Development of Monitoring Strategies
to Inform Management Actions
In support of Riparian Ecosystem Restorations:
as applied to Clover Groff Stream Restoration

A Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Master of Landscape Architecture in the Graduate School of The Ohio State University

By

Gulsah Bilge, BSLA
Graduate Program in Landscape Architecture

The Ohio State University
2012

Thesis Committee:
Deborah Yale Georg, Associate Professor, Adviser
Jason Kentner, Assistant Professor
Abstract

Under current recommendations for ecological restoration by the Society for Ecological Restoration (SER-b, 2004), the critical elements of post construction monitoring and management are all but eliminated. This study addresses the question: Can monitoring inform management actions in to support of restoration viability, using existing resources?

“Comprehensive criteria for biodiversity evaluation in conservation planning” (Regan et al, 2007), shows that restoration landscapes are not valued highly or rated as ecologically viable landscapes, as most restorations do not achieve full biological diversity. Another factor is the degradation which often continues, limiting the ability to achieve fully restored biological function. Monitoring and Management (M&M) were integral parts of restoration process until 2002; however, monitoring and management are no longer supported as part of scope of services included in implementation of restoration designs. M&M services are expected to be provided by the owner agency without any plan for the ongoing monitoring and management necessary to support the full restoration of the ecosystem (Higgs, 2003).

Goebel (2011) claims that restored ecosystems should be capable of being self-maintaining and should be self-sustaining. Until such a condition exists, restorations need monitoring and management to continue mitigation of the degradation forces that
damaged the original ecosystem. This investigation applies the standards for monitoring and management to a case study of the existing Phase 1 riparian restoration at Clover Groff Ditch, Columbus, Ohio completed in 2010 by City of Columbus Recreation and Parks funded by an OEPA grant. The restored area is constructed using vegetative and structural restoration treatments; however, there is no active monitoring or management plan in place to assess and mitigate continuing degradation forces.

This study provides guides and methods for monitoring by volunteers to inform the owner of needed management (Higgs, 2003). The forms and methods derive from site monitoring and analysis during late February through April of 2012. The analysis of the restoration identifies locations degrading in habitat diversity, invasive species and land miss-use. Due to the time limitations of the study, prescriptive management actions related to specific monitoring results and refinements to forms and methods are not included in this study, but are recommended as a future outgrowth of this work. In critical review by the owner and experts, the value and potential of these forms and process is a viable means to inform management actions and to facilitate public education.

Keywords: Ecological Restoration, Riparian Restoration, Monitoring, Management, Post-Restoration Monitoring and Management.
Dedication

Dedicated to my family,

To my parents, Canan and Hamdi, my sister, Nurgul, who in spite of the distance have provided unconditional love, undying support and encouragement throughout the process…
Acknowledgments

I would like to express my sincere gratitude to my adviser, Associate Professor Deborah Georg, for her time, patience, support and guidance. I also express my thanks to my committee member Assistant Professor Jason Kentner for his invaluable comments and direction.

I owe special thanks to Bradley Westall and Justin Loesch from Columbus Recreation and Parks Department, for sharing all the information related to Clover Groff Stream Restoration Project, their time and significant contributions.

I also would like to thank the Turkish Ministry of Education for providing me financial support which made it possible for me to come to the United States and pursue my graduate studies. Thanks to all my friends in Landscape Architecture Department and in Columbus, for providing me ongoing support throughout these two years.

I finally would like to express my most sincere thanks to my parents, Canan and Hamdi, my sister, Nurgul, my niece, Elif Candan, and my friend, Ersin, whose encouragement always keeps me motivated. I also would like to express my infinite appreciation to God for bestowing me skills and ability to think.
Vita

March 29, 1987 .................................................. Born- Nevsehir, Turkey

2004-2008 .......................................................... B.S. Landscape Architecture, 
University of Cukurova, Adana, Turkey

2010-2012 .......................................................... Master of Landscape Architecture 
The Ohio State University, Columbus

Fields of Study

Major Field: Landscape Architecture
Table of Contents

Abstract ........................................................................................................................................... ii
Dedication ......................................................................................................................................... iv
Acknowledgments .............................................................................................................................. v
Vita ...................................................................................................................................................... vi
List of Tables ...................................................................................................................................... ix
List of Figures .................................................................................................................................. x
1. Background .................................................................................................................................... 1
   1.1 Justification ............................................................................................................................... 3
   1.2 Methodology .............................................................................................................................. 4
2. Literature review ............................................................................................................................ 8
   2.1 Background to ecological riparian restoration plans .............................................................. 8
   2.2 Monitoring ................................................................................................................................. 12
      2.2.1 Monitoring Methods ........................................................................................................ 12
      2.2.1.1 Short Term Monitoring .............................................................................................. 15
      2.2.1.2 Long Term Monitoring .............................................................................................. 15
      2.2.2 Best Monitoring Practices .............................................................................................. 16
      2.2.3 Monitoring in Restored Areas ......................................................................................... 18
      2.2.3.1 Pre-restoration Monitoring ....................................................................................... 20
List of Tables

Table 2.1 Examples of River Restoration Project Actions (Hansen et al. 1996).... 10
Table 3.1: Rosgen’s Level II stream classification system.................................. 33
Table 3.2: Degradation Forces and Mitigation Actions in Clover Groff.............. 37
Table 3.3: Degradation Forces and Current Condition of Degradation Forces ...... 38
List of Figures

Figure 2.1 Categories of River Restoration ................................................................. 9
Figure 2.2: Success of Restoration ............................................................................... 11
Figure 2.3: “Restoration monitoring program design and implementation” ........ 14
Figure 2.4: The interaction of monitoring and management with other aspects of the process is emphasized ................................................................. 20
Figure 2.5 Frameworks for Riparian Management Planning .................................. 25
Figure 3.1: Darby Creek Watershed ........................................................................ 31
Figure 3.2: Darby Creek Sub Watershed ................................................................ 31
Figure 3.3: Clover Groff Ditch Pre-restoration Condition .................................... 34
Figure 3.4: Ditched Stream Channel Design ......................................................... 35
Figure 3.5: Natural Channel ..................................................................................... 35
Figure 3.6: Proposal of Clover Groff Ditch Post-restoration Condition ............... 36
Figure 4.1: Children building bridge ....................................................................... 43
Figure 4.2: Children building bridge ....................................................................... 43
Figure 4.3: Bikers taking photos .............................................................................. 43
Figure 4.4: Bikers around stream ............................................................................ 43
Figure 4.5: Soccer areas and riparian area .............................................................. 43
Figure 4.6: Children throwing small rocks .............................................................. 43
Figure 4.7: Dog walker ................................................................. 44
Figure 4.8: Children playing with toy guns ................................... 44
Figure 4.9: Pre-restoration bridge .............................................. 45
Figure 4.10: Post-restoration bridge .......................................... 45
Figure 4.11: Pre-restoration outfall .......................................... 46
Figure 4.12: Post-restoration outfall .......................................... 46
Figure 4.13: Pre-restoration outfalls (from buildings) .................. 46
Figure 4.14: Post-restoration outfalls (from buildings) ............... 47
Figure 4.15: Pre-restoration outfall (from the road) .................... 47
Figure 4.16: Post-restoration outfall (from the road) ................. 47
Figure 4.17: Pre-restoration ...................................................... 47
Figure 4.18: Post-restoration .................................................... 47
Figure 4.19: Pre-restoration streambanks ................................ 48
Figure 4.20: Post-restoration streambanks ............................... 48
Figure 4.21: Pre-restoration streambanks ................................ 48
Figure 4.22: Post-restoration streambanks ............................... 48
Figure 4.23: Child mountain-biking .......................................... 49
Chapter 1: Background

“An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment, interacting as a functional unit. Humans are an integral part of ecosystems” (Millennium Ecosystem Assessment, 2005). Goebel defines it as “Ecosystems refer to all organisms that interconnect to each other with physical constituents such as air, water, and minerals that support them” (Goebel, 2011).

There are basically two classes of ecosystems, aquatic and terrestrial. All of the others are included in these two broad typologies. Aquatic ecosystems are broken down into two sub-ecosystems: 1) marine (ocean, estuary, and sea coast ecosystems) and 2) fresh water (pond/lake (lentic) and river/spring (lotic) and wetland ecosystems). Terrestrial ecosystems also have two types sub-ecosystems; natural (tundra, forest, desert, grassland) and man-made (crop field and garden) (Dickinson and Murphy, 1998). The riparian ecosystem is classified as an aquatic ecosystem where land and water meet (USDA, 2003). Riparian ecosystems are the focus of this study, as they are the places people love to be. In addition to being at the intersection of "land and water", these ecosystems provide numerous opportunities to people and environment, from recreational benefits, and water purification, to habitats and sustenance.
Norris (Virginia Restoration Scientist) states “Riparian ecosystems have many functional characteristics that result from the unique physical environment. It is recognized that they are highly productive because of the convergence of energy and materials that pass through riparian wetlands in great amounts. Riparian wetlands are also generally more productive than adjacent upland ecosystems because of their unique hydrologic conditions” (Norris, 2001). In our urban centers, these areas have been in use for years; beginning with early settlement, people found that they could provide for basic needs (i.e., food, shelter, water). In addition, they used the waterways for transportation for both for people and goods and ultimately for recreation (Norris, 2001). Even though riparian areas are ideal places for unique animals and plants, because of the potential for nutrition, energy and transportation provision, excessive use and misuse of these areas cause serious damage to ecosystem (Gore, 1985). To return the riparian areas to undisturbed condition and to preserve stability and productivity in these areas, some mitigation actions are required in order to enhance habitat (Burgess and Bides, 1980). These restoration needs and mitigation actions have started to become common with the impacts on riparian areas right after European settlement of North America (Roni, 2005; Goebel, 2011). Deforestation has affected streams in terms of sediment’s amount and size, flow rate and velocity, and habitat quality and diversity Goebel, 2011; Murphy, 1995; Salo and Cundy, 1987) dredging and snagging has simplified the streams (Sedell, 1984) and agriculture have caused degradation with channelized, dredged, drained, straightened, deepened, polluted and filled streams (NRC, 1992). Irrigation has brought about unstable stream flows, increase in water temperatures, decrease in aquatic habitat quality and diversity (Orth, 1987). Urbanization has been one of the reasons for decrease
in habitat quality and quantity and simplification of it, channelized and filled streams, instability in stream flows because of decrease in pervious surfaces, and pollution (Booth et al., 2002). As a result of both anthropogenic and natural degradation factors, it is put effort into restoring simplified and degraded riparian areas and improving habitat all over the world (NRC, 1992).

1.1 Justification

Degradation has become the inevitable result of this intense use over the centuries. As a result, many urban and urbanizing riparian zones are in such degraded condition, they no longer provide sustainable ecosystems and their associated services: the habitats, water purification, recreation or sustenance. To restore these services, a new science of riparian ecosystem restoration has emerged in landscape architecture and environmental engineering. In practice, as things are now done, restorations are created, but have no follow up. As an emerging area of landscape architectural and environmental engineering practice, no standards of procedure or expectations of post installation actions are defined. This would be comparable to investing in building a bridge, and never maintaining it.

