LETTERS

edited by Jennifer Sills

Reservations About Dam Findings

IN THE RESEARCH ARTICLE "NATURAL STREAMS AND THE LEGACY OF WATER-POWERED MILLS" (18 January, p. 299), R. C. Walter and D. J. Merritts observe that milldam density is regionally more important than previously recognized (*1*–*7*). We have several reservations: (i) Local observations cannot necessarily be generalized to wider settings, (ii) pre-Colonial forms were inconsistently documented, and (iii) implications for contemporary watershed management are unclear.

The detailed observations in the Research Article are from southeastern Pennsylvania, a famously fertile portion of the eastern U.S. Piedmont with high historic milldam density. Most portions of the Piedmont could not support this milling density, yet no detailed comparison of mill deposits with deposits in relatively dam-free basins was provided. More evidence is needed to justify broad application of these findings elsewhere.

Enhanced understanding of historic valley conditions can offer useful guidance for parts of stream rehabilitation design, but the characteristics of the valley's streams in pre-Colonial times remains undetermined. Walter and Merritts provide some evidence—such as organic-rich, hydric (i.e., consistently saturated) soils, interpreted to indicate channel bottoms with multiple low-flow channels—to question previous work on Piedmont channel processes. However, contrary evidence from one cited source was ignored (*7*), and three of four sources cited do not support the "typical" alluvial profile. None, other than (*3*), describe prominent buried hydric soils or wetlands, and several, including (*3*), mention buried gravel bars, uncharacteristic of interpreted conditions. Wide variation in reported ^{14}C data is not addressed. Pennsylvania ^{14}C ages (median 450 years ago) are used to indicate presettlement surfaces, but Maryland samples from similar deposits are much older (median 3410 years ago). Given the importance of such details to describing the pre-Colonial channel form, more detailed documentation is necessary.

A milldam near Bloomville, New York.

Streams in the mid-Atlantic have responded to boundary conditions, including base-level adjustments, water and sediment supply fluctuations, and varying beaver populations (*8*), throughout the Holocene. Before European colonization, valley conditions likely reflected the activities of Native Americans rather than a natural regime. Perturbations increased in frequency and magnitude after colonization, and they continue to this day. Accordingly, the milldam observations do not justify the inference that historic fluvial forms can address contemporary riparian management issues, as pre-Colonial forms evolved from historic boundary conditions.

The strategy resulting from these observations, which is already practiced, is to dredge valley bottom sediment and realign channels in a semblance of pre-Colonial morphology. This strategy has risks. Recreating these forms without addressing contemporary upland sediment supplies could result in partial refilling of dredged valleys. Lowering floodplains in meandering reaches also permits straighter down-valley paths for a wider range of flows, which can destabilize riparian corridors (*9*). In either scenario, the constructed morphology would require maintenance such as periodic dredging or structural controls, both arguably no closer to "natural" than current conditions.

For watershed managers, suggesting that pre-Colonial river valley forms represent an updated "ideal" condition resembles the misuse of generic stream "types" for restoration design over a decade ago (*10*). The current demand to mitigate adverse impacts to wetlands and waterways is high, but watershed managers need to consider both contemporary and historical causes of stream impairment before deciding how to respond.

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References

1. N. E. Allmendinger, J. E. Pizzuto, G. E. Moglen, M. Lewicki, *J. Am. Water Resources Assoc.* **43**, 1483 (2007).
2. D. J. Bain, G. S. Brush, *Am. J. Sci.* **305**, 957 (2005).
3. R. B. Jacobson, D. J. Coleman, *Am. J. Sci.* **286**, 617 (1986).
4. S. W. Trimble, *Science* **285**, 1244 (1999).
5. L. B. Leopold, R. Huppman, A. Miller, *Proc. Am. Philos. Soc.* **149**, 349 (2005).
6. J. E. Pizzuto, *Sedimentology* **34**, 301 (1987).
7. J. E. Costa, *Geol. Soc. Am. Bull.* **86**, 1281 (1975).
8. R. Ruedemann, W. J. Schoonmaker, *Science* **88**, 523 (1938).
9. S. M. Smith, K. L. Prestegaard, *Water Resources Res.* **41**, (2005).
10. D. Malakoff, *Science* **305**, 937 (2004).

