

2011 MEDALS & AWARDS

KIRK BRYAN AWARD

Presented to
Robert C. Walter And Dorothy J. Merritts

for
Natural Streams and the Legacy of Water-Powered Mills
Science, v. 319, p. 299-304.

Citation by Ellen E. Wohl

The 2011 Kirk Bryan award goes to Robert Walter and Dorothy Merritts for the 2008 *Science* paper “Natural Streams and the Legacy of Water-Powered Mills.” This paper generated national and international attention because of its thorough and timely examination of some long-held assumptions about river form and river restoration. The scientific community has come to regard gravel-bed streams as having a characteristic meandering planform bordered by fine-grained overbank deposits. This conceptualization is based at least in part on mid-Atlantic streams initially described in some of the classic fluvial geomorphic studies of the 1960s. Stream restoration projects commonly seek to recreate this river form under the assumption that it represents the most stable, widespread, and natural configuration for mid-sized rivers. The Walter and Merritts paper calls this conceptualization into question by presenting careful documentation that, prior to European settlement of the eastern United States, many of the streams were small, multi-thread channels in valleys with extensive wetlands that accumulated relatively little sediment. These streams and valley bottoms were subsequently buried by thicknesses of up to 5 m of sediment that was trapped upstream from tens of thousands of mill dams constructed along the streams to create water power for diverse uses during the 17th to 19th centuries. As these mills were abandoned, the filled millponds were forgotten, vegetation grew over the pond sediments, and the streams incised into the sediments and assumed a new, stable planform that was subsequently interpreted to reflect ‘natural’ stream configuration in the absence of human manipulation of watersheds and valley bottoms. By demonstrating that the floodplains are actually historical fill terraces and that the streams are not natural archetypes for gravel-bed, meandering streams, Walter and Merritts have provided an opportunity



Robert C. Walter



Dorothy J. Merritts

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for members of the stream-science community to re-evaluate long-held assumptions about stream process and form, the historical influence of humans on streams, and appropriate models for stream restoration.

A strength of the work presented in this paper is the careful, detailed interpretation of past environments based on stratigraphic and historical records. Walter and Merritts use diverse sources of prehistoric and historical information to reconstruct the environment of valley bottoms prior to, during, and following the period of initial European settlement. As stream science becomes increasingly quantitative and based on numerical simulations, this paper provides a strong reminder that conceptual and numerical models must be firmly grounded in the reality of records from the field. The expectation of what streams ‘should’ look like is fundamental to our understanding of geomorphic process and form and the application of this understanding to stream management, including restoration. Expectations based on inappropriate assumptions can have direct and widespread consequences. The work of Walter and Merritts exemplifies the application of stratigraphic, paleoenvironmental, and historical records to understanding past and present landforms and to contemporary resource management. Because this work represents fundamental scientific research, as well as the application of scientific understanding to issues of concern to contemporary society, the paper is worthy of the high honor of the Kirk Bryan Award.

Response by Robert C. Walter

There are few things more gratifying than being recognized by ones peers, especially when this honor began with a recommendation from a colleague as accomplished as Ellen Wohl. I am deeply grateful to Ellen for her recommendation, and to the Kirk Bryan Award committee for selecting our 2008 paper for this citation. I am privileged and humbled.

When I was as a graduate student, I read a short article about the great Boston Red Sox slugger Ted Williams. He was attempting to describe what he visualized in the batters box that made him such an outstanding hitter. He said: “When I step into the box, time slows down for me. When the pitch is delivered the ball looks to be the size of a beach ball. That’s

when I know I’m in the zone.” I carried that article for years as inspiration of what it must feel like to be so in tune with your profession that time slows down.

In the summer of 2003, and I found myself standing in ankle deep water of a small second-order stream in Lancaster County, Pennsylvania. I was with my colleague Dorothy Merritts and her student Lauren Manion. Lauren was showing us a perplexing site she had found a few days earlier. What was perplexing was that this ankle-deep, 3-m-wide stream had a vertical cut bank nearly 5 m high. The bank was composed entirely of silts and clays, which were horizontally bedded and finely laminated. They looked like pond sediments, and not at all what one expects to see in the bank of a

small, meandering stream: no lateral accretion surfaces, no fining-upward sequences, no sand or gravel...just 5 m of massive, finely laminated silty-clay. Dorothy said: “There must have been a dam. These have to be pond sediments”. We walked less than 100 m downstream where we found large, rough hewn blocks of limestone in the stream, some the size of this podium, and we traced them into both banks. The boulders on the left bank were neatly stacked like large bricks, representing the remains of a 5-m-high stone dam. The boulders on the right bank merged into an equally well-crafted stone wall that braced one side a long ditch dug into the base of a colluvial hill slope. We followed the ditch about a kilometer, where it lead to an old, long defunct, water-powered mill. As we took

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in this sequence of events—the high banks, the stone dam exactly the same height as the banks, a kilometer-long millrace—we began to piece the puzzle together.