Degradation factors may cause changes in “channel shape” (sinuous or meander) and in “cross-section and channel profile” (slope) (WDFW, 2003) Restoration may be defined as removal of degradation factors within natural riparian zone contains streambank stabilization, stormwater management facility establishment, water quality protection and improvement, providing wild life habitat within riparian zone (Cronin, 2003).
Regan’s study shows that restoration landscapes are not valued highly or rated as ecologically viable landscapes. Moreover, findings indicate that “the current biological value of sites is regarded as the most important criterion for meeting the biodiversity goal. Next in importance is threats followed by fully restored biological value. This order of preference reflected the view that it was more important to protect relatively pristine and intact sites as protection of biodiversity would be implicit.” (Regan et al., 2007).

1.2 Methodology

“Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” (SER, b, 2004). The ultimate goal is to provide a better solution. To restore riparian areas, according to Goebel, there are 7 things which must be considered: 1) Disturbance type (due to natural impacts or anthropogenic effects) 2) scale of disturbance 3) types of sites changed and/or created 4) differential effects of disturbance 5) exclusion of disturbance 6) interactive multiple disturbances 7) biological legacies” (Goebel, 2011)

Defining the reference ecosystem influences the achievement and goals of the restoration process. Reference ecosystem is defined as “an actual ecosystem or its conceptual model that is used in setting goals and planning a restoration project, and later in its evaluation. In its simplest form the reference ecosystem is an actual site, its written or oral description, or both” (SER-a, 2004). According to Goebel (2011), “It is impossible to retain or return exactly to historical conditions. There is a wide range of conditions to choose from at any ecological scale (population to landscape) and all of them are transient, not fixed in “time”. There is no single, ideal state for restoration for
any given site or area.” Future change is inevitable. As a consequence of ongoing recovery from past human activity and disturbance, and future changes in wildlife, the environment, and introduced organisms, all protected areas will continue to change.

“The Society of Ecological Restoration International (SER, 2004) provides a list of nine ecosystem attributes as a guideline for measuring restoration success. “They suggested that a restored ecosystem should have the following attributes: (1) similar diversity and community structure in comparison with reference sites; (2) presence of indigenous species; (3) presence of functional groups necessary for long-term stability; (4) capacity of the physical environment to sustain reproducing populations; (5) normal functioning; (6) integration with the landscape; (7) elimination of potential threats; (8) resilience to natural disturbances; and (9) self-sustainability. Although measuring these attributes could provide an excellent assessment of restoration success, few studies have the financial resources to monitor all these attributes. Furthermore, estimates of many attributes often require detailed long-term studies, but the monitoring phase of most restoration projects rarely lasts for more than 5 years” (Ruiz-Jaen et al. 2005). To develop strategies to manage the inevitable changes in support of the riparian ecosystem restoration we must address the 7 factors cited by Goebel, and 9 attributes provided by SER.

While restoration projects are being applied to riparian ecosystems, post restoration monitoring and management plans gain importance. According to Norris (2001), “Landscape ecology has arisen from practical consideration of how ecological ideas could be applied in land management. This idea is especially important when considering riparian restoration because the potential site is part of an interactive
watershed network. Management decisions made on any portion of the watershed will affect another portion or portions, either directly or indirectly, positively or negatively”. In addition, the World Bank Global Environment Division claims that monitoring is the primary tool to determine final conditions and results of the project.

The first thing to consider is disturbance. Since the disturbance might be a natural or anthropogenic (i.e. human) effect, understanding the impacts and sources of disturbances to ecosystems is critical in restoration actions.

With the City of Columbus Recreation and Parks’ Clover Groff Stream Restoration Project in the Big Darby Creek watershed, there is an opportunity to examine riparian ecosystem in the sequence of restoration: from the areas as “degraded”, the preparation of restoration, the process of restoration and a completed restoration phase. The key to maintaining a restored riparian ecosystem is to manage it for maximum biological and self-sustaining potential. Supporting restored areas by designing effective monitoring and management strategies is critical to the viability of riparian restoration work and to determining if restoration goals are achieved. Applicability of proposal and feasibility of practice evaluation guides through successful restoration plan with monitoring and management process. Instead of making areas untouchable, public participation and maintenance allow us to reach the project objectives with the best monitoring and management projects (Goebel, 2011).

Monitoring is the key to evaluate restoration success and sustainability. Effective monitoring in Clover Groff restoration area can be conducted by sponsors, volunteers, students from surrounding schools or local residents. Monitoring does not require technical or scientific background. Identifying indicators and adopting these indicators to
diagnose changes in order to track restoration are essential for accurate analysis and interpretation of collected data and samplings (Williams et. al., 2010). A Proposed monitoring strategy could use the point-count method and audio recording for birds, and quadrant vegetation analysis method and periodic photography for plants. According to point count method, all individual birds (heard-seen) are reported in 25m from where observer stands. However this 25m should be in the riparian corridor (Asante, 2006). It is important to repeat bird monitoring approximately at the same time of the day and approximately same time of the year.

For effective quadrant vegetation analysis, 1x1(m) square-shaped area is selected, then it is doubled until observer thinks all plant samples are included in selected area (Goodall, 1952). The minimal sampling area may vary according to species and community type (Goodall, 1952). Vegetation sampling should be conducted around plants’ flowering time, and approximately same stage of seasonal progression for following years; baseline data harvesting time is also important for sampling time (Burton et al., 2011). There are specific monitoring stations where M&M strategies should be applied in order to track degradation forces and degradation of the land area itself. Monitoring provides feedback into the adaptive management plan for the area.
Chapter 2: Literature Review

2.1 Background to ecological riparian restoration plans

Riparian areas have been degraded severely by natural and anthropogenic forces for decades (Goebel, 2011; Gregory, 1974). It is popularly believed that ecological restoration is the process of assistance during recovery of ecosystem restoration, and amount of intervention and timeframe should be minimized (Darby and Sear, 2008; Goebel, 2011; Higgs, 2003). Contrary to this popular belief, sustainable river restorations suggest constant durability of physical conditions within the restored area instead of short time accompaniment and interventions, especially, if the degradation forces are still active within the restoration project area. It should be considered that without monitoring and management programs, restoration projects will be ineffective and the area will return the degraded condition over time.

Ecological riparian restorations address water quality improvement, streambank stability, biodiversity and habitat enhancement (Connin, 1991). Before a restoration project is to be developed, practitioners should consider including plans: explanation of area’s restoration requirement, potential restoration area description with regard to ecological conditions, definition of restoration project goals and objectives, identification of reference ecosystem and description of it, description of possible results of restoration project and its integration with current condition, clarification of steps, project agenda
and restoration cost for each part of the process (pre-restoration, during construction, post-restoration) even for adjustment actions, development of evaluation and well-prepared monitoring plan, and explanation of post restoration maintenance and management strategies (SER- b, 2004).

Riparian restoration include upland areas and stream itself, however there are different types of restorations and mitigation actions according to designated restoration areas Hansen et al. (1996) classifies the river restoration types according to their objectives as, “watercourse reaches, continuity between reaches and river valleys” (Figure 2.1). Type 1 is developed for short reaches restoration, type 2 includes passages of the river restoration, and type 3 is for the whole riparian area restoration (Mitsch and Jørgensen, 2004). Some specific mitigation actions according to these 3 types of river restoration are exemplified in Figure 2.2.
| Type 1: Rehabilitation of watercourse reaches | Rehabilitation of water course reaches  
Reach meandered  
Culverted reach opened to create better habitats  
Two step cross-sectional profile created  
Ochre sedimentation basin established in connection with the watercourse  
Stones laid out  
Gravel laid out  
Artificial fish hiding places established  
Other solid objects laid out  
Current concentrators established  
Sand traps constructed  
Trees and bushes planted within the 2 meter cultivation-free border zone  
Trees and bushes removed within the 2 meter cultivation-free border zone  
Artificial bed and/or bank established (fascines, concrete, paving slabs, etc.)  
Artificial bed and/or bank removed (fascines, concrete, paving slabs, etc.)  
Other methods: |
| Type 2: Restoration of continuity between watercourse reaches | Obstruction replaced by riffle  
Obstruction replaced by meanders  
Bypass riffle established at preserved obstruction  
Riffle established at preserved obstruction  
Culverted reach opened to create free passage  
Culvert falls evened out (drop manhole removed, etc.)  
Greater water depth and/or current breakers in underpass culverts  
Falls evened out at culvert outlet/bridge  
Fish ladder/fish sluice established/removed  
Formerly periodically “dried-up” stream reach completely restored  
Formerly periodically “dried-up” stream reach partly restored  
Water pumped into stream to maintain flow in periodically “dried-up” reach  
Otter pass established  
Other |
| Type 3: Rehabilitation of river valleys | Water table and flooding frequency increased by  
– re-meandering the watercourse  
– raising the bed  
– terminating drains in meadows  
– establishing a dam  
– meadow trickling  
– narrowing the watercourse  
Lakes/ponds/wetlands etc. re-established/established in the river valley  
Vegetation management in the river valley  
Other |

Table 2.1 Examples of River Restoration Project Actions (Hansen et al. 1996)
The most efficient restoration plan should be responsive to “stakeholder success, learning success and ecological success” (Figure 2.2) (Palmer et al, 2005). Evaluation of success of the restoration may differ according to stakeholders (Watts, 2007). Palmer et al. (2005) identified some points to examine to decide whether riparian restoration is successful: outcome satisfaction, project budget and expenses, post-restoration aesthetic, ecological success, contribution to science, recreational and educational potential and use”.

Figure 2.2: Success of Restoration (Palmer et al, 2005)
2.2 Monitoring

Monitoring stream channels and adjacent areas are significant for landowners and managers because it helps to determine “has the activity met its objectives? And, what accounts for its level of performance?” (World Bank, 1998) and how the management practices impact the areas in terms of health and condition. For a riparian area, another important thing is the health of the plants in the area. If they are healthy, they help reduce the erosion of streambanks, increasing quality of water by acting as a filter, providing habitat for wildlife and new opportunities for recreational activities (MRWAEC, 2012).

2.2.1 Monitoring Methods

Project monitoring is the collection, observation and interpretation of data (World Bank, 1998). Accuracy of the measurements and monitoring is important in order to provide a successful adaptive management plan, to be a guide to the prospective restoration projects (Thayer et al., 2003). Collected data is analyzed to evaluate the project decisions and to identify improvement or constraints in an early stage in order to make some adjustment in the applied plan if needed (World Bank, 1998). Tockner and colleagues (1998) states that “A key challenge in the evaluation of the effects of restoration is the development and testing of an appropriate monitoring scheme, which has to include a wide range of physical, chemical, geomorphic, and ecological parameters.”

Monitoring should run parallel to original aims of the restoration project in order to inform decisions about the intervention which may be required during or after the project is concluded. “The identification and selection of appropriate indicators are
essential for monitoring programs to effectively assess riparian restoration.” (Williams, *et. al.*, 2010). Monitoring should start before the restoration project is commenced, continue during the implementation and after restoration has been completed. Restoration monitoring should follow ten steps consisting of three integral segments (Figure 2.1) (Herrick *et al.*, 2006). First segments is, “monitoring program design”, parallel to pre-restoration monitoring, second segment is, “short term monitoring”, important to assess restoration success in terms of documentation and adjustment of factors, and the last segment is, “long term monitoring”, more comprehensive to determine whether the restoration is successful (Herrick *et al.*, 2006) . Selected indicators can be used for both short term monitoring and long term monitoring; however, long term monitoring data feedbacks into management actions (Newey *et al.*, 2009).

