The Historic Dimension Series

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Were We Wrong About These Dam Things?

by Jennifer L. Reynolds **Spring 2018**

"All waters of every free-flowing river should be commandeered from its natural bed in economic service to the nation" (Solomon, 2010)

Hydropower has often been referred to in the United States as "White Coal" and at one time the popular American view was that, "All waters of every free-flowing river should be commandeered from its natural bed in economic service to the nation" (Solomon, p. 327). Regionally ubiquitous and visually striking, these small water-powered factories known as milldams clung to the streams of the developing country and were the epicenter of many communities and an integral part of the pre-industrial American economy. Recently milldams have ignited a debate in scientific and environmental policy forums. The debate centers on the future of these existing structures—these milldams are culturally and historically significant, yet they are detrimental to the American river system.

History of Milldams

Since the late 1600's until the early 1900's we have utilized milldams as engines for the American economy by harnessing water power to run furnaces, mining operations, iron forges, and most commonly mills. These ubiquitous structures proliferated across the American landscape. In 2008, Walter and Merritt's conducted a county-by-county compilation of U.S. manufacturing census data and determined more than 65,000 water powered mills were constructed in 872 counties in the eastern United States by 1840.

There were many variations in milldam designs as well as their uses. Most mills consisted of an impoundment structure or dam that was constructed on a waterway. This allowed for an interruption in the flow of water on the river, thus raising and maintaining the flow and allowing for consistent, sufficient flow enough to provide mechanical hydropower. Many of the earliest dams in the United States were no more than ten to fifteen feet high. The structure of the dam was generally constructed from readily available, local resources such as wood, consisting of wooden cribs, frames, or even branches and tree trunks, masonry, stones, earth, or a combination thereof and were generally used for small-scale industry. Many of these dams were later converted to concrete structures.

The dam structure itself impounded the rivers flow which thereby created a millpond. The impounded water would then pass through the dam's spillway turning a water wheel or turbine which thus provided the necessary horsepower through mechanical hydropower or direct, on-site generation of energy for the numerous varieties of watermills; or later to generate small-scale hydroelectricity. The various multitude of mills ranged in uses from turning a sawblade, hammer or rollers/stones that may grind corn or flour to making paper or textiles.

Self-sufficient mill towns were established in geographically remote areas and thrived solely from these operations. Milldams and their associated mill ponds have also provided a variety of benefits such as; ponds to procure ice blocks from before the existence of refrigeration, or providing an area

Fig. 2: Historic Starr's Mill on Whitewater Creek-Senoia,Georgia.

of relaxation and recreation complete with a serene setting and an enchanting waterfall, or an idyllic afternoon on the pond. By impounding the rivers, these types of dams also provided refreshing swimming ponds at various state parks. To many these dams are beautiful relics of centuries past that played a significant role in the development and history of America. Advancements in technology eventually allowed for the phasing out of many milldams, but significant numbers still stand today, spread across the American landscape

Effects on the Environment

Although these iconic pastoral structures may appear idyllic, the proliferation of these dams would leave a legacy of physical and ecological alteration to the American landscape. Some recognized early in the 19th century the deleterious effects of milldams, yet the economic advancements were considered more important than the environmental consequences and so these structures continued to be utilized. Walter and Merritt's in 2008 conducted a study that revealed the eastern United States characteristic meandering river form may not be the natural archetype for this region. Instead they have proposed that the streams were substantially differ-ent from those of modern streams. Their data combined with historical maps and records, showed instead that before European settlement, the streams were small anabranching channels within extensive vegetated wetlands that accumulated little sediment

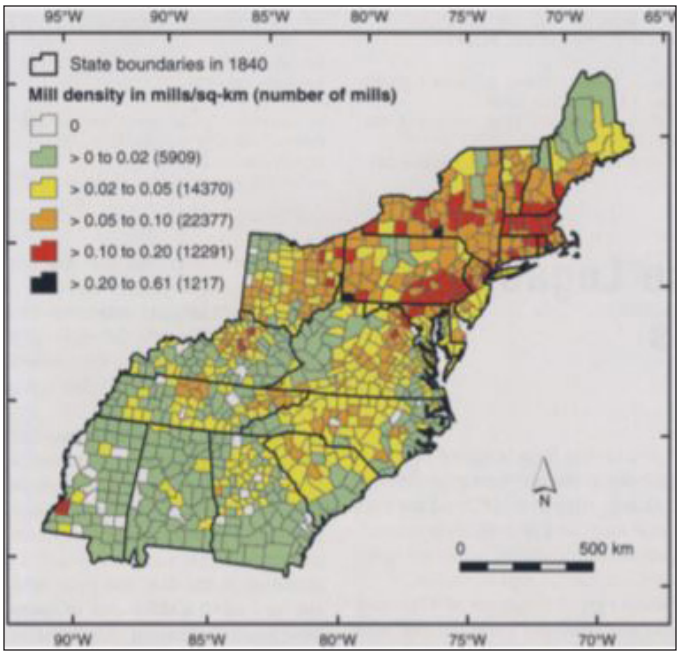

Fig. 3: Density of water-powered mills along eastern U.S. streams by 1840 (by county).

