MNTU's Stream Habitat Work in Minnesota

How We Design Effective, Durable Habitat Improvement - Part 1

By John Lenczewski

Fishing on a fully restored reach of pine creek in SE MN. Note the photo of the original stream in the same location on the opposite page.

This is the first in a series of articles exploring how MNTU and its chapters go about designing and implementing trout and steelhead habitat projects around the state. We'll begin by broadly examining our approach to design and the importance of flood flows, floodplains and accounting for each stream's need to transport its sediments. Later articles will examine the many constraints we work under (legal, land use, infrastructure, watershed conditions, site conditions, etc.), the different methods we use tailored to each project site, challenges of working in flood prone areas, efforts to provide diverse anglers with a mix of different styles of finishing touches and more. A key reality to keep in mind is that no single method or material is suitable for every project site. Rather we need to select "different tools from the toolbox" to use at each site.

A Key Relationship Exists Between Stream Flow, Sediment and Channel Dimensions

At the risk of oversimplifying complex and dynamic systems, the channel dimensions of a healthy stream are able to accommodate the regular flood flows and efficiently transport the sediment load moving in the stream channel in such a way that it does not significantly build up sediment (aggradation) nor significantly erode down into the stream bed and banks (degradation). A balance exists between sediment transport, stream flow, stream slope and the size of sediments. However, historic changes in peak stream flows and sediment loads (due to clear cut logging, land clearing, farming on highly erodible hillsides, etc.) have degraded most of our trout streams across the state and upset this balance. As a result, many stream channels are overly wide and contain excessive amounts of fine sediments such as sand and silt. To make matters worse, many stream channels no longer have good access to their floodplain and instead are confined between deep deposits of soils for the uplands, which continually erode and are redeposited a short distance downstream.

Consequently, a common approach on our habitat projects is to narrow the stream channel so sediment is transported through the project reach, while simultaneously lowering and sloping back streambanks to allow the stream to quickly access its floodplain in rising flows and reduce erosive stress on the outer bends. Of course securing soils with vegetation to reduce sediment loads is a key objective on every project.

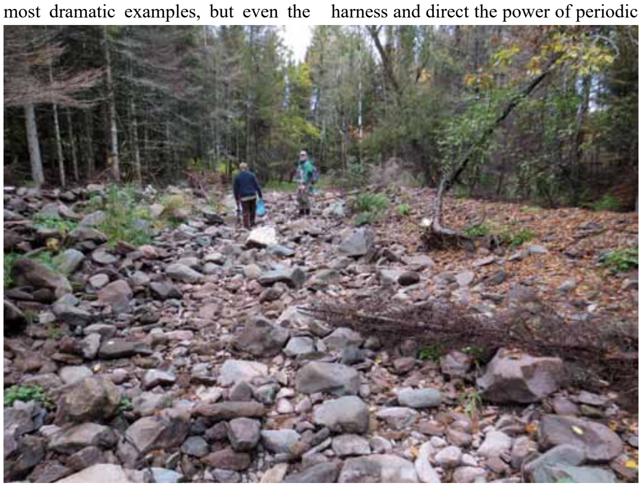
Accounting For Sediment Loads

Erosion is inevitable. Even the most pristine streams and rivers erode some material from their banks and beds. All streams and rivers must transport this erosional material from their headwaters downstream. Trout have evolved to take advantage of stream conditions shaped by moderate rates of erosion and sedimentation. The problem for trout, as well as water quality, is when degradation of a watershed leads to much higher flows (stream discharge), rates of erosion and sedimentation. Every watershed in which MNTU works to restore and improve, habitat has been degraded. In many cases historical land-use practices led to much greater flood volumes than

Hay Creek Pre-Project: An overly wide channel has filled with sand, making the stream shallow.

Hay Creek post-project: The Same location of Hay Creek, narrowed and revegetated, now a deep run with a gravel/cobble bottom stream channels could accommodate. Stream beds eroded, cutting down into the landscape as seen in the Pine Creek photo opposite, leaving steep eroding banks. In southeast Minnesota, huge volumes of fine sediment were deposited in valley bottoms, further trapping stream channels in tight, trough-like stream banks. These legacy sediments are continually re-eroding and covering habitat downstream.

