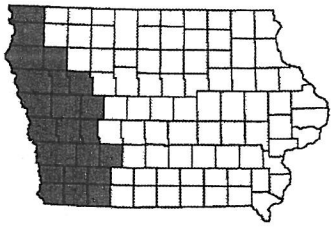
HUNGRY CANYONS ALLIANCE

The Problem



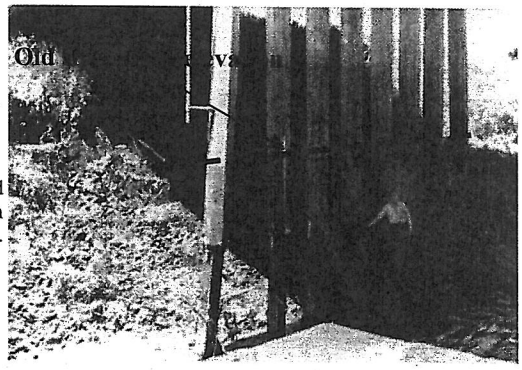
22 counties eligible for Hungry Canyons Alliance cost share.

The Hungry Canyons Alliance (HCA) was formed locally to research and implement solutions to the problem of stream channel erosion and degradation in a 22 county area of the deep loess soils region of western Iowa. Channelization of streams and land use changes during the first half of the 1900's caused stream channels to erode, causing an estimated $1.1 billion in damages to public and private infrastructure (bridges, culverts, utility lines, etc.), loss of farmland, and increased sediment loads. A survey of western Iowa bridges in 2000 revealed that 404 were endangered due to stream channel degradation. Golden Hills RC&D in Oakland, Iowa helped to form and currently provides office space and administrative assistance to the Hungry Canyons Alliance.

Straightened versus meandering stream. (Walnut Creek, Pottawattamie County).

The Solution

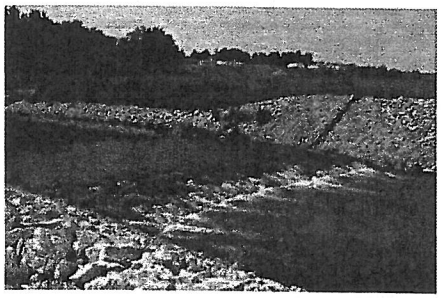
An affordable solution to this problem is to build grade control structures in streams. Streambed stabilization is the key to preventing further erosion and protecting infrastructure. Grade control structures at regular intervals will help streams stabilize by changing their profile from an erosive steep incline to a stable stair-step pattern. Structures, which normally have a raised weir section and are constructed with steel sheet pile, riprap, and concrete grout, allow the stream elevation to drop in a controlled setting, while preventing further degradation, and create a calm backwater condition that allows silt to settle out upstream, decreasing sediment loads and turbidity, and increasing water quality.



Bridge endangered by exhumation of pilings.

Savings

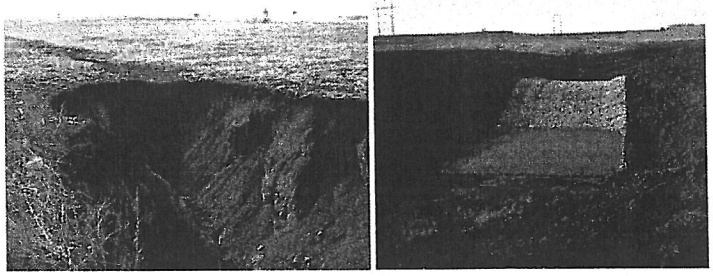
The HCA provides state and federal money available to the 22 counties through a cost share program for streambed stabilization structures. County governments provide a minimum of 20% match for each structure. Since 1992, the program has provided $18.17 million in state and federal appropriations and the technical assistance needed to complete 255 grade control structures in 17 counties in western Iowa. Another 45 structures are in progress. These structures will protect an estimated $73.8 million in property value. It is estimated that 522 acres of land, equivalent to 19.5 million tons of sediment, will be protected from erosion by construction of the 300 grade control structures. HCA streambed stabilization structures, with an average cost share of $48,731, protect approximately $246,227 in property per structure. **For every $1 invested in Hungry Canyons Alliance streambed stabilization**



HCA steel sheet pile weir with riprap and cement grout that protects a large sewer main for the City of Denison, Iowa.

structures, more than $4.30 of property value and an average of 1.07 tons of sediment are protected from streambed degradation. During FY 2006, 23 HCA structures were approved for cost share and construction was completed on another 22.

