Manual of Fisheries Survey Methods

Chapter 27: Evaluation of Stream Habitat Improvement Projects

Jessica L. Mistak, Jeffrey J. Braunscheidel, Scott K. Hanshue, Frank D. Kolson, Andrew J. Nuhfer, Mark A. Tonello, and Todd C. Wills

Suggested citation:

Mistak, J. L., J. J. Braunscheidel, S. K. Hanshue, F. D. Kolson, A. J. Nuhfer, M. A. Tonello, and T. C. Wills. 2009. Evaluation of stream habitat improvement projects. Chapter 27 *in* Manual of Fisheries Survey Methods. Internal document on Intranet, Michigan Department of Natural Resources, Fisheries Division.

Table of Contents

Evaluation of Stream Habitat Improvement Projects

Jessica L. Mistak, Jeffrey J. Braunscheidel, Scott K. Hanshue, Frank D. Kolson, Andrew J. Nuhfer, Mark A. Tonello, and Todd C. Wills

Introduction

When stream habitat improvement is warranted, resulting projects must use techniques that are appropriate for Michigan's diverse fisheries management objectives and geographical regions. To ensure that projects are implemented using appropriate techniques, all stream habitat improvement projects in which Fisheries Division is involved, either through implementation or funding, should be accompanied by the following: defined goals and objectives, an approved Prescription, steps for documenting project effectiveness, and an evaluation using standardized methods. The resulting information on project effectiveness will be used to justify support for future habitat improvement work and to ensure future habitat improvement investments provide the greatest return.

Background

Habitat improvement projects in streams often involve the placement of structure either to decrease bank erosion or to improve instream habitat diversity. In Michigan, the use of structure to improve stream habitat began in the 1930s, or after the initial logging era had peaked (Hubbs and Eschmeyer 1938; Rodeheffer 1939, 1945). Since that time, considerable effort has been directed to improve fish habitat and increase fish production by stabilizing bank erosion, installing sediment traps, and constructing spawning riffles; as well as placing structures in streams such as log sills, whole trees, and boulder groupings.

A review by Steen (2003) of Michigan's stream habitat improvement projects found that approximately 36% of the projects involved sediment traps, while 47% involved habitat enhancement, and 53% included erosion control or bank stabilization. This review determined that very few projects included criteria to determine project success or failure, although 18% of projects were nonetheless rated as successful by the project manager. To support the above findings, a survey was conducted of stream habitat improvement projects completed within the past 10 years in which Fisheries Division had some level of input (T. C. Wills, Michigan Department of Natural Resources Fisheries Division, personal communication). This survey found that the primary objective of stream habitat improvement projects is often the removal of sediment (41%); followed by general habitat improvement (13%), bank stabilization (11%), and establishment of cover (11%). Yet, even with stated objectives, many projects were not evaluated to see if objectives were met (40%). The perceived effectiveness of the projects was low in general, with 7% considered excellent, 32% considered good, and the rest ranked poor or unknown. The survey also found that the most commonly used technique was sediment traps (35%), followed by bank stabilization (19%), and spawning riffles (11%). Other techniques, including addition of wood, lunker/bank structures, road-stream crossing improvement, wood structures, dam removal, riprap, and half-log structures were used much less. Multiple parties were involved in most stream habitat projects (27%), while Fisheries Division was solely responsible for 22% of the stream habitat projects. The U.S. Forest Service was responsible for 18% of all projects included in the survey and local watershed groups were responsible for 14%. Other entities such as universities, local governments, conservation districts, and interest groups were minimally involved in stream habitat improvement projects.

Issue

Recently, the practice of stream habitat improvement has been scrutinized, in part because of its often high cost and lack of project evaluation. The request for careful scientific investigation of stream habitat improvement projects has occurred on both a local scale (e.g., grant or funding organizations) and a national scale (e.g., Beschta et al. 1995; Kondolf and Micheli 1995; Smokorowski et al. 1998; Bash and Ryan 2002; Champoux et al. 2003; Moerke and Lamberti 2003, 2004; Bernhardt et al. 2005; Thompson 2006). Fisheries Division needs to document project effectiveness to justify support for future habitat improvement work and to ensure future habitat improvement investments provide the greatest return.

Implementation

Although it is time consuming, an assessment of the current water quality and habitat issues in the watershed, especially causes of impairment upstream of the proposed project, should be completed prior to implementation of a habitat improvement project. By addressing the causes of habitat degradation, we can increase the success of stream habitat improvement projects (Kauffman et al. 1997; Roper et al. 1997). To ensure that the physical framework of a stream provides support for the riparian and aquatic resources, geomorphic principles or natural channel design should drive the improvement project by considering channel shape, pattern, gradient, flow alterations, and sediment movement in the project design (Kondolf and Micheli 1995).

Evaluation

Individual projects should be monitored to not only measure project effectiveness over time and changing conditions, but also to refine the use of techniques. The cost of monitoring should be built into a project proposal. Frissell and Ralph (1998) appropriately stated that “no standard checklist, blueprint, or catalog exists for monitoring and evaluation that can be applied to all river and stream restoration programs and projects.” Instead, our monitoring plans should be created from a solid foundation of clearly defined objectives and subsequent evaluation (Dahme et al. 1995).

Fisheries Division staff should use existing tools (e.g., Streams Status and Trends Program and the Prescription process) to systematically collect data and store information related to stream habitat improvement projects. To carry out habitat improvement project evaluations, staff should follow standardized protocols developed for spawning riffles, sediment traps, bank stabilization, and fish cover structures. These procedures will be subject to periodic review and adjustments will be made as needed to ensure that projects are properly evaluated.

Streambank Stabilization Evaluation Procedure

Background

Streambank erosion is a natural geologic process that occurs in all rivers and streams. However, unnaturally high rates of erosion may result from a variety of anthropogenic disturbances at both local and watershed scales. For example, after a stream is channelized to accommodate watershed development, accelerated streambank erosion occurs as the stream seeks to reestablish a stable channel size and configuration. Damaging or removing streamside vegetation can also cause a dramatic increase in bank erosion. For example, runoff increases when land use changes occur in a watershed, such as clearing the land for agriculture or development. As the stream channel adjusts to accommodate the additional flow, increased streambank erosion occurs from the widening of the channel or downcutting of the streambed (which often creates high and unstable eroding banks). Accelerated bank erosion leads to increased sedimentation that damages aquatic habitat for organisms ranging from insects and mollusks to fish. Erosion control may be necessary where an area of streambank has been disrupted or destroyed by human activities and where restoration of the damaged bank will accelerate recovery to a more stable state. Thus, bank stabilization efforts are intended to reduce sedimentation to levels more representative of undisturbed systems.

Technique

Bank stabilization techniques can be categorized according to the type of materials used. Methods used include one or a combination of the following:

Soft materials

- Tree or brush revetments
- Bank revegetation – vegetative seeding, planting, or bio-engineering techniques such as live fascine bundles and live stakes

Hard materials

- Rock rip-rap
- Geotextiles and rock gabions
- Stairways or other structures that provide access to the water

Evaluation

The magnitude of each project plays a significant part in determining how much and what type of evaluation is conducted. An entire river or watershed rehabilitation project should be more intensively evaluated than a small project. Similarly, projects that involve new techniques or are unique in nature should be evaluated more thoroughly.

