

EVALUATION OF THE STREAM RESTORATION AT HARRIS/HOWARD PROJECT



Prepared by
NC State University
June 2013



For
NC Clean Water Management Trust Fund

Stream Restoration Evaluation at Harris/Howard Project

Introduction and project description. In 2006, NC State University was awarded a monitoring contract with the Clean Water Management Trust Fund (CWMTF) (2005A-900). The purpose of the contract was to establish an evaluation protocol for assessing a subset of the CWMTF's stream restoration, stormwater and agricultural best management practices (BMP) projects. The original contract included field evaluation of forty two existing stream restoration, stormwater and agricultural projects, to provide a snapshot of project effectiveness and water quality benefits. NC State University was asked to prepare a rapid, yet effective evaluation of these projects. These evaluations were planned for a single project visit and were used to assess whether the project was meeting intended goals. Eighteen stream sites were selected for the initial assessment work that was conducted during the summer of 2006. In addition, in 2008 and 2009 eleven additional sites were evaluated and five sites from the 2006 surveys were revisited and rescored. The revisited sites include Ambrose, Harris/Howard, Raccoon, Sharp and Upper Laurel. Supplemental funding was later awarded to NC State University in 2010 (2010-3675) to conduct additional stream assessment work. As a result, between 2010 and 2012, an additional 33 CWMTF-funded restored streams were assessed including revisits to ten streams, including a third visit to Ambrose, Harris/Howard, Raccoon, Sharp and Upper Laurel and a second visit to Ramey, Tom's, Little Sugar-Hidden Valley, East Fork and Rocky Branch Phase II. In addition, 32 restored streams funded by other agencies were visited in order to obtain data for adequate statewide and urban landuse coverage. It is anticipated that the results and recommendations from this effort will provide CWMTF with a better understanding of the status and water quality benefits of stream restoration projects and will aid in the selection process for future projects. This report provides a summary of the stream restoration assessment component of this grant project.

Stream Restoration Projects:

- *Selection Criteria.* Stream restoration projects that feature natural channel design approaches including modification to dimension, pattern and profile and were longer than 1000 linear feet were the target for this assessment project. Some exceptions were made at the discretion of NC State University and Clean Water Management Trust Fund staff.
- *Site Evaluation.* An evaluation protocol for stream restoration projects was developed by NC State University, and is posted online at <http://www.bae.ncsu.edu/programs/extension/wqg/sri/cwmtf/index.html>. This protocol was field tested and subsequently sent to several agencies and individuals for external review. The goal of this protocol is to be a rapid and effective assessment of four major components of restoration. As part of this evaluation, numeric values are given to several parameters within four categories: channel condition including bedform, dominant substrate material and streambank stability; riparian habitat including riparian vegetation and floodplain condition; aquatic insect condition including community structure and cover/refuge; and the condition and function of instream structures. Stream size, land cover, eco-region and the number of years following construction are variable. Each evaluation was conducted by a group of five to eight trained individuals divided into teams. An engineering team scored channel condition and instream structures. Two biology teams sampled and scored vegetation and macroinvertebrate communities. In addition, photographs of each site were also collected and can be provided to CWMTF upon request.

Harris/Howard Project Description

The Surry Soil and Water Conservation District and Mitchell River Coalition were able to target specific reaches of the South Fork of the Mitchell River for restoration. Several stream restoration projects have been conducted in this catchment. Bank erosion and sedimentation are severe problems in this reach of the South Fork of the Mitchell River. Prior to construction at the Harris/Howard Project, bank erosion was estimated to produce 5,000 tons of sediment per year based on BEHI (Bank Erodibility Hazard Index) evaluations. This project included approximately 5,200 linear feet of restoration and 9,000 linear feet of livestock exclusion.

Table 1. Project characteristics and goals

Project Name	CWMTF #	County	Ecoregion	Primary Landuse
Harris/Howard	2002A-405	Surry	Northern Inner Piedmont	Rural - Pasture
Year Constructed	Drainage Area	Length	Slope	Width
2005	2.60	5200	0.009	23.0-26.0
Primary Goal of the Project		Secondary Goal of the Project		Repairs
Reduce sedimentation		Improve aquatic habitat, fisheries improvement		Structures (minor)

Field Observations

The following tables summarize the observations of NCSU field team during the evaluations on August 20, 2006, September 3, 2008 and June 14, 2011. Table 1 lists the scores for the four major categories and Table 2 lists the index data for each assessment by category. The tables also contain for comparison the average scores for all streams assessed (including 15 revisits).