A second HCA program provides funding to landowners where grade control is necessary to stabilize active gully erosion. This program is funded with the interest earned from state appropriations. This program has built 67, and approved another 15, structures for a total cost share of $526,250.



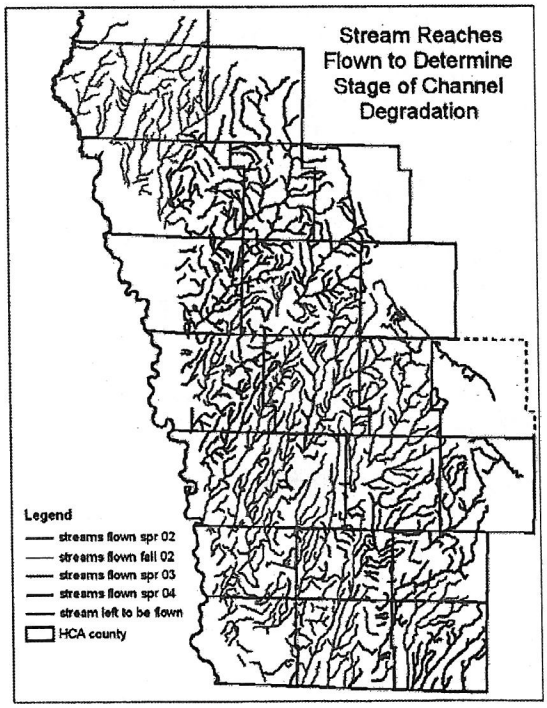
Left: A typical gully in western Iowa. Right: To replace an erosive gully, a gabion basket chute was built with cost share from the HCA's landowners structure program.

The HCA has quarterly meetings at which issues concerning stream erosion and streambed stabilization are discussed. Regular attendees include county engineers, county supervisors, NRCS employees, SWCD commissioners, DNR fisheries biologists, engineer consultants, contractors, and concerned landowners.

The following projects are examples of the type of assistance that the HCA makes available to the 22 member counties.

Aerial Stream Classification

The HCA is conducting an aerial assessment and classification of streams in the deep loess region of western Iowa to determine areas of active stream erosion and the impact streambed stabilization structures have on controlling stream degradation. Over 85% of stream reaches identified for aerial classification have been flown and 50% of the collected video has been analyzed. Upon encountering locations of extremely erosive streams and threatened bridges, the responsible county/agency was notified. The stream assessment consisted of flying along streams in a small helicopter while videotaping the stream channel and recording positions with a global positioning system receiver. Streams were classified based on a six-stage channel evolution model to describe the dominant channel processes occurring along stream reaches. Streams across the region in 1993 and 1994, and in a smaller area in 2000, were similarly classified. The comparison of the recent classification to those of the past allows us to describe how stream stabilization structures have impacted the streams and make predictions as to where future stream erosion will occur. The data may also be used to mathematically model channel evolution in the region. Approximately 5,330 miles of stream in 21 western Iowa counties will be classified during the 2002-2006 project. Videos and maps will be made available to county engineers and USDA Natural Resources Conservation Service offices for stream stabilization project planning. The HCA provided all of the funding for this project using state funds.