According to Herrick and colleagues (2006), a “Monitoring program design should be an integral part of the restoration planning process, beginning with the definition of restoration objectives and monitoring objectives (Step 1), which are developed iteratively with a landscape stratification (Step 2) and the assessment of the current status of key ecosystem attributes and processes (Step 3). In addition to identifying the processes that must be addressed by the restoration treatments, the assessments are used to select monitoring indicators (Step 4); and locations within the area to be restored (Step 5) where baseline measurements are completed (Step 6)”.
Figure 2.3: “Restoration monitoring program design and implementation” (Herrick et al., 2006)
2.2.1.1 Short Term Monitoring

It is believed that monitoring conducted right after implementation is the most significant step of restoration monitoring, nevertheless, for the restored area recovery takes longer time than expected—as it may take decades- and selected indicators for annual monitoring may not be economically viable (Herrick et al., 2006). These indicators help restoration to be successful (Step 7) and management plans can be developed in response to alteration of these indicators (Step 8) (Herrick et al., 2006). Short term monitoring is conducted to suggest management actions to contribute to improvement of design, construction methods and monitoring process (Montana Water Center, 2009). Since it is hard to determine project impacts in the short term, monitoring should be based on indicators of probable success, instead of exact biodiversity measurements (Burton et al., 2011).

2.2.1.2 Long Term Monitoring

Long term monitoring measurements are repeated in order to assess success of restoration, to alter goals and objectives of restoration and to prepare a management program (Step 9) (Herrick et al., 2006). Indicators for long term monitoring should demonstrate objectives of the restoration, the features of ecosystems present and the needed actions for achieving restoration objectives (Step 10) (Herrick 2006). Both short term and long term monitoring should provide a solid basis for management actions (Burton et al., 2011). For the monitoring—short and long term—data harvesting procedures should be determined and intermittent field sampling should be continued in order to provide high quality collected data (World Bank Global Environment Division, 1998).
Long term monitoring techniques are used for observing the changes and degradation in riparian areas and in streams during the recovery and management process (Montana Water Center, 2009). Herrick et al. (2006) suggests that to prepare an economical monitoring plan “multiple indicators” that will reflect different objectives of restoration should be chosen.

2.2.2 Best Monitoring Practices

To evaluate whether restoration objectives and goals have been met, monitoring should be conducted and checked to determine if ecosystem services have been repaired (Hooper, 2009). These features should be developed and identified in restoration plans (Hooper, 2009). According to the “Multiple Indicator Monitoring Protocol” prepared by U.S. Department of the Interior, monitoring should rely on these objectives: “1) address multiple short- and long-term indicators, 2) measure the most important indicators relevant to detecting change, 3) use existing procedures to the extent possible, 4) improve efficiency through the use of electronic data collection, 5) yield statistically acceptable results within realistic time constraints, and 6) provide useful data to inform management decisions” (Burton et al., 2011). The reason why this protocol was prepared is to improve collection of essential data and more required restoration monitoring data (Burton et al., 2011). Dr. Mary Baker (USDA) mentions that when they declassified restoration monitoring guidelines to public, they received suggestions related to “1) “reference site” requirement of the guidelines 2) the cost-burden of any monitoring, 3) a request for more detail in the guidelines, 4) the desire for monitoring requirements to be consistent among programs, and 5) the need for examples of successful restoration monitoring efforts”
(Minutes of the Meeting, 2003). After all these suggestions are considered, USDA revised the monitoring guidelines and identified five essential features as “parameters, data evaluation methods, baseline assessment, reference condition, frequency and time span” (Minutes of the Meeting, 2003).

Dr. Mary Baker also explained these five features: *Parameters* should be related to goals and objectives, and should gauge “structural and functional parameters”; *data evaluation methods* should include assessment of hypothesis, comparison of reference site and restored site and “qualitative trend analysis”; *baseline assessment* should represent pre-restoration analysis information, pre-restoration condition and historical data; *reference conditions* should be identified in order to have an idea about pre-disturbed condition of the area and restored area would eventually be similar to reference area; *frequency/time span* is related to parameters and after restoration, it loses importance over time, however, it should contain unexpected condition plans and management strategies with at least five years monitoring plan” (Minutes of the Meeting, 2003).

In order to develop a successful and comprehensive monitoring plan twelve steps have been identified by Thayer et al. (2003) as following:

1) Goals and objectives of the restoration project should be identified and should be documented in the project file.

2) According to restoration project type and techniques, information should be gathered from similar projects.

3) Habitats should be identified and reported in and around the project area.
4) “Structural, functional, and socioeconomic characteristics” should be identified and described.

5) Experts’ opinion should be taken into consideration.

6) Hypotheses should be stated in order to assess later (post-restoration).

7) Collect historical data and indications of trends and causes of decline.

8) Reference site should be determined by considering the character of restoration area.

9) Time span should be specified.

10) Monitoring methods should be stated.

11) Review and revisions should be programmed in case of requirement of project.

12) Monitoring cost should be estimated and be adjusted according to available funds.

2.2.3 Monitoring in Restored Areas

As soon as a riparian restoration is completed, monitoring should emerge in order to assess if the restoration project is implemented as planned and to change the plan if needed (New Hampshire Department of Environmental Services, 2004). Monitoring should be started right after restoration project has been completed and conducted during first five growing seasons by using same monitoring methods (vegetation, animals, and water quality) as used in pre-restoration monitoring, with photographs taken from specific monitoring stations (Thompson and Luthin, 2004).

In order to monitor restored areas, specific points should be clarified before monitoring starts: identifying photography points where you can observe degradation in wetlands, stream and riparian area itself and use the same points to help evaluate the
process of recovery. Photos should be taken before restoration (pre-restoration), during construction and after restoration (post restoration). It is more valuable if photos can be taken at the same monitoring station and in four different seasons and with labels (date and monitoring station) on them.

Audio recording gives information about bird species and intensity of birds in the area. The weather conditions, date and the “name” of the monitoring station should be attached to the record. Assessing the pre-restoration objectives after completion will allow comparison of habitat maps created before implementation and after restoration (Thompson and Luthin, 2004). Vegetation is one of the most important indicators in restored areas, so observation of plantings is critical while they are developing root systems (some loses are expected) (Thompson and Luthin, 2004).

Restoration and management demand monitoring as an essential process of project success (Thayer et al., 2003). For a successful monitoring plan, “project design, construction and implementation” should be taken into account (Figure 2. 2) (Thayer et al., 2003). During the project conception process, goals and objectives of restoration should be identified according to local culture and successful projects and measurement methods ought to be defined to meet identified goals and objectives before construction begins (Thayer et al, 2003). While developing a monitoring plan, potential effects of monitoring to the area and local communities should be considered, with reference sites selected according to structural and functional features of restoration area (Goebel, 2011). The baseline data should be collected appropriately before construction and identify measurable assumptions in order to evaluate success of restoration. (Thayer et al., 2003).

A well-planned monitoring program helps develop an effective management plan.
2.2.3.1 Pre-restoration Monitoring

Pre-restoration monitoring should provide resources for the area maps, photos, environmental samplings and other pre-condition information about the area. It is significant to commence pre-restoration monitoring both in reference site and project area (Thayer et al., 2003). Pre-restoration monitoring and sampling should be conducted at least a year before project construction, because short term monitoring may cause different characteristic analysis as a result of storm, flood etc. (Thayer et al., 2003). The information allows landowners or managers to evaluate whether project goals and
objectives have been met (USDA Forest Service Lake Tahoe Basin Management Unit, 2007). The sampling should deal with biotic and abiotic parameters, therefore, it can be said that pre-restoration monitoring focuses on mapping (plant communities and anthropogenic effects) and sampling (plant and fish communities, water quality and soil) in order to contribute to restoration project effectiveness. (New Hampshire Department of Environmental Services, 2004).

2.2.3.2 Restoration Construction Monitoring

To develop a Riparian Restoration Monitoring and management strategies in support of restored riparian ecosystems, it is important to evaluate changes in the area and to make adjustment to the restoration plan constantly.

Identifying indicators and adopting these indicators to diagnose changes in order to track the restoration is essential for accurate analysis and interpretation of collected data and samplings (Williams et al., 2010). There are some indications which give some ideas about the response of the area to the restoration project. These indications can be classified as riparian areas and stream channels. If the riparian areas have following symptoms, it shows failure of the project: “a) Noxious weed invasion, b) Hedged shrubs, c) Encroachment of upland shrub species, d) Riparian shrubs and trees are mostly old with few young plants, e) Riparian shrubs and trees are mostly old with few young plants, f) Fewer native grasses” (MRWAEC, 2012). If the following symptoms are noticed around the stream channels, it also shows the failure of the project: a) Channel widening, b) Unvegetated, eroding streambanks, c) Increased frequency of new streambanks, d) Channel downcutting, e) Increased silt/clay on channel bottom, f) Stream unable to
overflow its banks during annual spring runoff” (MRWAEC, 2012). Construction monitoring should be conducted to check whether design requirements have been met (Thayer et al., 2003).

2.2.3.3 Post-restoration Monitoring

Post-restoration monitoring is an essential part of ecological restoration plan according to Society for Ecological Restoration, however, monitoring and management (M&M) plan is not considered as integral part of the process. It is claimed that ecologically restored area should be capable of being self-maintaining and should be self-sustaining (Goebel, 2011). However, during post-restoration process the area is needed to be managed and monitored to allow continuing mitigation of disturbances, before it reaches a self-maintaining and self-sustaining stage. New Hampshire Department of Environmental Services (2004) asserts that, post-restoration monitoring requires repetition of the measurement and sampling parameters of pre-restoration monitoring after a certain period of time, like five years. Therefore, it can be said that well conducted pre-restoration monitoring with satisfactory pre-condition data provides a baseline for successful post-restoration monitoring.

Post-restoration monitoring should be conducted as both long-term and short-term trend monitoring. While long term trend requires 3- to 5-year intervals of data collection and continuity of sampling with the extension of every 3-5 years, short term monitoring data may be collected annually and repeated twice or three times in a year (Burton et al., 2012). If the degradation forces are still active, monitoring cycle should continue until all
forces are eliminated. Riparian zones are capable of recovering quickly and vegetation is responsive to restorative actions and adaptive management.

2.3 Management

Management has been a disputable component of the restoration process (Higgs, 2003). Previously it was a core part of restoration planning and implementation; however, it was removed from the process in 2002 by SER (Society for Ecological Restoration) (Higgs, 2003). SER states that restored areas should be self-maintaining and self-sustaining (SER-a, 2004), however, in some areas degradation forces cannot be eliminated completely. Therefore, these restored areas still require management actions to complete the recovery process or improve ecosystem health. Though it is now not part of the recommended process, SER does regard management strategies as part of the restoration process but outside the formal restoration process.

Adaptive management has many different definitions according to scientists. Halbert and Lee (1991) defines adaptive management as “… an innovative technique that treats management programs as experiments.” Further they suggest that adaptive management permits action to proceed in the face of uncertainty. “Adaptive management uses each step of a management program as an information-gathering exercise whose results are then used to modify or design the next stage in the management program”. With this system there is a feedback loop between science and management so decisions “can make use of the best available scientific information in all stages in its development”. During management plan development, the best available data should be utilized, and new data harvested so that restorers can learn about the structure and
function of the affected natural systems (Wieringa and Morton, 1996). Even though adaptive management is interpreted differently by various scientists, all scientists agree that monitoring is an integral part of adaptive management (Thom, 1997). It should be known that monitoring ought to be conducted to develop adaptive management actions and respond to potential problems (Eubanks, 2004).