Project designs must take into account the amount of sediment being transported into the project area from upstream (the "sediment load") and be able to move this amount of sediment through the project reach. If stream channel dimensions are too wide, substantial amounts of sediment will be deposited in the project area, essentially filling in the channel and making it shallow. In some cases so much material is deposited that it raises the stream bed and creates a wide debris field through which low flows are spread out into shallow trickles. Large floods ("100 year events", etc.) produce the most dramatic examples, but even the routine floods which occur every two or three years will deposit significant amounts of sediment if the channel is too wide to transport the stream's sediment load.



In sandy soils or where there is a large bed load of sand (see opposite page photos of Hay Creek), overly wide stream channels are incapable of transporting the sand and fill quickly, becoming increasingly wide and shallow. For this reason, MNTU has professionals perform detailed surveys of each project reach to determine the stream's slope, the composition of its sediments and whether the channel's dimensions are appropriate to prevent excessive sedimentation by fine material such as sand and silt. Narrowing channels to the appropriate dimensions can quickly flush fine sediments and create deep pools with gravel and cobble bottoms, as it did on Hay Creek.

Channel Down Cutting

On the flip side, if the stream channel is too narrow to accommodate high flows, the force of flood flows will cut down into the bottom of the stream bed (bed erosion) and carry the large sediment load downstream to be deposited as soon as the channel widens out. This pattern was dramatically displayed on the Little Stewart River project site where a flood cut down the stream bed 3 to 5 feet to bedrock over several hundred feet where the valley was narrow and then deposited the material downstream in pile of rubble as soon as the valley bottom widened out. (see the photo below)

A severe flood filled the channel of the Little Stewart river with rock and debris in the photo to the upper left. Above, the same reach is shown after restoration. the stream has access to the new floodplain in times of high water. Rock and log structures direct flows to the center of the stream.

Designing For Flood Level Flows

When anglers think of trout habitat, they typically are thinking about moderate and low flow habitat, rather than stream conditions during flood stage. But effective, durable in-stream habitat also requires designing for high flood flows. This is because it is the high flows which scour holes, move sediment and shape a stream's channel. For this reason, the high flow at the point when the stream is just about to overflow its banks is referred to by scientists as the "channel forming flow." MNTU and the stream design professionals we work with design habitat projects with flood flows in mind and we design to work with floods. We design the entire reach from the top down, not isolated banks, always mindful that flood energy must go somewhere downstream. We actually anticipate, harness and direct the power of periodic flooding to scour out deep pools and sort sediment loads in ways that will be beneficial to trout, aquatic invertebrates and other aquatic life. We also position in-stream habitat features, which provide food production areas and trout cover under moderate and low flows, in such a way that they become better as a result of flood flows, or at least withstand them.

Pine Creek Pre-Project: A Downcut stream channel is trapped between towering eroding soil banks over 10 feet high.

For example, the rock and log cross vane structures in the photograph below extend well into the banks and are designed to roll high flows into the center of the stream. This takes stress off the stream banks, but also scours deep pools for trout and steelhead. We also utilize them at the tops and bottoms of project sites for their added benefit as grade control structures preventing the down-cutting action of severe floods from working upstream into a project reach.

The Importance of Restoring Floodplains to Reduce Destructive Energy

The key to maintaining a stream channel that will both provide good habitat and effectively transport sediment through a project reach is ensuring that a rising stream can quickly get out of its banks and utilize its floodplain to release flood energy (and fine sediment) there, rather than tearing apart stream banks. The erosive stress of water against stream banks increases as the depth of the water increases. Spreading flood waters over a wide floodplain relives these stresses on stream bends. For this reason restoring ready access to the floodplain through bank sloping and even re-creating floodplain is a top priority on every project.

The Little Stewart project restored a stable channel which has withstood numerous floods. In the photograph below note that a floodplain was recreated which permits high flows to quickly get outside the channel and dissipate energy across the floodplain.

On Pine Creek severe flooding had caused the stream bed to cut more than 10 feet down into the landscape so that flows from even major flood events could no longer release their energy onto the former floodplain. Here large amounts of streamside soil were removed and low floodplain terraces created so that high flows can quickly spread onto this new floodplain and protect the in-stream habitat from being blown out. Note the low banks on either side of the angler on the photo on the opposite page.

You should now have a basic understanding of why we must design habitat projects to efficiently move sediments through a project reach, the role channel width and flood flows plays in this, how we design projects to work with flooding, and the importance of reconnecting streams to their floodplains. In the second part of this series we will examine the many constraints we face working in DNR easement corridors (limited width, existing land use, landowner cooperation, infrastructure, etc.) and turn to the suite of methods we use to create good, durable habitat tailored to site conditions.