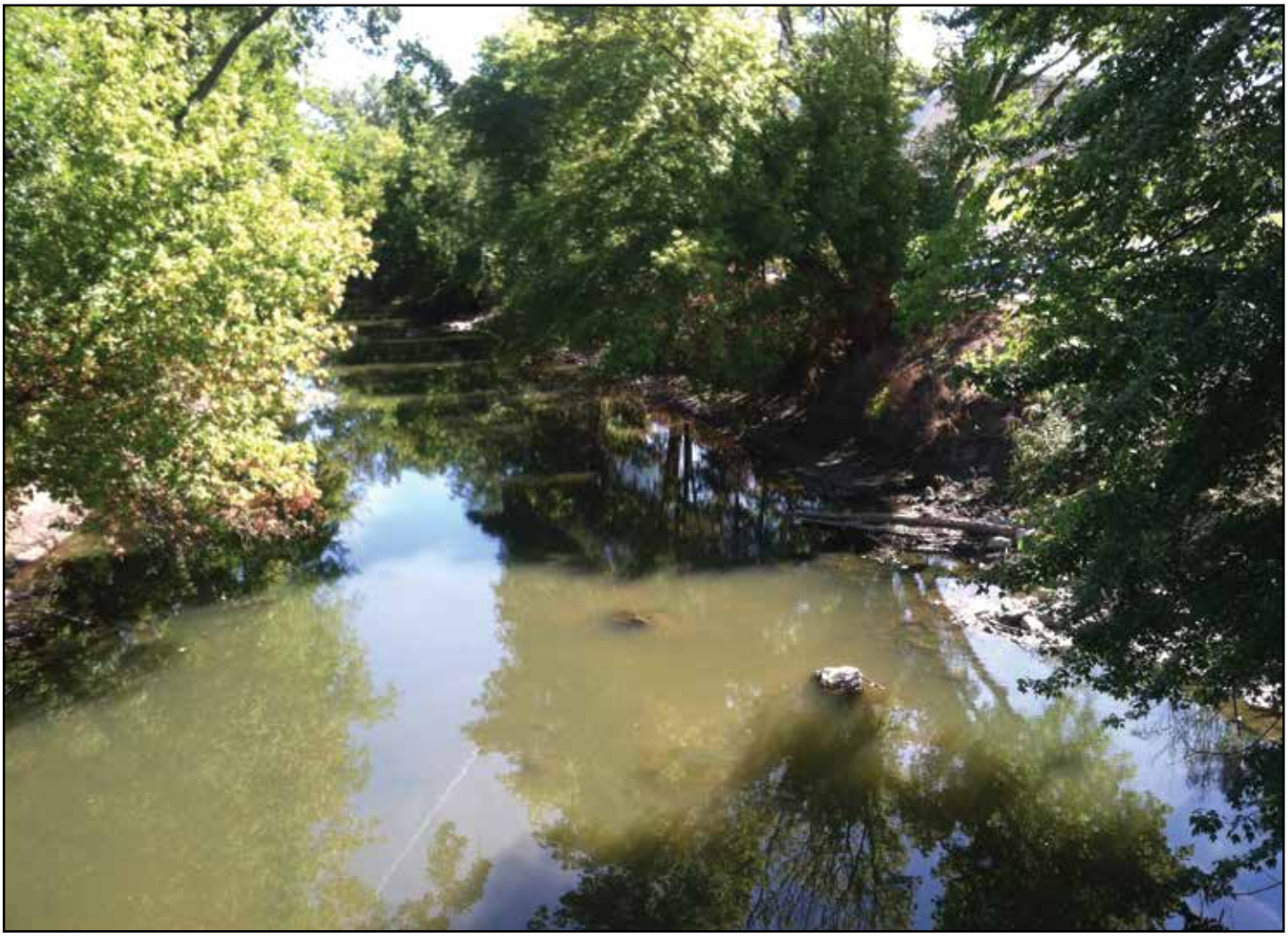
Habitat Restoration of the Ottawa River
at the University of Toledo, Ohio



Reach 5 post construction view of hydraulic cover stones and bendway wier with locked log.