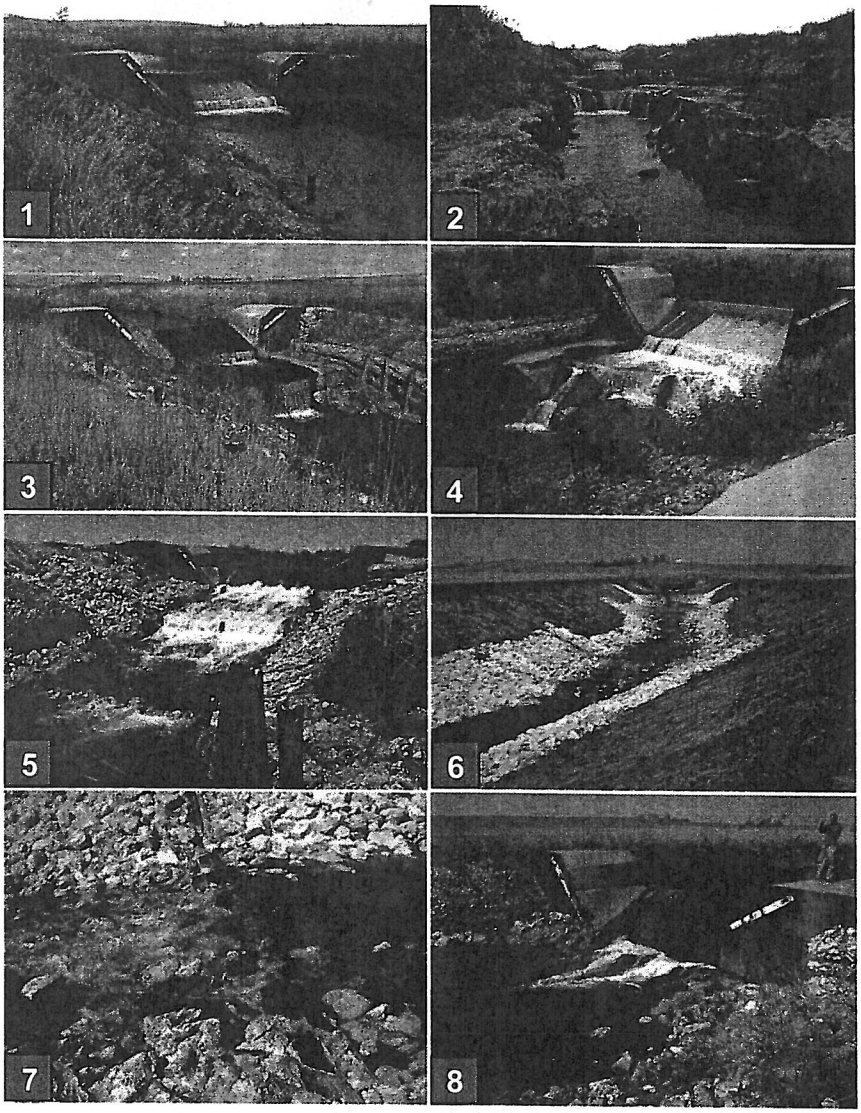


Stream reaches flown to determine the stage of channel degradation.

The classification data will also be used by the HCA and its member counties to identify the most actively deepening stream reaches that obviously need grade control, but because the erosion is so severe, the stream profile needs to be surveyed first along the entire reach to determine the amount of grade control needed and where the best location is to place a structure.

Endangered Pipeline Structure Protected

A 5 ft. concrete grade control structure (photo #1), built and maintained by Northern Natural Gas (NNG) since the early 1970's, has been destabilized and nearly destroyed by advancing, in-stream, knickpoint migration (photo #2). Streambed downcutting has caused the structure to now vertically control approximately 16 feet (photo #3), when it was only designed to vertically control 5 feet. The spillpad itself was starting to crumble (photo #4), was almost completely undermined, and was separating from the sheet pile, causing the sheet pile to begin to bow. The structure had a projected life of 0.5 to 1 year.



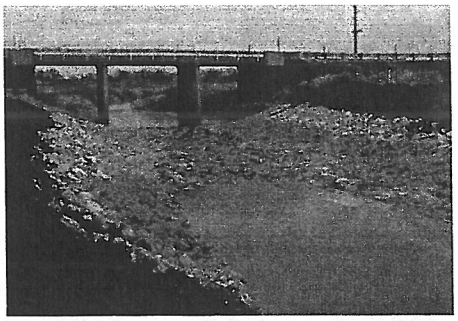
NNG structure 1) originally before any erosion in fall of 2000, 2) with knickpoint moving upstream toward structure in fall of 2000, 3) after knickpoint erosion in fall of 2001, 4) spillpad starting to crumble in summer of 2003, 5) after completion of repair work in spring of 2004, 6) after completion of three 4-ft weirs downstream in spring of 2005, 7) close-up of lowest weir in spring of 2005, 8) water backed up to base of original structure in spring of 2005.

NNG had spent millions of dollars since building the original structure, trying to protect the structure from knickpoint migration. NNG had given up on the structure and was planning on re-drilling their pipelines under the stream to a greater depth, at a cost of $2.4 million, and allowing their structure to fail.