To assess the longevity of the project and whether the technique used was successful, every project should be documented by visual monitoring. Visual evidence of erosion, vegetative instability, or other adverse responses may require adjustments to the project. Large or unique projects should be monitored more intensively by evaluating substrate characteristics, bank stability, and bank erosion. Data should be collected from the exact same locations to provide repeatable measurements over an extended time period. Measures of success will be defined relative to the objectives of the project. Monitoring protocols for bank stabilization projects are shown in Table 1.

Methods

Assess the site at least once before construction to obtain pre-data, preferably during the summer (low-flow) months. Survey the area near the habitat improvement following construction as directed to monitor changes in the stream channel.

Visual Monitoring

During each visit, conduct a visual assessment of the site using the Visual Assessment Form (Appendix A). Draw a general map of the area showing identifying features. Record GPS coordinates for the bank stabilization project. In addition, digital photographs should be taken to document the location of the project.

Table 27.1.–Summary of monitoring procedures by habitat improvement project type.

Project type/ Objective	Visual monitoring	Substrate characterization (pebble count)	Other monitoring
Streambank stabilization			
Bank stabilization and reduced sediment input	Prior to treatment, and 1 and 3 years after treatment	Prior to treatment, and 1 and 3 years after treatment	Bank stability monitoring (bank pins): At time of treatment, and 1 and 3 years after treatment
			Bank Erosion Hazard Index (BEHI): Prior to treatment and 3 years after treatment
Spawning riffle			
Increase fish spawning success	Prior to treatment, and 1 and 3 years after treatment	Prior to treatment, and 1 and 3 years after treatment	Electrofishing: BACI[a] design- 2 consecutive years before, followed by a transitional period of 2 years, then 2 consecutive years after
Fish cover			
Add habitat complexity	Prior to treatment, and 1, 5, and 10 years after treatment		Longitudinal profile: (OPTIONAL–needed only if objective is to change instream channel habitat) Prior to treatment, and 1, 5, and 10 years after treatment
Increase abundance of fish of target size or age group	Prior to treatment, and 1, 5, and 10 years after treatment		Electrofishing: (OPTIONAL: BACI[a] design) 2 consecutive years before, followed by a transitional period of 2 years, then 2 consecutive years after
Increase angler catch rates and/or harvest of target species	Prior to treatment, and 1, 5, and 10 years after treatment		Creel survey: (OPTIONAL: BACI[a] design) 2 consecutive years before, followed by a transitional period of 2 years, then 2 consecutive years after
Sediment trap			
Increase number and depth of pools and/or increase fish spawning success	Prior to treatment, and 1, 2, and 5 years after treatment, and every following 5 years until trap is retired	Prior to treatment, and 1, 2, and 5 years after treatment, and every following 5 years until trap is retired	Longitudinal profile: Prior to treatment, and 1, 2, and 5 years after treatment, and every following 5 years until trap is retired
			Cross-section transect: Prior to treatment, and 1, 2, and 5 years after treatment, and every following 5 years until trap is retired
			Bank stability monitoring (scour chains and bank pins): Prior to treatment, and 1, 2, and 5 years after treatment, and every following 5 years until trap is retired

[a] BACI = Before, after, and control versus impact

Substrate Characterization–Pebble Count

A pebble count is conducted to determine the composition of the stream bed or substrate. The methods presented here are modified from Wolman (1954) and Harrelson et al. (1994).

Pebble counts should be conducted in at least one riffle immediately upstream of the project and one riffle immediately downstream of the project to evaluate how stabilization of the bank has changed the composition of the substrate. At least 100 particles should be randomly sampled in each cross-section transect to characterize the bank-full width of the stream bed. Measure the intermediate axis of each particle in millimeters, including embedded particles and those too large to be picked up, and include this information on the Pebble Count Form (Appendix B). A sand gauge may aid in the accurate measurement of sand and silt.

Bank Stability Monitoring–Bank Pins

Bank pins (Figure 27.1) should be used to determine the extent of lateral migration of the stream channel. This method is used in conjunction with pebble counts to determine changes in substrate composition as well as changes in the position of the stream channel through time.

Bank pins should be installed soon after project completion at locations within the bank stabilization project. The pins should be placed in areas prone to erosion and deposition, such as the outside and inside of meander bends. Calculate the amount of erosion at each bank pin using the Bank Pins Field Form (Appendix C) and procedures modified from Ogdahl et al. (2006):

1. At a meander bend or other suitable location within the bank stabilization project, drive 2 to 3 smooth rods (4–5’ long, 0.3–0.5” diameter) horizontally into each bank at different elevations. Projects that exceed 1,000 feet should install several series of bank pins.
2. Install the pins vertically from near the toe of the bank to the top of the bank. Pins should be set flush to the bank. Take care to not disturb the bank while inserting pins.
3. Paint the end of the pins and clearly document the location for ease of relocation.
4. Measure the horizontal distance of pin exposed at the time of installation and during each sampling event to compute bank erosion rates in cm/yr. A metal detector may be needed to relocate pins.
5. If pins are entirely lost, make a note and insert another pin at the same elevation.

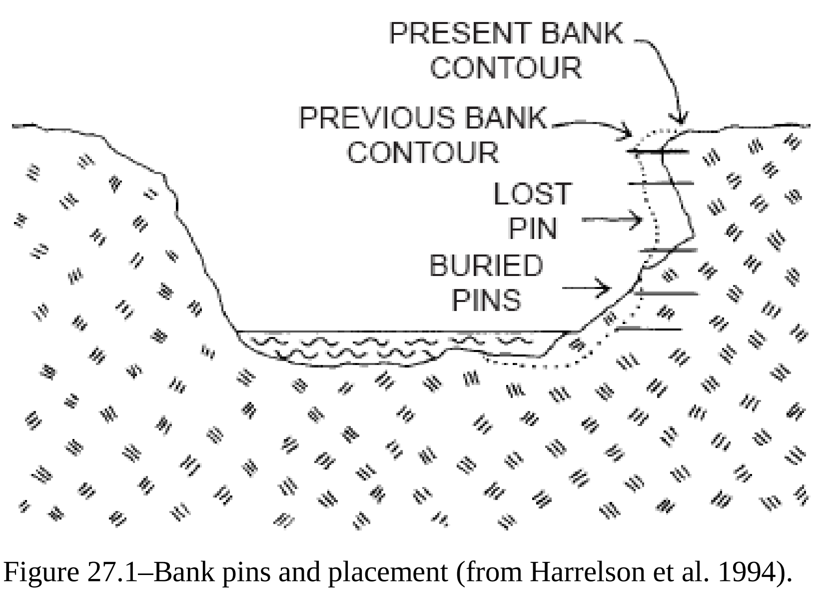


Figure 27.1–Bank pins and placement (from Harrelson et al. 1994).

Bank Erosion Hazard Index

The Bank Erosion Hazard Index (BEHI) is a method for assessing streambank erosion potential and estimating total sediment loading. It assigns point values to several aspects of bank condition and provides an overall score that can be used to inventory streambank condition over large areas, prioritize restoration efforts, and evaluate changes over time.

The BEHI assessment is based on the Rosgen (2001) method to characterize streambank conditions by numerical indices of bank erosion potential. The BEHI methodology evaluates a bank's susceptibility to erosion as a function of five metrics to compute an erosion risk index, and then the five individual indices are summed to provide a total erosion risk index. The five metrics include:

- The ratio of streambank height to bank-full height
- The ratio of riparian vegetation rooting depth to streambank height
- The degree of rooting density
- Streambank angle (i.e., slope)
- Bank surface protection afforded by debris and vegetation

Calculate the BEHI score (Table 2) using the Bank Erosion Height Index Form (Appendix D) and the following procedures recommended by Ogdahl et al. (2006). Measurements should be taken at a location within the bank stabilization project. Clearly identify the location using GPS coordinates so that repeating evaluations may be made in the same location.

