| DEQ | WATER RESOURCES DIVISION<br>SURFACE WATER ASSESSMENT SECTION<br>POLICY AND PROCEDURE | | DEPARTMENT OF ENVIRONMENTAL QUALITY |
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| Original Effective Date:<br>December 23, 2008<br><br>Revised Date:<br><br>Reformatted Date:<br>May 27, 2014 | Subject: Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers<br><br>Program Name:<br>Surface Water Quality Program | | Category:<br>☒ Internal/Administrative<br>☐ External/Non-Interpretive<br>☐ External/Interpretive<br><br>Type:<br>☐ Policy<br>☒ Procedure<br>☐ Policy and Procedure |
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**ISSUE:**

This Surface Water Assessment Section (SWAS) procedure establishes the process necessary to monitor the fish community, macroinvertebrate community, and habitat quality in wadeable rivers and streams in support of ambient water quality monitoring, National Pollutant Discharge Elimination System (NPDES) permit support, and other point and nonpoint source needs.

**AUTHORITY:**

Section 3103(1) of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA).

**POLICY:**

## I. INTRODUCTION

The development and subsequent modification of these biological and habitat survey protocols was a result of the increasing demand for a more vigorous and standardized evaluation of Michigan's water resources. The SWAS implemented the revisions included in these protocols prior to the 2006 field season. These protocols can be used to assess the existing condition of Michigan's wadeable streams and rivers as well as detect spatial and temporal trends. Specifically, the SWAS uses these protocols to fulfill monitoring requests, assess known or potential areas of concern or where more information is needed, achieve assessment coverage of watersheds, provide information to support and evaluate the effectiveness of Michigan Department of Environmental Quality (MDEQ) protection programs (e.g., NPDES, nonpoint source, and site remediation), and make site-specific determinations of designated use support (per R 323.1100 of the Part 4 Rules, Water Quality Standards [WQS], developed pursuant to Part 31of the NREPA) as well as spatial and temporal designated use support determinations on statewide and watershed levels.

The biosurvey protocols consist of separate qualitative evaluations of the macroinvertebrate community, fish community, and habitat quality in wadeable lotic (flowing) streams or rivers. These evaluations may be conducted and applied independently or in combination. The biological integrity of a stream is based on the results of the fish and/or macroinvertebrate community evaluations.

The physical transition between wadeable and nonwadeable rivers is not distinct. On larger rivers, the determination of the ability to adequately sample should acknowledge the broad scale of habitat features and the potential difficulties with collecting biological and habitat information representative of the entire river reach rather than simply consider the access location. The ability to safely wade the majority of the channel and adequately sample all available habitats should be considered in situations where the applicability of these protocols is questionable due to the size of the river. For large, nonwadeable rivers where it is determined that these protocols are inappropriate, the Quantitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (MDEQ, 2013) should be used. Survey locations in the "Very Large" Valley Segment Ecological Classification stratum (Seelbach et al., 1997) should be assessed using the protocols for nonwadeable rivers.

Certain studies or situations may require quantitative or alternate methods. The biosurvey protocols presented here do not preclude the use of alternate methods; however, the use of alternate methods is the exception.

## II. PRINCIPLES OF FISH, MACROINVERTEBRATE, AND HABITAT SURVEYS

Better stream quality is normally indicated by greater warmwater fish and macroinvertebrate diversity and abundance, as well as a more even distribution of individuals among taxa at one station compared with another. Conversely, poorer stream quality is indicated by lower diversity and abundance at one station when compared to another. Large-scale changes in stream quality over time may be recognized at a given station by repeated sampling and comparison of fish and macroinvertebrate data.

Fish and macroinvertebrate community composition generally reflect conditions present for an extended period of time prior to sampling. However, temporary events, such as decreases in dissolved oxygen concentrations or the presence of toxicants, may cause losses of sensitive taxa either by emigration or death. Similarly, an abundance of tolerant organisms may indicate persistent degraded stream quality. Changes in fish or macroinvertebrate community structure may also occur if trophic changes occur due to pollution or perturbation.

In these protocols, analyses of the warmwater fish and macroinvertebrate communities are made according to a set of measurements or "metrics." These metrics have been selected from those used in the United States Environmental Protection Agency's (USEPA) Rapid Biological Assessment Protocols (Barbour et al., 1999), Ohio Environmental Protection Agency's protocols (Ohio Environmental Protection Agency, 1987a, 1987b, and 1987c), the state of Illinois' biological procedures, and those procedures developed specifically for Michigan and tested by the MDEQ. The individual metrics provide information on a variety of biological attributes and, when combined, intend to indicate overall changes in the fish and macroinvertebrate communities in response to various stream quality conditions. The accuracy of the protocols, however, depends on the selection and evaluation of excellent regional reference sites. These reference sites were selected from streams within each of Michigan's ecoregions recognized as excellent in quality by biologists. These sites are the level against which all other field measured stream biological parameters are compared. Each ecoregion has several reference sites, spanning different stream widths. The glacial history of Michigan created 5 distinct ecoregions, separable by soil types, topography, and stratigraphy (Omernik, 1987). The ecoregion approach provides a logical framework to use with these biological monitoring protocols when excellent sites are described within each ecoregion.

