Injecting Biology along Riprap Shorelines

by Bill Bartodziej and Simba Blood

Introduction

A long-established response to lakeshore erosion has been the introduction of riprap and the use of other hard armoring techniques. In the United States, this approach has resulted in thousands of miles of riprap being placed along shore edges. In numerous instances, riprap is overused – showing up along shores that have gradual slopes with modest wave energy. Although these hard armoring techniques are often effective at reducing erosion and slowing soil loss, they generally have a negative impact on critically important habitats for fish and wildlife.

In recent years there has been a movement toward "softer" shoreland restoration and management. Ecological restoration designs that use woody and herbaceous plant species are gaining popularity as a means to stabilize shores. Introducing appropriate plant communities helps improve water quality, provides wildlife and fish habitat, and enhances the appearance of the shore. These associated benefits are typically not possible when only using rock riprap for stabilization.

With ecological shoreland restoration now gaining momentum, consultants, natural resources managers, and lakeshore owners are pondering what can be done with old, degraded riprap shores. Improper installation or years of disturbance from waves, people, and sometimes ice result in riprap segments that are experiencing failure and in need of repair. In other situations, environmentally conscious shoreland owners and natural resource managers may consider transforming stable riprap shores into ones that provide high quality fish and wildlife habitat.

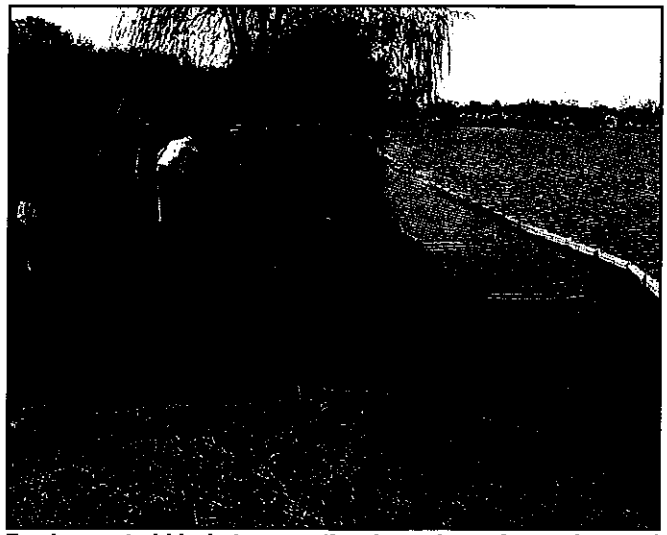
This article describes a project that used an ecological restoration approach to improve a long stretch of degraded riprap shoreline along an urban lake in Minnesota. The long-standing riprap tradition was broken and now lake users, fish, and wildlife are reaping the benefits.

A three-year-old shore restoration segment on Lake Phalen, St. Paul, Minnesota.

Site History

Lake Phalen is a 200-acre intensively used urban lake located in a St. Paul, Minnesota park. Much of the three-mile lakeshore has been highly modified since its inauguration as a park in 1899. Dredging and filling were started almost immediately, and beginning in 1910 the subsequent erosion was addressed by the use of rock riprap. This approach was used for the next 90 years. By 2000, almost 60% of the lake's perimeter was covered by riprap, much of it in various stages of failure. A base goetextile fabric was never installed under the riprap, which led to soils amongst the rock being washed away. Many lake banks were experiencing moderate to severe erosion, and walking paths were threatened. Steep drops near the pathways created safety concerns. Invasive weed species growing amongst the riprap dominated the shore.

The highly degraded state of the shore prompted the Ramsey-Washington Metro Watershed District to contact the City of St. Paul, the legal shoreland owner, and discuss restoration options. City staff were entirely open to the idea of trying an ecological



Erosion control blankets cover the shore slope after native seed is broadcast.

restoration design. Additional key partners -- Minnesota Department of Natural Resources, Ramsey County, and the Minnesota Board of Water and Soil Resource -- joined the project.