I grew up in Lancaster County, I fished these creeks as a boy and rode my bike around the countryside. “There were hundreds of mills in Lancaster County...” I said, letting the thought trail off. Silently, as if blinders were lifted, we began to see the cumulative impact of hundreds of dams. Time slowed, and for a fleeting moment I felt like Ted Williams in the batters box... nature was tossing us a huge, juicy fastball right down the center of the plate.

I am grateful to many colleagues and mentors who instilled in me a love for the Quaternary, and I would like to acknowledge a few here: John Moss (F&M), John Hollin (INSTAAR), John Andrews (INSTAAR), John Westgate (University of Toronto), and my graduate advisor Jim Aronson (CWRU, now Dartmouth). The late Derek York (University of Toronto) shared with me his passion for deep (and not so deep) time, and his ability to recognize important research problems. He is sorely missed.

Response by Dorothy J. Merritts

Thank you, Ellen, and members of the Quaternary Geology and Geomorphology Division for honoring our work on mid-Atlantic streams. Our work builds on the legacies of the great geomorphologists Luna Leopold (first Kirk Bryan award winner, 1958) and Reds (M. Gordon) Wolman, who for years worked on the same small to mid-sized Piedmont streams in Maryland and

Pennsylvania upon which we now spend much of our time. We were fortunate to discuss this work with Reds on multiple occasions, and even to share two days with him in the field before he passed away. We also were fortunate to work with Milan Pavich (USGS), 33rd winner of the Kirk Bryan award. Throughout this research, I benefited from early training by Bill Bull (35th winner of the Kirk Bryan award). Mid-Atlantic Piedmont streams are far different than those of the Pacific Rim that I traipsed with Bill, but his influence enabled me to see the signal of rapid base-level change in a landscape where we didn't expect to find it.

Nearly 40 years ago, Luna Leopold delivered the outgoing president's address to the Geological Society of America at its 1972 meeting, the last time it was held here in Minneapolis. The title of his address was “River Channel Change with Time” (GSA Bulletin v. 84, no. 6, p. 1845-1860). The channel was Watts Branch, a small (10-km² drainage area) tributary to the Potomac River. Luna had monitored channel change since 1972, and concluded it was occurring “far more rapidly than [he] expected”. Urbanization had just begun, and he attributed change and its rapidity to this phenomenon.

Luna's observations and astute insights remain sound, but he didn't realize that the channel he studied was the remnants of a race, a ditch dug by some 19th c. miller to bring water through an older sediment-filled millpond to his mill just downstream. Luna's channel sections were located within the incised channel of this filled pond. We now know that the milldam breached sometime between 1910 and 1955, and this breaching

led to rapid incision, channel migration, and erosion. Also, we now know that the valley was a stable wet meadow with groundwater springs, thick nutrient-rich organic mat, and small channels throughout the Holocene. This Holocene wetland formed on a coarse Pleistocene periglacial colluvial substrate.

What lessons can we learn from nearly 60 years of research on the same streams? Causality is not necessarily the most obvious or even concurrent phenomenon. Base-level change from breaching of old dams, not (just) urbanization, has led to widespread channel incision throughout the mid-Atlantic region. Stratigraphy and mapping are fundamentally important. Boulders and cobbles in the bed of a small stream might be exhumed from a Pleistocene gelifluction sheet, not necessarily evidence of transport during modern storms. Millpond sedimentation was equivalent to a Pompeii effect, blanketing and preserving the Holocene landscape. Finally, when we look back at the classic early work of Reds and Luna we find that they made many of the same discoveries that continue to surprise us. One of the most important is the role of freeze-thaw in bank erosion. Luna referred to it in his 1972 GSA address as the “main mechanism of bank retreat”. Our *detailed*, ongoing studies support this finding, yet modern policies for reducing sediment load to the Chesapeake Bay, an impaired water body, do not account for bank retreat or freeze-thaw.

In closing, we thank our many colleagues (especially Mike Rahnis, Noel Potter, Frank Pazzaglia, and Allen Gellis) and the Department of Earth and Environment at Franklin and Marshall College for their continued support and collaboration.