but stored substantial organic carbon. "The picturesque notion, supported by many ecologists, that a stream untouched by human hands meanders in a single S-shaped channel with high vertical banks seems to be wrong. Instead, this shape is an artefact of the thousands of small milldams built on eastern streams between the seventeenth and nineteenth centuries" stated Dorothy Merritts of Franklin and Marshall College (p. 1).

Post-European settlement regional land clearing for agriculture and development along with poor soil management practices increased upland erosion rates 50 to 400 times above the Holocene background, impacting sedimentation rates in regional waterways. Milldams were responsible for impounding substantial volumes of sediment from eroded upland soils. These "legacy" sediments may be contributing to the modern degradation of water quality. In 2007, the United States Environmental Protection Agency concluded that suspended sediments are the single largest contributor to stream water impairment across the nation. The US Geological Survey stated at their proceedings that "sediment is the largest contaminant of surface water by weight and volume and has been identified by the United States Environmental Protection Agency as the number one problem threatening America's waterways" (Koltun et al., p.1)

Today, the deleterious effects of dams are perhaps most dramatically represented by the destruction of spawning fish populations and the devastation of wetlands and other sensitive riverine ecologies. Numerous drownings have also occurred at these low head dams due to the hydraulic suction caused during high flows. These extensive studies and the contemporary

Fig. 4: Milldam at Sheppard's Mill, a well preserved gristmill/sawmill in Sandy Ridge, North Carolina.

Fig. 5: Milldam and beautiful waterfalls at Falls Mill on Factory Creek in Belvedere, Tennessee.

realization of the detrimental effects of dams have allowed us to question the continued existence of these structures.

Call for Removal

About 40 years ago a shift in the cultural narrative began to take place as the depiction of dams as primarily a destructive technology and the questioning of water control technology and its place in modern society has come to dominate public discourse. According to author Donald Jackson this was a major shift in the cultural narrative because "in our not so distant past dams were commonly perceived, promoted, and appreciated as a way to improve—and even beautify—the environment" this narrative shift "reflected the values of a society that both uses natural resources to serve human purposes and, yet at the same time, has come to appreciate the so-cial value of free-flowing rivers and natural landscapes" (p. 2-4).

Many are demanding the removal of these historical structures. Since the 1990's, dam removals from growing societal pressure, especially of smaller 'run of river' dams, have increased. Many milldams are being removed due to public safety hazards such as drownings and efforts to restore the connectivity of aquatic ecosystems, yet these benefits may be negated by the concern that the pools behind these dams contain substantial amounts of sediment and sediment-related contaminants that would be released downstream upon dam removal causing environmental degradation of aquatic ecosystems and riparian wildlife. Recent river restorations projects have called for the complete removal of milldams even though considerable scientific uncertainty exists regarding the morphological and sedimentological effects and the potential environmental benefits. According to Hart et al. we really haven't conducted enough research on dam removals. They felt that the scarcity of empirical knowledge on environmental responses to dam removal contributes to this uncertainty. Even though there is a consensus calling for the removal of milldams many scientists concur that we might need to consider alternatives to removing the old milldams until we better understand the effects of releasing legacy sediments.

Melinda Daniels, an associate professor of Geography at Kansas State University who recently studied the connection between beavers and river restoration, felt that river restorers as well as river scientists are possibly focusing too much on creating continuous free-flowing streams and not considering the role of beavers as ecosystem engineers. She has proposed rather than tearing down the whole milldam and radically changing the surrounding ecosystem, the researchers recommend that river restorers alter the dams and only remove part of it. Leaving the dam structure partially intact would then in essence mimic the role of beavers allowing some ponded water to remain so they are better suited to contain the sediment. Before removing these milldams should we be conducting thorough research regarding the mobility of "legacy sediments" and possibly considering other options?