In 2002, the HCA became aware of the problem and knew that allowing the structure to fail would destabilize Walnut Creek upstream from the structure, endangering 23 bridges and hundreds of acres of farmland. The HCA and NNG began discussing how the site could be stabilized. An agreement was reached in which the HCA provided technical assistance and coordinated repair of the existing NNG grade control structure and construction of three new HCA grade control structures downstream. Repair work was completed in spring of 2004 (photo #5), at a total cost of about $68,000, and construction of the three new structures (photo #6-8) were completed in spring of 2005 at a total cost of about $372,000. NNG and HCA paid for $358,000 and $82,000, respectively. The project saved NNG and its customers over $2 million. NNG has repeatedly expressed their appreciation for the HCA's assistance and has begun modifying more of their grade control structures throughout the Midwest in accordance with what they learned in western Iowa from the HCA. According to Richard Troyer, NNG operations manager, "We relied on their expertise as far as erosion and developed some nice-looking structures. It is a win-win situation. It protects our lines and also farm land and area bridges."

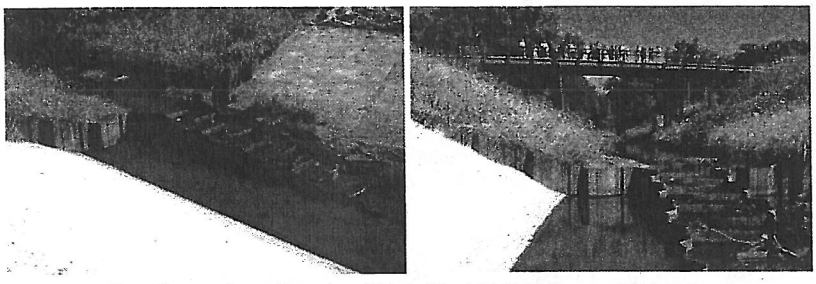
Controlling Erosion While Allowing Fish Migration

The HCA has been working with the Iowa Department of Natural Resources (DNR) to design and construct weirs that will allow fish to migrate upstream. First, the DNR and HCA had a series of meetings to determine which streams were priorities for fish, such as catfish, to be able to migrate up and down. Second, the DNR and HCA agreed on a design that will allow fish migration. The design, exemplified by this recently completed structure (shown at right), consists of a 20:1, horizontal-to-vertical, grouted rock slope downstream from a V-notch sheet pile weir.



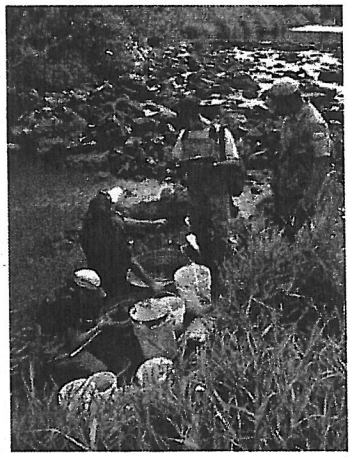
Crawford County sheet pile weir with a 20:1 grouted riprap slope

The two photographs below show a new weir design developed by the Page County Engineer. Fish are allowed to migrate over the structure by swimming up a gentle slope in the center of the structure through a series of alternating steel baffles that decrease water velocities and allow the fish to rest behind the baffles, while the structure still protects the bridge by providing grade control. This structure is currently being monitored by the Iowa DNR to see how well fish are able to migrate through the structure.



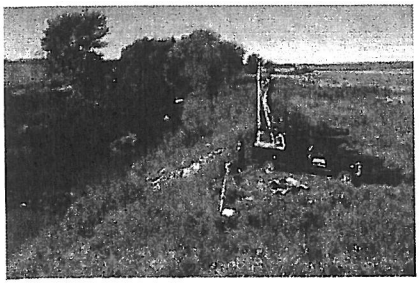
Page County sheet pile weir w/ fish baffles highlighted on an HCA tour.