With the establishment of the main campus of the University of Toledo along Bancroft Road in Toledo, Ohio in 1931 was the added feature of the presence of a major river approximately 3,700 feet in length. Over the last seventy years, the Ottawa River has received little attention in regards to campus planning, which is evidenced by the location of buildings and parking lots up against the banks. For many, the river has been seen and described as a "dirty ugly ditch". In addition, following major flooding in the 1940s and 1950s, much of the river was dredged, straightened and leveed in order

Construction of longitudial toe protection structure.

to protect from future hazards. As a campus and community we have turned our backs to the river, ignoring its unique and important ecological functions and untapped potential to enhance the University landscape.

Since 2005, faculty, staff, students, alumni, and community members have been working to address a wide range of issues and challenges associated with the 3,700 feet of the Ottawa River that passes through the main campus of the University of Toledo. Established by then President Dan Johnson, the President's Commission on the River has spent that last nine years focusing on efforts in the areas of beautification, storm water improvements, natural areas and environmental improvements, overlooks and pathways, student involvement, education and public awareness, community outreach and engagement. Funded by grants and donors, the Commission has raised over $600,000 to support projects and activities aimed at improving the river. Several notable accomplishments have been achieved by the Commission in association with UT Facilities and Grounds and other university and community partners.

Starting in 2009, the Commission undertook the largest project to date with a proposal to undertake natural restoration improvements for both bank and aquatic habitat along the river. Stream habitat assessments by the Ohio Environmental Protection Agency (OEPA) and other studies indicated that the section of the river on main campus failed to meet state attainment standards for aquatic habitat conditions. In addition, following major projects to address contaminated sediments and combined sewer overflows in downstream sections of the Ottawa River in the City of Toledo, efforts were underway at various locations to address natural habitat and population for wildlife, fish and aquatic species in the river. These initiatives included dam removals, wetland restoration, stream improvements and riparian plantings and removal of non-native invasive plants in areas upstream from the campus. The University of Toledo decided to work on similar improvements for the river on campus and as an effort to engage with community activities and partners.

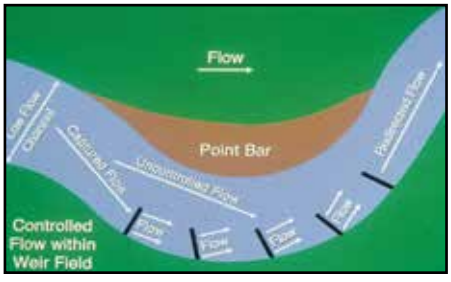
Funding

An education grant of $90,000 from the Stranahan Foundation provided an opportunity to engage science teachers and students from the Toledo Public School (TPS) Early College High School, located on the UT Scott Park campus, with the design and planning for aquatic habitat restoration within 900 feet of the river adjacent to Savage Arena. The project aim was to engage the high school students with involvement in the development of the project and provide them a forum to meet and learn about college degree options in environmental science. There was also opportunity for the students to interact with professionals working in the field from federal and state agencies, non-government organizations, and consultants. With additional planning support from the U.S. Army Corps of Engineers (ACOE) - Buffalo District, an initial site plan for the placement of several in-stream aquatic habitat structures was completed for the proposed project area in 2011 with plans to proceed to construction that summer. The in-stream habitat structures would be made from natural materials (wood and stone) and consist of bendway weirs, locked logs and hydraulic cover stones – all of which provide shelter and protection for aquatic species out of the main flow of the channel and would also allow for establishment of aquatic plants as food sources.

However, following a public meeting on the proposed restoration project, interest was expressed by several groups to encourage expanding the restoration concepts to include the entire 3,700 feet of the Ottawa River on main campus. With securing of additional project grants from Ohio EPA ($235,000) and U.S. Fish and Wildlife Service ($161,000), the Commission and project team proceeded to have the ACOE extend their design work for the other river sections on main campus. Final design work was completed by fall of 2011, and the first stage of construction was completed in July 2012 with the completion of a cutbank structure along 900 feet of the river bank adjacent to the UT Law School. The cutbank was deemed a necessary step due to the requirement to increase river water storage on campus following a potential one hundred year flood event. The building of the cutbank also provided an opportunity to remove over 4,000 square feet of construction debris placed there in the 1950s. Once completed, the site was replanted with over 300 native plants. There are also future plans that will improve public access to the river with a walking path and benches at the site.

