RIVER BANKS & BUFFERS

Prioritizing Erosion Sites for Restoration

in the Connecticut River Watershed

The Connecticut River, New England's largest and most powerful, has been rearranging the landscape ever since the glaciers left. Natural communities adjust silently to the inevitable movements of the river, but human communities do not. People build their roads, cemeteries, factories, and homes on its banks, and then are caught by surprise when the river moves again. Erosion sends sediment to fertilize floodplains but also to cover fish spawning beds and threaten water quality.

EROSION ON THE UPPER CONNECTICUT RIVER

Riverbank erosion is one of the most prevalent and misunderstood problems facing the Connecticut River and its tributaries. In many cases it is the result of the river's natural tendency to scour and deposit sediments as it flows through the landscape. Seasonal flooding and the abrasion of ice as it breaks up in the spring inevitably chew at the river's banks. The fluctuation of water behind peak generating hydroelectric dams and the wakes from passing power boats also take their toll of riverbank soils. People who eliminate the band of trees whose roots have held the riverbank in place are surprised when chunks of their land later fall in and wash away. When the Connecticut River Joint Commissions surveyed all 1300 New Hampshire and Vermont riverfront landowners in 1991, the number one issue on the landowners' minds was bank erosion.

Rationale for Setting Priorities

Traditionally there has been a competitive struggle for scarce funding on the part of landowners, conservation districts, and natural resource agencies who want to tackle problems of riverbank erosion. Funding is limited, and comes infrequently and in small doses. There are several purposes for priority setting over a large geographical area:

- enable a multi-disciplinary level of analysis that is unlikely to be available for individual sites;
- apply the same criteria to all sites;
- gain support and participation from a wide diversity of agencies and organizations for restoration at the selected sites; and
- attract funding sources and partners for addressing restoration on the selected sites based on the professional credibility of the selection process.

Traditional riverbank repairs

Erosion and vintage Detroit rip-rap in the Northeast Kingdom.

Each decision about the river involves a compromise between river dynamics and human investments. Too often in the past, restoration efforts have been band aids applied without understanding the root cause of erosion, and have only served to move the problem elsewhere. For a number of years, the traditional remedy for riverbank erosion has been to "armor" the bank with boulders, concrete walls, or even automobile bodies. These solid materials have not always withstood the river, and often have been found to accelerate the passing waters and instigate greater erosion and damage at sites downstream. In recent years, there has been a growing desire on the part of state and federal agencies, scientists, citizen organizations, and landowners to gain a greater understanding of natural river processes, identify ways to reduce the human factors that lead to more erosion, and find more river-friendly ways to restore eroded riverbanks.

Public awareness

As an aid to public understanding, the Connecticut River Joint Commissions published a series of fact sheets, *The Challenge of Erosion in the Connecticut River Valley,* in 1996, updating them in 1998 to include new state-of-the-art stabilization techniques. These fact sheets provide an overview of river dynamics, the role of riparian buffers, the pluses and minuses of various streambank stabilization techniques, a field assessment work sheet, and how to get a permit for work along the riverbank in the special context of a river affected by two state jurisdictions in addition to federal oversight.

Erosion inventories

Field documentation of erosion sites on the upper Connecticut River began in 1992 when the Grafton County Conservation District undertook an inventory of all erosion sites on its 89 mile section of the river. This work reported erosion severity, soil types, slope, shoreline characteristics and adjacent land uses. Other conservation districts followed as funding permitted, and by 2000 all nine conservation districts had completed their baseline inventories of erosion sites on the approximately 225 miles of the Connecticut River mainstem in New Hampshire and Vermont from Guildhall south. There are hundreds of erosion sites.

These inventories concluded that areas with no riparian buffer tended to have a higher rate of erosion, especially in combination with livestock grazing. Silty and sandy soils tended to have less vegetation and a higher erosion trend than loamy soils. Low banks with shallow slopes were generally stable, while higher, steeper banks tended to have greater slumping and erosion.

American Heritage River opportunity

In 1997 the opportunity arose to nominate the Connecticut River for national American Heritage River recognition, and communities and organizations responded by identifying projects they would undertake if the honor were granted. The Connecticut River Joint Commissions, Connecticut River Watershed Council, and the Connecticut River Conservation District Coalition jointly proposed to address riverbank erosion in the four states. CRJC offered to develop a process for prioritizing the Vermont and New Hampshire sites which had already been inventoried, while the Watershed Council enlisted help from CRCDC to extend the inventory and prioritization to the Massachusetts and Connecticut portions of the river.