Management of restored riparian areas is important in order to meet defined, evaluated and integrated goals and objectives. These defined goals and objectives are classified according to four general management strategies: “1) Maintenance of existing riparian conditions, 2) Improvement of degraded riparian conditions, 3) Recovery of lost riparian areas, 4) Development of new riparian areas” (Smith and Prichard, 1992). To provide environmental (ecosystem) services to humankind and to habitats, protection and reinforcement of riparian areas is the essential goal of riparian management (Moyle et al., 1996). Riparian areas should be managed for the following: “decrease erosion, improve water quality, provide healthy ecosystems, maintain river courses, allow fish stock management, decrease insect pests, increase the capital value of adjacent lands, enhance the shelter effect, allow opportunities for diversification, provide for retention and uptake of nutrients, lower water tables, increase fish stocks, provide landscape refuge, and decrease algal growth” (Price and Lovett, 2002). To suggest a successful prolonged adaptive management plan and actions, new methods and different tracks should be used for “planning, acting, monitoring, and evaluating” (Downs and Kondolf, 2002; Smith et al., 1998). During the preparation of a framework for a management plan for the riparian area, three steps should be followed: “a regional reconnaissance, a landscape-scale riparian assessment, and site-scale riparian plans” (Figure 2.3) (Bentrup et al., 2000).
Regional scale reconnaissance of existing spatial and temporal information yields a sense of the ecological conditions and issues. The regional context allows stakeholders to consider multiple resource issues in the riparian planning effort and to address several issues simultaneously.” (Bentrup et al., 2000).

Adaptive management is adopted to assure integrity of the area after restoration by considering and measuring original goals and objectives (Eubanks, 2004). These measurements are essential component of monitoring plan, as monitoring plans are integral parts of management strategies. Eubanks (2004) explains that with an example: During monitoring process; if observer notices a section is degraded or misused,
management plans should be altered to assist recovery by focusing on the degradation factors or misuse to contribute to restored ecosystem health.

2.3.1 Management Strategies

Riparian areas are exposed to both natural and human-based disturbances. Management plans of riparian areas should address both problems such as runoff based erosion by considering slope condition (upland and stream slope), soil condition and consideration of soil lose, icing condition and flow, anthropogenic impacts on erosion, water condition (quality), flow rate and velocity, sediment amount and accumulation, (Smith and Prichard, 1992).

Eubanks (2004) provides management strategies that should be followed to contribute to ecosystem health:

1) Anthropogenic impact mitigation as much as possible and control of visiting areas,

2) Restoration of area and during recovery process closing the area to visitors,

3) Public involvement, involvement of volunteers and organizations and let them play an active role during management process (allows cost effective management),

4) Identification of social and physical goals/ objectives for recreational use and concurrent evaluation of these goals/objectives, in other words observing the recreational impacts and managing people’s perception, action and needs,

5) Management intensification in order to mitigate degradation impacts within the area by limiting the use of some degraded areas such as designation of certain
trails while some others are closed off for restoration (visitors should be informed).

If an Adaptive management strategy is to be developed, it should follow the cycle of a) defining objectives and goals by considering restored area condition, b) designing particular plans for implementation, specific degradation factors, contents of monitoring/evaluation, c) assessment of monitoring/evaluation, and investigation of post-restoration process to learn from mistakes, d) Adjustment of the management plan regarding monitoring/evaluation and investigation results to feedback into original management approaches (Nez Perce Tribe, 2010).

2.3.2. Active and Passive Management Plans

Adaptive management falls into two main categories according to their evaluation and adjustment steps, and the data quality that they provide for forthcoming project goals and objectives, as active adaptive management and passive adaptive management (Bormann, 1998). “Both passive and active adaptive management require careful implementation, monitoring, evaluation of results, and adjustment of objectives and practices. Active adaptive management usually allows more reliable interpretation of results, and leads to more rapid learning” (Chopra, 2005).

Active adaptive management practices are developed in order to distinguish different management models to find out “best” strategy by conducting experiments (Bormann, 1998; Chopra, 2005). Monitoring and evaluation utilize these experiments to analyze different models and their reaction to management actions concurrently (Bormann, 1998).
Passive adaptive management practices are more ambiguous compared to active adaptive management practices. Managers assume that selected program, that is prepared to meet management objectives, is the “best” management approach according to predictions made (Ministry of Forests and Range, 2012). If the management program does not meet management objectives considering monitoring results, current management program is modified consecutively to determine “best” management strategy (Bormann, 1998; Ministry of Forests and Range, 2012).

2.3.3. Best Management Practices

Information about Great Basin riparian areas in this chapter, unless otherwise cited, comes from Jeanne C. Chambers and Jerry R. Miller’s *Great Basin Riparian Ecosystems* (Chambers and Miller, 2004).

The Great Basin had been exposed to both natural and anthropogenic degradation factors and it was assumed that more than half of the riparian areas were disturbed and damaged in the Great Basin area. Even though the area had previously been home to numerous plant and animal communities, both streams and riparian areas had been damaged due to anthropogenic pressure. The area is located in semiarid region that has more erratic behavior in case of severe weather condition (rain, snow, freeze), and it may easily be affected by degradation factors compared to an area located in humid region. Alterations in the riparian zone and stream itself with regard to structure and function of the ecosystem had lasted very long without a restoration or a management plan.

After previous ineffective semiarid riparian restorations, it is understood that the deficiency of perception of current physical and biotic processes and degradation forces
are the actual reason for unmet restoration goals and objectives. To develop best restoration and management practices for the area requires understanding of “geomorphic, hydrologic, and biotic processes”, human based and natural degradation forces plays a key role in volatile and special scales.

The Great Basin ecosystem management program was implemented in 1992, by USDA Forest Service Research, by focusing on the issues within the area. The main aim of the management project was targeting the “geomorphologic processes, hydrological regimes, and vegetation dynamics of the system”. According to identified goals and objectives, plant materials, landform and surface condition would be reconstructed in order to understand importance of degradation forces on ecosystems. The character of riparian areas in terms of water condition and landform, and assessment of resolved and still present degradation forces would be addressed in details; the reaction to both natural and human related disturbance forces would be modeled considering area sensitivity; alterations in flow rate and velocity, and water quality would be assessed regarding sensitivity of the area; the relationship between riparian zone plants and water related landform conditions would be identified, and the degradation forces’ impact on the relationship would be elucidated; animal habitat and distribution relationships should be identified and compared to historical condition; new methods and guidelines developed with the understanding of current and past ecosystem processes to successfully manage the area. In the “riparian ecosystem dynamics” of the Great Basin, the most effective management practice can be developed after a monitoring and evaluation process.
Chapter 3: identification of Case Study Site

3.1 Case investigation


Big Darby Creek is a state of Ohio and United States National Scenic River and one of the most significant water resources in the Midwestern US. It used to have high quality stream water, a diversity of vegetation and animals, and it is still home to some endangered species (OEPA, 2004). Recently some parts of Big Darby Creek and its tributaries have been negatively impacted by anthropogenic degradation factors and have issues related to water quality and habitat loses (OEPA, 2004). Clover Groff Stream Run was one of the most degraded of Big Darby Creek’s headwaters.

Stream restoration typically refers to removal of degradation forces (Cronin, 2003); however, for Clover Groff Run Stream Restoration the situation is different. Degradation factors are still active and the main goal of restoration is creating wildlife habitat and increasing water quality by “re-naturalizing” the watercourse. After restoration has been completed, protection of the restored area is not guaranteed (SER- b, 2004). In order to protect restored area monitoring strategies to inform management actions need to be developed, this is the goal of this study.
Big Darby Creek is located in central Ohio and is known as one of the best quality aquatic system in the Midwest (accad.osu.edu, 2011). Even though Ohio EPA ranked Big Darby Creek as one of the five significant warm freshwater habitat areas, there are a lot of issues such as storm sewage discharges, urbanization and related increased urban runoff, channelization, transportation and recreation in the main stream and all tributaries. Clover Groff Run, was known as Clover Groff Ditch. It is a part of Big Darby Creek watershed (Figure 3.3) and was known as one of the poorest water quality headwaters in the Big Darby Creek due to the agricultural modifications.
Clover Groff Ditch, located in western part of Columbus and Franklin County, is one of the most degraded areas and an important impairment sources to Hellbranch Run (Figure 3.4), major tributary for Big Darby. It had not met the requirements of being a healthy stream such as having biologically diverse vegetation and high quality water with stable streambanks, dissipating flow velocity, decreasing sediment and siltation, increasing aquatic habitat (Coquille Watershed Association, 2012). Clover Groff Stream just like other low gradient streams did not have a chance to recover naturally to return a stage that performs like healthy streams. This study will focus on completed Phase I, to design an effective Monitoring & Management (M&M) community resources to inform management actions.

There are several stream classification systems which have some limitation in application. There is only one exception: Rosgen stream classification method which is the most common one in the United States (Ward et al., 2008). According to Rosgen method, streams are grouped into a four-level class hierarchy: “Level I; geomorphic characterization that integrates topography, landform, and valley morphology. At a broad scale the dimension, pattern, and profile are used to delineate stream types. Level II; morphological descriptions based on field-determined reference reach information. Level III; stream “state” or condition as it relates to its stability, response potential, and function and . Level IV; validation at which measurements are made to verify process relationships” (In addition to these hierarchical stages, streams also have different kinds of channel attributes (Table 1), according to Rosgen type approach, “(1) mean bank full depth; (2) maximum bank full depth; (3) bank full width; (4) flood-prone area width; (5) channel sinuosity; (6) mean channel slope or water surface slope; and (7) median channel
material size.” (Ward et al., 2008). Hence, this channel is known as “low gradient Rosgen type F-6 stream” with low quality substrate, low quality buffer density and diversity, serious channel incision, low quality floodplain. In all of these mentioned conditions there exist little or no biological diversity within the riparian buffer zone and there is no chance of natural rehabilitation of the area.

Table 3.1: Rosgen’s Level II stream classification system.

<table>
<thead>
<tr>
<th>Stream Property</th>
<th>Stream Types*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Entrenchment Ratio, ER</td>
<td>&lt;1.4</td>
</tr>
<tr>
<td>Width to Depth Ratio, W/D</td>
<td>&lt;12</td>
</tr>
<tr>
<td>Sinuosity</td>
<td>1-1.2</td>
</tr>
<tr>
<td>Bed Slope, S (%)</td>
<td>4-10</td>
</tr>
</tbody>
</table>

*Add after the stream type a number that corresponds to the mean bed material type where: Bedrocks: 1; Boulders: 2; Cobble: 3; Gravel: 4; Sand: 5; Silt-Clay: 6. For example: A Rosgen Type C4 stream has a gravel-bed.

Clover Groff Ditch had been altered by anthropogenic degradation forces such as urbanization, lack of native vegetation and abundant invasive species which cause unstable eroding banks, excessive stormwater runoff, land misuse and uncontrolled use of area. Previously, the area has been disturbed by agricultural activities, “the stream was dredged, straightened, deepened” (Figure. 3.5) and most of natural life vanished due to various human actions. Restoration plan had suggested a meandering channel characteristic within a widened floodplain which includes incorporated wetlands, and vegetated riparian buffers with native plants.
The main aim of the Clover Groff Run stream restoration project was returning the Clover Groff Ditch back to a functioning system with constructed pools, riffles, and runs, creating an accessible floodplain and habitable areas for all habitats, improving the quality of water for warm water habitat (Oxbow, 2008). As part of Big Darby Creek, which known for its high water quality, Clover Groff Ditch has a score even lower than a normal ditch does. Ditches normally have scores around 30s in terms of Qualitative Habitat Evaluation Index (QHEI, which is a 100 point system from 0 to 100). According to the Ohio EPA Clover Groff Ditch did not meet Federal Water Quality Standards with a score of 22. Oxbow River & Restoration Inc. (2011) aimed to reach 60s; they believe that since the restored area is located in a park (Frank Park and Clover Groff Natural Area), it is protected and there will not be anthropocentric damages. In addition to that it is mentioned that the area cannot repair itself, since it is flat.