What to Do About Those Dammed Streams

IN THE RESEARCH ARTICLE "NATURAL STREAMS and the legacy of water-powered mills" (18 January, p. 299), R. C. Walter and D. J. Merritts contribute to the evolving story of human impact on streams in the U.S. mid-Atlantic Piedmont. Historical forest removal,

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farming, and soil erosion produced widespread valley-bottom sedimentation, followed by modern stream incision into these deposits, termed "legacy sediment." This raises the question of what, if anything, should be done. Should we dig up legacy deposits to reduce sediment loading to Chesapeake Bay? Should streams be restored to their pre-Colonial condition? The legacy sediment debate is decades old (*1*, *2*), but its social context has evolved. The emergence of a stream restoration industry and long-running struggles to reduce sediment loading to the Chesapeake Bay provide a constituency and pressure for large-scale remediation, action apparently advocated by Walter and Merritts (*3*).

"Hot spots" of stream bank erosion can be found, although the longevity of sediment still in valley bottoms supports observations of small erosion rates in most places. Eroded sediment can be redeposited before leaving the watershed (*4*), indicating that local reductions in sediment loading from bank protection will correspond to a proportionally smaller reduction in loading to the Chesapeake Bay. Current practice is not effective at identifying "hot spots" or establishing their connection to receiving waters. We need to demonstrate that these actions are worthwhile before undertaking widespread and expensive earth-moving.

Walter and Merritts reinforce earlier work indicating that today's streams differ from their pre-Colonial condition. A pristine stream is an unlikely template for restoration because the drivers of stream dynamics (water and sediment runoff and riparian vegetation) have all changed. Combined with the elimination of beavers, there is little prospect of returning mid-Atlantic Piedmont streams to their presettlement form, a restoration target that Montgomery appears to advocate in an accompanying Perspective (*5*).

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References

1. R. B. Jacobson, D. J. Coleman, *Am. J. Sci*. **286**, 617 (1986).
2. J. E. Costa, *Geol. Soc. Am. Bull.* **86**, 1281 (1975).
3. *Science* Podcast, 18 January 2008.
4. N. E. Allmendinger, J. E. Pizzuto, G. E. Moglen, M. Lewicki, *J. Am. Water Resources Assoc*. **43**, 1483 (2007).
5. D. R. Montgomery, *Science* **319**, 291 (2008).

Response

BAIN *ET AL.* QUESTION OUR HYPOTHESIS THAT milldams were primary factors in historical sedimentation in mid-Atlantic valleys. Hillslope gullying and sheetwash erosion undoubtedly occurred during postsettlement land clearing and farming, but the trapping of immense volumes of fine-grained sediment along valley bottoms is a process that we attribute to those factors coupled with raised base level and backwater effects of damming. Whereas previous workers focused on increased sediment supply and stormwater runoff from upland land-use change, we maintain that changes in stream velocity and sediment-transport capacity due to widespread damming were overlooked. As all agree that soil erosion rates were high during early settlement and that the valley floors filled with sediment, the central question—which our work addresses—is, how abundant were milldams and millponds on U.S. streams, and what was their cumulative impact on sedimentation?

Bain *et al*. suggest that southeastern Pennsylvania had anomalously high mill densities because of its fertile soil. However, a wealth of historical evidence shows that water-powered milling was associated with nearly all manufacturing processes of the 17th to 20th centuries, including logging, mining, forging, textiles and paper production, and machining (*1*, *2*). Mill densities, irrespective of soil fertility, increased throughout the eastern United States with time and settlement, but the upstream extent of impact from milldams varied with stream gradient and dam spacing.

The "wide variation" in radiocarbon ages of the presettlement hydric soil that we report is consistent with our interpretation that widespread wetlands were stable for thousands of years, since mid-Holocene climatic and ecological conditions became established. It is inappropriate to calculate a median radiocarbon age that combines the analyses of separate samples from different locations and stratigraphic intervals within the presettlement hydric soil.