In June, 1998, President Clinton announced that the Connecticut River had been selected as one of the fourteen American Heritage Rivers, giving impetus to the hopes and plans of people along the river.

Sustainable Riverbanks projects

Subsequently, the Connecticut River Watershed Council received a grant from the Environmental Protection Agency to refine the inventory process and complete the erosion site inventories for the southern two states, and the Connecticut River Joint Commissions received a similar grant to develop and apply a methodology for prioritizing erosion sites in Vermont and New Hampshire for restoration. The two organizations, joined by the Connecticut River Conservation District Coalition, formed a partnership to foster cooperation on their complementary *Sustainable Riverbanks* projects.

The projects were launched at a work session in Greenfield, Massachusetts, in October 1999, that was attended by officials and technical experts from a number of federal and state agencies, as well as specialists from the academic community, citizen organizations, local government, and consultants.

A cautious approach

The discussion on how to prioritize erosion sites for restoration emphasized a number of cautions:

- scour and deposition of sediments is a natural process common to all rivers, which must be respected.
- the river's dynamic characteristics at individual sites must be evaluated in order to determine whether erosion is "natural" at that site, and therefore cannot be overcome.
- expenditure of public funds to restore eroded sites should only be done at feasible sites, and at those offering distinct potential public benefits in terms of improving water quality, enhancing fish and wildlife habitat, protecting public infrastructure or lands, safeguarding valuable agricultural soils, or preserving historic or archeological sites.
- landowner support and cooperation is an essential element for any restoration.

PUBLIC BENEFITS

improving water quality

enhancing fish and wildlife habitat

protecting public infrastructure or lands

safeguarding valuable agricultural soils

preserving historic or archeological sites

Guidance for setting restoration priorities

Based on the work session discussion, the Connecticut River Joint Commissions, assisted by the Connecticut River Watershed Council and the Connecticut River Conservation District Coalition, developed a system of evaluating and ranking potential restoration sites (see insert). This guidance was provided to the nine conservation districts along the Connecticut River in New Hampshire and Vermont.

Conservation District priorities

Over several months in Spring, 2000, the nine districts reviewed their erosion inventories and selected their priority sites based on this guidance and on their familiarity with both sites and landowners. They identified twenty-seven sites as good candidates for restoration, but recognized that many more sites had very similar characteristics. These priority sites represented a variety of conditions. Some were less than 100 feet in length. Several were over 2000 feet, and one was over a mile long. Some were on straight stretches of river, others were on outside bends or oxbows. Of the agricultural sites, several had crops planted to the edge of the river, while others had a grass buffer. None had a buffer of shrubs or trees.

TECHNICAL TEAM

The Connecticut River Joint Commissions recruited a team of technical experts in riverbank restoration, seeking their help in analyzing the information provided by the conservation districts and in making field visits to each site for an on-the-ground assessment. Team members were drawn from the USDA Natural Resources Conservation Service, US Fish & Wildlife Service, US Environmental Protection Agency, Vermont Department of Environmental Conservation, and New Hampshire Department of Environmental Services as well as from the Connecticut River Joint Commissions and the Connecticut River Conservation District Coalition. They brought strong experience in river dynamics, riparian and aquatic habitat, soils, and agency permitting requirements.

The technical team identified several overriding considerations that affect riverbank restoration work on the upper Connecticut River. These are the significance of dams, riparian vegetation, river dynamics, treatment technology, and, finally, the likelihood of receiving a permit. These considerations are discussed in more detail below.

Significance of dams to priority setting

A predominant influence on the upper Connecticut River is hydroelectric dams which alter the river's natural transport of sediments. Over half of the upper Connecticut River—140 miles—is impounded in reservoirs, subject to daily raising and lowering of water levels resulting in saturation and de-watering of the bank face, leading to piping and destabilization. Any effort to restore riverbanks in the reservoir pools faces greater challenges than those on free-flowing sections of river.

Significance of riparian vegetation to priority setting

Trees and woody shrubs in a river buffer have deep, extensive root systems that intertwine and hold the soil far better than the shallow roots of grasses or crops. They do a better job of capturing runoff and filtering pollutants from both surface and subsurface runoff. Also, they provide habitat for birds and animals, and shade the water for fish. Erosion inventories show that the majority of eroded riverbanks are those where a woody riparian buffer is absent. Investments in riverbank restoration should be accompanied by landowner commitment to planting and maintaining a suitable buffer of native woody species.