Preservation, Restoration, Adaptive Reuse

The National Park Service (NPS) recognizes the dual objectives that exists regarding milldams across the US. Their Rivers, Trails and Conservation Assistance Program has partnered with American Rivers to develop tools to help communities and individuals succeed with dam removal projects as part of its role in providing technical assistance to conserve rivers. Yet, the NPS is also very sensitive to protecting cultural values and

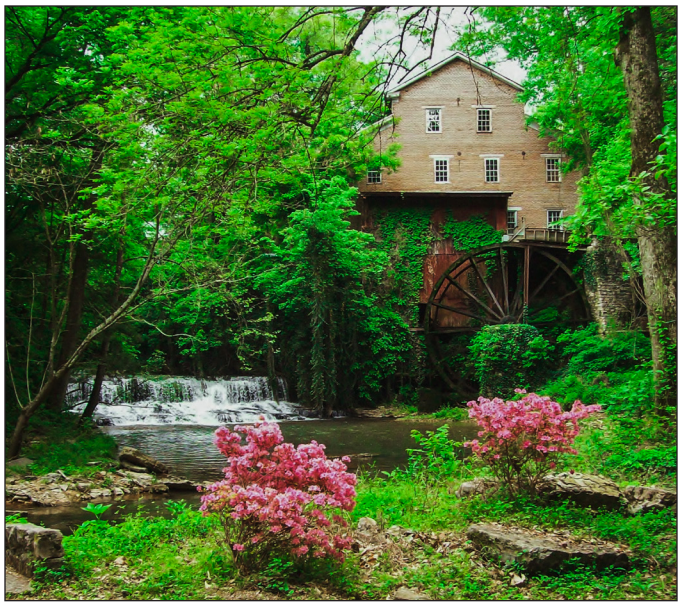

Fig. 6: Falls Mill on Factory Creek-Belvedere, Tennessee

they recognize that the balance between natural and cultural resource protection can be delicate and rather challenging. They have produced a report along with American Rivers to help communities consider removal, avoidance/no action - a form of preservation, partial-preservation, adaptive reuse or preservation in-service. This report outlines a series of selected case study projects that highlight some of the different options.

There have been numerous successful projects that have aimed to restore the functioning of the mills and/or preserve the dam structure along with the historical milldam buildings. One of these projects is Yates Mill, a fully restored, circa-1756 gristmill located in Raleigh, North Carolina. It is the centerpiece of Historic Yates Mill County Park, located in central Wake County. The mill is listed on the National Register of Historic Places and is one of a few restored, operational automatic mills in the country. The mill is a cultural, educational and historic treasure that provides agricultural heritage, environmental resources and history through educational programs, events and exhibits.

Falls Mill, situated in Belvedere, Tennessee depicts the milling industry of the rural south as it existed in the mid-nineteenth century. Listed on the National Register of Historic Places, this water-powered gristmill is complete with a 109-year-old 32-foot waterwheel nestled in an idyllic setting along Factory Creek. It serves as a museum and fully functioning gristmill. John and Jane Lovett, owners of the mill, welcome field trips, family vacations and the opportunity to purchase their freshly stone-ground white corn.

Another successful project is Sheppard's Mill located in Sandy Ridge, North Carolina, in Stokes County that was built in 1904 by Calla "Kelly" Sheppard following a fire

Fig. 7: Yates Mill – One of the last standing gristmills in the country.

that destroyed an earlier structure on site. It was operated by the Sheppard family as a triple turbine water-powered grain and sawmill until 1958 when Hurricane Hazel knocked a hole in the mostly wooden dam essentially ending the operation. Later the mill was purchased and many various restorations were completed by millwright Joe Terry and local carpenter Charles Moorefield. Recently the mill was purchased by Bill Neese and currently the dam is part of The Sheppard Mill Center, a non-profit organization that is currently seeking 501 (c)(3) status. Their mission is to turn the historic landmark into an education center and outdoor recreational area catering to paddle sports. The yellow mill building sits along the banks of Snow Creek, a tributary to the Dan River. According to the *Winston Salem Journal*, the 110-year-old mill is quite a treasure that has been well-kept and immaculately restored. The historic mill building contains a remarkable collection of well-preserved mill machinery, from rollers to sifters to millstones to elevators, that looks as if it is ready to start grinding wheat into flour (O'Donnell, 2012).

Currently, there are numerous adaptive-reuse projects that have been completed or are occurring across the US. Many have successfully adapted the historic mill buildings into event centers or loft-style condominiums. Weddings and other events benefit from the wide-open floor plans of the mills and the enchanting waterwheels or waterfalls that are a result of the dams. The elaborate woodwork and the water features make for wonderful photo opportunities, so these centers are generally in demand and are able to procure substantial facility rental rates. The milldam buildings can stand as monuments to early American history and can be converted into museums, restaurants, classrooms, office/retail spaces or microbreweries while still retaining the original characteristics of the mill. These mills are excellent field trip locations and have also become popular tourist destinations.

Fig. 8: Sheppard's Mill, well preserved water-powered gristmill/sawmill in Sandy Ridge, North Carolina.