Design

With the construction of the cutbank complete, planning for the in-stream habitat restoration proceeded in the fall of 2012 with final design and public meetings. The final design called for the installation of twelve in-stream restoration structures and sixty hydraulic cover stones along 2,800 linear feet of river. The structures included: six locked logs; two sets of LUNKERS (total length 88ft); one section of Longitudinal Peaked Toe Protection (200 linear feet) with five single stone bendway weirs with a stone smile structure, and three bendway weirs with locked logs. Stone would come from local quarries and the locked logs built from hardwood trees donated from a local landowner and from site. The in-stream structures would be anchored into the bank, protected with rock stone keys at each end that extended several feet deep and up to fifteen feet with the bank and where filled with stone, choked with soil and planted with live stakes of willows and other locally harvested plants. The number, location and select of the various types of in-stream restoration structures was determined based on current habitat conditions, addressing flow conditions and to provide a range of different habitat structures so as to be able to assess their relative functions and long term successes to improve aquatic habitat conditions. Final concept plans and design were completed by the USACOE and provided to the project team in December 2013 along with detailed cost estimates by river reach and structure type.



Restoration Structures

A Longitudinal Peaked Stone Toe Protection (LPSTP) is a continuous stone dike placed longitudinally at or slightly streamward of the toe of the eroding bank. It is triangular in cross-section. The LPSTP does not necessarily follow the toe exactly, but can be placed to form a smoothed alignment through the bend. However, in some cases a smoothed alignment might not be desirable from the environmental or energy dissipation points of view. The amounts of stone used (i.e.,1 ton/lineal foot, 2 tons/lineal foot) will depend on the depth of scour at the toe, estimated stream forces (impinging flow) on the bank and flood durations and stages. A benefit of this type of protection is its ability to resist the erosive flow of the stream and stabilize the toe of the slope. It does not directly protect mid and upper bank areas. The success of the method depends on the ability of the stone to launch into a scour hole and self-adjust, protecting the bank against further erosion. Bank grading is not always needed; therefore any established vegetation above the crest of the LPSTP may not need to be disturbed. Typically adventitious rooting live poles are placed against the stone on the bank side, then the area between the stone and the native bank material is backfilled (which plants the live poles) and creates a floodplain bench. The LPSTP and poles (live siltation) will capture alluvium and any failed upslope material on the bank side creating an area for vegetation establishment.

Cutback feature in Reach 1 in the summer of 2013, one year post construction.

A Bendway Weir (BW) is a stone structure that extend from the bank and angle upstream 70 degrees from a line tangent to the bank. As opposed to Rock Vanes/Bank Barbs, they are level crested (flat) along the longitudinal axis. The length depends on the amount of river that needs to be controlled and proposed thalweg relocation. The height of a BW is usually one foot above the base flow water surface elevation (typical lowflow or 80 percent exceedence). The crest of the weir needs to be lower than any flow that can erode the bank. Water flowing over it is redirected at an angle that is perpendicular to the longitudinal axis of the weir. Because it is angled upstream, this pushes the erosive energy (flow) away from the outer bank of the stream. The erosive helical flow, that is created as the stream travels along the bend, is broken up and the stream velocity over the weirs drops by approximately 50 percent. This reduced flow velocity creates a resting area (within-channel refugia) and increased structural diversity for fish. One study shows that adding weirs increased species richness of fishes by 260 percent and individual numbers by over 24,000 percent. Because of the slower stream velocities along the outer bank, weirs will allow for deposition and plant colonization to occur along the outer bank of the bend of the river and sometimes in the area of the weirs. Also the deepest section of the river (thalweg) is moved from the outside of the bend of the

stream to a smoothed alignment off the stream end of the weirs. Like all redirective methods, it will usually reduce, but not eliminate, bank erosion as the primary function is thalweg management and energy dissipation.

A Hydraulic Cover Stone (HCS) is a large single stone placed singly, or in grouping, in a flowing channel. The constant movement and undulation (rippling) of the water from the HCS results in a type of cover, hydraulic cover, that masks fish location from the view of predators. The stones also provide resting areas and in-channel refugia for fish during high-energy, highflow events. Three stone placements create three different hydrologic scenarios:

- Above Base Flow: Stone crest set slightly above the base flow water surface, resulting in a V-shaped wake and flow split with a double return eddy flow pattern downstream of the stone. However, these stones might be used as perches for predators to catch fish and other species.
- At Base Flow: Top of the stone set at an elevation slightly lower than the typical base flow water surface elevation. When sited correctly, the accelerated flow over the top of the stone changes from subcritical to supercritical flow and then farther downstream the flow returns back to subcritical (usually with a weak hydraulic jump). The hydraulic jump entrains air and aerates the stream.
- Below Base Flow: Stone crest set just below the base flow water surface elevation results in an acceleration of the water moving over the top of the stone, with standing waves forming downstream of the stone. Standing waves do not propagate in any direction, almost like a set of water hills locked in place.

