

Title: Dead River Stream Restoration

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Opening Paragraph: The Dead River is a designated trout stream draining to Lake Superior in Marquette County, in Michigan's Upper Peninsula. In May 2003 a large rain event during spring thaw triggered the activation of an emergency overflow dike called a fuse plug. The fuse plug spillway channel and foundation, built the fall before, failed, causing the 1,500 acre storage reservoir elevation to drop approximately 25 feet. The structure failure:

- Released approximately 9 billion gallons of water, which flooded, damaged or destroyed streamside homes and camps, several roads, 9 bridges, 5 downstream dams or dikes, 2 parks, 3 public access sites and a railroad grade; blocked the mouths of several tributaries; knocked down thousands of trees; interrupted power, gas and telephone service to area residents; and damaged the Presque Isle Power Plant.
- Mobilized approximately 1 million cubic yards of sediment and debris, equivalent to a 500-year precipitation event, which destabilized approximately 4 miles of river channel and deposited up to 2 meters of sediment on the floodplain (Figures 1 and 2).
- Caused 4 miles of river to establish a new channel through freshly deposited sand and scoured valley floor.
- Triggered the evacuation of 2,300 residents in four townships and the City of Marquette.
- Caused an estimated \$100 million in total damages.

Between 2003 and 2009 the dam's owner, the Upper Peninsula Power Company (UPPCO), restored a total of 4 miles of river channel and reestablished riparian vegetation and wetlands along the river corridor. The channel restoration combined the principles of natural channel design to create a stable channel configuration that will transport its water and sediment loads with the installation of instream grade control and bank stabilization structures (cross-vanes, J-hooks, W-weirs, riffles, and rootwads) to provide short-term channel stability until vegetation fully establishes to provide long-term stability.

Problem: In May 2003 the Silver Lake fuse plug on the Dead River in Marquette County failed, damaging local homes, roads, bridges, dams and dikes, and utility service to local residents; destabilized 4 miles of stream channel; and caused an estimated \$100 million to total damages.

Results: There is little environmental data for this remote river, either before the failure of the dam's fuse plug or after. Nonetheless, this portion of the river was a

State-designated trout stream, and data from a nearby reference stream (Conner Creek) indicate that macroinvertebrates in the Dead River would have been numerous and diverse and included a large number of sensitive mayfly, caddisfly and stonefly taxa.

The stream restoration activities conducted between 2003 and 2009, including installation of the stream bank and stream bed stabilization structures described above, have:

- Stabilized the channel and greatly reduced long-term stream bank and bed erosion.
- Reduced sediment loads to downstream reservoirs and river reaches.
- Began the recovery processes by establishing habitat features formerly present in this trout stream (e.g., pools, riffles, woody debris deposits).
- Substantially reduced the recovery times for macroinvertebrate and fish communities, probably from many decades to years.
- Accelerated the re-establishment of a shaded riparian corridor by planting a 100-foot wide buffer of deciduous and coniferous trees and shrubs on each side of the river.

Annual inspections of the restored channel by Michigan Department of Natural Resources and Environment (MDNRE) staff have confirmed that:

- The riparian and wetland plantings are surviving.
- The designed channel is generally stable.
- The instream structures are providing the intended bank stabilization and stream bed grade control (Figure 3).
- Pools at the edges of constructed riffles and cross-vanes are becoming larger and deeper.

In addition, limited macroinvertebrate and aquatic habitat surveys at nearby Conner Creek and two sites approximately 4.5 miles downstream of the dam site (Table 1) from 2006 (3 years post-failure) found that:

- While the total number of macroinvertebrate taxa and number of sensitive taxa (mayfly, stonefly and caddisfly) were approximately equal between sites, sediment-sensitive mayflies composed a substantially higher proportion of the overall macroinvertebrate community at the reference site (26%) than at the two sites impacted by the dam failure (10% and 9%).
- Instream habitat quality 3 years post-failure depends partly on the stream power at a particular site; the more energetic riffle/run site downstream of the dam site (Site 63) had higher scores for habitat metrics associated with sedimentation and channel stability (sediment deposition, epifaunal substrate/cover, and channel alteration) than the nearby, lower energy glide/pool site 62. Presumably future instream habitat recovery will

Additional biological data will be collected in 2011.

Partners and Funding: NPS staff participated in technical reviews of the restoration engineering plans and continue to conduct regular inspections of the restoration site on the State's behalf, and the State is reimbursed by UPPCO. NPS staff charged \$200,475 in staff costs to UPPCO. These funds were used to match the FY 2005 319 grant.

Photographs:

Figure 1. Aerial photographs of sediment deposition in the floodplain 2 months after the dam failed.



Figure 2. Photographs of the impacted reach 2 months after the dam failed.

Riparian zone, showing downed vegetation, excessive sediment deposition, and a channel scoured to bedrock



Figure 3. Photographs of the impacted reach 7 years after the dam failed, including some of the instream stabilization structures. Note the regenerating floodplain vegetation.



Data:

Table 1. Post-dam failure macroinvertebrate data for 2 sites approximately 4.5 miles downstream from the dam site, and a reference stream.

Metric	Conner Creek (reference stream)	Site 62	Site 63
<i>Macroinvertebrate Data</i>			
No. taxa	28	24	26
No. EPT taxa*	13	11	11
Percent mayflies	26	10	9
Score**	7	2	2
Overall rating	Excellent	Acceptable	Acceptable
<i>Aquatic Habitat Data</i>			
Habitat type	Riffle/run	Glide/pool	Riffle/run
Sediment deposition score	18	1	19
Epifaunal substrate score	15	5	14
Channel alteration score	20	6	6
Overall rating	Excellent	Marginal	Good

* Sensitive macroinvertebrate groups; mayflies, stoneflies and caddisflies.

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