The Clover Groff Run stream restoration project aims “1) to return the Clover Groff ditch to a functional stream with an accessible floodplain and 2) to provide an ecosystem that will meet a use designation of Warm Water Habitat (WWH) water quality criteria”. With the stream restoration, the degraded part was reformed to a meandering
channel and the floodplain widened and lowered compared to its degraded prior condition.

Clover Groff Stream Restoration Project has three phases: I) Completed in 2010 II) recently completed in 2012, and III) in progress (expected to start construction at the end of 2012). Phase I dealt with a 1.1 mile straightened degraded ditch (Figure 3.1) which is restored as a functional stream by adopting “natural meandering pattern”(Figure 3.2) (Columbus Recreation and Parks Dept., 2008). Clover Groff Run was modified for farming activities more than five decades ago. The stream channel was deepened, widened and straightened, and the stream lost its ability to carry flood water and nothing remained of native plants and habitats.

The restoration created sinuous channels, maintained pools, riffles and runs, aids mitigation of erosion, damage and destruction (Figure 3.6). Floodplain has been spread out by considering seasonal changes and precipitation rates. After precipitation, the stream will have enough capacity to run without any damage to adjoining properties. 

Even after restoration, some of the degradation forces still exist. Even though the ecological restoration’s purpose is to create a self-maintaining and self-sustaining ecosystem, the forces that created the need for restoration are still active, so the restoration needs monitoring and management with continuing post-project appraisal.

Figure 3.6: Proposal of Clover Groff Ditch Post-restoration Condition (Oxbow, 2011)

3.2 Degradation Forces

The degradation forces in Clover Groff Run Stream can be seen as urbanization, storm water outfalls/point discharges, excessive stormwater runoff, unstable and eroding banks, invasive species, land misuse, uncontrolled use of area by pedestrian and bicycles, area compaction, plant and channel debris removal/relocation/insertion, excessive usage in areas not designed for pedestrians (stream banks).

Anthropogenic disturbances are indicated below according to type of degradation factors and possible mitigation actions to prevent these degradation forces in Clover Groff Run Stream.
Table 3.2: Degradation Forces and Mitigation Actions in Clover Groff Restoration Area

(Bilge, 2012)

3.3 Mitigation Actions

Clover Groff Run stream had been restored by Oxbow River and Stream Restoration Inc. as sub-conductor and Shaw & Holter, Inc. as contractor according to the plan which was prepared by Columbus Recreation and Parks Department (Appendix A) with the funding provided by OEPA Water Resource Restoration Sponsorship Program and other 319 grant funds. On site, the Oxbow River and Stream Restoration Company
utilized environmentally friendly equipment to prevent soil contamination and to reduce soil compaction and soil damage. Shaw & Holter, Inc. were responsible for mass excavation and replacement of new top soil on the revised floodplain. During preparation and construction of the project existing native plants were to be protected. After construction of the new floodplain, the revegetation process was completed by using approximately one thousand five hundred trees, thirty thousand bare root shrubs, native grasses and forbs distributed over the 18 acre area. Restoration actions are demonstrated in Table 3.2 by considering existence of the degradation factors and success of the actions.

<table>
<thead>
<tr>
<th>Degradation Force</th>
<th>Mitigation Action</th>
<th>Still Present/Resolved</th>
<th>Degradation Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urbanization</td>
<td>-</td>
<td>Stabilized</td>
<td>1</td>
</tr>
<tr>
<td>Unstable/ Eroding Banks</td>
<td>Slope Rounding and Revegetation</td>
<td>Continuing</td>
<td>3</td>
</tr>
<tr>
<td>Invasive Species</td>
<td>Revegetation</td>
<td>Continuing</td>
<td>1</td>
</tr>
<tr>
<td>Land Misuse</td>
<td>Revegetation</td>
<td>Continuing</td>
<td>5</td>
</tr>
<tr>
<td>Uncontrolled Use of Area</td>
<td>Bridge</td>
<td>Continuing</td>
<td>5</td>
</tr>
<tr>
<td>Flooding</td>
<td>Wetland Construction</td>
<td>Reduced</td>
<td>0</td>
</tr>
<tr>
<td>Stormwater Outfalls</td>
<td>-</td>
<td>Continuing</td>
<td>3</td>
</tr>
<tr>
<td>Excessive Stormwater Runoff</td>
<td>-</td>
<td>Continuing</td>
<td>1</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Reshaping channel</td>
<td>Resolved</td>
<td>0</td>
</tr>
</tbody>
</table>

0: No degradation, 1: Low degradation, 3: Moderate degradation, 5: High degradation

Table 3.3: Degradation Forces and Current Condition of Degradation Forces (Bilge, 2012)
According to repeated observations in this study from mid-February to mid-May, degradation scales are provided in terms of mitigating the degradation factors and result of these mitigation actions (Table 3.3).

3.4 After Restoration in Clover Groff

Phase I of Clover Groff Run Stream restoration was completed in 2010, and the monitoring of the project has been conducted by both Ohio EPA and Oxbow River and Stream Restoration, Inc. Oxbow has a permit for the monitoring at the one, three and five-year marks. After restoration QHEI had been assumed to be approach QHEI of 56; however, post restoration the project performed better with the QHEI of 64 when restoration completed. QHEI is important for Clover Groff Run stream restoration, because it is used as prediction tool and measure of success for the project. The project is a “pioneer” for the City of Columbus, and to confirm success for this restoration project, provides potential for more such work to be implemented. The City of Columbus also put efforts into this project to ensure continuity of undisturbed condition. Currently in the project area there are some problems related to lack of monitoring and management strategies. The current monitoring is not responsive to protection of the restored ecosystems and the area itself. In addition to that, monitoring data is not publicly available, nor performed in the recommended monthly cycles needed to provide effective input to management actions.
Monitoring and Management (M&M) strategies will be based on public involvement, as it is the most available labor pool for the on-going efforts needed. As Purcell et al. (2007) states, in order to promote sense of involvement and community ownership, suggested Monitoring and Management (M&M) strategies will be based on public involvement.
Chapter 4: Monitoring and Management Actions

4.1 Clover Groff Restoration Monitoring Plan

In this chapter, it is going to be explained how an effective and unfunded monitoring can be conducted in restored areas. In spite of the fact that Clover Groff Run has been restored, most of the anthropogenic and natural degradation forces are still active. Immediately after restoration project has been completed, it might be seen restoration project meets the defined goals and objectives. However, as time goes by, degradation forces will continue to play active role in degradation process. The most effective way to follow is conducting monitoring consistently in lieu of monitoring once or twice a year. Typical monitoring plans offer a few times monitoring during on first year and few times on third year and fifth year after restoration (Thayer et. al, 2003). However, for the restored area to be recovered, consistent monitoring helps early identification of the problems which is so important for a restoration project to be sustainable. Weekly monitoring should start with completion of the construction (Thayer et al., 2003).

To monitor area on a weekly basis, from mid-February to mid-May (2012) Clover Groff Run stream restoration area has been visited. During these visits, some problems have been identified related to human based (anthropogenic) degradation. Even though the main aim was “re-naturalization” of the stream, creation of wildlife habitat, increase
in water quality and construction of meandering characteristics to the stream (Seger, 2008), algae blooms, unstable and eroded streambanks due to land misuse, excessive stormwater runoff and invasive species are still be agenda. As mentioned before, monitoring data should include information about the condition of vegetation cover, animals (fish, invertebrates, birds) within the project area, water condition, sediment deposition, outside temperature and water temperature, bank erosion and other problems areas (Clinton et al., 2005). It might also include attitudes of other visitors, site managers, personnel and adjacent residents, such as appropriate/inappropriate uses of the area (Eubanks, 2004). In order to compare restored area and reference area, same monitoring formats and techniques should be adopted to gather data. Visual and audio techniques are always helpful to detect changes, so taking photos of the problematic areas and audio recording of birds’ singing constantly from the same spots allow comparison of previous visits and current condition (Eubank, 2004).

After project area had been observed two to-three times, degradation factors were observed. According to intensity of degradation forces in the project area, four monitoring stations were established, and according to abundance of vegetation and bird density two audio recording stations were sited. The following figures show the degradation factors in Phase I adjacent to Franks Park restoration area. Unless otherwise cited, figures in this chapter are from Gulsah Bilge (2012).
Figure 4.1: Children impacting slope

Figure 4.2: Children building “bridge”

Figure 4.3: Bikers taking photos

Figure 4.4: Bikers around stream

Figure 4.5: Soccer areas and riparian area

Figure 4.6: Children throwing small rocks
Management practices are shaped according to harvested monitoring data (Eubanks, 2004). So, management cannot start before the area is monitored. Monitoring allows us to define specific problematic areas with specific issues. According to these specific problems, specific solutions should be suggested. The best way to do so is monitoring the area before restoration, during construction and after completion of restoration (Thayer et al., 2003). Following photos give information about pre-restoration and post-restoration condition of selected monitoring stations in Clover Groff restoration area:

Installation of abutments, relocation of stream channel, widened floodplain and riffles can be seen in Figure 4.9 and Figure 4.10. As one of the most degraded areas in Phase I, this Monitoring station experienced land misuse, habitat loss, pulled out vegetation cover, excessive stormwater run stream and related to that geotextile fabric has become visible. While pre-restoration condition has some trees, mass excavation and ripped of top soil combining human impacts caused unvegetated stream banks. Even
though trees, shrubs, grasses were planted along the stream (Seger, 2008), this area needs additional actions.

![Pre-restoreation bridge](image1.png)  ![Post-restoreation bridge](image2.png)

Figure 4.9: Pre-restoreation bridge  Figure 4.10: Post-restoreation bridge

Previously the stream was straightened and deepened (Seger, 2008) in Figure 4.11, it can be seen that stream is located in between trees while in Figure 4.12 stream has been relocated and meanders have been constructed without damaging native healthy trees. Even though the color of water changed and it seems healthier lately, in Figure 4.12, algae blooms are a problem potentially the result of the lawn treatments from golf course upstream and surrounding development.
Even though algae may be an indicator for healthy aquatic ecosystems, excessive amount of algae may threaten the stream health. This entire nutrient loading entering from the outfalls directly into the stream system is not a good thing and may be the cause of the algae we are seeing. The constructed floodplain is able to filter much of these external inputs; however, high runoff and drain tile may bypass the buffer.
Previously, stream had steep and high banks covered with invasive species. With the restoration project, pressure on the streambanks has been reduced and floodplain widened and incorporated wetlands have been constructed in order to preserve and develop water quality. To prevent erosion of streambanks and provide stability vegetation cover plays a key role. In Figure 4.20 it can be seen that native plants on gently sloping stream banks allow excessive sediment deposition within the stream channel.
Monitoring can be conducted by elementary school or middle school students for educational purposes while increasing awareness about the restoration area and improving sense of community ownership in order to take care of stream. There is a similar stream restoration project in Berkeley, CA. called Strawberry Creek. Local schools and colleges were involved first to increase awareness and educate local residents about restored area and its conservation (Purcell et al, 2007). College students conducted pre-restoration monitoring related to vegetation with the aim of restoration project to
remove invasive species. The high school students removed exotic plants and replanted native species under the supervision of graduate students (Purcell et al., 2007).

