II. People and Fish

Terry Lee, a water planner, developed his own theory of the beaver's key role in stream restoration in 2006. He found Tuttle's work when he googled "Beaver Hypothesis."

Lee is known for his success in protecting an important source of water in Minnesota, the "Decorah Edge." This geologic formation, where slow flowing waters from an aquifer spill over a layer of Decorah shale, sustains vegetation that naturally filters and purifies groundwater. The "Edge" supplies half the drinking water for the Rochester, MN area, but it was threatened by development until Lee spearheaded efforts to enact protective city and county ordinances. Buying the "Edge" land would have been extremely expensive.

Now Lee, who is with Environmental Services of Olmstead County, MN, has a new proposal to protect the environment while saving taxpayers' money. His investigation of how beaver dams could improve the local hydrology has promising implications nationwide.

Terry Lee, who's been a water resource specialist for 25 years, has an innovative solution for today's problem of more frequent and severe floods: let nature's engineers restore natural water storage. Like other planners nationwide, Lee must cope with a landscape that's lost much floodplain storage, just as extreme weather events are becoming more common. Heavy rains in August of 2007 caused one stream in Olmstead County to crest 90 inches above normal, over six Minnesota counties, led to seven deaths, plus $26 million in damage. According to a public radio report, witnesses in Stockton, MN saw their neighbors' house float by with the owners on the roof.

Rising waters, rising bills

Because peak flows have been rising steadily, Olmstead County is facing a bill of $8 million for larger bridges and culverts to accommodate the rising waters. That led Lee to explore the concept that "increased watershed storage leads to smaller bridges and culverts and that this improved flood protection can be funded by cost savings in bridge and culvert construction."

A 2003 "Watershed Study" identified several sites along Cascade Creek, a tributary of the Zumbro River, where manmade ponds would greatly reduce peak flows. But the Minnesota Dept. of Natural Resources (DNR) banned any construction to obstruct that stream's main flow. But building weirs and berms at sites along Cascade Creek's tributaries would not be nearly as effective as the original plan. So Lee began considering alternatives.

Lee first became intrigued with beavers while directing a 2006 dam study by a student, Greg Thompson. The warmer water of beaver ponds was said to harm trout, but when Thompson sampled water temperatures above and below beaver dams, he found that where differences in temperatures existed, the fish adjusted their behavior. For example, trout fed from 10 pm to 9 am when the water was cooler. This was contrary to the prevailing management paradigm that the warmer water of

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Lee's Beaver Hypothesis

- Beaver are ecosystem engineers that completely alter stream ecology.
- Beaver dominated all but the largest streams in North America during the evolution of native stream and riparian species.
- Native species are still genetically programmed to lifecycles either dependent upon, or benefiting from beaver-created habitat.
- Restoration of native stream ecosystems requires beaver.
- Beaver have historically and continue to provide essential ecosystem services for the benefit of humans.

Photo by Terry Lee

Road damage from a 2007 flood of the Whitewater River in Minnesota.

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beaver ponds harmed trout.

Dam removal backfires

Another widely accepted belief that dams prevented trout passage, led to an 1982 -1986 study by Ed Avery of the Wisconsin Dept. of Natural Resources (WI DNR). Fisheries managers removed 546 beaver dams from 33 miles of the Pemebonwon River in an attempt to increase brook trout for anglers, but this backfired. Trout population in the river dropped, while trout increased in inaccessible tributaries, resulting in a significant decline in the trout available to fishermen.

Avery concluded, "Beaver dams did not prevent movement of brook trout either upstream or downstream in the Pemebonwon River." But he'd added, "There appeared to be no way brook trout could move in either direction through primary beaver dams on most tributaries of the Pemebonwon River", and that message was adopted.

A popular "free flowing stream" paradigm, leaves little room for seriously assessing the role of beaver in area streams.

Sculpins & mussels

Lee worked with Thompson and David Huff, a graduate student at the University of Minnesota on a 2007 survey of sculpins. The sculpin is a common, but inconspicuous fish that is an important food for larger trout. Fisheries managers and Huff had assumed that beaver dams would harm sculpins, but Lee "wanted to see if there were any streams where sculpin might still respond favorably to a keystone species that they had co-evolved with." Indeed, the survey's results showed that the sculpins grew larger in streams with beaver dams.

Sculpins are an important host fish for an immature stage of some mussels. When a biologist surveyed Deer Creek and found threatened Ellipse mussels above and below a beaver pond, he decided that the dam had ruined the middle of the mussel bed. Yet, Lee said, "a recent survey of a beaver pond on the Root River found that it was functioning as a small-scale sediment sorting facility." Pebbles were deposited upstream, while finer sediment, such as sand, was deposited later. Lee said, "Based on the sediment deposition at that site, it seems more likely that the beaver created the habitat needed for the Ellipse mussels."

Photo credit: John Weiss, Rochester Post-Bulletin

Terry Lee collects rocks from a beaver dam for a survey of insects as his work is videotaped.