This group drafted a five-year ecological restoration plan (available at www.rwmwd.org) to treat over a mile of degraded lakeshore. These partners also provided essential financial and staff support. The goals of this plan are to reduce shoreline erosion, eliminate public safety hazards and increase recreational opportunities, improve fish and wildlife habitat, increase the abundance and distribution of native plant species, and add to the body of knowledge regarding management and restoration of urban shorelines. Restoration work began in 2001, with design and direct project management provided by Bill Bartodziej of the Ramsey-Washington Metro Watershed District.

Site Design

In 2002, a 1500 linear foot shore segment at the southeastern end of the lake was restored. This project was identified as Phase II in the 5-year plan and was among

the most challenging sections of shore on the lake. Due in part to the north/south orientation of the lake, this shore is subject to moderate to heavy ice and wave action. The effects of this were intensified by the loss of former stands of bulrush. The eroding banks were quite steep – 2:1 to 3:1 slope. This steepness was carried out into the lakebed as well; some of the underwater slopes were greater than 2:1.

In upland areas, there was generally less than 10 feet of land between the shore and the walking paths. Over the years, this shore segment was covered with layer upon layer of riprap mixed with sandy, granular fill soils. The riprap was widespread, deposited from the top of the slope out to 10 feet into the lake. This heavy rock layer created uninhabitable substrate for emergent plants.

The main purpose of constructing the berm was to create a wave buffered emergent planting shelf from the top of the berm to the shore – averaging 6 feet wide. Once vegetated, this area would become a beneficial emergent aquatic plant habitat and natural wave break.

The restoration plan called for the establishment of a diverse, native plant buffer from the walking path down to the shallow water emergent zone. In order to accomplish this, the design called for the removal of rock along the slope. This rock would then be used to create a berm approximately 6 feet offshore from the Normal Water Level. A Minnesota Department of Natural Resources permit was secured for the berm construction.

It was specified that the top of the berm be 0.5 feet above the Normal Water Level and consist of a 3 to 5 foot wide base. With the relatively narrow base, it was thought that ice action would likely flatten the berm after several years. The main purpose of constructing the berm was to create a wave buffered emergent planting shelf from the top of the berm to the shore – averaging 6 feet wide. Once vegetated, this area would become a beneficial emergent aquatic plant habitat and natural wave break. Using rock in this fashion also saves money by eliminating the cost of hauling the material off-site.

Grading

Rock and earth moving began in early May 2002. An excavator – a Kobelco 210 -- was used to remove rock riprap from the slope and to create the berm. A local contractor, Semple Excavating, performed all of this work. Large, flat pieces of limestone riprap were set aside and used to create three 30-foot wide lake access points. The limestone slabs were positioned to create natural looking steps down to the water's edge. The remaining riprap and fill soils along the bank were smoothed to create a 3:1 to 4:1 slope.

Local topsoil, a sandy-loam, from a site less than 10 miles away was used to cover the slope. Soil placement generally extended from the pathway to the berm and was spread to a depth of approximately 1 foot. City of St. Paul transported soil to the restoration site – over 700 cubic yards. The excavation operator found it useful to work the shore in 50-foot segments – moving rock to build the berm, reshaping the slope, and then covering with topsoil.

A soil cap being placed over the remaining riprap.

Planting Plan

The planting plan consisted of three components – the upland, transitional, and emergent zones. All plants introduced were native to Minnesota. In developing a species list, a variety of key factors helped shape plant selections. For instance, undisturbed remnant shoreline areas were surveyed to look for common native species. Particular attention was paid to the elevations of emergent and transitional plants. This information helped determine the target elevations of a variety of species used in the restoration. Native shoreline species that were relatively abundant in remnant areas were given priority in the plan.

Shorter growing plants were selected for areas near the pathway to keep views of the lake open. Also, wildflowers chosen were fairly aggressive and showy – common species were butterfly weed, purple coneflower, and purple prairie clover. Hearty, rhizome-spreading plants, such as river bulrush, lake sedge, and prairie cord grass, were selected for the transitional zone. This was due to Phalen being fed by an urban watershed and having substantial water level fluctuations. More conservative shoreline species have been shown to be adversely impacted by this type of urban stressor. Hard-stem and soft-stem bulrush were the base species in the emergent zone. Broad-leaf species, like arrowhead and pickerel plant, were not selected due to the potential for heavy wave action during high water events.