An excellent quality stream for the ecoregion would have most metrics rating similar to the reference sites. Poor quality streams would have most metrics rating substantially different than the reference sites. The use of these metrics creates a uniform and systematic evaluation for each station. This approach makes the results easily interpretable, since they are expressed relative to the reference sites.

Multiple metrics for coldwater fish communities are not included in this procedure. The coldwater fish community is evaluated for the presence of at least 50 fish, relative abundance of anomalies, and relative abundance of salmonids collected.

The habitat evaluation is also important in determining the nature and degree of abiotic constraints on the biological potential. This habitat evaluation is accomplished through stream characterization based on selected physical measurements and descriptive watershed features. Habitat metrics are used to assess a wide range of physical characteristics that are important to the optimum development and stability of biological communities. Ultimately, the metrics are used to rate overall habitat quality. The habitat metrics used in this protocol are based on the USEPA's Rapid Bioassessment Protocols (Barbour et al., 1999).

## III. GENERAL SAMPLING CONSIDERATIONS

1. Sampling should occur between June 1 and September 30 during periods of stable discharge and at times of low or moderate flow. This sampling period helps to ensure consistency between sampling studies by reducing variability due to seasonality and flow fluctuations within years or between years.

2. For basin investigations or long-term studies, stations should be sampled during the same time frame to minimize seasonal variability in fish and macroinvertebrate distribution or abundance.

3. Maximum impact of a municipal or industrial discharge usually occurs during summer low stream flow and maximum temperature conditions. Dilution is minimal for pollutants during low flow conditions, while elevated stream temperatures and productivity produce maximum fluctuations in diurnal oxygen concentrations. High temperatures also increase fish and macroinvertebrate metabolic rates, which may amplify toxics effects.

4. Consideration must be given to the sampling sequence to ensure the least disruption of the communities to be sampled. Sampling should generally occur in the following order: fish, macroinvertebrates, and habitat.

5. Record all data on the Stream Survey Cards shown in Appendix J, including a sketch of the station location to assist future sampling. A considerable amount of the data on the survey card is optional and used for informational purposes to assist the biologist with site description. Shaded areas on the card must be filled out for later entry into the biosurvey

database. The following channel modifications should be noted by checking the appropriate box(es) on the survey card:

none - natural stream channel, no evidence of modifications.
dredged - stream channel has been excavated (widened, deepened, straightened), evidence of dredge spoils along stream banks.
canopy removal - woody riparian vegetation has been removed from 1 or both banks either by physical removal or with the use of defoliant sprays.
snagging - removal of logs, deadfalls, and other large woody debris from the stream channel.
impounded - station is located either directly upstream of an impoundment or directly downstream of a dam.
relocated - stream channel has been completely rerouted from the original channel usually to follow a roadway, railway, or has been redirected for industrial purposes (e.g., mill race) or has been rerouted to another watershed.
bank stabilization - this includes engineered cattle access points or the stream bank has been armored with rip-rap, sheet piling, revetments, etc.
habitat improvement - identified by the presence of artificial banks (lunker structures), wing deflectors, half-logs, rock dams, etc.

The presence of attached algae, aquatic macrophytes, or bacterial slimes should also be noted. Although the determination of nuisance conditions will be left to the biologists' professional judgment, the following examples are provided as guidance for identifying nuisance conditions:

1. *Cladophora* spp. and/or *Rhizoclonium* spp. greater than 10 inches long and covering greater than 25% of a riffle.
2. Rooted macrophytes present at densities that would impair the designated uses of the water body.
3. The presence of bacterial slimes.

## IV. SITE SELECTION

Sites may be selected for assessment using a targeted approach and/or a randomized approach. Sites may be selected using a targeted approach to investigate specific concerns. Sites should be randomly selected using the Macroinvertebrate Community Status and Trend Monitoring Procedure (MDEQ, in preparation) to evaluate spatial and temporal biological trends and attainment status on a watershed and statewide level.

These biological and habitat survey protocols are intended for use in wadeable portions of perennial and intermittent streams that flow between well-defined stream banks. Streams that become lentic or lose all perception of flow due to impoundment or other hydrologic modification or are ephemeral are not suitable for assessment using this procedure.