Bain *et al*. disagree with our characterization of presettlement mid-Atlantic Piedmont valley bottomlands as containing multiple branches of smaller streams, with pervasive wetlands and hydric soils. Our conclusion was based on hundreds of study sites in 20 mid-size watersheds throughout the mid-Atlantic Piedmont. We described the stratigraphic evidence of buried dark, organic-rich soils with near planar surfaces spanning valley bottoms and noted that this same association was observed elsewhere by earlier workers. The dark buried soils that we describe in the mid-Atlantic piedmont contain seeds of presettlement obligate and facultative wetland plants. We propose that the construction of numerous beaver dams helped to create anabranching stream networks in the mid-Atlantic region during presettlement times, and beavers were an important factor in creating the pervasive wetlands that are now buried beneath thick stacks of postsettlement mud (*3*).

Wilcock and Bain *et al*. argue that elevated supplies of stormwater runoff and sediment from uplands at present are a much more serious problem than stream bank erosion or impacts of historic milldams, but they provide no data or references to support these claims or to indicate that modern upland erosion rates actually are high. Our measured values of eroded sediment from stream banks at multiple sites are high and contradict these concerns (*4*). Other research, in fact, indicates that upland erosion rates diminished substantially in the past century (*5*). Wilcock contends that eroded stream bank sediment can be redeposited downstream and might not degrade waterways. We counter that silts and clays eroded from upland farm slopes and construction sites are no more likely to be carried downstream than suspended sediments eroded from stream banks, yet policy-makers do not consider efforts to minimize upland soil erosion to be futile.

We did not discuss specific stream restoration practices in our paper, and we consider Wilcock's statement that we "advocate" large-scale remediation to be grossly misleading. We hope our research will inform the science of future stream and wetland rehabilitation in the mid-Atlantic region, and we advocate scientific investigations to evaluate new approaches.

Recognizing the importance of wetlands, state and federal agencies spend millions of dollars attempting to restore existing wetlands or to create wetlands where none ever existed. Through our discovery of extensive presettlement hydric soils buried along Piedmont valley bottoms, with potentially viable seed banks, a new opportunity emerges to rehabili-

tate previously unrecognized valley-bottom wetlands. In response to Bain *et al*., we assert that it would be bad policy to ignore these presettlement conditions and to assume that all stream impairments are modern.

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References

1. T. S. Reynolds, *Stronger Than a Hundred Men: A History of the Vertical Water Wheel* (Johns Hopkins University Press, Baltimore, 1983).
2. M. Dopp, *Bull. Am. Geogr. Soc.* **45**, 902 (1913).
3. R. C. Walter, D. J. Merritts, *Science* (www.sciencemag.org/cgi/eletters/319/5861/299).
4. R. C. Walter, D. J. Merritts, M. Rahnis, "Estimating volume, nutrient content, and rates of stream bank erosion of legacy sediment in the Piedmont and Valley and Ridge Physiographic provinces, southeastern and central Pennsylvania" (Report to Pennsylvania Department of Environmental Protection, 2007); www.depweb.state.pa.us/chesapeake/lib/chesapeake/pdfs/padeplegacysedimentreport2007waltermerrittsrahnisfinal.pdf.
5. S. W. Trimble, P. Crosson, *Science* **289**, 248 (2000).

CORRECTIONS AND CLARIFICATIONS

Reports: "Efficient inhibition of the Alzheimer's disease β-secretase by membrane targeting" by L. Rajendran *et al*. (25 April, p. 520). The mice were misidentified as APPsw/PSΔE9 mice. The correct nomenclature is APPPS1 mice, according to R. Radde *et al*., *EMBO Rep*. **7**, 940 (2006).

TECHNICAL COMMENT ABSTRACTS

COMMENT ON "100% Accuracy in Automatic Face Recognition"

Weihong Deng, Jun Guo, Jiani Hu, Honggang Zhang

Jenkins and Burton (Brevia, 25 January 2008, p. 435) reported that image averaging increased the accuracy of the automatic face recognition to 100% and thus could be applied to photo-identification documents. We argue that the feasibility of image averaging on identification documents is not fully supported by the presented evidence.