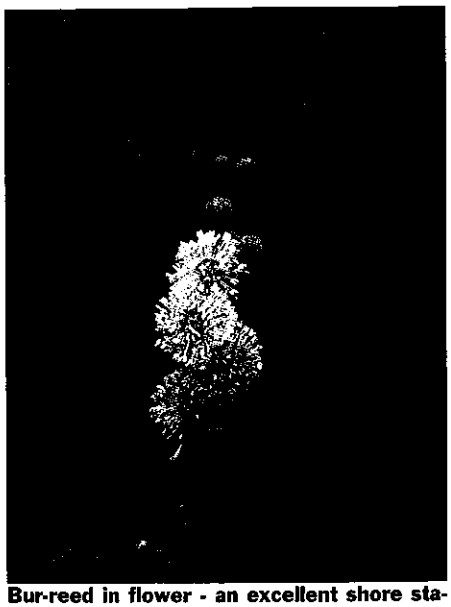
Prevegetated Blankets

The newly shaped toe of the slope was protected with a prevegetated erosion control blanket consisting of a coconut fiber matrix enclosed in a permanent, 3- dimensional netting structure (North American Green - C350). Dan Larsen at the Brock-White Company supplied all erosion control materials. Bare root material and two-inch plant plugs were introduced into 6-foot lengths of C350 blanket 8 weeks before placement in the field. Approximately 1500 feet of prevegetated blanket was grown in 10 hoop

greenhouses. The prevegetated blanket was moved from the greenhouse facility to the lake by using a flatbed truck. Deliveries were spread out over the period of the installation. The blanket was anchored 1 foot below the Normal Water Level and overlapped at least 6 inches on the sides. The placement of the mat in relation to the Normal Water Level was determined by the analysis of historical hydrological data for Lake Phalen. Mat installation closely followed the soil placement – covering each 50-foot segment immediately after grading.

Upland Prairie

The exposed soils in the upland areas were seeded with a short grass prairie mix, and then covered with either a coconut fiber erosion control blanket (North American Green C125) or a straw/coconut fiber blend (North American Green SC150), depending upon the steepness of the slope. The upland planting began in mid May. This is typically a cool and wet period in Minnesota, and plantings installed during this period have high rates of survival without supplemental watering. Students from



Bur-reed in flower - an excellent shore stabilizing species.

neighboring schools installed thousands of 2" prairie plant plugs in the upland areas. Plugs were generally installed on 2-foot centers.

Transitional Shoreline Zone

The transitional shore areas just above the C-350 blanket were seeded and planted by District staff and Ramsey County Corrections inmate work crews. Plant installation for this zone took place in mid to late May. Student volunteers were not used for this zone, mainly because of the difficult footing and its close proximity to the shore. Similar to the uplands, 2" plugs were installed on 1.5 to 2-foot centers.

Emergent Shelf

In late June into early August, at the start of the summer draw down period, emergent plants were installed between the berm and the shore. In Minnesota, installing emergent plants during this period reduces the risk of mortality from flood events. The average water depth was 1 foot along the emergent shelf. A mix of hardstem and soft-stem bulrush, bur-reed, river bulrush, and three-square rush, in 4" containers, were installed on 4-foot centers. Because of the berm, temporary wave-break structures, such as brush bundles or jersey barriers were not needed to reduce wave action. A majority of the plant installation was conducted with District staff and inmate work crews.

Economical Restoration

The total cash outlay for this phase of the shoreland restoration project was $72,000. This works out to be $48 per linear foot of shoreline. Costs were kept low with generous in-kind contributions from project partners and a substantial input of student volunteer hours. If all in-kind services were eliminated, it is likely that this project would have cost approximately $100 per linear foot. This is still more economical than riprap projects, which, for this stretch of shore, would run close to $150 per linear foot.

The transformation of a riprap shoreline: The southeast shore in 2001 (bottom) and 2004 (top).

Biological Diversity Abounds

Over the last three growing seasons, plants in all zones have become well established and erosion has been reduced. The bank slumping that threatened the pathway has been eliminated and safety hazards from uneven and unstable riprap are gone. The limestone access points now provide a safe and convenient path for folks that want to get close to the water. In a 2004 survey, over sixty native plant species were identified in the shore buffer – a majority of these species have flowered. Park patrons are enthused with the restored shoreline and have expressed enjoyment in observing the birds, butterflies, frogs, turtles, and fish that are attracted to the newly established habitat.