Table 2. Scores for major categories of Evaluation

	Evaluation Categories	2006	2008	2011	Average	Points possible
Channel Condition	Bedform Condition	17	19	19	16.1	20
	Dominant Substrate Material	11	12	12	8.0	12
	Streambank Stability	21	24	24	21.8	24
Riparian Habitat	Riparian Vegetation	11	12	16	14.6	20
	Floodplain Condition	22	22	19	18.6	24
Aquatic Insects	Community Structure	14	17	19	13.0	24
	Cover and Refuge	12	10	20	11.2	20
Instream Structures	Structure Function	15.9	15.9	15.7	13.5	16
	Structure Condition	10.8	11.9	11.7	9.8	12
	Total Score	135	144	156	126.5	172

Evaluation Categories	2006	2008	2011	Avg.
Community Structure				
Total No. abundant taxa	2	3	3	2.0
No. of abundant EPT taxa	2	2	3	1.6
EPT abundance	3	3	4	2.0
Abundant taxa in common	3	3	3	3.2
% shredders and predators	2	4	3	2.9
# indicator taxa	2	2	3	1.8
Cover and Refuge				
Cover type	6	4	10	4.5
Overall cover %	6	6	10	6.8
Bedform Condition				
Riffle habitat & location	2	3	3	3.0
Run or glide habitat & location	3	4	4	3.5
Pool habitat & location	4	4	4	3.5
Structure habitat & location	4	4	4	3.3
Additional CGU habitat & location	4	4	4	2.9
Dominant Substrate Material				
D50	4	4	4	2.8
D84	3	4	4	2.6
% <2 mm	4	4	4	2.7
Streambank Stability				
Bank height ratio	4	4	4	3.7
Root depth ratio	2	4	4	3.6
Root density %	4	4	4	3.7
Bank angle (degrees)	3	4	4	3.6
Surface protection	4	4	4	3.8
Near bank Stress	4	4	4	3.6

Table 1: Index results. Possible scores ranged from 1 to 4 for all categories except cover and refuge categories. Instream structure condition is reported as an average for the three most common structure types on each project. Structure function scores are averaged over all structures.

Evaluation Categories	2006	2008	2011	Avg.
Instream Structures				
J-Hook condition (n=44, n=21, n=26)	3.9	3.9	4.0	3.8
Crossvane condition (n=9, n=31, n=19)	4.0	4.0	4.0	3.6
Constr. riffle condition (n=6, n=1, n=14)	2.8	4.0	3.7	3.7
Bank protection	3.9	4.0	3.9	3.5
Biological habitat	4.0	4.0	4.0	3.6
Grade control	4.0	4.0	4.0	3.4
Flow deflection/concentration	4.0	4.0	3.8	3.2
Floodplain Condition				
Floodplain connection	4	4	4	3.2
Vegetated buffer width	4	4	3	2.9
Floodplain habitat	4	4	1	2.3
Floodplain encroachment	3	3	3	3.0
Soil characteristics	3	3	4	3.6
Percent exposed or bare ground	4	4	4	3.7
Riparian Vegetation				
Structural complexity	2	2	2	2.2
Planted tree/shrubs/livestakes	3	3	2	3.3
Natural tree & shrub regeneration	2	2	4	2.6
Invasive exotic species	3	2	4	3.0
Streambank root mass	1	3	4	2.1

Discussion of Results

Channel condition

Bedform. The stream is a steep-gradient step-pool channel for large portions of the restoration reach. The restoration has provided good pool and good step-pool habitat for much of the reach. However, several of the riffles constructed of a mixture of small boulders and cobbles in addition to gravel (rock-n-roll riffles) have scoured substantially, leaving areas of deeper water with scattered large rocks. Rock-n-roll riffles are a new technique and further monitoring of these structures will help in improving their function. Good quality pools and step-pools are common throughout the reach, especially in the meander bends.