When the sampling station is located at a road crossing, sampling should occur upstream to avoid direct influence of the roadway. Locally modified sites, such as small impoundments and bridge areas, should be avoided, unless data are needed to assess their effects on the water body. In addition, areas located immediately downstream of lentic water bodies (e.g., lake outlets) should be avoided. Sampling near the mouths of tributaries entering large water bodies should also be avoided, if possible, since these areas will have habitat more typical of the larger water body (Karr et al., 1986).

## V. QUALITATIVE FISH SAMPLING PROCEDURE AND DATA ANALYSIS

A. Fish Sampling Procedures

1. The stream shocking unit is the preferred fish sampling device, except where physically impractical. Backpack shocking units may be used when sampling smaller streams or headwaters. All safety procedures must be observed when using these units (see SWAS Procedure No. WRD-SWAS-005).

2. Fish shocking must always be done in an upstream direction.

3. The sampling effort expended should be sufficient to ensure that all fish species present are sampled in proportion to their occurrence in the stream reach chosen. As a goal, at least 100 individual fish should be examined from each station. This will generally require approximately 30 minutes of electrofishing per station, encompassing 100-300 feet with sufficient sampling to include all significant available habitat. In small streams (10 feet wide), the length of the sampling station should be approximately 100 feet. In moderate size streams (30 feet wide), the length should be approximately 300 feet. In larger streams and rivers, the length of the sampling station should be about 5-10 channel widths. If necessary, increase the length of the selected sampling area. If the number of fish collected is no greater than 100 individuals after 45 minutes, discontinue further sampling and calculate metrics based on reduced sample size.

4. All collected fish should be placed immediately in water filled tubs. Care should be taken to keep fish alive by replenishing the holding tub water and processing the fish as quickly as possible. Tubs may be placed in the stream shocking unit or along the stream banks. A livebox may also be placed directly in the stream to hold collected fish. Portable battery operated aerators may also be used.

B. Data to be Recorded

When sampling has been completed at each station, the following information should be recorded:

1. The location of the sampling stations should be specifically indicated on the station card so that future studies can be repeated at the same station. Latitude and longitude coordinates should be obtained using a global positioning system unit. The station reaches should be identified on a detailed map of the study area together with any necessary comments or descriptions on the field card.

2. Record the names and number of each species collected with a length greater than 1 inch and determine the total number of fish collected. If unsure of correct field identification, return

representatives to the lab for later identification. Regional keys have been chosen for their ease of use and elimination of extraneous taxa. Hubbs and Lagler (1964) should be used as the primary key when identifying all gamefish. For nongame fish, Smith (1988) may be used but verification of identification should be through the use of Hubbs and Lagler (1964). Additional information on Petromyzonidae (lampreys) can be found in Vladykov and Kott (1980).

3. The following externally observable anomalies should be noted as total number of individuals afflicted: bent spine (scoliosis), open lesions, severely eroded fins, fungus patches, growths on skin or fins, tumors, and poor physical condition indicated by severe emaciation, excessive mucus coating, and hemorrhaging. This measurement is meant to apply only to extreme or obvious conditions. Common external parasites, such as copepods (anchorworms), and common visible internal parasites, such as black spot and yellow grub should not be considered anomalies unless extreme or very severe infestations are present. All determinations of anomalies should be compared to those illustrated and presented in Allison et al. (1977).

4. Record the amount of time spent electrofishing at each station including the number of passes through the sampling station and the number of shocking probes used. Also record average stream width (wetted stream channel width at time of sampling) and distance of reach electrofished. Catch per unit effort will be calculated as the total number of fish collected divided by the number of minutes spent shocking at each station (catch per minute), and as the number of fish per stream area (catch per square meter).

5. Record the length of all fish listed in Appendix G to inch group or to size range. These data may be used for additional biomass or productivity estimates.

C. Data Analysis Techniques

Following sample analyses, a Fish Score will be calculated for each warmwater station based on the sum of each of the 10 metrics listed below. Each metric score for an individual station is contrasted to the ecoregional reference sites. A biosurvey category describing the degree of similarity to the reference sites will be given to each station based on the total metric point score calculated. These contrasts and categories are described in separate reports (Creal et al., 1996).

There are some overriding considerations in this interpretation. When fewer than 50 fish are collected, or when the percent of fish with anomalies exceeds 2%, the site will not be scored following the metrics, but will be considered to be “Poor” (below acceptable quality).

In addition, for coldwater designated streams, significant populations of salmonids should be present. Therefore, for coldwater designated streams, relative abundance of salmonids is the metric used (i.e., relative abundance of salmonids equal to or exceeding 1% as described in separate reports (Creal et al., 1996).