The HCA and DNR have continued to cooperate on a couple research projects to find the most cost effective structures that allow fish migration. The first study involved modifying two weirs in Cass County on Turkey Creek to a 15:1 downstream slope. Before and after the modifications, the DNR and the Natural Resource Ecology and Management Department at Iowa State University caught, tagged, and released fish from above and below the weirs. The major results of this study were: 1) catfish were documented moving over the 15:1 weirs, 2) fish communities were slightly better (5%) near the weirs compared with reaches without weirs, and 3) macroinvertebrate abundance and diversity was 60% greater near the weirs compared to reaches without weirs. This study was funded with HCA state funding (17%) in partnership with the US Geological Survey (22%), US Fish and Wildlife Service (15%), Iowa State University (35%), and the Iowa Department of Natural Resources Fisheries Bureau (11%).



Iowa State University students and DNR biologists sampling fish and macroinverterbrates downstream from an HCA weir.

The second study, performed by the University of Iowa's IIHR–Hydroscience and Engineering Department, measured velocities on different weir backslopes and perform modeling of different structure slopes to optimize for channel catfish migration while reducing flow velocities, slope lengths, and costs. There were two major results of this study. First, without considering drainage area, low gradient (20:1, 22:1, 25:1) grouted or riprap weirs and fish ladders with baffles performed the best. The medium gradient (12:1, 14:1, 16:1) weirs also performed satisfactorily. Second, when considering drainage area, it is recommended that: when the drainage area is less than 20 mi^2, the best structure is a low gradient weir because the variable controlling fish passage is the flow depth; when the drainage area is between 20 and 100 mi^2, the best structure is either a low or medium gradient weir because the variable controlling fish passage



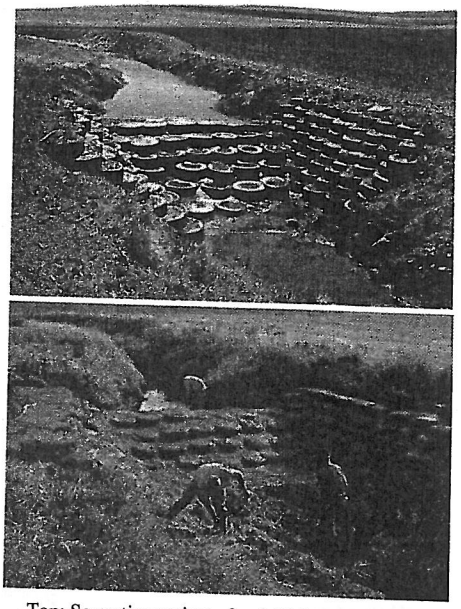
University of Iowa students readying the equipment to measure weir flow velocities.

is either the flow depth or maximum velocity; when the drainage area is larger than 100 mi^2, the best structure is a medium gradient weir because the variable controlling fish passage is maximum velocity. This study was funded with HCA state funding (25%) in partnership with the DNR (25%) and the Iowa DOT Highway Research Board (50%).

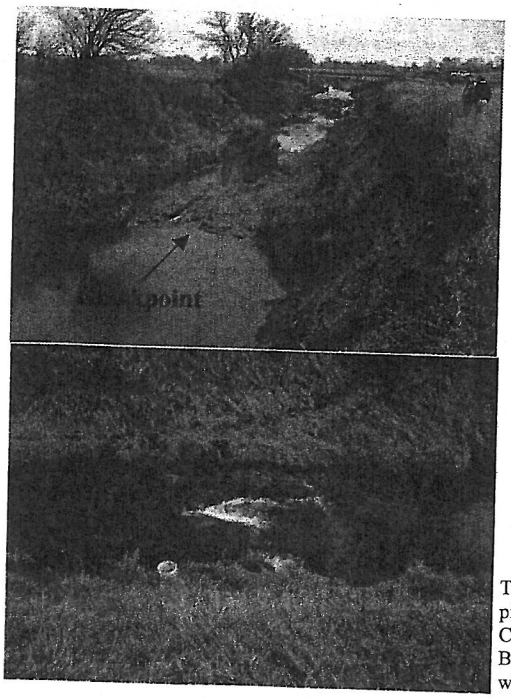
Changes were made to the DNR stream classification design criteria using the recommendations from these two research projects. These changes included using a 15:1, horizontal to vertical, grouted rock slope downstream from a V-notch sheet pile weir instead of a 20:1 (more expensive) slope.