2008 Revisit. With the increase in vegetation and associated increase in bank roughness, the stability in and around all structures and bedform habitats has improved. Previously scoured riffles have been replenished with a mix of gravel and cobble material. Also, minor repair in some areas may have enhanced grade control downstream of riffle sections.

2011 Revisit. Bedform has remained stable and high quality since the 2008 revisit. Bedform scores were good for riffles and excellent for all other channel geomorphic units.

Dominant Substrate. The riffle substrate is predominantly clean gravels with some cobble material and very little fine material present. The d84 was slightly smaller than would be expected and is likely the result of significant scour and loss of bed material in several of the boulder/cobble/gravel mix riffles.

2008 Revisit. The coarsening in the riffles was evidenced by a slight increase in the d84 particle size and a reduction in the percent of material that is less than 2mm.

2011 Revisit. Substrate remains excellent for this stream. The riffles are clean gravel and cobble material with little sand.

Bank Stability. Bank stability is fair. The new vegetation on the streambanks is beginning to establish and there are no areas of significant bank erosion, sloughing or failure in the restoration reach. Herbaceous cover and woody stems are beginning to become well-established. The associated rootmass along the banks is developing.

2008 Revisit. Streambanks have developed more extensive vegetation and associated rootmass since construction, resulting in extremely stable banks.

2011 Revisit. Streambank stability remained excellent. Vegetation is continuing to thrive and become more prevalent, providing excellent stability for this stream.

Bank and Riparian Habitat

Riparian Vegetation. Vegetation at Harris Howard was young and undeveloped at the time of the survey, due to recent project completion. Planted trees and live stakes were generally doing well, though some trees on the terrace appeared stressed, apparently due to low soil moisture and impact from Japanese beetle and deer. Planted trees and live stakes appeared at lower density than is often used on mitigation projects – it will be interesting to see how the forested buffer develops. Ground coverage with planted and naturally generated graminoids is good, though effective streambank root mass will take some time to develop. There are dense patches of *Microstegium vimineum* scattered through the project. Replanting native grasses could combat the further spread of *Microstegium*. Remnant trees around the project are producing some natural regeneration of yellow poplar, red maple, and sycamore.

2008 Revisit. The vegetation is still young and immature with planted trees and shrubs under some stress. Natural regeneration scored low this year and fescue as well as *Microstegium vimineum* continued to plague the site. Rootmass has improved along the banks.

2011 Revisit. Howard-Harris reach of the South Fork of the Mitchell River has a fully vegetated although is an immature buffer consisting of mainly forbs and graminoids with a few trees. Natural regeneration seedling and sapling trees are developing much more so than the planted stems. The dense herbaceous growth has slowed the development of all trees. Evidence of occasional cattle intrusion into the buffer was visible for much of the entire reach. Alders, willow and sycamores are the most common trees and shrubs with maples being the predominant seedling tree.

Floodplain Condition. The stream can access the floodplain easily. Soil condition is mostly good, with scattered areas where soil amendment would benefit developing vegetation. Inclusion of wetland areas and remnant trees create the beginnings of a diverse habitat.

2008 Revisit. Floodplain access scored excellent again and the wide buffer along with wet areas resulted in an excellent habitat score. Soil at the site was generally good and there was little to no exposed ground.

2011 Revisit. The stream is well connected to the floodplain, with a reasonably vegetated buffer and little to no incision. There is minimal human impact within the buffer, but there is considerable cattle impact. With improved control of the cattle impact, the good soil conditions should allow woody stem tree growth to fully develop.

Aquatic Insects

Community Structure. Benthic insect observations were collected from two sites; an upstream location and a site near the lower end of this very long project. The upstream site is much smaller than the restored site and was immediately below the confluence of two smaller tributaries. In addition this is a relatively new stream feature, constructed in 2005, therefore we would expect that the benthic fauna has not recolonized effectively to date. Much lower taxa richness values were found in the restored reach and many taxa collected at the upstream site were not found within the restored reach (*Serratella*, *Agnatina*, *Pteronarycs*, Perlodidae, *Glossosoma*, Philopotamidae, *Lepidostoma*, *Helichus*). In addition, very few predators/shredders were collected in the restored reach. These data suggest that the stream feature is in an early stage of functional development.