Metric Description

Metric 1. Total Number of Fish Species. This is total number of fish species collected at each sampling station. For a given watershed size and type of stream (warmwater), total number of fish species decreases with environmental degradation. This metric is scored by comparison to excellent sites of similar size.

Metric 2. Number of Darter Species. This is the number of species in the genera Ammocrypta, Etheostoma, and Percina (Percidae: Etheostomatinae), and the number of species of Sculpins (Cottidae) and of Madtoms (genus Noturus). These species are sensitive to habitat degradation due to the unique habitats that they require for reproduction. Such habitats are degraded by siltation, dredging, or reductions in oxygen content. The presence of 1 or 2 taxa may indicate good water quality so care should be taken during sampling to collect all small fish.

Metric 3. Number of Sunfish Species. This is the total number of species in the family Centrarchidae exclusive of largemouth and smallmouth basses (Micropterus sp.). They are particularly responsive to declines in pool habitats and habitat structure such as instream cover (Gammon et al., 1981; Angermeier, 1983).

Metric 4. Number of Sucker Species. This is the total number of species in the family Catostomidae. Many species are not tolerant of habitat and chemical degradation, due to habitat specificity and dominance of benthic insects in their diet. In addition, large size and long lives provide a multiyear integrative perspective.

Metric 5. Number of Intolerant Species. This is the total number of species classified as intolerant (Appendix A). Intolerant fish are those that are sensitive to many types of environmental degradation and tend to be absent from degraded surface water bodies.

Metric 6. Percentage of Total Sample as Omnivores. This is the ratio of the number of omnivores to the total number of fish collected. Omnivorous fishes are those species that routinely take significant quantities of both plant and animal material (often including detritus) and have the ability, usually indicated by the presence of a long gut and dark peritoneum, to utilize both. Appendix B contains a list of omnivorous fishes commonly found in Michigan. The common omnivores of small midwestern streams are Pimephales notatus and P. promelas, while Cyprinus carpio and Dorosoma cepedianum, also omnivores, are found over a wider range of stream sizes.

Omnivores can become dominant in degraded conditions, apparently as a result of irregular supply of both plants and invertebrate foods. Irregularity in plant or invertebrate availability results in declining abundances for fish that specialize on 1 food type or the other.

Metric 7. Percentage of Total Sample as Insectivorous Fish. This metric measures the ratio of the number of insectivorous fish to the total number of fish collected and tends to vary inversely with Metric 6. Most cyprinids are insectivores (Carlander 1969 and 1977); besides the omnivores mentioned above (Pimephales), some other minnow species are strict herbivores and a few are piscivores. Although a dominant trophic group in Midwestern streams, relative abundance of insectivorous fish decreases with degradation, perhaps in response to variability in supply or production of insects, which in turn may decline in response to alteration of water quality, energy sources, or instream habitat. Appendix C contains a list of insectivorous fish commonly found in Michigan.

Metric 8. Percentage of Total Sample as Piscivores. This metric is a ratio of the number of all species that are predominantly piscivores as adults to the total number of fish collected. Some opportunistic fish species may feed on invertebrates as well as fish, including both fry and juveniles. Do not include species, such as creek chub, that may opportunistically include some fish in their diet only when very large (Fraser and Sise, 1980). Viable and healthy populations of top carnivore species such as smallmouth bass, walleye, northern pike, grass pickerel, and others indicate a healthy, trophically diverse community. Appendix D contains a list of piscivorous fishes commonly found in Michigan.

Metric 9. Percentage of Total Sample as Tolerant Species. This metric is a ratio of the number of tolerant fish to the total number of fish collected. Tolerant fish are those species able to adapt to a wide range of environmental conditions and are often common in highly degraded surface water bodies. Appendix E provides a list of tolerant species.

Metric 10. Percentage of Total Sample as Simple Lithophilic Spawners. This metric is a ratio of the number of simple lithophilic spawners to the total number of fish collected. Simple lithophilic spawners require clean gravel or cobble for spawning and do not construct nests or provide parental care. They are especially sensitive to sedimentation and siltation of these substrates. Appendix F provides a list of simple lithophilic spawners.

## VI. QUALITATIVE MACROINVERTEBRATE SAMPLING PROCEDURE AND DATA ANALYSIS

A. Macroinvertebrate Sampling Procedures

1. The sampling effort or time expended at each station should be sufficient to ensure that taxa present are sampled in proportion to their occurrence in the stream reach chosen. Approximately 20 minutes of total sampling time per survey station should generally ensure adequate sampling of all habitat types and macroinvertebrate taxa in a stream reach.