Locked Logs (LL) consist of entire trees, generally larger than two inches in diameter anchored in or placed under structures. Locked limbs are smaller branches (with or without leaves), tree tops or sections of small tree trunks that are less than two inches in diameter. They can be placed into a stream by hand or with mechanical assistance. Depending on size of the woody material and the stream, they can be placed singularly or in bundles of several logs. These structures are secured into the bank or locked by placing stone around the lower portion of the tree with the upper portion pointed downstream at typically a 15 to 35 degree angle relative to the bank. Trees that still have attached root wads are preferred because the roots act as a spread anchor in the stone and don't allow them to work out from underneath the stone. Care should be taken to make sure to anchor the tree or limb to the bank so that the woody debris does not break free and create more work downstream. Avoid the use of mechanical fasteners such as cables. If the structure fails, cables can cause problems downstream where they can become lodged. They provide in-stream cover, vertical and horizontal structure, hydraulic roughness and faunal refugia. Dead wood in a stream is extremely important for macroinvertebrates, both as food supply at the base of a food web and as a substrate/habitat. These logs provide cover and feeding grounds for juvenile and adult fish. The increased roughness of LL along an outside bend of a stream creates a chaotic structure and redirects the thalweg closer to the inside of the bend. In larger streams, they assist with ice management. The slower water created by the hydraulic roughness allows for a thicker, earlier forming ice along the banks between the LL. When the spring ice melt occurs, the thicker ice near the bank stays put long enough to help protect plants and smaller stone protection from ice shear.

Installation of live stakes in locked log feature.

A LUNKERS (Little Underwater Neighborhood Keeper Encompassing Rheotactic Salmonids) structure was first developed and used in Wisconsin. It is an engineered, undercut-bank structure designed to provide habitat for fishes while providing bank stability. It is typically 8 feet long, 1 to 2 feet tall and 3 feet deep, constructed of hardwood or if numerous wet-dry cycles are anticipated, concrete or plastic-wood. It is open to the front and sides of the structure to allow for water to flow through. The toe of the outer bank of the stream is leveled. The structure is placed on the level bed and 0.5 inch x 7 foot long sections of rebar are driven through predrilled holes and into the stream substrate, anchoring the LUNKERS to the stream bed. The area bankward of the structure is filled with riprap or covered with large stones and some soil. Circular coir fiber rolls are positioned on top of it to provide substrate for vegetation. Concrete-roofed LUNKERS can be used as fishing platforms in handicapped accessible facilities. It is important that it is placed on the outside of the bend of the stream that will receive flow. Otherwise, sediment fills up in it, deeming them functionally useless.

Permitting

Early in 2013 state and federal permits were prepared and submitted to the US Army Corp of Engineers and Ohio EPA to address issues with stormwater and distribution of stream conditions, with the nec-

essary permits secured in May. Meetings and consultations in advance of the construction were also conducted with the city and county so they were informed and aware of the construction, even though as state lands the university site was not subject to local planning or regulatory oversight. From May to July, related efforts of habitat restoration were underway along the river banks. With the assistance of Partners for Cleans Streams - funded by a environmental jobs grant from NOAA via the Great Lakes Restoration Initiative - eight student workers spent eight weeks at UT removing large numbers of non-native invasive plant species along the river banks, most notably Tree of Heaven, Honeysuckle, and Buckthorn, and preparing access points for subsequent in-stream river habitat restoration work, with over 2,400 feet of linear river banks cleared of non-native plants.

Above: LUNKERS, post construction. Below: Placement of eight foot section of LUNKER in Reach 3.

In May 2013, the University solicited bids from of eight pre-approved contractors based on a vendor list provided by two local organizations that had recently completed similar habitat restoration projects. Based on the review and evaluation of submitted bids, including detailed cost estimates provided by the contractors, Ecological Restoration Inc. was selected. The contractor completed a required site visit in June to assess the site, review final design plans, and discuss staging, materials and local suppliers. In August 2013, Ecological Restoration Inc. undertook the placement of the in-stream habitat structures in the river using native wood materials and stone, plus an additional sixty single stone rocks. The mobilization of materials and equipment took three days, actual construction was completed over ten days, with cleanup and demobilization including hydroseeding of exposed soil areas undertaken over additional two days. Time lapse videos of sample selected in-stream structures can also be found on our Youtube channel at "U Toledo Presidents Commission on the River". During construction the site was subject to periodic site inspection by OEPA with no major issued cited.