Post-restoration monitoring data showed that native vegetation cover increased with this effort and surveys indicated that “students’ involvement in the restoration activities increased their awareness and appreciation of the creek’s value and educated them about scientific concepts of restoration and conservation” (Purcell et al, 2007).

A similar strategy can be followed in the Clover Groff restoration to reduce human related degradation. In addition to monitoring, potentially some competitions can be organized within the surrounding neighborhood to have more people involved and allow these people have fun interacting with each other and competing for a fun prize or honor, as part of the stream care project.
4.2 Data “harvest” Development of Data Collection Templates to Inform Management Action

Monitoring data should be gathered properly, because monitoring results inform management actions. Proper monitoring data allows for: consistent and accurate results, comparison between previous conditions and current condition/improvement or degradation in the area. By harvesting data with repeatable techniques and utilizing a standardized format for monitoring data can better inform decisions. (Clinton et al., 2005). While annual monitoring is conducted in spring, consistent monitoring should be conducted at least twice a month in order to define changes, development and degradation in project area. Typical monitoring results, monitoring data of the Clover Groff restoration area should be publicly available. That’s why public involvement is suggested for harvesting monitoring data, because Clover Groff Ditch is located in a development area and it has opportunity to have local residents’ conservation efforts be part of the solution to the continuing degradation.

Public involvement is the key point for the success of restoration and to meet the restoration goals and objectives (Goebel, 2011). This involvement might be provided by surrounding schools, churches’ youth groups, citizens, organizations or other interested parties; however, the problem is that volunteer monitoring data may all be different and may not be a helpful source during the management decision process. In order to resolve this usable data conflict, it is first needed to answer the question: “how can we get usable data from volunteers?”. The answer comes out to be that if prototype monitoring forms and consistent monitoring stations are used for restoration monitoring by volunteers, data will be inconsistent format and it will provide longitudinal data as well as alert managers
to critical “spots” for early interventions and mitigation of serious degradations. As part of the work standardized monitoring forms have been designed, connected to field located monitoring stations 1-4 for site impacts, and A and B for birds. (Appendix C-D).

These monitoring forms adopt the areas identified in the site observations and provide readily identifiable scales of impact and images for volunteer monitors to use in their observations. The forms can potentially be delivered to users via the web or through handouts to those who seek a permit to run environmental classes, clean-ups or other activities in the park.
Chapter 5: Conclusion

Based on the assessment of Clover Groff Run stream restoration and developed monitoring strategy, there are some parts in this research that are not yet completed for the management actions to be considered completed. The management actions will be informed as monitoring forms are collected. The data that needed to be collected by monitoring the restored area to inform management actions are included in chapter 4. Most of the data requires collection of consistent usable longitudinal monitoring data which aims monitoring designated stations. Monitoring stations can easily be found on area with monitoring station identification signs and provided maps. There will be signboards includes introductions to give information about “where to monitor?” and “what to monitor?” as standing on the monitoring stations. All four stations have sub-stations in response to specific degradation factors and specific directions to take photos according to specific prototype work frame.

Proposed monitoring strategies and forms for Clover Groff restoration area have not been tested due to time constraints. Since first year monitoring has been completed recently, degradation forces still present in the area will not be considered until third year after project labeled as completed. Hence, with this proposed monitoring plan, it will be easy to download these monitoring forms from the website of Columbus Recreation and Parks Department. Upon completion of monitoring and monitoring forms, it is possible to
upload documents via website or to send email to Columbus Recreation and Parks Department. After all data acquired, full management actions can be defined according to results of monitoring forms and identified degradation factors by starting with mitigation of anthropogenic impacts. With these monitoring forms, potential degradation forces will be identified and early identification will allow better support of the restoration project.

Upon installation of monitoring stations, field testing can be conducted for revisions. For Clover Groff Stream restoration to be successful and ultimately self-sustaining, the management actions connected to the input from monitoring data can be developed. If these monitoring forms and potential management actions are successful in response to support of restoration, it may serve as a model for other restoration projects. Moreover, similar restoration projects may follow these monitoring strategies.

Limitations,

Primarily time and resources, ideally physical monitoring stations or GPS cues could be placed on site for monitoring, and actual test of the forms could be done.

Future research,

GPS based monitoring program may be suggested instead of building monitoring stations so that people can use their phone or another portable device to access the wireless connection that is provided in the area. Therefore, there is no need to build new monitoring stations and contribute to destruction of the area.

In addition to all these future work opportunities, new iphone application may be created. This application may offer choices as taking photos of streambanks and stream
itself to decide current condition. It will allow uploading photos directly to the system. Coordinates of the monitoring station will be showed, when photo is taken. It is more environmentally friendly approach for a restoration monitoring strategy.

Conclusions,

Refinement and testing of the forms, exploration of delivery systems for the volunteer/citizen scientist to participate, investigation of the administrative implications of such a volunteer force for ecological/restoration monitoring, and a full monitoring and management protocol based on the research identified.

All of these are future outgrowths of this work, with this work providing Columbus Recreation and parks with the potential for becoming a leader in restoration monitoring and management through volunteer efforts.
References


- Bilge, G. 2012. Monitoring Clover Groff Stream Restoration from mid-February to mid-May. The Ohio State University. Columbus, OH


• Columbus Recreation and Parks. 2012. Clover Groff Run Stream Restoration. Columbus, OH.


• Goebel, C. (2011). “Rehabilitation and Restoration of Ecosystems”, the Ohio State University. Columbus, OH.


• Oxbow River and Stream Restoration, Inc. (2011).


• Philadelphia Water Department. 2012. Waterways Restoration. Received 19 April, 2012 from [http://www.phillywatersheds.org/what_were_doing/waterways_restoration](http://www.phillywatersheds.org/what_were_doing/waterways_restoration)


Appendix A: Documents Relating to Clover Groff Run Stream Restoration
Clover Groff Ditch Pre-Restoration Condition and Restoration Plan (Columbus Recreation and Parks, 2012)
Clover Groff Run Stream Restoration Site Plan (Columbus Recreation and Parks, 2012)
Clover Groff Run Stream Restoration Project Board (Columbus Recreation and Parks, 2012)
Appendix B: Thesis Presentation, 18.05.2012

Attendees: Deborah Yale Georg,

Jason Kentner,

Bradley Westall,

Justin Loesch.
DEVELOPMENT OF
MONITORING STRATEGIES
TO INFORM
MANAGEMENT ACTIONS

In support of
Riparian Ecosystem Restorations:
as applied to CLOVER GROFF STREAM RESTORATION

Gulsah Bilge
05.18.2012

Deborah Yale Georg (Advisor)
Jason Kentner (Committee Member)

Special Thanks to
Columbus Recreation and Parks Department
Bradley Westall
Justin Loesch
OVERVIEW

- The question
- The justification
- The methodology
  - The literature
    - Restoration in response to anthropogenic disturbance
    - M & M: what, when, who
    - Case Study test
  - Need for study site
  - Site selection
  - Site review/prelim observations
  - Development of monitoring metrics/specifics
  - Establishment of test monitoring locations
  - Test monitoring March-May 2012
- Findings related to anthropogenic disturbances:
  - 3 primary causes
  - Test Monitoring Results
  - Monitoring model for field application by Volunteers

Conclusions

HEALTHY AND UNHEALTHY STREAMS

- Streambank stability
- Bank storage of water
- Lower velocity
- Native Habitats (supply food)
- Cool and clean water
- Severely eroding banks
- Large debris flows/flood debris
- Lack of vegetation/fish invertebrates
- Siltation
- Loss of native plants and habitats

http://www.phillywatersheds.org
**STREAM RESTORATION**

*Removal of a disturbance*

**ACTIONS**
- Stabilization of stream banks,
- Installation of stormwater management facilities,
- Protecting water quality,
- Providing wildlife habitat,
- Replanting (Cronin, 2003).

**ALTERATIONS**
- Channel shape (sinuosity and meander characteristics),
- Cross-section and channel profile (slope along the channel bed)
- Water quality issues
  - Erosion
  - Habitat degradation

---

**PROCESS OF RESTORATION**

- Technical repair
- Replanting/ vegetating’
- Erosion Control
- REMOVAL or mitigation of disturbances
- Completion and monitoring to inform management actions
- Management and mitigation/ supportive actions
- Continued monitoring and Feedback to Management Plan

---

**Construction**
- Stripping top soil

---

**Design Development**
- Pre-monitoring

**New floodplain excavation**
- Creation of wetlands
- Replacement of top soil

**Assessment**
- Monitoring
- Management

---

Cronin, 2003; Sager, 2008
DEGRADATION FACTORS WHICH CAUSE NEED FOR RESTORATION:

Degradation Factors:

- **Urbanization**
  - Storm water Outfalls/ Point Discharges
  - Excessive Stormwater Runoff
  - Unstable and Eroding Banks
- **Invasive Species**
- **Land misuse**
  - Uncontrolled Use of Area by Pedestrian and Bicycles
  - Area Compaction
  - Plant and channel debris removal/ relocation/ insertion
  - Excessive usage in areas not designed for pedestrians (stream banks)

Riparian restorations are developed in response to ecosystems destroyed or impaired by natural and anthropocentric degradations forces (Goebel, 2011), including the degradation effects of urbanization, land misuse and habitat destruction from invasives.

METRICS OF RESTORATION SUCCESS

- **Stakeholder Success**
  - Aesthetics
  - Economic Benefits
  - Recreation
  - Education
- **Learning Success**
  - Scientific contribution
  - Management Experience
  - Improve Methods
- **Ecological Success**
  - Guiding image exists
  - Ecological improvement
  - Self-sustaining
  - No lasting harm done
  - Assessment completed

Palmer et al., 2005
PURPOSE OF THE STUDY

- M & M no longer integral to process (Higgs, 2003).
- Monitoring = 1/year sampling in years 1, 3 and 5
- Management plan and funding eliminated
- Monitoring is reduced to documentation of status no feedback or resultant action produced by monitoring results

- How can better monitoring occur?
- Who can do it?
- How can it be consistent?
- How can it inform management actions?

WHY A CASE STUDY?

- Key researchers use this methodology to test and evaluate site based system practices
- Hypothetical modeling would not provide insight to the anthropogenic degradations which occur.
- Provides an opportunity to test findings in “real world” environment
**BIG DARBY CREEK**

- Important Water Resource in Central Ohio
- Exceptional Water Quality
- Most Biologically Diverse (Fish/ Mussels/ Invertebrates)
- State and National Scenic Rivers
- Provide Habitat for Endangered Species

**Pollution sources**
- Agriculture
- Sewage Development,
- Urban Runoff,
- Channelization,
- Riparian Removal.

**Decline in Water Quality and Stream Habitat**
- Nutrient enrichment
- Organic Enrichment
- Siltation,
- Habitat alterations.