2. Macroinvertebrate samples should be taken from all available habitats using a triangular dip net with a 1 millimeter (mm) mesh or by hand picking. When necessary, substrates should be scrubbed with a small hand brush to dislodge organisms. Samples should be taken from both high velocity and low velocity areas within the selected sampling reach. It is generally accepted that the optimum habitat for macroinvertebrates includes gravel, cobble, and boulder substrates necessary to support the periphyton-based benthic community. Efforts should be

directed toward preferentially sampling these habitats. However, additional organisms may be hand picked, scrubbed, or netted from other habitats such as fixed submerged boulders, vegetation, logs, pilings, or other structures. The sampling team should coordinate their effort to identify all available habitats with consideration given to the proportional occurrence of these habitats. Substrates such as sand and silt should be sampled if present; however, they may be sampled with reduced effort.

3. The samples should be thoroughly rinsed in the sampling net or by using a screen with a 1 mm mesh size. Samples are placed in a bucket to form a composite sample. Large organic or inorganic debris should be vigorously shaken by hand in the composite bucket to dislodge attached organisms. This cleaned debris is carefully (i.e., avoid the loss of organisms) removed from the bucket.

4. The composite sample is subsampled to obtain approximately 300±60 organisms for identification and enumeration. The composite sample is stirred in a nonuniform direction with care taken to dislodge organisms (e.g., snails) from the sides of the bucket to ensure that all organisms are sufficiently mixed throughout the bucket. A subsample is immediately extracted using a small net with a mesh size of 1 mm while the material in the composite is still suspended. An additional subsample from the bottom of the composite bucket may be necessary if heavy material that is not evenly distributed is present.

   The subsample should be placed in a light colored plastic or enamel pan and all organisms present identified, enumerated, and recorded. Additional subsamples may be extracted from the composite as needed until approximately 300±60 organisms are counted. To avoid sampling bias, all organisms captured in a subsample must be counted; therefore, it may be prudent to limit each subsample to 1 small sweep of the composite sample with the small net so that the target number of organisms is not exceeded.

   The remaining composite sample should be placed in the pan and searched for 3-5 minutes for large or rare taxa that were not included in the subsample(s). Taxa observed during sampling that were not represented in the sample should also be recorded (e.g., Gerridae, adult Gyrinidae, Decapoda). These additional taxa should be recorded by marking 1 individual on the data sheet with a circle around the number.

B. Data to be Recorded

1. Organisms should be identified to the taxonomic level indicated in Appendix H. Appendix H also contains a list of the primary keys to be used to identify the macroinvertebrates. Alternate keys may be used, but verification of identification should be through those keys listed in Appendix H. The collected organisms in the subsample should be returned to the laboratory for identification where field identification is not feasible.

2. When sampling has been completed at each station, the following information should be recorded on the stream survey data sheet:

a. The sampling area should be identified on a detailed map together with necessary comments on the field card. Latitude and longitude coordinates should be obtained using a global positioning system unit.
b. The total number of organisms collected.
c. The numbers of each taxa collected and identified.
d. Sampling time in minutes (total time for all samplers).

C. Data Analysis Techniques

Following sample analyses, a macroinvertebrate score will be calculated for each station based on the sum of the 9 metrics listed below. Each metric score for an individual station is contrasted to the ecoregional reference sites. A final biosurvey category describing the degree of similarity to the reference sites will be given to each station based on the total metric point score calculated. These contrasts and categories are described in a separate report (Creal et al., 1996).

Metric Description

Metric 1. Total Number of Taxa. This is the total number of taxa identified, as specified in Appendix H in the macroinvertebrate subsample. Taxa richness has historically been a key component in most all evaluations of macroinvertebrate community integrity. The underlying reason is the basic ecological principle that healthy, stable biological communities have high species diversity. Increases in number of taxa are well documented to correspond with increasing water quality and habitat suitability. Small, pristine headwater streams may, however, be exceptions and show low taxa richness.

Metric 2. Total Number of Mayfly Taxa. This is the number of taxa in the order Ephemeroptera. Mayflies are an important component of a high quality stream biota. As a group, they are decidedly pollution sensitive and are often the first group to disappear with the onset of perturbation. Thus, the number of taxa present is a good indicator of environmental conditions.

Metric 3. Total Number of Caddisfly Taxa. This is the number of taxa in the order Trichoptera. Caddisflies are often a predominant component of the macroinvertebrate fauna in larger, relatively unimpacted streams and rivers but are also important in small headwater streams. Though tending to be slightly more pollution tolerant as a group than mayflies, caddisflies display a wide range of tolerance and habitat selection among species. However, few species are extremely pollution tolerant and, as such, the number of taxa present can be a good indicator of environmental conditions.

Metric 4. Total Number of Stonefly Taxa. This is the number of taxa in the order Plecoptera. Stoneflies are one of the most sensitive groups of aquatic insects. The presence of 1 or more taxa is often used to indicate very good environmental quality. Small increases or small declines in overall numbers of different stonefly taxa is thus very critical for correct evaluation of stream quality.