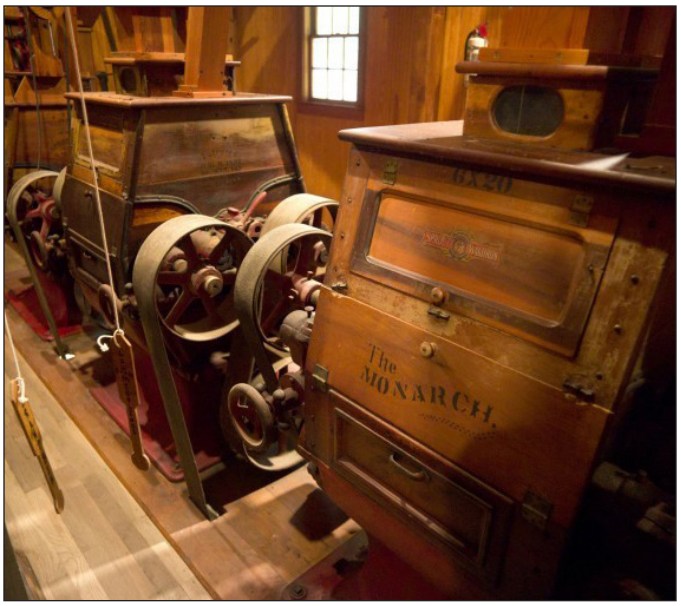

Fig. 9: Restored rollers – ready to start grinding wheat into flour at Sheppard's Mill in Sandy Ridge, NC.

Mitigation

In 2014, a case study was conducted at Sheppard's Mill in Sandy Ridge, NC. Aware of the issues of sedimentation, the caretaker requested the guidance of Geomorphologist, Dr. Dan Royall, and several graduate students of the University of North Carolina at Greensboro in regulating the cumulative sediment pulse that was being released during routine pond flushes. The mill does not contain an over-shot waterwheel; instead the hydro-power is derived from three turbines, therefore the dam gate is opened two to three times a month to perform required sediment flushes and maintenance. Sediment builds up behind all of these impoundments. Regular flushing of the pond requires a drawdown of the millpond which involves scouring and re-suspending sediment deposited in the reservoir and transporting it downstream by opening low-level gates in the dam.

This case study revealed that the timing of the drawdown event could mitigate the cumulative sediment pulse that was released into the stream during routine pond flushes. It was discovered that there was a large sediment pulse at the immediate opening of the lower gates, as the torrent of water is released, and again nearing the end of the drawdown when the discharge or water flow diminished. Controlling the timing of the draw-down event by limiting the amount of time the gates are open diminishes the more concentrated sediment that is being delivered into the stream without an adequate flow or discharge to disperse it. This sediment needs to be limited because it could overwhelm the creek's transport capacity or its ability to disperse the sediment and thereby aggrade the channel or allow the sediment to build up. An overabundance of sediment in this portion of stream can disrupt the riparian ecosystem.

The findings of the Sheppard's Mill case study could be used as an analog for other mill sites with similar gates or drawdown apparatus. Due to varying discharge rates of rivers, grain size distribution of sediment (gravel, sands or silts), as well as varying size of dams or impoundments it would be ideal to conduct a sediment export analysis in situ for any mill before commencing drawdown events to limit sedimentation. Limiting these sediments can help to minimize ecological disturbances and aid in continued operation of these historic milldams.

Conclusion

Drawing upon these successful preservation projects, before proposing to remove a milldam one should evaluate its significance and history as well as its potential to be restored or preserved. These structures are a significant part of American history and culture and have played a crucial role in the early economic development of this country. Impounded sediments and the ecological disruption caused by the dam's structure must be considered and can be mitigated to a certain extent. The NPS report regarding dam removal and historic preservation states that a compromise can be reached and some structures may be candidates for partial removal through breaching or notching of the dam. Another alternative to dam removal according to the report is the construction and use of a bypass channel to achieve fish passage at the site of a historically significant dam. A bypass channel circumvents a dam by mimicking a tributary or side channel of the mainstream river, allowing the dam to remain in place. The ideal option regarding milldams would be to strive for a balance with the ability to preserve some of these historic structures while mimimizing any further damage to the rivers and their ecosystem.

Fig. 10: Milldam gates open releasing a torrent of water and sediment from behind the impoundment.

Fig. 11: Turbid water created by sediment pulse released near the completion of the millpond drawdown.

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Photos provided courtesy of:

Figure 3-Milldam Density Map, Dr. Dorothy J. Merritts, Franklin and Marshall College

Figures 5,6 & 9-John N. Lovett, owner of Falls Mill- Belvedere, Tennessee

Figure 7-Gary Roth, President & CEO, Capital Area Preservation, Inc.

Figures 8 & 9-David Rolfe, photographer-Winston Salem Journal

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