The offshore rock berm enabled an emergent plant zone to become vegetated. The dominant plant species are hard-stem and soft-stem bulrush and bur-reed. River bulrush, lake sedge, and prairie cord grass are now expanding along the shoreline transitional zone. In spring, bluegills are commonly seen spawning amongst the bulrush. Herons, egrets, and cormorants are frequently noticed feeding along the emergent shelf. Leopard frogs are often detected swimming along the water's edge, eventually taking cover in the abundant sedges and grasses. Surveys prior to the shore restoration project indicated that frogs were extremely rare along the shore. Anecdotal evidence suggests that frog populations have responded positively to the increase in high quality shoreline habitat on Lake Phalen.

Soon after the emergent plants became established, several muskrat appeared along the shore. Over the last two years, they have built tunnels along several slope areas. We have noticed some moderate feeding damage on patches of emergent plants. These animals are a welcome addition to the shoreland ecosystem; however, young plants are quite susceptible to overfeeding. We will be closely monitoring their activities over the next several years.

Lessons Learned

Plants in the prevegetated blankets were viable, however, root structures did not fully cover the blanket area. This led to unvegetated, open patches, along the toe of the slope that were susceptible to erosion. To remedy this, supplemental planting was used to fill these voids.

In 2003, as part of the next phase in the overall project, smaller pieces of flat-sized (11"x22") erosion control blanket were prevegetated with aggressive hardy native shoreline species. This replaced the 6-foot lengths of prevegetated blankets that were used along the base of the slope. This propagation approach was more efficient in the greenhouse, providing more robust plant material. In the field, plant placement was more refined. With the smaller prevegetated pieces, installation crews were able to match a variety of microhabitats with appropriate plant species. These smaller prevegetated mats were also more economical.

When designing the restoration, it was thought that the rock berm would provide adequate protection to the toe of the slope, and this, coupled with the prevegetated blankets, would eliminate the need for coconut rolls or biologs being placed along the shore. This would equate to a substantial cost savings to the project. Observations in the summer of 2002 suggested that moderate wave energy was reaching the shore during high water events. In some areas, this disturbance was

impeding plant expansion in the transitional zone. In 2003, as an added measure of protection, 10 foot long, 16" diameter biologs were installed at the spring water level elevation along approximately 1000 feet of shore. This essentially eliminated all wave action along the base of the slope. To stimulate the revegetation, the smaller pre-vegetated mats were installed in bare patches immediately behind the biologs.

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Student Education

During the last several years, over 1500 local school students have had the opportunity to learn about Lake Phalen's ecology, grasp the importance of shoreland habitats, and get a chance to put native plants in the ground. This outreach and education has made this ecological restoration project even more valuable to the community. It has provided unique service learning opportunities for students in an urban setting. Their involvement has built community support and understanding for the project. Having such a large number of local students learn and directly contribute to the restoration will likely work to build a sense of pride and ownership over many generations. This will foster long-term community support for this high quality urban water resource.

Project Update

In 2005, the Lake Phalen Ecological Shoreland Restoration Project will be entering Phase V. This is the final phase detailed in the 5-year plan. Annual project updates are available on the Watershed District website – www.rwmwd.org.

A guidebook titled *Lake Phalen Shoreland Restoration – Walking Tour and Plant Guide* was recently published. It contains restoration site summaries, detailed shoreline maps, and over 250 high-quality color photos of 115 plant species now found around the lake. This book is available through the Watershed District at a cost of $10.

Because of the success this project has experienced, there is the likelihood that additional funding will become available for continued shoreland restoration and management. To date, this is the largest lake shoreland restoration project in Minnesota. In the near future, project partners are planning to coordinate with university scientists to begin a formal research project with quantitative data collection. **L&W**

For more information, contact Bill Bartodziej, Ramsey-Washington Metro Watershed District, 2346 Helen Street, North St. Paul, MN 55109. (651) 704-2089 or email: Bill@rwmwd.org