Metric 5. Percent Mayfly Composition. This is the ratio of the number of individuals in the order Ephemeroptera to the total number of organisms collected. As with the number of mayfly taxa, the percent abundance of mayflies in the total invertebrate sample can change dramatically and rapidly to minor environmental disturbances or fluctuations.

Metric 6. Percent Caddisfly Composition. This is the ratio of the number of individuals in the order Trichoptera to the total number of organisms collected. As with the number of caddisfly taxa, percent abundance of caddisflies is strongly related to stream size with greater proportions found in larger order streams. Optimal habitat and availability of appropriate food type seem to be the main constraints for large populations of caddisflies.

Metric 7. Percent Contribution of the Dominant Taxon. This is the ratio of the number of individuals in the most abundant taxon to the total number of organisms collected. The abundance of the numerically dominant taxon is an indication of community balance. A community dominated by relatively few taxa for example, would indicate environmental stress, as would a community composed of several taxa but numerically dominated by only 1 or 2 taxa.

Metric 8. Percent Isopods, Snails, and Leeches. This is the ratio of the sum of the number of individuals in the order Isopoda, class Gastropoda, and class Hirudinea to the total number of organisms collected. These 3 taxa, when compared as a combined percentage of the invertebrate community, can give an indication of the severity of environmental perturbation present. These organisms show a high tolerance to a variety of physical and chemical parameters. High percentages of these organisms at a sample site are very good evidence for stream degradation.

Metric 9. Percent Surface Dependent. This metric is the ratio of the number of macroinvertebrates that obtain oxygen via a generally direct atmospheric exchange, usually at the air/water interface, to the total number of organisms collected. High numbers or percentages of surface breathers may indicate large diurnal dissolved oxygen shifts or other biological or chemical oxygen demanding constraints. Areas subject to elevated temperatures, low flows, or erratic flows may also show disproportionately high percentages of surface dependent macroinvertebrates. Appendix I contains a list of surface dependent aquatic macroinvertebrates.

## VII. HABITAT ASSESSMENT

Habitat evaluations are made on instream habitat first, followed by channel morphology, bank structural features, and riparian vegetation. The habitat assessment process involves rating the sum total of the 10 metrics as *Excellent, Good, Marginal,* or *Poor* based on the criteria included on the Habitat Assessment Field Data Sheets (Appendix J). The point ranges for both Riffle/Run and Glide/Pool streams are listed below with each station's overall rating based on its potential to support biological communities. The range of scores used to classify each metric, as well as the range of scores representing the sum total for the habitat assessment, is described in the following rating tables:

| METRIC (Riffle/Run) | SCORING RANGE/RATING | | | |
|---|---|---|---|---|
| | Excellent | Good | Marginal | Poor |
| **Substrate and Instream Cover** | | | | |
| 1. Epifaunal Substrate/Available Cover | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 2. Embeddedness | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 3. Velocity/Depth Regime | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| **Channel Morphology** | | | | |
| 4. Sediment Deposition | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 5a. Flow Status – Maintained Flow Volume | 9 - 10 | 6 - 8 | 3 - 5 | 0 - 2 |
| 5b. Flow Status – Flashiness | 9 - 10 | 6 - 8 | 3 - 5 | 0 - 2 |
| 6. Channel Alteration | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 7. Frequency of Riffles (or Bends) | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| **Riparian and Bank Structure** | | | | |
| 8. Bank Stability | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 9. Vegetative Protection | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 10. Riparian Vegetation Zone Width | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |

| METRIC (Glide/Pool) | SCORING RANGE/RATING | | | |
|---|---|---|---|---|
| | Excellent | Good | Marginal | Poor |
| **Substrate and Instream Cover** | | | | |
| 1. Epifaunal Substrate/Available Cover | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 2. Pool Substrate Characterization | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 3. Pool Variability | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| **Channel Morphology** | | | | |
| 4. Sediment Deposition | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 5a. Flow Status – Maintained Flow Volume | 9 - 10 | 6 - 8 | 3 - 5 | 0 - 2 |
| 5b. Flow Status – Flashiness | 9 - 10 | 6 - 8 | 3 - 5 | 0 - 2 |
| 6. Channel Alteration | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| 7. Channel Sinuosity | 16 - 20 | 11 - 15 | 6 - 10 | 0 - 5 |
| **Riparian and Bank Structure** | | | | |
| 8. Bank Stability | 17 - 20 | 11 - 16 | 5 - 10 | 0 - 4 |
| 9. Vegetative Protection | 17 - 20 | 11 - 16 | 5 - 10 | 0 - 4 |
| 10. Riparian Vegetation Zone Width | 17 - 20 | 11 - 16 | 5 - 10 | 0 - 4 |

| Habitat Characterization | Total Point Score (metrics 1-10) |
|---|---|
| 1. Excellent | >154 |
| 2. Good | 105 – 154 |
| 3. Marginal | 56 – 104 |
| 4. Poor | <56 |