Significance of river dynamics to priority setting

Hydrologists and other experts who study the patterns and effects of rivers are more likely to think of themselves as students of the river, rather than experts, because of the complex nature of river behavior. Experience and research make it clear that certain sites are inevitably going to experience erosion as a result of the river's natural dynamics. Sites that are poor candidates for restoration are those on outside bends and those opposite a tributary that delivers depositional sediments into the river, pushing the thalweg or main current toward the opposite bank.

Meandering rivers frequently cut a new channel in times of flood, and the shortcut often becomes the predominant channel regardless of property lines or state boundaries. The Connecticut River is no exception, particularly between Maidstone and Guildhall, Vermont, and Stratford and Northumberland, New Hampshire. In the 1980s the river separated a portion of Bradford, Vermont, and is annexing it to Piermont, New Hampshire.

Meanders and natural erosion on the upper river.

Standing in the way is rarely successful. Those who seek to tackle riverbank erosion problems must learn to "think like a river" as a first step in learning what to do and where.

Significance of treatment technology to priority setting

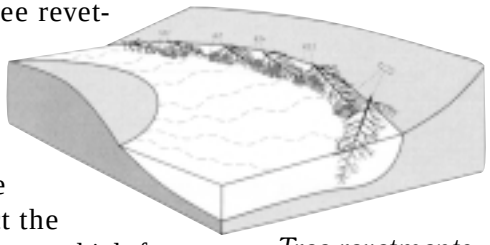
Hard rock armoring has become increasingly discredited because of its adverse effects on vulnerable riverbanks downstream, and its tendency to speed up the current, contributing to downstream flooding. Armoring has been shown to create new erosion adjacent to rip-rapped areas. Application of a rock blanket results in permanent loss of shoreline habitat, and affects aquatic habitat when the rock acts as a heat sink, raising water temperature. River users also speak of its unsightliness and the deterrent it poses to fishermen, swimmers, and others who walk the shoreline.

Riverbank restoration professionals now prefer to avoid use of riprap altogether, or in certain circumstances, limit riprap to the toe of the riverbank, particularly where the toe is subjected to regular water level fluctuations from peak generating of hydropower. Where a rock toe is applied, this treatment is augmented with bioengineering. Wherever possible, restoration designers are turning entirely to bioengineering as a better, more river-friendly way to protect against erosion, reinforce soils, develop a root network, and maintain or improve wildlife habitat.

In May, 2000, members of the Sustainable Riverbanks technical team helped organize and participated in a New England regional Streambank Restoration Training workshop, held in Fairlee, Vermont. National experts reinforced the recognition that vegetative stabilization is the tool of choice for stabilization.

Tree revetments as a preferred technology

On several upper Connecticut River tributaries, tree revetments have been used with promising results. This is a relatively inexpensive technology, suitable for installation by volunteers, based on a professional design. Tree revetments use densely branched softwood trees or tops with a butt diameter of 6-12". Cedar, fir, and spruce all work well. The trees are anchored to the toe of the bank in an overlapping horizontal pattern with the trunks facing upstream. Higher banks may need two or more rows of revetment. The trunks are cabled to duckbill anchors driven into the bank. The trees deflect the current from the bank and trap sediment in their needled branches, which forms a shelf for planting and catches slumping bank material from above. Fascines, live stakes or willow wattles can be planted in the entrapped sediments to re-vegetate the upper portions of these sites.



Tree revetments are a low-cost, river-friendly alternative to stone.

Tree revetments should be installed in autumn so their needles do not dessicate and fall off before they have a chance to catch and hold sediment**.** Revetments have a good record of reforming a river's channel and improving fish habitat.

Permit approvals

Permits are necessary for streambank stabilization, construction, and other earth disturbances on the bank or in the bed of a river or stream. The Connecticut River is under the jurisdiction of New Hampshire up to the mean low water mark on the Vermont shore where it stood in 1936. Therefore, on the upper Connecticut River, in most instances the permitting agency is the New Hampshire Department of Environmental Services' Wetlands Bureau, which works in conjunction with the U.S. Army Corps of Engineers to review and approve project applications. Both agencies prefer vegetative stabilization to hard armoring with riprap or concrete. Proposals to dredge natural deposits of river sediments are unlikely to receive approval.