1. Ratio of Bank Height to Bank-full Height

    a. Place a surveyor's rod on the streambed at the base of the bank. Use a rod level to vertically align the rod.
    b. Measure the bank height (top of bank) and bank-full height by tightly stretching a measuring tape horizontally from the respective bank feature to the surveyor's rod. Bank-full height is the elevation point of incipient flooding and may be identified by a floodplain break, depositional bench, point bar, change in vegetation, change in slope, and/or change in bank materials (see Michigan's Stream Team (2005) for additional information on bank-full identification). Read the height of the feature on the survey rod. Alternatively, use a laser level to determine the height on the rod.
    c. Calculate the ratio by dividing the total bank height by the bank-full height.

2. Ratio of Root Depth to Bank Height

    This metric is scored based on the ratio of average plant root depth to bank height. Greater root depth ratios represent decreased risk for erosion. To estimate root depth, stand at the base of the bank and visually estimate the average depth of the bank that is penetrated by roots. If desired, a surveyor's rod can be used to determine the average depth of root penetration.

3. Root Density

    This metric represents the percentage of streambank that is covered, and thus protected, by plant roots. A stream with 100% of its banks covered in roots is rated very low for erosion severity. To estimate root density, stand at the base of the bank and visually estimate the percentage of streambank covered by roots.

4. Bank Angle

    Bank angle is determined by estimating the degree of bank slope from the water line at base flow to the top of the bank. Undercut banks will have a value greater than 90°. Lower bank angles correspond to lower erosion severity ratings. Bank angle can be measured using a clinometer; however, the BEHI categories are sufficiently broad that visual estimates are generally adequate.

5. Surface Protection

   This metric estimates the average percentage of the streambank that is covered, and thus protected, by plant roots, logs, rocks, etc. The greater the proportion of bank surface that is protected, the lower the erosion hazard rating. To estimate surface protection, stand at the base of the bank and visually estimate the percentage of streambank that is covered by roots, logs, rocks, etc.

Table 27.2.–Bank Erosion Hazard Index (BEHI) modified from Rosgen (2001). Metric scores are modified from a range of values to a single value to reduce subjectivity.

BEHI	Bank height/ Bank-full height		Root depth/ Bank height		Weighted root density		Bank angle		Surface protection		Total
Rating	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Score
Very low	1.0–1.1	1.5	90–100	1.5	80–100	1.5	0–20	1.5	80–100	1.5	≤7.5
Low	1.11–1.19	3	50–89	3	55–79	3	21–60	3	55–79	3	7.6–15
Moderate	1.2–1.5	5	30–49	5	30–54	5	61–80	5	30–54	5	16–25
High	1.6–2.0	7	15–29	7	15–29	7	81–90	7	15–29	7	26–35
Very high	2.1–2.8	8.5	5–14	8.5	5–14	8.5	91–119	8.5	10–14	8.5	36–42.5
Extreme	>2.8	10	<5	10	<5	10	>119	10	>10	10	42.6–50

Summary

The defined goals and objectives for the project should be tied to the selected monitoring methods. Information collected during pre- and post-treatment monitoring will be used to make a decision on project effectiveness and whether further action is needed. The resulting information on project effectiveness will be used to justify support for future habitat improvement work and to ensure future habitat improvement investments provide the greatest return.

Spawning Riffle Evaluation Procedure

Background

Although the effectiveness of constructed spawning riffles in streams of the Great Lakes region has varied, they can provide needed habitat in smaller streams where a coarse gravel substrate was an original stream characteristic.

During 1989–2000, spawning riffles were constructed downstream of existing sediment basins by the United States Forest Service's Hiawatha National Forest in several of Michigan's Upper Peninsula streams. Following installation of these riffles, numbers of age-0 salmonids increased significantly at most locations (C. Bassett, U.S. Forest Service, personal communication). These same methods were evaluated in three Wisconsin streams but no evidence of increased juvenile trout production could be detected (Avery 1996). The difference in effectiveness may be attributed to the fact that the Wisconsin streams studied were considered to be marginal trout waters and lacked historical evidence of successful spawning whereas the Michigan streams were known to be used by spawning trout. Constructed riffles have also been used by the Minnesota Department of Natural Resources to successfully increase walleye spawning habitat in several tributaries to inland lakes (Dustin and Jacobson 2003). In both Michigan and Minnesota, successful spawning habitat improvement projects were constructed in streams that were characterized as physically stable and had evidence of use by spawning adults (Dustin and Jacobson 2003; C. Bassett, U.S. Forest Service, personal communication).

Technique

A properly designed and constructed riffle should ensure fish passage at all flows and maintain stable width-to-depth ratio of the channel, sediment transport, and channel capacity. Site specific knowledge of channel characteristics (pattern, dimension, and profile) and bed materials is necessary to construct a stable structure.

The following minimum site criteria should be met prior to installation of a spawning riffle:

- Stable channel morphology (e.g., avoid areas impacted by beaver, incised channels, or channels exhibiting scour)
- Moderate gradient and depth (e.g., avoid depositional, shallow, and high velocity reaches)
- Accessible for construction and maintenance
- Suitable water temperature and/or groundwater input (depending on fish species of interest)

Placement of gravel is not appropriate for all stream types and, if used incorrectly, may lead to increased bank erosion or the gravel being covered over by sand (see Rosgen (1996) for additional guidelines on applicability of gravel placement by channel type). When appropriate, gravel should be placed in areas where riffles are naturally forming, such as the transition zones between pools and riffles, or in areas similar to where riffles naturally occur in undisturbed portions of the same, or reference, stream. To avoid having the constructed riffle act as a check dam, added gravel should be placed on the lower third of the naturally forming riffle and at a depth lower than the average annual flow. The structure should be constructed using natural boulders and cobble from local sources. If enhancement of spawning substrates is a primary objective, then smaller cobbles and gravels should be placed on the top of the substrate of the riffle.

Evaluation

At a minimum, the riffle should be visually monitored after installation. Visual observations should include an assessment of bank stability where the structure is keyed into the bank, sediment transport (e.g. did fines move through or bury the structure), and evidence of fish spawning. Visual evidence of bank erosion, vegetative instability, or other adverse responses to the stream channel may require adjustments to the structure. Large or unique projects should also include characterization of the substrate and an assessment of the fishery. Data should be collected from the exact same locations to provide repeatable measurements over an extended time period. Measures of success will be defined relative to the objectives of the project. Monitoring protocols to measure the objective of increasing fish spawning success by means of a constructed spawning riffle are shown in Table 1.

Methods

Assess the site at least once before construction to obtain pre-data, preferably during the summer (low-flow) months. Survey the area near the habitat improvement following construction as directed to monitor changes in the stream channel.

Visual Monitoring

During each visit, conduct a visual assessment of the site using the Visual Assessment Form (Appendix A). Draw a general map of the area showing identifying features. Record GPS coordinates for the spawning riffle. In addition, digital photographs should be taken to document the location of the project.

Substrate Characterization- Pebble Count

A pebble count is conducted to determine the composition of the stream bed or substrate. The methods presented here are modified from Wolman (1954) and Harrelson et al. (1994).