Five of the habitat metrics discriminate between *Riffle/Run* and *Glide/Pool streams*. Metrics 2, 3, and 7 are paired into separate *Riffle/Run* and *Glide/Pool* metrics (i.e., 2a and 2b). Metrics 1 and 4 each contain criteria for both *Riffle/Run* and *Glide/Pool* systems. In addition flow status (Metric 5) is broken down into 5a and 5b and is intended to measure both the ability of a stream to maintain sufficient base flows, as well as the flow response to runoff events (flashiness).

The site assessment approach for determining the *Riffle/Run* and *Glide/Pool* status of a stream is based on visual observation of the following characteristics:

Riffle/run streams characteristically:

- Demonstrate a regular (repeating) riffle/run sequence.
- Have substrates primarily composed of coarse sediment particles (i.e., course sand/gravel or larger particle sizes in high velocity reaches of the stream).
- Tend to have moderate to high gradient landscapes.

Glide/pool streams characteristically:

- Demonstrate primarily a glide/pool sequence.
- Have substrates that are primarily composed of fine sediment (fine sand and smaller). Coarse (gravel or larger) sediment particles may be present in firm bottom deep pools or along margins of some stream reaches; however, this occurrence is very infrequent.
- Have low to moderate gradient landscapes. Undisturbed portions of the floodplain may tend toward wetland characteristics.

There will be situations where riffle/run streams tend towards glide/pool or where glide/pool streams tend toward riffle/run. If the stream type is unclear, visually survey an expanded length of stream channel, noting the dominant substrate and flow characteristics. If the stream type remains unclear, complete both *Riffle/Run* and *Glide/Pool* habitat field forms. (Note: Riffle/Run channels that tend towards glide/pool or glide/pool channels that approach riffle/run conditions generally score nearly identically.) If there is reasonable agreement between the 2 forms, record an average of the 2 scores.

There will be occasions when the existing conditions do not fit 1 or more of the metrics given. In such cases, score each metric as close as possible and note the condition(s) that deviates from the expected, along with any needed explanation for your final score.

A. Procedure for Performing Habitat Assessment

The habitat assessment should be performed on a sufficient length of stream that reflects the typical habitat conditions associated with the biological sampling results. At a minimum, this reach should be no less than the section of stream used for biological sampling. Some parameters require an observation of a broader section of the watershed than the biological sampling reach alone and may require traversing the stream corridor to the extent deemed necessary to assess the habitat feature. As a general rule-of-thumb, use 2 lengths of the biological sampling reach to assess these parameters. If there is a team of 2 or more biologists, come to a consensus for each metric.

**Metric 1 EPIFAUNAL SUBSTRATE/AVAILABLE COVER** *Riffle/Run* and *Glide/Pool Streams*

This metric includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provide macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most riffle/run streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in riffle/run streams. Riffles and runs offer a diversity of habitat through variety of particle size and, in many small high-gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in glide/pool streams. However, "new fall" will not yet be suitable for colonization.

Assess both *Riffle/Run* and *Glide/Pool* streams by estimating the amount of stream channel in the sample reach that contains substrates that are free from sedimentation or siltation impacts and favorable for epifaunal colonization. Materials that are easily moved or displaced (silts, sand, and fine gravels) or unstable vegetation, such as bank grass or small stemmed brush tops, are not considered as stable. Some of the larger varieties of vascular aquatic macrophytes may be considered as a stable substrate; however, woody debris that is free-floating in back eddy's or temporarily trapped along stream margins should not be considered as a stable substrate.

| **Habitat Parameter** | **Condition Category** | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **1. Epifaunal Substrate/ Available Cover**<br><br>**(*Riffle/Run* and *Glide/Pool*)** | Greater than 70% (50% for glide/pool streams) of substrate are free from sedimentation/siltation and favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/ snags that are not new fall and not transient). | 40-70% (30-50% for glide/pool streams) mix of stable habitat; free from sedimentation/ siltation and well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% (10-30% for glide/pool streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed, removed, or covered by sediment/silt. | Less than 20% (10% for glide/pool streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 2a EMBEDDEDNESS** *Riffle/Run Streams*

This metric refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition and is a parameter evaluated in the riffles and runs of high-gradient streams.