**BIG DARBY CREEK - CLOVER GROFF DITCH**

*The Darby Creek Watershed*

*accad.osu.edu, 2011*

*epa.ohio.gov, 2011*
CLOVER GROFF RESTORATION

- Farming activities
- Deepened, widened and straightened
- Loss of native plants and habitats
- Sediment load, stagnant, channelized
- Polluted (runoff) and warm

- **Columbus Recreation and Parks Department:** Preparation of Stream Restoration Plan
- **Shaw & Holter, Inc.:** Contractor
- **Oxbow River and Stream Restoration:** Sub-contractor
  Minimum impact to the environment

- **Budget:** $1,587,120
- **Funding:** OEPA Water Resource Restoration Sponsorship Program

Three phases of restoration

- Riffle/ Run/ Pool System
- Slope Rounding and Re-vegetation
- Invasive Species
- Bridges
- Outfalls
- Log Jam Complexes
- Wetland Maintenance

Natural Channel Design

Oxbow River and Stream Restoration, 2010
CLOVER GROFF RESTORATION

Phase I:
- 1.1 miles of ditch
- 5.5 miles from the Hellbranch Run Confluence
- 5,775 linear ft functional stream/ Floodplain

DEVELOPED PLAN
- Floodplain min 100’
- Incorporated Wetlands
- Re-“Naturalize” Ditch with Riffles and Pools
- Planted Shade Trees and Native Grasses
- Abundant Places for Wildlife to Establish

INTERVENTIONS TO STREAM
Entrenched, polluted ditch
- Functioning stream with new floodplain,
- Sinuous channel,
- Coarse substrate,
- Riffle/ run/ pool flow

Qualitative Habitat Evaluation Index (QHEI) gives a quantitative assessment of physical and biological characteristics of a sampled Stream. QHEI is critical for assessing disturbance and land use practices (EPA, 1994).

Condition of Substrate, In-stream Cover, Channel Morphology, Riparian Zone, Pool/ Riffle and Map Gradient

Clover Groff:
- Pre restoration QHEI score: 22
- Required min QHEI : Min 56
  (Warm Water Habitat water quality or Class III Primary Headwater Habitat criteria)
- When completed QHEI score: 64 (Fall 2011)
WHY MONITORING & MANAGEMENT (M&M)?

**Monitoring**
- To check has the restoration met its objectives
  - Reference site Comparison
  - Pre/Post-Restoration Comparison
  - Measurement and Observation
  - Requirement definition
  - Current Monitoring data not public (Hooper, 2009)

**Management**
- To Test Project Objectives and Goals
  - Linkage between Science and Decision Making
  - Adjustment Implementation,
  - Improvement the Probability of Restoration Success
  - Protection and Sustainability of the Area
  - Better meet the goals of the restoration (Hooper, 2009)
SUSTAINING RESTORED ECOSYSTEMS

Can monitoring strategies and management actions be used to support restoration viability?

• Goal: Design an effective monitoring strategy using community resources to inform management actions.

TEST MONITORING STATIONS

Mid February-mid May Monitoring
• Urbanization
  + Storm water Outfalls/ Point Discharges
  + Excessive Stormwater Runoff
  + Unstable and Eroding Banks
• Invasive Species
• Land misuse
  + Uncontrolled Use of Area by Pedestrian and Bicycles
  + Soil Compaction
  + Plant and channel debris removal/ relocation/ insertion
  + Excessive usage in areas not designed for pedestrians (stream banks)

Modified from: Oxbow River and Stream Restoration, 2010
STREAM AND GRASSED BANK: MONITORING STATION 1

Oxbow River and Stream Restoration

Pre-restoration summer condition

Post-restoration spring condition

Post-restoration spring condition with degradation factors

STREAM BANKS: MONITORING STATION 2

Oxbow River and Stream Restoration

Pre-restoration summer condition

Post-restoration spring condition

Post-restoration spring condition
STREAM CHANNEL AND FLOODPLAIN:
MONITORING STATION 2

Pre-restoration summer condition
8.29.2006
Post-restoration spring condition
3.25.2012

STREAM CHANNEL AND SEEDBANKS:
MONITORING STATION 2

Pre-restoration summer condition
Post-restoration winter condition
Post-restoration spring condition

Oxbow River and Stream Restoration
STAGNANT POOL CONDITION WITH OUTFALL:
MONITORING STATION 4

Pre-restoration spring condition

Post-restoration spring condition

9.4.2006
3.25.2012
4.29.2012

OXBOW RIVER AND STREAM RESTORATION

STORMWATER RUNOFF FROM BUILDINGS:
MONITORING STATION 4

Post-restoration spring condition after heavy rain event

3.11.2012
3.25.2012

4B
4B
MONITORING

× HOW CAN AN EFFECTIVE AND UNFUNDED MONITORING BE CONDUCTED IN RESTORATION AREA?

√ Public Involvement is the KEY (Purcell et al, 2007)
√ Citizens
√ Schools and Youth Groups,
√ Organizations and other interested parties

× HOW CAN WE GET USABLE DATA FROM VOLUNTEERS?
  × Monitoring forms
  × Involvement

MONITORING: OVERVIEW

Riparian Areas

× Riparian Areas Stream Channels
× Noxious weed invasion,
× Hedged shrubs,
× Encroachment of upland shrub species,
× Mostly old riparian shrubs and trees few young plants,
× Fewer native grasses" (MRWAEC, 2012).

Stream Channels

× “Channel widening,
× Unvegetated, eroding streambanks,
× Increased frequency of new streambanks,
× Channel downcutting,
× Increased silt/clay on channel bottom
× Stream unable to overflow its banks during annual spring runoff” (MRWAEC, 2012).
MONITORING GUIDES AND FORMS:

- Distributed to those seeking permission for “cleanups”, environmental and educational activities
- Web based delivery of forms, return via email or web
- Development of Monitoring Record forms for volunteer use
  - Coordinates monitoring efforts to produce useable longitudinal data
  - Coordinates monitoring data for specific “target” monitoring stations
  - Provides opportunity for public “science” and environmental education
  - Gives real involvement and partnering with the public in the management actions.

MANAGEMENT ACTIONS

Observed monitoring data ➔ Management actions

- Early Identification
  - Specific Areas: Specific Problems/ Specific Solutions
    - Mostly summer use- Fall construction

- Anthropogenic impact mitigation: control of visiting areas,
  - Closing the area to visitors during recovery
  - Observing the recreational impacts
  - Managing people’s perception, action and needs,
  - Management intensification: mitigate degradation impacts
  - Removal of invasive species, if needed replanting
  - Public involvement,
LIMITATIONS OF THE STUDY

- Site Factors
  - Active Degradation Forces

- Time
  - Lack ability to test on the field
  - Time frame (From February to May)
  - Completeness of monitoring to inform full management actions

OUTCOMES

- Future studies and work which could follow:
  - Field testing form revision
  - Develop a management plan connected to Monitoring
  - Serve as a model
  - Similar project follow the monitoring plans
Questions?

WORK CITED

- epa.chicago.gov, 2011
- Goebel, C 2011. “Rehabilitation and Restoration of Ecosystems”, The Ohio State University. Columbus, OH.
- Leach, J. 2011. Evaluation of the Clover Groff Stream Restoration – Phase I. The Ohio State University. Columbus, OH.
Appendix C: February 9, 2012 to April 20, 2012 Preliminary Monitoring Forms and Data
**Clover Groff Restoration Area**  
Riparian Area & Stream: Station ____

| Date and time: |  
|---|---|---|---|---|
| Weather Conditions: |  
| Volunteer Monitoring Group Name: |  
| Team Name: |  

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Indicator Number (1-10)</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We use standard observation to collect data for the **condition of streambanks, land forms, stream form, need for replanting, land misuse, excessive stormwater runoff, unstable eroding banks** and any other problem related to area. Severity will be rated 1: lowest level impact, 3: moderate and 5: high impact areas. Data will be collected at one of the determined monitoring stations (A-B-1-2-3-4). At the monitoring station, photos will be required to complete survey.
Clover Groff Restoration Area

Water Quality: Station ____

Date and time: ____________________________

Weather Conditions: ____________________________

Volunteer Monitoring Group Name: ____________________________

Team Name: ____________________________

<table>
<thead>
<tr>
<th>Flow Severity</th>
<th>Algae Cover</th>
<th>Water Color</th>
<th>Water Surface</th>
<th>Water Condition</th>
<th>Water Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(NF) No Flow</td>
<td>(NA) Absent</td>
<td>(NC) No Color</td>
<td>(Cl) Clear</td>
<td>(Ca) Calm</td>
<td>(NO) None</td>
</tr>
<tr>
<td>(Lo) Low</td>
<td>(Ra) Rare (&lt;25)</td>
<td>(LG) Light Green</td>
<td>(Sc) scum</td>
<td>(Ri) Ripples</td>
<td>(O) Oil</td>
</tr>
<tr>
<td>(N) Normal</td>
<td>(Co) Common (26-50)</td>
<td>(DG) Dark Green</td>
<td>(Fo) foam</td>
<td>(W) Waves</td>
<td>(Ac) Acrid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Pungent)</td>
</tr>
<tr>
<td>(Fl) Flood</td>
<td>(A) Abundant (51-75)</td>
<td>(Re) Red</td>
<td>(Db) Debris</td>
<td>(We) White Caps</td>
<td>(Sw) Sewage</td>
</tr>
<tr>
<td>(Hi) High</td>
<td>(Do) Dominant (&gt;75)</td>
<td>(Ta) Tan</td>
<td>(Sh) Sheen</td>
<td></td>
<td>(RE) Rotten Egg</td>
</tr>
<tr>
<td>(Dr) Dry</td>
<td>(G/B) Green/Brown</td>
<td></td>
<td></td>
<td></td>
<td>(F) Fishy</td>
</tr>
<tr>
<td></td>
<td>(Bl) Black</td>
<td></td>
<td></td>
<td></td>
<td>(M) Musky</td>
</tr>
</tbody>
</table>

Other:

Air Temperature: ____________________________

Water Temperature: ____________________________

Data will be collected at one of the determined monitoring stations (A-B-1-2-3-4). Please choose the one best fits your stream’s water condition? Monitoring stations may differ in terms of quality conditions. At the monitoring station, photos will be required to complete survey.
**Clover Groff Restoration Area**

Invasive Species: Station ____

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Infestation Rate</th>
<th>Number of Plant (In small area)</th>
<th>Coverage by Plant (In small area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiflora Rose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teasel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada thistle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ailanthus sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daylily sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japanese Bush</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeysuckle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other:

To complete the form you will need to choose 1x1m area first. If you think this area gives information about the area general, you can fill the form out. If you do not think the area is introductory enough, you may double area until you feel comfortable. Data will be collected at one of the determined monitoring stations (A-B-1-2-3-4). At the monitoring station, photos will be required to complete.
**Clover Groff Restoration Area**

**Bird Monitoring: Station A**

<table>
<thead>
<tr>
<th>Number of Species</th>
<th>List Species Observed</th>
<th>Banded Yes/No?</th>
<th>If Yes Band Colors &amp; Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Comments:**

We use standard five minute point counts to collect data for bird monitoring. Data will be collected at determined bird monitoring stations (A-B), and also bird count data from other monitoring stations will be gathered. At the stations (A-B), 1 minute audio recording will be required to complete survey.
Clover Groff Restoration Area
Bird Monitoring: Station B

Date and time: ____________________________________________
Weather Conditions: _______________________________________
Volunteer Monitoring Group Name: ___________________________
Team Name: ______________________________________________

<table>
<thead>
<tr>
<th>Number of Species</th>
<th>List Species Observed</th>
<th>Banded Yes/No?</th>
<th>If Yes Band Colors &amp; Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other Comments:

We use standard five minute point counts to collect data for bird monitoring. Data will be collected at determined bird monitoring stations (A-B), and also bird count data from other monitoring stations will be gathered. At the stations (A-B), 1 minute audio recording will be required to complete survey.
Appendix D: May 18, 2012 Revised Monitoring Forms
### Clover Groff Restoration Area

**Invasive Species:**

Circle Monitoring Station Observed: 1 2 3 4 A B

Sub: a b c

<table>
<thead>
<tr>
<th>Date and time:</th>
<th>Weather Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volunteer Monitoring Group Name:</th>
<th>Team Name (Optional):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Designated plants may be found in the area. Data will be collected at one of the determined monitoring stations (A-B-1-2-3-4). At the monitoring station, photos are required to complete survey.