The pebble count should be conducted in the constructed riffle to determine the effectiveness of the project over time. At least 100 particles should be randomly sampled in a cross-section transect to characterize the bank-full width of the stream bed. Measure the intermediate axis of each particle in millimeters, including embedded particles and those too large to be picked up, and include this information on the Pebble Count Form (Appendix B). A sand gauge may aid in the accurate measurement of sand and silt.

Electrofishing

Fisheries survey methods may include one pass catch-per-effort (CPE), mark and recapture, or depletion estimates (see Lockwood and Schneider (2000) for detailed methods). The area surveyed should include the entire artificial riffle zone and an additional stream reach located downstream of the riffle where slower-velocity, shallow water habitat or aquatic vegetation conducive to young-of-year fish are present. Capture efficiency will be higher when target young-of-year fish are larger, so sampling should be done as late in the summer as feasible. Additionally, fish data should be compared to a control reach on the same system or, if appropriate, a Streams Status and Trends Program fixed site. Success of the project will be determined by an increase in young-of-year target fish species.

Summary

The defined goals and objectives for the project should be tied to the selected monitoring methods. Information collected during pre- and post-treatment monitoring will be used to make a decision on project effectiveness and whether further action is needed. The resulting information on project effectiveness will be used to justify support for future habitat improvement work and to ensure future habitat improvement investments provide the greatest return.

Fish Cover Evaluation Procedure

Background

Many rivers in Michigan historically contained an abundance of wood cover and high quality habitat. Much of this habitat was removed or destroyed to facilitate the transport of logs to sawmills during the late 1800s and early 1900s. Today, instream wood structure is often removed to facilitate navigation, increase perceived aesthetics, alleviate flooding (which is often exacerbated by poor land-use practices), and facilitate operations at hydroelectric dams.

It is a commonly accepted tenet of stream management that wood habitat and overhead cover of some form is important for the survival of many fish species, including trout. According to Alexander et al. (1995), “Cover for fish is critical in Michigan streams, because most are low-gradient, run-type streams (rather than riffle/pool type streams) whose major source of habitat diversity is this woody debris”. Wood cover serves a number of functions in Michigan’s rivers by providing protection from predators for important game fish like trout or smallmouth bass, creating channel diversity such as pool habitat to provide holding areas for both adult and juvenile fish, and creating habitat for a number of invertebrate species that fish use as prey. Reintroduction of woody habitat to rivers may be appropriate in systems where it historically occurred and is now either absent or present at low levels.

Technique

Woody habitat inventory is a tool that can be used to determine where fish cover projects are needed. Such an inventory is typically done on a watershed or stream segment scale by floating or walking stream reaches and counting and recording the amount of wood cover present. Comparisons can then be made between stream reaches and even different streams, allowing managers to identify streams or stream stretches that contain little woody habitat and overhead cover. Such data are collected statewide for reaches surveyed under the Streams Status and Trends Program (Wills et al. 2006).

In Michigan, fish cover projects are completed using a number of different techniques. Whole trees can be placed in the stream channel individually or in groups to create logjams. The trees can be strategically positioned to narrow and deepen the channel or to create a pool. Platform or "lunker" structures can be installed along banks to create artificial undercut banks, while island structures and half-logs can be installed to provide valuable mid-channel overhead cover for fish.

Evaluation

Fish cover projects should be monitored in order to assess the longevity of the project, the project's effect on local stream morphology, and whether the technique used was successful. At a minimum, all projects should be evaluated using the standardized visual monitoring form designed to collect information on the project location, type, and performance. Visual evidence of erosion, vegetative instability, or other adverse responses may require adjustments to the structure. Large or unique projects should also include an evaluation of fisheries population response to additions of fish cover. Data should be collected from the exact same locations to provide repeatable measurements over an extended time period. Measures of success will be defined relative to the objectives of the project. Monitoring protocols corresponding to some common objectives of fish cover projects are shown in Table 1.

Methods

Assess the site at least once before construction to obtain pre-data, preferably during the summer (low-flow) months. Survey the area near the habitat improvement following construction as directed to monitor changes in the stream channel.

Visual Monitoring

During each visit, conduct a visual assessment of the site using the Visual Assessment Form (Appendix A). Draw a general map of the area showing transects and benchmark locations, descriptions, and other identifying information. Record GPS coordinates for each fish cover structure and all survey benchmarks. In addition, digital photographs should be taken to document the location of the project, survey transects, and benchmarks (if used).

Longitudinal Profile

Longitudinal profile surveys should be conducted for projects that intend to change instream habitat (e.g. increase pool size or numbers). Longitudinal profiles approximate the average slope of features such as water surface, channel slope, bed, and bank-full height (Rosgen 1996). This information is important for detecting changes in vertical stability (i.e., aggradation, degradation) and for monitoring head cutting.

To conduct a longitudinal profile, select a reach that is between 5 and 10 bank-full widths, includes the habitat improvement (or, for larger projects, is a representative reach that is no more than 1,000 feet), and begins and ends on the same facet (e.g., top of riffle to top of riffle). Using the Longitudinal Profile Form (Appendix E), document the bed elevation at each major habitat feature (pool, riffle, run) above and below the habitat improvement project. Harrelson et al. (1994) provides a thorough guide for longitudinal profile survey methods.

Electrofishing

An electrofishing survey should be completed when the project objective is to increase abundance of fish of either a target size or age group. Fisheries survey methods may include one pass CPE, mark and recapture, or depletion estimates (see Lockwood and Schneider (2000) for detailed methods). The area surveyed should include the entire project reach. Capture efficiency will be higher when target young-of-year fish are larger, so sampling should be done as late in the summer as feasible. Additionally, fish data should be compared to a control reach on the same system or, if appropriate, a Streams Status and Trends Program fixed site.

Creel Survey

If the objective of the project is to increase angler catch rates and/or harvest of target species, a creel survey should be completed. See Lockwood (2000) for detailed methods on how to conduct a creel survey.

Summary

The defined goals and objectives for the project should be tied to the selected monitoring methods. Information collected during pre- and post-treatment monitoring will be used to make a decision on project effectiveness and whether further action is needed. The resulting information on project effectiveness will be used to justify support for future habitat improvement work and to ensure future habitat improvement investments provide the greatest return.

Sediment Trap Evaluation Procedure

Background

Many of Michigan's fisheries managers were introduced to the use of sediment traps or basins as a tool for removing sand bedload from streams by Hansen et al. (1983). Their research found that stream flow downstream of sediment traps produced deeper pools, improved substrate composition, and provided cleaner gravel for spawning. In addition, sediment traps led to positive results exhibited by trout populations (Alexander and Hansen 1983, 1986). Since 1983, Michigan has installed almost 200 sediment traps with a total annual maintenance cost of approximately $200,000 circa 2001 (T. C. Wills, Michigan Department of Natural Resources Fisheries Division, personal communication).

Technique

In-stream sediment traps are areas within a channel that are excavated to maximize the natural deposition of material moving downstream. They are designed to allow sediment deposition through increased cross-sectional area and resulting reduced flow velocities (Burke 1999). Sediment traps can provide effective response to a point-source release of sediment to the stream; for example, following a dam failure. They are most frequently used to divert and remove sediment that would otherwise negatively affect fisheries habitat and aquatic macroinvertebrates (Cordone and Kelley 1961; Waters 1995). Because construction and maintenance costs are expensive, the use of sediment traps and detention basins should be secondary to other erosion control and prevention techniques.