Monitoring

Following the in-stream construction over seven hundred native plants were placed along the riverbank and in the water. Species included Water willows, Burt Oak, Dogwood, Indigo Bush, Black Chokeberry, Hazelnut, Black Walnut, Tulip Poplar, Hornbeam, Ninebark, Sycamore, Black Cherry, and Sumac. Additional planting will be completed in the summer of 2014 due to funding remaining from the NOAA grant to Partners for Clean Streams. Permanent information signage will be placed along the river on campus to educate the University community and visitors about the river and restoration efforts. Ongoing assessment and monitoring of the bank vegetation and in-stream habitat restoration structures will be conducted to determine the impact of the work that has occurred. Dr Hans Gottgens and graduate students from the UT Department of Environmental Sciences have additional research grant funding to support multi-year pre and post construction assessment of the in-stream structures for fish habitat and populations. OEPA is scheduled to return to the site within the next 2-3 years for comprehensive habitat evaluations to determine if the river aquatic ecosystem has improved based on state assessment standards.

Lessons Learned

The biggest challenges within this project were to secure the additional funding to allow for expansion of the restoration to include the entire length of river on main campus and addressing the potential flood risk increase by the needed additional step of building the cutbank structure. In addition as the design and planning work proceeded over a two year period, modifications in the number, location and size of the in-stream habitat restoration structures needed to be made to balance budget limitations and appropriately manage for the future flood risk with the additional structures to be placed in the river channel. Of the successes realized with this project were the added benefit of raising understanding and awareness of the river and the importance of aquatic habitat to the university and local communities and the ability to engage multiple funding agencies and part-

ners into the project.

Additional important considerations and lessons learned during the project included the need for continued public engagement and communication which was achieved by regular meetings, a variety of media and online outlets, and project signage on site. Use of the university media office, Commission website and Facebook page, and emails to key project partners, funders and Commission members were critical to the task of keeping everyone informed as the planning and construction proceeded. Establishing and maintaining lines of communication with key regulatory agencies and other interested parties was also critical so questions and concerns could be dealt with in a quick and efficient manner.

It is also important to emphasize that planning and design of such habitat restoration projects can take time and effort to work through concepts and proceed to contracting and construction. For example almost three years were required proceeding actual construction. Also during construction it was important to have oversight by expert(s) on habitat restoration and work with an experienced contractor in order to make any necessary field adjustments and modifications due to conditions and best practices. Such oversight also assisted unexpected issues that arose during construction when it was necessary to adjust the size and type of stone materials and logs to be used to build the in-stream habitat conditions when the original specifications could not be met by the supplier. Coordination and close communication between the project team, field expert and contractor are essential.

Future Efforts

As the Commission begins to close in on a decade of work, the potential opportunities remain exciting with great potential for continued improvements to the river on our campus. Future efforts will focus on addressing the serious challenges associated with the collection of surface storm water runoff from our buildings and parking lots. Currently, the stormwater is discharged directly into the Ottawa River. Ongoing and committed work to stop the continued appearance and expansion of the non-native invasive plants will also continue. In addition, improvements to aging bridge structures will need be carried out and more overlooks will be developed, along with a planned river trail system. Due to the many improvements, there has been an increased use of the river as an outdoor classroom for our students, which furthers collaboration and public education surrounding the Ottawa River, such educational experiences will increase. Along with our community, collaborators, and University partners we all look forward to having our river gain its place as a signature piece of the University of Toledo for our current and future students and the community we all share. **L&W**

by Dr. Patrick Lawrence

For more information on this project, or the work of the Commission, readers are referred to our website at http://www.utoledo.edu/commissions/river/ or our Facebook page. You can also contact Dr. Patrick L. Lawrence, Chair & Professor, Department of Geography and Planning, College of Languages, Literature and Social Sciences and Chair, UT President's Commission on the River, University of Toledo, Ohio, Phone: 419-530-4128, Fax: 419-530-7919, Email: patrick.lawrence@utoledo.edu.