Using Scrap Tires in Grade Control Structures

The HCA, with financial assistance from the Iowa DNR Solid Waste Alternatives Program, built an experimental grade control structure with scrap tires. Scrap tires are difficult to recycle and often reduce landfill capacity. The first phase of this project involved theoretical and experimental research done by Iowa State University. The second phase was construction of a prototype structure on a small stream in Cass County, with the help of the NRCS (Natural Resource Conservation Service) and a landowner. Scrap tires were arranged in layers, bolted together with lag screws, and filled with soil cement. However, the soil cement was not resilient, so the loose soil cement was removed and the structure was covered with a layer of concrete grout. Another structure, using concrete grout instead of soil cement, will be built. The third phase of this project was the creation of a design manual which described construction technique and evaluated its cost, effectiveness, and structural stability compared to traditional grade control structure designs and materials. It has been distributed to county engineers and NRCS offices in western Iowa so similar structures may be built. The information learned will make any future scrap tire structure designs more cost effective (a second scrap tire structure has been designed and will hopefully be built in spring 2007).



Top: Scrap tire project after initial construction. Bottom: Loose cement removed and the scrap tires have been filled and covered with flowable concrete grout.



Knickpoint Migration Study

The stream video will also be used to find the locations of actively eroding stream knickpoints. Some of these knickpoints will be monitored closely as part of a research project to measure knickpoint propagation rates in the field. The overall goal of the proposed research is (1) to examine the morphodynamics of actively migrating knickpoints for different flow conditions, and (2) to develop a knickpoint erosion model that is applicable to the deep loess area of western Iowa. An accurate knickpoint erosion model for loess will aid in the placement of future HCA grade control projects. The project will be conducted by the University of Iowa's IIHR–Hydroscience and Engineering Department and it will be financed with HCA state funding (20%) in partnership with the Iowa DOT Highway Research Board (80%).

Top: Knickpoint downstream from a sheet pile weir with a 20:1 riprap slope on Walnut Creek in Montgomery County.
Bottom: An actively eroding knickpoint (the white 5-gallon bucket for scale).

Stage-Discharge Study

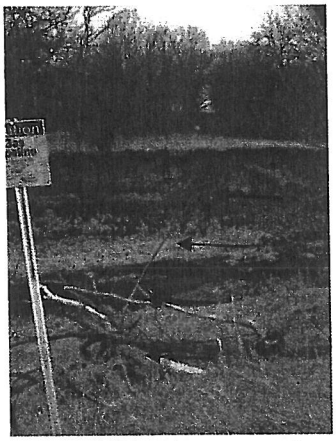
There are no gaged (measures water discharge) medium to small sized (less than or equal to 100 square mile drainage area) streams in western Iowa, which limits our ability to predict erosion. To remedy this, a semi-automatic, permanent, sensor network will be installed on 10 representative, ungaged streams in the deep loess area of Western Iowa. Stage-discharge relationships for these streams will be developed. The project will be conducted by the University of Iowa's IIHR–Hydroscience and Engineering Department and it will be financed with HCA state funds (39%) in partnership with the Iowa DOT Highway Research Board (61%).

Future of the Hungry Canyons Alliance

The Hungry Canyons Alliance will continue to provide the people of western Iowa with technical assistance and cost share for grade control structures as long as the need for stream erosion control exists and we receive appropriations from our state and federal legislators.

Eastern Nebraska also has streams that have been channelized in areas of deep loess soils. These streams have responded in the same manner as western Iowa streams that were channelized; they are actively downcutting, which has caused damages to public and private infrastructure (bridges, culverts, utility lines, etc.), loss of farmland, and increased sediment loads. However, unlike Iowa, nothing has ever been done at the federal or state level to prevent streambed degradation in eastern Nebraska.

Because of this, the HCA has been asked to provide guidance to several parties in eastern Nebraska that are concerned about downcutting streams and who are trying to organize a group similar to the HCA to provide cost share for grade control projects in eastern Nebraska.



This stream has downcut enough that a once buried gas pipeline was exposed and then severed by a falling tree in Nebraska.

Degradation on this stream has caused the near-vertical actively-eroding streambanks in Nebraska.

This stream has downcut enough that once buried footings on a major state highway bridge in Nebraska have been exposed, endangering the bridge.

An actively eroding knickpoint in bedrock in SE Nebraska. Although, bedrock knickpoints move slower than knickpoints in loess, this knickpoint moved over 50 feet in five years.

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