Sediment traps have several advantages and disadvantages; please refer to Michigan Department of Natural Resources Fisheries Division, Policy and Procedure 02.02.12 for descriptions. Careful consideration must be given to stream type and location before a sediment trap is designed. Sediment traps should be located immediately upstream of the area affected by excessive sediment bedload in a location with low gradient to capture the maximum amount of sediment (Hansen et al. 1983). Use of sediment traps may not be practical or effective in systems with a large, natural sand bedload; in areas that have been permanently altered by historic land use practices; or on streams without natural controls such as bedrock, as the removal of bedload could cause extensive downcutting (Heede 1980). Sediment traps may also not be practical in stream reaches with steep banks that preclude access to the stream by heavy equipment. Careful consideration should also be given to the cost of construction, maintenance, and adjacent streambank habitat alterations. To ensure that personnel and monetary resources are used effectively, projections of trap efficiency should be made prior to trap construction (Hansen 1973).

Evaluation

Ideally, data collected to evaluate sediment traps should provide measurements that can be used to create detailed longitudinal profile and particle (substrate) size frequency distributions that can be compared through time (pre- vs. post-construction), as well as upstream and downstream of the sediment trap (Table 1). Data should be collected from the exact same locations to provide repeatable measurements over an extended time period (years to decades).

Protocols for determining the effectiveness of sediment traps (as measured by *desirable* changes in the stream channel, i.e. an acceptable level of downcutting and exposure of coarse substrate) were developed for Fisheries Division research study 702: Effects of Sediment Traps on Michigan River Channels (T. C. Wills, Michigan Department of Natural Resources, personal communication) to provide repeatable, quantitative, survey-quality measurements of channel shape, pattern, and substrate composition both above and below the sediment trap. After initial site setup, data collection can be accomplished in less than two days with a crew of 2-3 people. Required equipment includes an auto (or laser) level and tripod, stadia rod, steel measuring tape, ruler or gravelometer, and materials for setting up the site (see below). Familiarity with survey equipment and techniques for measuring stream morphology (such as completing channel and longitudinal profiles) are required but not discussed in detail in this protocol; see Harrelson et al. (1994) for a comprehensive review of surveying techniques.

Methods

Assess the sediment trap site at least once before construction to obtain reference data. The summer (low-flow) months are optimum for surveys. Also, assess the sediment trap 1, 2, and 5 years after construction. Less frequent visits (every 5 years) can be made thereafter if little change occurs within the first couple of years.

Visual Monitoring

During each visit, conduct a visual assessment of the site using the Visual Assessment Form (Appendix A). Draw a general map of the area showing transects and benchmark locations, descriptions, and other identifying information. Record GPS coordinates for the sand trap and all survey benchmarks. In addition, digital photographs should be taken to document the location of the project, survey transects, and benchmarks (if used).

Substrate Characterization- Pebble Count

A pebble count is conducted to determine the composition of the stream bed or substrate. The methods presented here are modified from Wolman (1954) and Harrelson et al. (1994).

The pebble count should be conducted, at a minimum, upstream and downstream of the constructed sediment trap, although preferably a pebble count should be conducted at each cross-section. At least 100 particles should be randomly sampled in a cross-section transect to characterize the bank-full width of the stream bed. Measure the intermediate axis of each particle in millimeters, including embedded particles and those too large to be picked up and record this information on the Sediment Trap Evaluation Form (Appendix F). A sand gauge may aid in the accurate measurement of sand and silt. Additional information on pebble count methods are presented under ***Additional Options***.

Longitudinal Profile

After establishing all vertical benchmarks and collecting channel profile measurements, conduct a longitudinal profile through entire study reach to determine channel slope, identify headcuts, and tie all benchmarks together. Begin and end the longitudinal profile on the same facet (upstream riffle to downstream riffle). Determine the bed elevation at each major habitat feature (pool, riffle, run), above and below the sediment trap, and at each cross-section transect location. All data should be recorded on the Sediment Trap Evaluation Form (Appendix F).

Cross-Section Transect

Establish transects upstream and downstream of the sediment trap. Survey (4) transects upstream of the trap and (8) transects downstream of the trap. Transects on representative habitat types (riffle, pool, and run, if present) within 8 stream widths upstream of the trap serve as “controls” for comparison with downstream transects. Be sure transects nearest the trap are far enough away that they will not be affected by excavation activity. Space transects in a generally logarithmic arrangement as a function of stream width (i.e. 1, 2, 4, and 8 stream widths upstream and 1, 2, 4, 8, 16, 32, 64, 128 stream widths downstream), and locate transects so they represent every major habitat type (riffle, pool, run) that occurs. If necessary, add transects so there are at least two per major habitat type. Transects at the extreme ends of the study reach can be omitted if time is an issue, but doing so will reduce the likelihood of determining how far (and how fast) any changes in the stream channel occur.

Set up benchmarks at new study sites. Measures of water surface and bed elevations are made relative to vertical benchmarks. A vertical benchmark is a big nail permanently driven into the base of a large tree. A minimum of two vertical benchmarks should be visible for each transect being surveyed; if one is lost, the other can serve as a backup. All vertical benchmarks should be uniquely identified or numbered (i.e., described in detail relative to various objects). For vertical benchmarks at the base of a tree, note the species, diameter at breast height (dbh), position, and any distinguishing characteristics of the tree. Spray the benchmarks with a small amount of fluorescent orange paint so that they are visible for future surveys but inconspicuous to someone who may try to remove them.

Horizontal benchmarks (transect pins) are steel rebar driven into the bank >5’ inland from the water’s edge. Horizontal benchmarks need to be set up so that when a steel tape is stretched from one pin to the other, measurements are taken at the exact location of each previous year’s measurements. Spray the rebar with fluorescent orange paint for visibility and cap them with safety caps when the survey is completed. Small, orange flags work well for marking the location of each transect on the streambank for future surveys.

Survey from the upstream end of the study reach to the downstream, locating the level so you can see as many transects as possible. Establish additional vertical benchmarks if all transects cannot be surveyed using those already sighted. These benchmarks should be set up so that the surveyor can sight from benchmark to benchmark for the entire reach being surveyed.

For each surveyed transect record the benchmark identification numbers and the vertical benchmark elevation before surveying the transect. Collect channel profile data (Figure 27.2) by measuring the elevation and distance (from left pin, facing downstream) of left horizontal benchmark (top of transect pin and ground next to transect pin), left bank, left top-of-bank (TOB), left water's edge, streambed, right water's edge, right TOB, right bank, and right horizontal benchmark (top of transect pin and ground next to transect pin). All data should be recorded on the Sediment Trap Evaluation Form (Appendix F).

Points for measuring the elevation of the streambed are spaced in even intervals so that there are 20 equally-spaced points per transect (measure the elevation and distance of the thalweg as well). The amount of time spent on each channel profile can be reduced by measuring the streambed elevation at fewer points (i.e., 5 or 10) along the transect, but detail is sacrificed. Collect the first streambed elevation at the left top-of-bank, and then subsequent elevations in even increments along the transect. At each point on the streambed, use your fingers or a small kitchen strainer/scoop (mounted on a pole if the water is too deep to reach by hand) to sample the substrate. Randomly choose a substrate particle by hand or from the scoop for measurement. Identify fine particles as silt, clay, or sand, and measure coarse particles with a ruler or gravelometer (Bain 1999).