2008 Revisit. Aquatic insect and cover/refuge evaluations have been collected at this project on two occasions; August 2006 and September 2008. Benthic insect observations were collected from two sites; an upstream location and a site near the lower end of this very long project (5200 linear feet). The upstream site is much smaller than the restored reach at which the samples were collected and was immediately below the confluence of two smaller tributaries. This relatively new stream feature was constructed in 2005; therefore we would expect that the benthic fauna has not recolonized effectively. However the 2006 data resulted in a total insect score of 14 and two categories had good responses (EPT abundance and Abundant taxa in common) suggesting that some recolonization has taken place. The 2008 score increased to 17 total points largely due to increases in percent abundant taxa and percent shredders and predator taxa between surveys. Many taxa collected at the upstream reference were not found in the restored reach; however, these data suggest that the stream feature is in an early stage of functional development.

2011 Revisit. During the 2011 survey Qual 4 samples were collected and identified in the laboratory. These data are included on Table 4. Samples were collected from an upstream reference, within the lower reach of this very long project (5200 linear feet) and from a site below the project. The downstream location was sampled to determine any impacts due to the project on the benthos. The stream was constructed in 2005. The 2006 data resulted in a total insect score of 14 points and the 2008 data improved to 17 total points. EPT abundance and the number of indicator taxa both received an Excellent score while all other biological metrics received Good scores resulting in a total score of 20 points (24 points total). The increase in scores of the biological metrics indicates that this stream restoration is recovering from impacts associated with construction and mimicking to some extent the reference condition. Seventeen mayfly taxa were collected from the restored reach. The score at the downstream site was 18 (24 points total). The number of total and EPT taxa was slightly lower at the downstream site, accounting for the lower score. However, this total score suggests that the biological condition of the stream below the project appears un-impacted from the restoration/construction activities. Many of the abundant taxa collected here were also collected from the reference site.

Table 2: Qual 4 Investigation Results.

Taxa/Project	Harris-Howard		
	Upstream Reference	Restored	Down-stream
Ephemeroptera	13	17	15
Plecoptera	5	6	5
Trichoptera	8	6	6
Misc Diptera	6	6	4
Chironomidae	5	9	11
Coleoptera	3	3	3
Odonata	1	1	-
Oligochaeta	1	-	-
Megaloptera	1	2	2
Crustacea	-	1	1
Mollusca	1	1	1
Other Taxa	-	-	-
Total Taxa richness	44	52	48
EPT richness	26	29	26
EPT abundance	109	166	104
Dominant Taxa in Common***	-	61%	70%

Cover and Refuge. As noted in the bedform discussion this project is a structure dominated restoration because of the gradient. Because of this some cover types were given high scores, most notably boulders and pools. In addition the overall cover score was also in the good category. Many habitat types were reduced in quality, which may be a reflection of project age because of age (constructed in 2005). These cover types include undercut banks, leaf packs, rootmats, and aquatic macrophytes.

2008 Revisit. Identical scores were given to these two categories during both investigations (total score = 12) suggesting that instream habitat has not evolved much between surveys.

This project is a structure dominated restoration because of the gradient therefore some cover types were given high scores, most notably boulders and pools during both surveys. The 2008 survey noted increase scores for undercut banks and woody debris/logs in the stream but not enough to change the total score.

2011 Revisit. The cover type and overall cover scores increased significantly during the 2011 survey compared to data collected in 2006 (12) and 2008 (12). Most cover types were given either Good or Excellent scores and overall cover was also given an Excellent score, resulting in a score of 20 total points. Only the score for the presence of leaf packs was very low. These data illustrate the improvement in habitat quality potential.

Instream Structures.

The stream has a steep gradient with a fairly low sinuosity and the restoration is subsequently structure dominated. An inspection of the structure condition noted that the structures are very stable and almost all are performing their intended functions. There are only a couple structures with minor piping issues; however, there is no evidence of catastrophic failure for any structure. There are numerous creative double drop boulder and log combination cross-vane and j-hook structures that are maintaining stable pool and step-pool formations throughout the reach and in particular in the meander bends. Several of the boulder/cobble/gravel combination riffles have suffered significant scour and are no longer performing their intended function. During the visit for assessment some of the structures were undergoing repair, future assessment will help judge the effectiveness of the repair.