Technical review process

Over a series of meetings and field visits, the technical team pinpointed and described each of the twenty seven priority sites on a map and chart, discussed the conservation district rankings, and evaluated each site in terms of river dynamics in the vicinity, adjacent land uses, landowner interests, and public benefits to be gained from restoration. Team members visited a number of the sites and made video recordings of the condition of the bank, noting any shelf under the water and the path of the current.

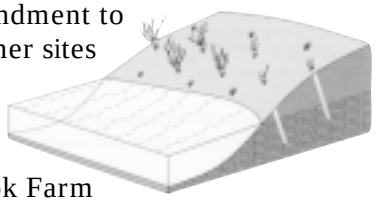
The team considered the following aspects of the site when evaluating its suitability for restoration:

- land use practices
- existing and potential fish and wildlife habitat
- recreational value
- potential public educational value of a demonstration project.

Several sites were identified as low priority because of recognition that the landowners would need to make substantial changes in land use before bank stabilization could be effective, or because the inherent dynamics of the river in that area would continue to create more erosion.

TOP PRIORITY SITES FOR RESTORATION

Out of this multi-disciplinary, iterative review process, a top priority site for restoration was selected, plus a site on each side of the river within an impoundment to see what restoration methods might be applied as demonstrations for other sites on impounded portions of the upper Connecticut River mainstem.



Live woody stakes, inexpensive and easy to install, sprout readily for good bank cover.

1 *Top priority: Hook Farm, Brunswick, Vermont*

Previous attempts at restoration of a site just upstream from the Hook Farm have resulted in damage to the Hook meadow. The farm sits on a sharp bend in the river, just downstream from the 60-80 foot high eroded bank at Brunswick Springs. This property is on a free-flowing stretch of river, and is not subject to daily water level fluctuations.

Accelerated flows had started to form a flood chute across the Hook property, but restoration undertaken in 2001, including bank reshaping, stabilization of the slope toe, and planting of a substantial woody buffer, is expected to deter future inroads from the river.

Bank restoration here will protect the following publicly valued resources:

- an excellent trout pool located below the meadow
- high quality agricultural land
- archeological resources located on the site.

The NRCS district conservationist developed a restoration plan with the following elements: regrading to create a smooth transition to the meadow; immediate seeding with grass; 520 feet of rock riprap toe extending two feet above ordinary low water level along the most severely eroded sections; and planting of a forested riparian buffer, 50 to 75 feet wide, to withstand the

Photo Tim McKay

Northeast Kingdom Corps crew begins planting the Hook Farm's new forest buffer.

impact of ice and flooding. The farm landowner participated, contributing plant material to the new buffer from elsewhere on the property. The buffer planting work was carried out in 2001 by the Northeast Kingdom Conservation Service Corps, that provides conservation field training to local youth.

2 *Impoundment demonstration: Fort at No. 4, Charlestown, New Hampshire*

A local non-profit organization owns this site of the reconstructed fort that had been the northernmost outpost of colonial settlers along the Connecticut River in the mid-1700s. The Fort is widely visited by tourists and schoolchildren, and thus offers an excellent opportunity to tell the story of riverbank erosion and restoration, in addition to the stories the Fort conveys so well of early colonial settlement and the French and Indian War.

The Fort at No. 4 is located on an impoundment where the Connecticut River is 800 feet wide, and water levels fluctuate daily as the dam downstream at Bellows Falls generates hydro power. The site is subject to significant scour from ice in the spring, and boat wakes from river traffic using a major boat ramp located nearby.

Archeological site, Fort at No. 4, Charlestown, New Hampshire.

Archeologists have discovered an important Contact Period Abenaki site close to the riverbank, finding evidence that the site was possibly occupied as early as 3,000 years ago, and used for some 3,000–5,000 years before that. Unfortunately, some of the site has eroded away since its initial exploration in 1992. This archeological resource offers special impetus to restoration at the site, and special challenges for the restoration plan.