When surveying channel profile transects, determine the elevation of the water surface ¼, ½, and ¾ of the way across the channel. Take a second vertical benchmark elevation after surveying the transect to confirm that the level has not shifted while taking readings. Differences in initial and final vertical benchmark elevations greater than +/- 0.02 inches will indicate that shifting or settling of the level has occurred. Transects (including benchmarks) will need to be re-surveyed if this happens.

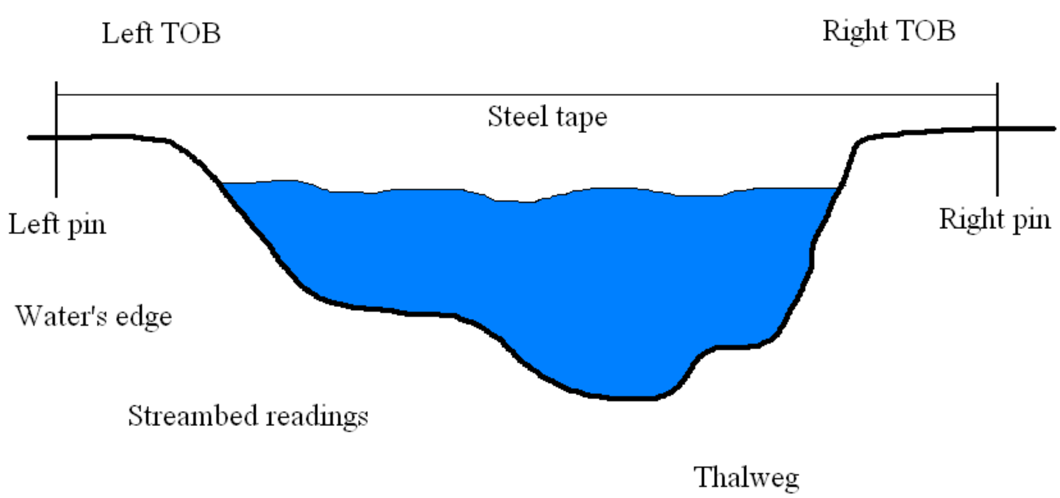


Figure 27.2–Transect setup for measurement of channel profile.

Bank Stability Monitoring–Scour Chains and Bank Pins

If obtaining survey-quality data are not feasible (or if time permits in conjunction with channel and longitudinal profiles), consider using scour chains and bank pins (Harrelson et al. 1994) to determine the extent of downcutting (or aggrading) and lateral migration of the stream channel. These techniques do not require as large an investment in time and personnel compared to surveying channel cross sections and longitudinal profiles. These methods can be used in conjunction with pebble counts to determine changes in substrate composition as well as changes in the shape and position of the stream channel through time. However, they do require the use of other specialized equipment (such as a metal detector to find the chains and pins after installation). The number of scour chains (Figure 27.3) and bank pins (Figure XX.1) used can vary depending upon the amount of effort devoted to the survey. Scour chains can be placed similar to channel profile transects as a function of stream width, or in proximity to major habitat features (riffles, pools, and runs). Bank pins can be installed at transects above and below the sediment trap, or in areas prone to erosion and deposition, such as the outside and inside of meander bends. Note that a metal detector will often be needed to locate scour chains that have been covered by sediment. All data should be recorded on the Sediment Trap Evaluation Form (Appendix F).

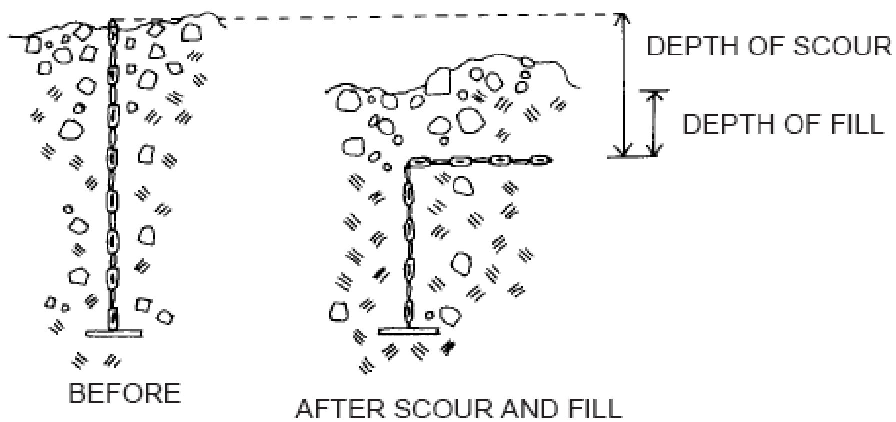


Figure 27.3–Scour chains and placement (from Harrelson et al. 1994).

Additional Options

If time does not permit transect-based channel profiles and pebble counts, zigzag pebble counts (Bain 1999) should be conducted both above and below the sediment trap. This is the suggested minimum level of survey effort for a sediment trap evaluation and will provide a quantitative estimate of substrate conditions both above and below the sediment trap that can be repeated in the future. The extent of the study reach over which to conduct the pebble count may vary, but should be determined as a function of stream width (similar to the transect spacing). Collect and measure a minimum of 100 particles above and below the trap (Harrelson et al. 1994). There is no disadvantage to collecting more particles (Bain 1999).

Summary

The defined goals and objectives for the project should be tied to the selected monitoring methods. Information collected during pre- and post-treatment monitoring will be used to make a decision on project effectiveness and whether further action is needed. The resulting information on project effectiveness will be used to justify support for future habitat improvement work and to ensure future habitat improvement investments provide the greatest return.

References

Alexander, G. R., and E. A. Hansen. 1983. Sand sediment in a Michigan trout stream Part II. Effects of reducing sand bedload on a trout population. North American Journal of Fisheries Management 3:365-372.

Alexander, G. R., and E. A. Hansen. 1986. Sand bed load in a brook trout stream. North American Journal of Fisheries Management 6:9-23.

Alexander, G. R., J. L. Fenske, and D. W. Smith. 1995. A fisheries management guide to stream protection and restoration. Michigan Department of Natural Resources, Fisheries Special Report 15, Ann Arbor.

Avery, E. L. 1996. Evaluations of sediment traps and artificial gravel riffles constructed to improve reproduction of trout in three Wisconsin streams. North American Journal of Fisheries Management 16:282-293.

Bain, M. B. 1999. Substrate. Pages 95–103 *in* M. B. Bain and N. J. Stevenson, editors. Aquatic habitat assessment: common methods. American Fisheries Society, Bethesda, Maryland.

Bash, J. S., and C. M. Ryan. 2002. Stream restoration and enhancement projects: is anyone monitoring? Environmental Management 29:877-885.

Bernhardt, E. S., M. A. Plamer, J. D. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, S. Clayton, C. Dahm, J. Follstad-Shah, D. Galat, S. Gloss, P. Goodwin, D. Hart, B. Hassett, R. Jenkinson, S. Katz, G. M. Kondolf, P. S. Lake, R. Lave, J. L. Meyer, and T. K. O’Don. 2005. Synthesizing U.S. river restoration efforts. Science 308:636-637.

Beschta, R. L., W. S. Platts, J. B. Kauffmann, and M.T. Hill. 1995. Artificial stream restoration – money well spent or expensive failure? Pages 76–104 *in* L. W. Mays, editor. Proceedings of Environmental Restoration, UCOWR 1994 Annual Meeting: August 2-5, 1994, the Big Sky Resort, Big Sky, Montana. University Council on Water Resources, University of Illinois, Carbondale.