<table>
<thead>
<tr>
<th>Common Name</th>
<th># of Plant</th>
<th>Coverage by Plant</th>
<th>Rating</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiflora Rose</td>
<td></td>
<td></td>
<td>No 1-2 Exist Covering</td>
<td>Shrub</td>
</tr>
<tr>
<td>Teasel</td>
<td></td>
<td></td>
<td>No 1-2 Exist Covering</td>
<td>Biennial</td>
</tr>
<tr>
<td>Canada thistle</td>
<td></td>
<td></td>
<td>No 1-2 Exist Covering</td>
<td>Perennial</td>
</tr>
<tr>
<td>Ailanthus sp.</td>
<td></td>
<td></td>
<td>No 1-2 Exist Covering</td>
<td>Tree</td>
</tr>
<tr>
<td>Daylily sp.</td>
<td></td>
<td></td>
<td>No 1-2 Exist Covering</td>
<td>Perennial</td>
</tr>
<tr>
<td>Japanese Bush Honeysuckle</td>
<td></td>
<td></td>
<td>No 1-2 Exist Covering</td>
<td>Shrub</td>
</tr>
</tbody>
</table>

**Other:**

---

94
### Clover Groff Restoration Area

**Bird Monitoring: Station A**

<table>
<thead>
<tr>
<th>Date and time:</th>
<th>Weather Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volunteer Monitoring Group Name:</td>
<td>Team Name (Optional):</td>
</tr>
</tbody>
</table>

(A B 1 2 3 4). Please choose the one best fits your stream’s water condition? Monitoring stations may differ in terms of quality conditions. At the monitoring station, photos will be required to complete survey.

- Blue Heron
- Green Heron
- Mallard Duck
- Belted Kingfisher
- Cardinal
- Bobolink
- Scarlet Tanager
- Parula
- Yellow-throated Warblers
- Carolina Chickadee
- Northern Mockingbird
- Eastern Meadowlark
- Pileated Woodpecker

Other:
### Clover Groff Restoration Area

**Bird Monitoring: Station B**

<table>
<thead>
<tr>
<th>Date and time:</th>
<th>Weather Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volunteer Monitoring Group Name:</th>
<th>Team Name (Optional):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(A B 1 2 3 4). Please choose the one best fits your stream’s water condition? Monitoring stations may differ in terms of quality conditions. At the monitoring station, photos will be required to complete survey.

#### Bird Species

- **Blue Heron**
- **Green Heron**
- **Mallard Duck**
- **Belted Kingfisher**
- **Cardinal**
- **Boboloink**
- **Scarlet Tanager**
- **Parula**
- **Yellow-throated Warblers**
- **Carolina Chickadee**
- **Northern Mockingbird**
- **Eastern Meadowlark**
- **Pileated Woodpecker**

**Other:**
### Clover Groff Restoration Area

#### Bird Monitoring

Circle Monitoring Station Observed:  1  2  3  4  A  B  Sub:  a  b  c

Date and time: 

Weather Conditions:

Volunteer Monitoring Group Name:

Team Name (Optional):

(A  B  1  2  3  4). Please choose the one best fits your stream’s water condition? Monitoring stations may differ in terms of quality conditions. At the monitoring station, photos will be required to complete survey.

<table>
<thead>
<tr>
<th>Blue Heron</th>
<th>Green Heron</th>
<th>Mallard Duck</th>
<th>Belted Kingfisher</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Blue Heron" /></td>
<td><img src="image2.png" alt="Green Heron" /></td>
<td><img src="image3.png" alt="Mallard Duck" /></td>
<td><img src="image4.png" alt="Belted Kingfisher" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cardinal</th>
<th>Bobolink</th>
<th>Scarlet Tanager</th>
<th>Parula</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Cardinal" /></td>
<td><img src="image6.png" alt="Bobolink" /></td>
<td><img src="image7.png" alt="Scarlet Tanager" /></td>
<td><img src="image8.png" alt="Parula" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yellow-throated Warblers</th>
<th>Carolina Chickadee</th>
<th>Northern Mockingbird</th>
<th>Eastern Meadowlark</th>
<th>Pileated Woodpecker</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9.png" alt="Yellow-throated Warblers" /></td>
<td><img src="image10.png" alt="Carolina Chickadee" /></td>
<td><img src="image11.png" alt="Northern Mockingbird" /></td>
<td><img src="image12.png" alt="Eastern Meadowlark" /></td>
<td><img src="image13.png" alt="Pileated Woodpecker" /></td>
</tr>
</tbody>
</table>

Other:
# Clover Groff Restoration Area

## Water Quality:

Circle Monitoring Station Observed: 1 2 3 4 A B
Sub: a b c

<table>
<thead>
<tr>
<th>Date and time:</th>
<th>Weather Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Volunteer Monitoring Group Name: ______________________________________

Team Name (Optional): ________________________________________________

(A B 1 2 3 4). Please choose the one best fits your stream’s water condition? Monitoring stations may differ in terms of quality conditions. At the monitoring station, photos will be required to complete survey.

---

### 1 Water Condition

<table>
<thead>
<tr>
<th>(Ca) Calm</th>
<th>(Ri) Ripples</th>
<th>(W) Waves</th>
<th>(We) White Caps</th>
</tr>
</thead>
</table>

### 2 Water Surface

<table>
<thead>
<tr>
<th>(Cl) Clear</th>
<th>(Sc) scum</th>
<th>(Fo) foam</th>
<th>(Db) Debris</th>
<th>(Sh) Sheen</th>
</tr>
</thead>
</table>

### 3 Flow Level

<table>
<thead>
<tr>
<th>(Dr) Dry</th>
<th>(NF), Pool No Flow</th>
<th>(Lo) Low</th>
<th>(N) Normal</th>
<th>(Fl) Flood</th>
<th>(Hi) High</th>
</tr>
</thead>
</table>

### 4 Water Color

<table>
<thead>
<tr>
<th>(Tr) Transparent</th>
<th>(B) Blue</th>
<th>(LG) Light Green</th>
<th>(DG) Dark Green</th>
<th>(R) Red</th>
<th>(T) Tan</th>
<th>(G/B) Green/Brown</th>
<th>(B) Black</th>
</tr>
</thead>
</table>

### 5 Water Odor

<table>
<thead>
<tr>
<th>(NO) None</th>
<th>(P) Petroleum</th>
<th>(Ch) Chemical (Other)</th>
<th>(O) Oil</th>
<th>(Ac) Acrid (Pungent)</th>
<th>(Sw) Sewage</th>
<th>(RE) Rotten Egg</th>
<th>(F) Fishy</th>
<th>(M) Musky</th>
</tr>
</thead>
</table>

### 6 Algae Cover

<table>
<thead>
<tr>
<th>(NA) Absent</th>
<th>(Ra) Rare (&lt;25)</th>
<th>(Co) Common (26-50)</th>
<th>(A) Abundant (51-75)</th>
<th>(Do) Dominant (&gt;75)</th>
</tr>
</thead>
</table>

Other:

Air Temperature: ______________________ Water Temperature: ______________________
### Clover Groff Restoration Area: Riparian Zone

Circle Monitoring Station Observed: 1 2 3 4 A B Sub: a b c

<table>
<thead>
<tr>
<th>Date and time:</th>
<th>Weather Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volunteer Monitoring Group Name:</td>
<td>Team Name (Optional):</td>
</tr>
</tbody>
</table>

Collect data for the condition of riparian zone. Severity will be rated **1: lowest level impact, 3: moderate and 5: high impact** areas. Data will be collected at one of the determined monitoring stations (A-B-1-2-3-4). At the monitoring station, photos are required to complete survey.

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misuse</td>
<td>Bikes in Stream</td>
<td>Inappropriate Recreation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Compaction</td>
<td>None, Low, Medium, High</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denudation</td>
<td>Plants well established, Plants showing disturbance, Plants to soil 50/50, Major disturbance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion</td>
<td>Healthy, Impacted, Eroding, Destabilized Down-cutting</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Sample Monitoring Forms as Applied April 29.04.2012
# Clover Groff Restoration Area

## Bird Monitoring: Station B

<table>
<thead>
<tr>
<th>Date and time:</th>
<th>4.29.2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Conditions:</td>
<td>Sunny (70 ° F)</td>
</tr>
<tr>
<td>Volunteer Monitoring Group Name:</td>
<td>Gulsah Bilge</td>
</tr>
<tr>
<td>Team Name (Optional):</td>
<td></td>
</tr>
</tbody>
</table>
**Clover Groff Restoration Area:** Riparian Zone

Circle Monitoring Station Observed:  

<table>
<thead>
<tr>
<th>Sub:</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
</table>

Date and time: 4.29.2012

Weather Conditions: Sunny (70° F)

Volunteer Monitoring Group Name: Gulsah Bilge

Team Name (Optional): __________________________

Collect data for the condition of riparian zone. Severity will be rated 1: lowest level impact, 3: moderate and 5: high impact areas. Data will be collected at one of the determined monitoring stations (A-B-1-2-3-4). At the monitoring station, photos are required to complete survey.

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misuse</td>
<td>5</td>
<td>Bikes in Stream</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Compaction</td>
<td>3</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denudation</td>
<td>4</td>
<td>Plants well established</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Severity (1-5)</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion</td>
<td>2</td>
<td>Healthy</td>
</tr>
</tbody>
</table>
Riparian Zone at Monitoring Station 1b (29.04.2012)
Clover Groff Restoration Area
Water Quality:
Circle Monitoring Station Observed: 1 2 3 4 A B
Sub: a b c

Date and time: 4.29.2012
Weather Conditions: Sunny (70° F)
Volunteer Monitoring Group Name: Gulsah Bilge
Team Name (Optional): 

*(A B 1 2 3 4). Please choose the one best fits your stream’s water condition? Monitoring stations may differ in terms of quality conditions. At the monitoring station, photos will be required to complete survey.*

<table>
<thead>
<tr>
<th>1 Water Condition</th>
<th>(Ca) Calm</th>
<th>(Ri) Ripples</th>
<th>(W) Waves</th>
<th>(We) White Caps</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Water Surface</td>
<td>(Cl) Clear</td>
<td>(Sc) scum</td>
<td>(Fo) foam</td>
<td>(Db) Debris</td>
</tr>
<tr>
<td>3 Flow Level</td>
<td>(Dr) Dry</td>
<td>(NF), Pool No Flow</td>
<td>(Lo) Low</td>
<td>(N) Normal</td>
</tr>
<tr>
<td>4 Water Color</td>
<td>(Tr) Transparent</td>
<td>(B) Blue</td>
<td>(LG) Light Green</td>
<td>(DG) Dark Green</td>
</tr>
<tr>
<td>5 Water Odor</td>
<td>(NO) None</td>
<td>(P) Petroleum</td>
<td>(Ch) Chemical (Other)</td>
<td>(O) Oil</td>
</tr>
<tr>
<td>6 Algae Cover</td>
<td>(NA) Absent</td>
<td>(Ra) Rare (&lt;25)</td>
<td>(Co) Common (26-50)</td>
<td>(A) Abundant (51-75)</td>
</tr>
</tbody>
</table>

Other:

Air Temperature: 70° F Water Temperature: -
Water Quality at Monitoring Station 3a (29.04.2012)