A "species at risk" webpage by U.S. EPA lists freshwater mussels, crayfishes, amphibians and freshwater fishes as the most imperiled. All appear to benefit from beaver impoundments. Scientists say the quiet waters created by dams are often nurseries for young fish, and, according to Lee's internet research, also appear to benefit mussels. Wetlands were called wastelands for decades prior to the current recognition of these watery habitats as the world's best life support system. Is a traditional view of beavers as nuisances now similarly obscuring their role?

"Although not constructed by man, beaver dams are very efficient at maintaining a stable streambed while allowing large flows to move downstream without causing considerable damage," according to a U.S. Army Corps of Engineers manual (Anonymous 1998). Yet despite many positive academic studies of beaverworks by hydrologists, such as Donald Hey of the Wetlands Initiative, an institutional bias still remains. Lee explains, "There is a widely adopted 'free flowing stream' paradigm, and like all paradigms, this one affects how scientists and resource managers assess data, both supportive and contrary. Evaluating streams using criteria designed to assess free flowing stream reaches creates a feedback loop that leaves little room for seriously assessing the role of beaver in area streams. It also results in a positive feedback loop that reinforces the free flowing stream paradigm, such that a keystone species like beaver can be relegated to a few passing references in the DNR's Stream Survey Manual."

Beavers dominated stream ecology in Minnesota, ever since the last glaciers, about 14,000 years. Not until 1729 when trappers had extirpated beavers, did a 125-year period of free flowing streams ensue. After 1854, man-made dams were installed to produce hydropower and many remain today.

A recent news story quoted a wildlife manager as saying he doubted whether beavers were ever common in Minnesota, But an archeological study of Native American sites there identified beaver remains at most. Of 190 species found, only deer and mussels were found more often at

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Incised, degraded streams

Beaver extirpation led to the disintegration of their mud and stick dams that hold back water and sediment. Without these natural barriers, since 1900 sedimentation has shrunk by 80% in some waterways. This loss, along with higher peak flows, causes incision, a gradual deepening and narrowing of streams that eventually disconnects them from floodplains.

We often hear about badly incised streams in the West, but this problem occurs elsewhere too. According to Lawrence Svien of the Natural Resources Conservation Service, a tributary of the Whitewater River in Minnesota incised an inch per year on average over 55 years!

Incision of streams leads to the draining of wetlands, lower water tables, and a drier landscape. Overall, the streams' base flows decrease while their peak flows increase, creating a feedback loop that causes even more stream degradation. Some of the tons of sediment carried downstream must be removed from reservoirs, where it is deposited.

But a 12-year Nebraska study (McCullough 2006) found that streams with beaver dams accumulated over 300 tons of sediment per mile per year, increasing the stream grade by about two inches per year

While investigating beaver activity, Lee found a *Wetlands Soils* book, with a chapter on "Wetland Soil and Landscape Alteration by Beavers" (Johnston 2001). It begins with "Long before humans began constructing wetlands, the beaver (Castor canadensis...) was changing the face of the North American continent, creating and modifying wetlands by building dams." The author speculates that beaver activity may have even created wetlands soils, and concludes, "Beavers and wetlands have co-evolved, and it is fruitless to try to separate the two."

Lee created a "Beaver Hypothesis" (see p. 5) that became the first slide in his PowerPoint program, "Leave it to Beaver, Rethinking Drainage Management." He recently gave this presentation that brilliantly blends knowledge about nature's engineers with local hydrologic information at the 2009 Minnesota Lakes and Rivers Conference. Although his focus is on solving Olmstead County's problem with rising peak flows, many areas face similar problems. Nationwide, considerable natural flood storage has been lost due to extensive beaver trapping, agriculture and development, while severe floods becoming more common

"Storing floodwaters in the upper reaches of streams is not only compatible with current land uses, it is essential to preventing catastrophic flooding."

How much can a single beaver dam help ameliorate flooding? During a March 2004 deluge, the results from a monitoring station on Minnesota's Nine Mile Creek showed that an upstream dam lowered that stream's discharge by five cubic feet per second. During the August 2007 flood, the presence of a beaver dam on Cold Spring Brook increased that stream's depth by 20 inches at the flood crest—and significantly increased its connection to the floodplain.

Natural restoration of flood-abating wetlands is becoming more attractive because the manmade alternative is so expensive. Constructed flood storage in the Rochester, MN area costs about $10,000 per acre-foot (one-foot-deep water covering one acre). **Two dams on Cold Spring Brook increased flood storage by seven acre-feet, saving $70,000.** Lee says "Storing floodwaters in the upper reaches of streams is not only compatible with current land uses, it is essential to preventing catastrophic flooding."

He envisions a landscape feasibility study of the potential of utilizing beaver corridors for Olmstead County's flood storage and conveyance objectives. The detailed maps needed to complete this study have only recently become available. First the locations of existing beaver dams would be determined and then a model created to show where the dams would be most effective. Access to sites would be needed as well as constraints on trapping, requiring the support of landowners, fishing groups, resource managers and trappers.

Lee does not expect change overnight, but compares this process to turning around a huge ship. It took a decade to educate officials and the public about the Decorah Edge and legally protect that vital source of drinking water. Lee's past success should encourage others to reexamine old assumptions about beaver activity and fully consider his proposal to use this key species in local stream restorations.

References:

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