Burke, C. B. 1999. Indiana drainage handbook: an administrative and technical guide for activities within Indiana streams and ditches. Report of Christopher B. Burke Engineering, LTD to Indiana Department of Natural Resources, Indianapolis.

Champoux, O., P. M. Biron, and A. G. Roy. 2003. The long-term effectiveness of fish habitat restoration practices: Lawrence Creek, Wisconsin. Annals of the Association of American Geographers 93:42-54.

Cordone, A. J., and D. W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 4:189-228.

Dahme, C. N., K. W. Cummins, H. M. Valett, and R. L. Coleman. 1995. An ecosystem view of the restoration of the Kissimmee River. Restoration Ecology 3:225-238.

Dustin, D. L., and P. C. Jacobson. 2003. Evaluation of walleye spawning habitat improvement projects in streams. Minnesota Department of Natural Resources, Investigational Report 502, St. Paul.

Frissell, C. A., and S. C. Ralph. 1998. Stream and watershed restoration. Pages 599-624 *in* R. J. Naiman and R. E. Bilby, editors. River ecology and management. Springer, New York.

Hansen, E. A. 1973. In-channel sedimentation basins- a possible tool for trout habitat management. The Progressive Fish-Culturist 35(3):138-142.

Hansen, E. A., G. R. Alexander, and W. H. Dunn. 1983. Sand sediment in a Michigan trout stream Part 1. A technique for removing sand bedload from streams. North American Journal of Fisheries Management 3:355-364.

Harrelson, C. C., C. L. Rawlins, and J. P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. U.S. Forest Service General Technical Report RM-245.

Heede, B. H. 1980. Stream dynamics: an overview for land managers. U.S. Forest Service General Technical Report RM-72.

Hubbs, C. L., and R. W. Eschmeyer. 1938. The improvement of lakes for fishing. A method of fish management. Michigan Department of Natural Resources, Bulletin of the Institute for Fisheries Research 2:1-235.

Kauffman, J. B., R. L. Beschta, N. Otting, and D. Lytijen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22:12-25.

Kondolf, G. M., and E. R. Micheli. 1995. Evaluating stream restoration projects. Environmental Management 19:1-15.

Lockwood, R. N., and J. C. Schneider. 2000. Stream fish population estimates by mark and recapture and depletion methods. Chapter 7 *in* J. C. Schneider, editor. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Lockwood, R. N. 2000. Conducting roving and access site angler surveys. Chapter 14 *in* J. C. Schneider, editor. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Michigan's Stream Team. 2005. Protocol for field surveys of stream morphology at gaging stations in Michigan. Available: http://www.deq.state.mi.us/documents/deq-lwm-nps-mi-field-survey-protocol.pdf. (July 2007).

Moerke, A. H., and G. A. Lamberti. 2003. Responses in fish community structure to restoration of two Indiana streams. North American Journal of Fisheries Management 23:748–759.

Moerke, A. H., and G. A. Lamberti. 2004. Restoring stream ecosystems: Lessons from a Midwestern state. Restoration Ecology 12:327-334.

Ogdahl, M., A. Steinman, D. Uzarski, and K. Thompson. 2006. A methodology for assessing erosion control best management practice (BMP) effectiveness. Annis Water Resources Institute, Grand Valley State University, Michigan. Available: http://www.liaa.info/crabmp/downloads/draft_methodology_final_june27.pdf (July 2007).

Rodeheffer, I. A. 1939. Experiments in the use of brush shelters by fish in Michigan lakes. Papers of the Michigan Academy of Science, Arts, and Letters 24:183-193.

Rodeheffer, I. A. 1945. Fish populations in and around brush shelters of different sizes placed at varying depths and distances apart in Douglas Lake, Michigan. Papers of the Michigan Academy of Science, Arts, and Letters 30:321-345.

Roper, B. B., J. J. Dose, and J. E. Williams. 1997. Stream restoration: Is fisheries biology enough? Fisheries 22:6-11

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D. L. 2001. A practical method for computing streambank erosion rate. Pages 9-15 *in* Proceedings of the 7th Federal Interagency Sedimentation Conference, Volume 2, Reno, Nevada. Available: www.wildlandhydrology.com/assets/Streambank_erosion_paper.pdf (July 2007).

Smokorowski, K. E., K. J. Withers, and J. R. M. Kelso. 1998. Does habitat creation contribute to management goals? An evaluation of literature documenting freshwater habitat rehabilitation of enhancement projects. Canadian Technical Report of Fisheries and Aquatic Sciences 2249.

Steen, P. J. 2003. History and inventory of stream habitat improvements for the State of Michigan. Master's thesis. University of Michigan, Ann Arbor.

Thompson, D. M. 2006. Did the pre-1980 use of in-stream structures improve streams? A reanalysis of historical data. Ecological Applications 16:284-796.

Waters, T. F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7, Bethesda, Maryland.

Wills, T. C., T. G. Zorn, and A. J. Nuhfer. 2006. Stream Status and Trends Program sampling protocols. Chapter 26 *in* J. C. Schneider, editor. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Wolman, M. G. 1954. A method of sampling coarse river-bed material. Transactions of the American Geophysical Union 35:951-956.

Written in 2009 by J. L. Mistak, J. J. Braunscheidel, S. K. Hanshue, F. D. Kolson,
A. J. Nuhfer, M. A. Tonello, and T. C. Wills

Michigan Department of Natural Resources, Fisheries

Stream Habitat Improvement
Visual Assessment

Prescription Number____________

MANAGEMENT UNIT____

CREW____

DATE_____________ WATER BODY______________________________

COUNTY_________________________ TOWNSHIP, RANGE, SECTION_______________________

GPS (decimal degrees) UPSTREAM: _________________Latitude _________________Longitude

DOWNSTREAM: _________________Latitude _________________Longitude

PROJECT TYPE AND ASSESSMENT:
Streambank Stabilization☐ Fish Cover Structure☐ Sediment Trap☐ Spawning Riffle☐

For All Projects:

Is project performing as designed? Yes No

What is the status of the project? Stable Slightly Altered Substantially Altered Gone

Describe any unanticipated impacts (positive or negative)_______________________________________

Estimated future lifespan of project ________ years

Would you recommend this type of project in this reach in the future? Yes No

Why or why not?____

For Fish Cover Structures Only:

Response of the streambed to the structure: Scoured/Deeper No Change Shallower Unsure

For Spawning Riffles Only:

Percent of downstream riffle now covered in sand: 0-20% 20-40% 40-60% 60-80% 80-100%

PHOTOGRAPHS:
Overview of project(s) ☐ At representative cross-section ☐
Looking upstream of project(s) ☐ Looking downstream of project(s) ☐

STATION SKETCH AND NOTES:

Michigan Department of Natural Resources, Fisheries

Stream Habitat Improvement
Pebble Count

Stream:	Location:
Observers:	Date:
GPS Coordinates (decimal degrees): Latitude	Longitude

	Millimeters	**Site 1 (100 minimum)**				**Site 2 (100 minimum)**			
		Count	Total #	Item %	% Cum	Count	Total #	Item %	% Cum
Silt/Clay	< 0.062								
Sand	0.062 - 0.0125								
	0.126 - 0.25								
	0.26 - 0.50								
	0.51 - 1.0								
	1.1 - 2.0								
Gravel	2.1 - 4.0								
	4.1 - 5.7								
	5.8 - 8.0								
	8.1 - 11.3								
	11.4 - 16.0								
	16.1 - 22.6								
	22.7 - 32								
	33 - 45								
	46 - 64								
Cobble	65 - 90								
	91 – 128								
	129 – 180								
	181 - 256								
Boulder	257 - 362								
	363 - 512								
	513 - 1024								
	1025- 2048								
Bedrock	> 2048								