2008 Revisit. Fifty-six structures were assessed during the revisit, including j-hooks, crossvanes and sills. All structures with previous piping issues had been repaired and displayed excellent stability and were performing all functions as intended. The numerous structures at this steep gradient stream create well-functioning high-quality step-pool system. Fifty-four of the structures were rated as being in excellent condition. The remaining three were in good condition. Almost all function categories were scored as excellent, indicating that they are providing grade control, habitat, bank protection, pool formation and directing flow appropriately. In addition, the coarsening of the constructed rock-n-roll riffles represented an improvement in habitat and stability. It appears that vegetation establishment along the banks has reduced scour in the riffles and they have replenished with gravel and cobble materials either naturally or manually.

2011 Revisit. Sixty-eight structures were assessed during the 2011 revisit, including cross-vanes, j-hooks and constructed riffle and/or step-pools. The over-whelming majority of the structures scored excellent for both condition and functions. Minor repairs were made to structures in 2006 at the time of our first visit to the project. Structures are remaining stable and continuing to provide excellent habitat, bedform and grade control for this project. Only two structures displayed fair scores in function categories.

Project Effectiveness

The Harris/Howard Project consists of a structure-dominated 5200 linear foot reach of restoration and approximately 9000 linear feet of cattle exclusion. Fifty-nine structures were assessed in this reach. The primary goals of the project were to reduce sedimentation and improve aquatic habitat, specifically for fisheries management. Bank stability is generally good within this relatively new project and newly planted vegetation is developing. We did note that some problems may exist with low soil moisture, impact from Japanese beetle and

deer, and that dense patches of *Microstegium vimineum* are scattered through the project. Due to the improved streambank stability, it is anticipated that the constructed channel will improve sedimentation in the catchment considerably. Overall refuge scores were high due to the number of structures in the restored reach; however, many habitat types were reduced in quality due to young project age and will likely improve as well. To our knowledge, fish community structure assessments have not been done to date. High refuge and pool habitat scores suggest that this reach is capable of holding fish. These data do not suggest that fish reproduction is occurring.

2008 Revisit. Substantial development in the floodplain and streambank vegetation occurred at the Harris/Howard project since our 2006 visit, resulting in a notable increase in streambank rootmass and associated stability. However, presence of invasive plants, particularly *Microstegium* continues to be a concern. Repairs to structures and a coarsening of bed material improved streambed habitats as well. Slight improvements in the invertebrate community likely reflect improvements in food resource and bedform habitat.

2011 Revisit. Total score for this project of 156 points exceeds the average score by almost 30 points. So, this project is extremely successful. Total score has increased by 21 points since 2006 for this project. With 11 of the points gained occurring between 2008 and 2011. The aquatic macroinvertebrate community and the riparian vegetation improvements attribute to most of the gain in performance for this project. It is anticipated that continued improvements will occur in the future.

Other Observations. This project incorporated the construction of fairly unique instream habitats and is the longest project our team evaluated. In addition, the project incorporates headwater reaches of the catchment. The evaluation was conducted only one year after construction and therefore many of the observations are early in the evolution of this stream feature. Because of these factors, project effectiveness will need to be determined in the future, and continued monitoring of this project is warranted. Further monitoring may show improvement in the areas stated in the goals of the project.

2008 revisit. Minor repair work combined with vegetation establishment resulted in a significant improvement in project effectiveness. It is anticipated that this highly successful project will continue to establish and provide excellent habitat for both fish and invertebrates.

2011 Revisit. The project has continued to thrive and improve since first constructed in 2005. However, the riparian buffer is still immature consisting of mainly forbs and graminoids with a few trees. Leaf packs were not common in the stream which is likely associated with the lack of tree cover. Natural regeneration is expected to continue and result in tree growth over the next decade. The development of canopy will likely result in continued improvement in the quality and function of the stream. It will be important to ensure the cattle fencing remains in place and invasive plants are managed over time so as to ensure this riparian buffer development over time.