, sediment yield from reservoir sedimentation is a factor of five larger than that estimated from gage records for watersheds larger than 140 km^2. This observation confirms that the different methods provide very different estimates of sediment yield. This possibility is reinforced by a sediment yield of 14 $Mg/km^2/y$ from a gage immediately above a reservoir with a yield of 142 $Mg/km^2/y$ based on reservoir accumulation.

1. Introduction

The mechanisms and rates associated with sediment erosion, transport, and storage change with increasing spatial scale. As water flow and sediment move from relatively steep upland hillslopes and channels to lower gradient alluvial valleys, the balance between upland sediment production and sediment yield over a decadal time scale is mediated by deposition along lowland channels and floodplains, typically producing yield that is smaller than upland supply. This has been termed the sediment delivery problem and is often approximated using a sediment delivery ratio that expresses the sediment delivered to a point in a watershed as a proportion of the amount of sediment eroded upstream (Walling, 1983; de Vente et al., 2007). The magnitude of the ratio generally decreases with drainage area but specific values and their variation with basin size depend on many factors. A wide range of sediment delivery factors are reported in the literature (Roehl, 1962; USDA, 1983; Scatena, 1987; Kinnell, 2004; Walling and Horowitz, 2005).

A predictive understanding of sediment delivery is of pressing importance because excess sediment and related turbidity are widespread impairments in rivers and coastal waters. Expenditures required to reduce sediment loading to specific goals will be enormous, and it can be difficult to demonstrate that any particular investment will achieve the desired result. Remediation and restoration actions may reduce sediment loading at specific locations, and some basis is needed for estimating the proportion of that reduction in sediment supply that appears farther down the watershed. A sound approach requires evaluation of landscape position and the magnitude of individual sediment sources. Information to guide this work is available primarily at the scale of hillslope plots or larger rivers on which gages exist (Table 1). Much less is known about sediment sources and sinks in the upland watersheds between plot scale and higher order rivers (Strahler,

* Corresponding author. Tel.: +1 207 581 2198.
E-mail addresses: sean.m.smith@maine.edu (S.M.C. Smith), wilcock@jhu.edu (P.R. Wilcock).

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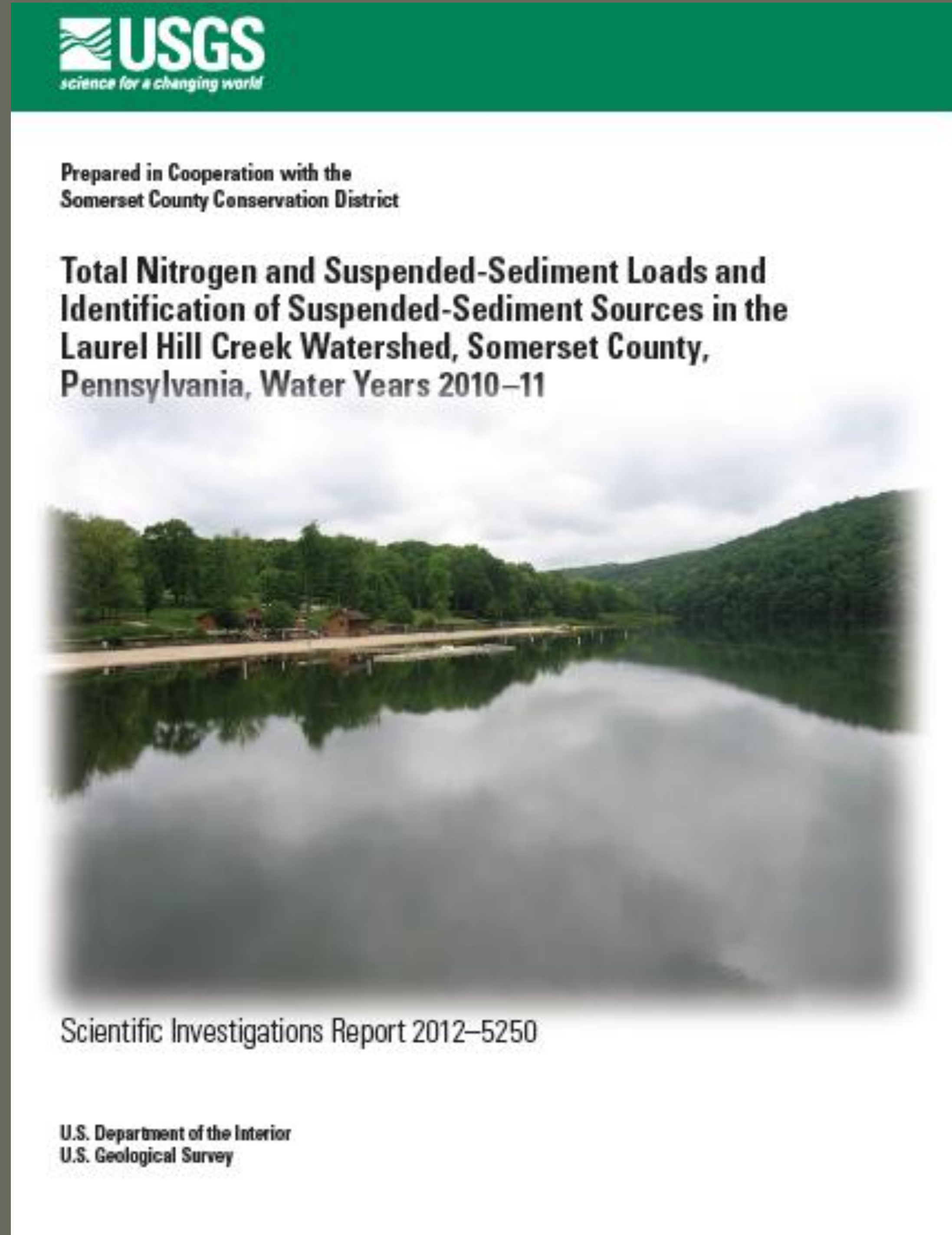
Takeaways

• Sediment fingerprinting approach used to quantify sources during storm flows

• Agriculture was the major source of sediment (53%) for the 10 storm samples

• Streambank sediments contributed 30 % of sediment sampled during storm flows



So, The Question Is:

Where Is This Sediment Coming From and How Do We Target Our Efforts?

And The Answer Is…

It Depends. But there are answers

Stormwater Management

0 and 1st Order Streams

Agricultural BMPs

Stream Restoration

Competent Vs. Depositional Channels

Dampen the Hydrograph

- Reduction in Stream Power

- Opportunity for Processing