Michigan Department of Natural Resources, Fisheries

Stream Habitat Improvement
Bank Pins

Stream:	
Location:	
Observers:	Date:

Pin No.	GPS Coordinates (decimal degrees)	Pin Location Description	Elevation of Pin from Streambed (ft)	Amount of Exposed Pin (cm)			Amount of Bank Erosion (cm/yr)	
				At Installation	After 1 year	After 3 years	After 1 year	After 3 years

Michigan Department of Natural Resources, Fisheries

Stream Habitat Improvement
Bank Erosion Height Index (BEHI)

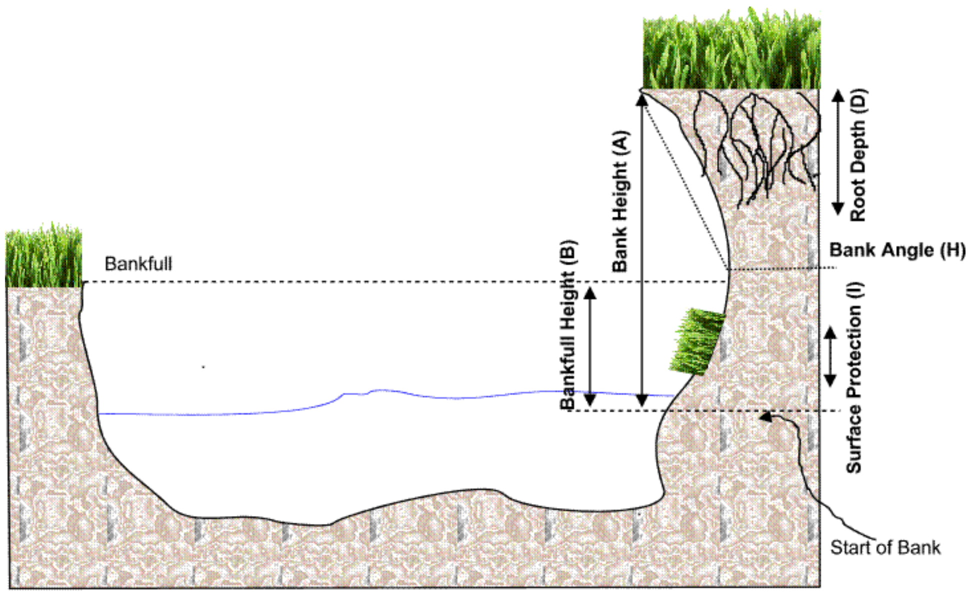
Stream:	
Location:	
Observers:	Date:
GPS Coordinates (decimal degrees): Latitude	Longitude
Location Description:	

						Study Bank Height / Bankfull Height (C)	**BEHI Score**
Study Bank Height (ft) =	(A)	Bankfull Height (ft) =	(B)	(A) / (B) =	(C)		
						Root Depth / Study Bank Height (E)	
Root Depth (ft) =	(D)	Study Bank Height (ft) =	(A)	(D) / (A) =	(E)		
						Weighted Root Density (G)	
		Root Density (%) =	(F)	(F) / (E) =	(G)		
						Bank Angle (H)	
				Bank Angle (°) =	(H)		
						Surface Protection (I)	
				Surface Protection (%) =	(I)		

Bank Material Adjustment

Bedrock (Overall Very Low BEHI) **Boulders** (Overall Low BEHI) **Cobble** (Subtract 10 points if uniform medium to large cobble) **Gravel or Composite Matrix** (Add 5-10 points depending on % of bank material that is composed of sand) **Sand** (Add 10 points) **Silt/Clay** (No adjustment)	**Bank Material Adjustment**	
	Stratification Adjustment Add 5-10 points, depending on position of unstable layers in relation to bankfull stage	

Very Low	Low	Moderate	High	Very High	Extreme	**RATING**	
5 - 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	**TOTAL SCORE**	



Bankfull
Bank Height (A)
Bankfull Height (B)
Root Depth (D)
Bank Angle (H)
Surface Protection (I)
Start of Bank

Michigan Department of Natural Resources, Fisheries

Stream Habitat Improvement
Longitudinal Profile

Stream:	
Location:	
Observers:	Date:

Item	Distance; Point; or **Station (ft)**	Back-Sight **B S (ft)**	Height of Instrument **H I (ft)**	Fore-Sight **F S (ft)**	Height; depth; or **Elevation (ft)**	**Notes, Comments, Remarks**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						

Site:						
Item	**Station (ft)**	**BS(ft)**	**HI(ft)**	**FS(ft)**	**Elevation (ft)**	**Notes, Comments, Remarks**
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						
76						
77						
78						
			Closure Error =			

Stream Habitat Improvement
Sediment Trap Evaluation
Bed elevations and substrates at transect (Study 702)

Hunt Creek Fisheries Research Station
1581 Halberg Road
Lewiston, MI 49756
(989) 786-2613

River: ______________________________ Location: ______________________________
Date: ______________ Crew: ______________________________
Transect #: ________ Transect location: ________ feet upstream ☐ or downstream ☐ of trap (check one)
Notes: ____

*Take vertical benchmark readings **before and after** channel profiles for each transect. Reset level and re-do profile if initial and final readings differ by >0.02 ft.*

Benchmark 1 I.D. __________ Initial reading (x.xx ft) __________ Final reading (x.xx ft) __________
Benchmark 2 I.D. __________ Initial reading (x.xx ft) __________ Final reading (x.xx ft) __________

***Visually estimate and record dominant substrate** in a circle centered on the sampling point with a diameter equal to the space between sampling points.*

Substrate: **C** – clay, **D** – detritus/silt, **S** – sand, **G** – gravel (<2.5"), **SC** – sm cobble (2.5-5"), **LC** – lg cobble (5-10"), **B** – boulder (>10") **W** - wood

***Scoop substrate at each sampling point** and **randomly** choose 5 particles from the scoop for measurement. **Visually identify fine particles** as silt, clay, or sand. **Measure coarse particles** with gravelometer and record appropriate substrate size code.*

Substrate size codes:
1 = ***organic***
2 = ***clay*** (0.00024-0.04mm)
3 = ***silt*** (0.05-0.062mm)
4 = ***sand*** (0.063-2mm)
5 = very fine gravel (2-4mm)
6 = fine gravel (5-8mm)
7 = medium gravel (9-16mm)
8 = coarse gravel (17-32mm)
9 = very coarse gravel (33-64mm)
10 = small cobble (65-128mm)
11 = large cobble (129-256mm)
12 = small boulder (257-512mm)
13 = medium boulder (>512mm)

Note: Sample point spacing should be indentical to the previous year's survey. If this is a new survey, transects should have a minimum of 20 sampling points.
Record change in top of bank/bank's edge in notes/comments. Left and right are determined as looking upstream.
Measure water surface elevation ¼, ½, and ¾ of the way across the wetted channel.

Distance from left pin (x.x ft)	Elevation (x.xx ft)	Water surface (x.xx ft)	Substrate code	Substrate size code (1-13)					Notes/comments (water's edge, left bank, island, etc.)
0.0		At left pin							
		At top of left bank							
		At top of right bank							
		At right pin							