Full text at www.sciencemag.org/cgi/content/full/321/5891/912c

RESPONSE TO COMMENT ON "100% Accuracy in Automatic Face Recognition"

R. Jenkins and A. M. Burton

Contrary to the suggestion of Deng *et al*., image registration reduced face-recognition accuracy when divorced from the averaging procedure. Average-to-photo mapping generalizes beyond specific photographs, and averaging either gallery images or probe images can improve the match. The alternative protocol suggested by the authors is unsuitable because it evaluates face-matching algorithms, not face representations, and relies on standard image sets.

Full text at www.sciencemag.org/cgi/content/full/321/5891/912d

Looking for Familiar Faces

IN THE BREVIA "100% ACCURACY IN AUTOmatic face recognition" (25 January, p. 435), R. Jenkins and A. M. Burton proposed a simple method to "elevate machine performance to the standard of familiar face recognition in humans." However, these statements seem overoptimistic.

Only one experiment resulted in perfect accuracy, and only 25 (averaged) face images were used. To meet the standards of human face recognition, a program would have to perform accurately on a sample much larger than 25.

Because the authors did not provide performance figures based on the standard methodology [i.e., FERET (*1*) or Face Recognition Grand Challenge (FRGC)], readers could not assess the efficacy of their method in comparison to existing algorithms.

Finally, My Heritage is a for-profit organization, which is not expected to share its intellectual property with the public. Therefore, the mechanism that achieved "100% accuracy" is unknown to the scientific community (including the authors). Given that the data and software of My Heritage online services change regularly, the reported experiment is practically unrepeatable.

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Reference

1. P. J. Phillips, H. Moon, P. J. Rauss, S. Rizvi, *IEEE Trans. Pattern Anal. Mach. Intell*. **22**, 1090 (2000).

Response

WE CERTAINLY DO NOT CLAIM THAT OUR PROcedure delivers 100% accuracy in all cases. Our main message is that whatever the level of accuracy achieved when photos are used, image averaging raises the bar. This approach focuses on the representation of the face instead of the matching algorithm. As such, it complements existing systems rather than competing with them.

Shamir compares automatic recognition with a putative human viewer. However, there is no general human viewer when it comes to face recognition. Humans are extremely good at recognizing familiar faces, but very poor at recognizing unfamiliar faces (*1*, *2*). Ignoring this distinction impedes our understanding of face recognition ability and leads to unrealistic ambitions on the part of those building automatic systems. By requiring systems to match pairs of photographs, they are creating a problem that humans find extremely difficult. We proposed matching a photograph to an average image in an attempt to integrate our psychological theory of face familiarity (*3*) with an automatic system.

Finally, our decision not to use the FERET/Face Recognition Vendor Test (FRVT) database was deliberate. That database does not contain enough photos of each face to generate average images, nor does it contain the level of variation required. The My Heritage gallery contains many thousands of real-world images encompassing the kind of variability encountered in everyday life (for example, photos taken with many different cameras). Similarly, our probe database was gathered by means of Google Image search. This natural variability presents a far more realistic and demanding challenge. It has already been established that FaceVACS performs well on the FERET/FRVT database; indeed, it was the overall winner of the most recent evaluations (*4*). We showed that it also works well on images over which the experimenter has no control, provided one feeds it averages rather than snapshots.

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References

1. A. M. Burton, S. Wilson, M. Cowan, V. Bruce, *Psych. Sci.* **10**, 243 (1999).
2. R. Clutterbuck, R. A. Johnston, *Visual Cognit.* **11**, 857 (2004).
3. A. M. Burton, R. Jenkins, P. J. B. Hancock, D. White, *Cognit. Psych.* **51**, 256 (2005).
4. P. J. Phillips *et al.*, "FRVT 2006 and ICE 2006 large-scale results" (National Institute of Standards and Technology, NISTIR 7408, 2007); http://face.nist.gov.

Letters to the Editor

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