In order to stabilize the 750 feet of eroding riverbank while protecting the archeological site, the Natural Resources Conservation Service developed a plan that does not disturb the existing bank, and uses rock set in a trench at the toe of the bank and extending up for at least three feet, with live woody stakes planted in joints among the rocks. Above the rock, bioengineering is applied, and ties into a riparian buffer of new trees and shrubs that will give further stability to the bank and provide habitat for birds and mammals. Moreover, the new buffer will illustrate to Fort visitors the species of native plants that were likely growing on the riverbank when colonists arrived in 1740, and those which supplied the settlers with food, craft, and building materials. Installation is scheduled for late summer, 2002.

CRJC assembled a special technical and advisory group for this project, consisting of professionals from both the state and county offices of the USDA Natural Resources Conservation Service, the New Hampshire Division of Historical Resources' archeology staff, the Sargent Museum, volunteer members of the board of trustees of the Fort at No. 4, DES Wetlands Bureau, and the Student Conservation Association. NRCS engineers designed the restoration plan, and local youth and Fort board members will be involved in the planting and monitoring of the riparian buffer.

3 *Impoundment demonstration: Birch Meadow Farm, Fairlee, Vermont*

A 1200-foot long section of riverbank at Birch Meadow Farm has been scoured and eroded by ice, with substantial loss of land to the river. The farm, owned by Steven Stocking, abuts the impoundment behind Wilder Dam, and recreational use of this portion of the river by power boats has contributed to bank instability. Restoration will safeguard prime agricultural soils, contribute to wildlife habitat,

and safeguard archeological resources. The landowner is interested in installing a buffer of woody vegetation to give better anchor to the soil and provide wildlife habitat and a possible cash crop.

Much of the riverbank is ten feet high, although immediately upstream it is thirty feet high. Soils are sandy, and there is a shelf underwater and extending off shore. The technical team has recommended use of a large tree revetment at this site, cabled well into the bank with duck bill anchors, and protected by a rock vane at the upstream end to deflect current from the restoration work.

The revetment, constructed of large conifers, will be interplanted with willow stakes and dogwood in the fall after the revetment is in place. This treatment will be repeated the following spring, and the next year as well, to take further advantage of the accumulated sediment to anchor growing root systems. A new riparian buffer at least 50 feet wide will include berry- and/or nut-bearing trees and shrubs which can benefit the farm economically. The landowner is closely involved in designing the buffer and preparing for the project. Installation is scheduled for summer 2002.

Photo Kevin Kaija

Steven Stocking (r) and NRCS staff inspect the eroded riverbank at Birch Meadow Farm, Fairlee, Vermont.

FURTHER RESTORATION OF PRIORITY SITES

Even relatively inexpensive riverbank restoration is costly, and beyond the budgets of the states. The magnitude of erosion on the upper Connecticut River can only be addressed if substantial new resources can be found. The Commissioner of Vermont's Department of Environmental Conservation and the Commissioner of New Hampshire's Department of Environmental Services have joined the Connecticut River Joint Commissions in requesting an ecosystem restoration study of the upper Connecticut River by the US Army Corps of Engineers. This work will evaluate the priority sites identified by the conservation districts, and assemble a comprehensive restoration plan that can be endorsed by Congress.

Each season and each year on the Connecticut River bring new patterns of flooding, ice scour, high water and low flow. Erosion is an ongoing process, and can never be eliminated, but good conservation stewardship can minimize its harmful effects and loss of property. Stewardship means maintaining a good riparian buffer of trees and shrubs, and it means operating recreational boats slowly near shore so their wakes don't chew away the riverbanks.

Not every erosion site can be restored. For those that can, the prioritization methodology outlined above can reassure public officials and the public that funds are being wisely spent.

Dean Hook at Hook Meadow, Brunswick, Vermont.

The technical team consisted of: Barry Cahoon, Vermont Department of Environmental Conservation; Tim McKay and Kevin Kaija, USDA Natural Resources Conservation Service; Eric Derleth and Philip Morrison, US Fish & Wildlife Service; Mike Dannehy, NH Connecticut River Valley Resource Commission; Peter Walker, New Hampshire Department of Environmental Services Wetlands Bureau; Dan Burke, US Environmental Protection Agency, Connecticut River Navigator; Jim Kennedy, Riverbank restoration consultant and landscape architect, NH. E-officio members included Judy Tumosa, Ex. Dir., Connecticut River Conservation District Coalition; Sharon Francis, Ex. Dir., and Adair Mulligan, Comm. Dir., Connecticut River Joint Commissions.

CONNECTICUT RIVER JOINT COMMISSIONS INC

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