The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas. Grasp and remove several cobbles at the sediment/water interface and estimate an average depth that is into the sediment.

| **Habitat Parameter** | **Condition Category** | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **2.a Embeddedness** ***(Riffle/Run Stream)*** | Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

### Metric 2b POOL SUBSTRATE CHARACTERIZATION *Glide/Pool Streams*

This metric evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel and sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types. *Glide/Pool* systems should be assessed by visual observations and, where possible, prodding with a net handle or wading staff, or simply wading slowly and carefully through the pool area itself.

| **Habitat Parameter** | **Condition Category** | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **2b. Pool Substrate Characterization** **(Glide/Pool)** | Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common. | Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present. | All mud or clay or sand bottom; little or no root mat; no submerged vegetation. | Hard-pan clay or bedrock; no root mat or submerged vegetation. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

### Metric 3a VELOCITY/DEPTH COMBINATIONS *Riffle/Run Streams*

Patterns of velocity and depth are included for riffle/run streams under this parameter as an important feature of habitat diversity. The best streams in most riffle/run regions will have all 4 patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 1.5 feet depth to separate shallow from deep, and 1.0 foot per second (f/s) to separate fast from slow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment and is expected to vary with stream size and watershed characteristics.

Both depth and velocity are relative to stream size. A deep pool in a stream that is 3 feet wide may be no more than 10-12 inches yet 4-6 feet deep in a river that is 80 feet or more wide. In a similar fashion, a flow velocity of 0.7 f/s may be considered to be fast in very small streams yet slow in larger systems.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **3a. Velocity/ Depth Regimes**<br><br>**(Riffle/Run)** | All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <1.0 f/s, deep is >1.5 ft.) | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/ depth regime (usually slow-deep). |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 3b POOL VARIABILITY** *Glide/Pool Streams*

This metric rates the overall mixture of pool types found in streams, according to size and depth. The 4 basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e., length, width, and depth) greater than half the cross-section of the stream for separating large from small and 3 feet depth separating shallow and deep. However, the size (width) of the stream channel will have a direct consequence on the relative relationship between pool sizes (see description of expected variation in stream velocity/depth assessment above).

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **3b. Pool Variability**<br><br>**(Glide Pool)** | Even mix of large-shallow, large-deep, small-shallow, small-deep pools present. | Majority of pools large-deep; very few shallow. | Shallow pools much more prevalent than deep pools. | Majority of pools small-shallow or pools absent. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 4 SEDIMENT DEPOSITION** *Riffle/Run and Glide/Pool Streams*

This metric estimates the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increases in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or man-made debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | Excellent | Good | Marginal | Poor |
| **4. Sediment Deposition**<br><br>**(Riffle/Run and Glide /Pool Streams)** | Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for glide/pool) of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for glide/pool) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 50% (80% for glide/pool) of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 5 CHANNEL FLOW STATUS** *Riffle/Run and Glide/Pool Streams*

The degree to which stream flow is maintained in the channel (5a) and the speed and magnitude of flow response to rain events (flashiness) (5b) collectively describes the channel flow status of the stream. The flow status will change as the channel enlarges (e.g., aggrading streambeds with actively widening channels), as a result of dams and other obstructions, diversions for irrigation, drought, increases in the amount of impervious surfaces in the watershed, or enhanced drainage to support agricultural land use. Channel flow can be especially useful for interpreting biological conditions under abnormal or lowered flow conditions, with indications of significant flow instability relatively easy to see in a stream at or near base flow conditions.

The amount of suitable substrates for aquatic organisms becomes limited when stream flow is not maintained at adequate levels. In both riffle/run and glide/pool streams, bottom substrates can become exposed, reducing good habitat areas for fish and macroinvertebrate communities. Estimating insufficient flows due to water loss can be done by looking for exposed river substrate materials along the lateral portions of the wetted channel, dried algae or fine sediment deposits on rocks, or large woody debris (LWD) above and adjacent to the waterline.

An increased response to precipitation events is called flashiness and is often correlated with a decrease in stream habitat. Flashy streams are most often impaired by excessive erosive energy that destabilizes and impairs habitat that is otherwise suitable for colonization by aquatic organisms. In stable streams, LWD, where available, can be found throughout the wetted portion of the channel, often perpendicular to the direction of flow. Streambank vegetation typically exists at or near the water/streambank interface. In flashy systems, woody debris is generally flushed from the thalweg toward the stream banks or is removed from the active channel entirely. Streambank vegetation is removed above normal flow levels by frequent high water events.

An estimation of stream flashiness is made by observing the vegetation density at the water/streambank interface, and, where applicable, the position of LWD and LWD jams in the stream channel. However, the difference between scoured banks and areas where streambank soils may naturally produce a poorly vegetated zone along the water-streambank interface must be recognized. Some soil types near the water’s edge are continually saturated and may normally be void of vegetation. In addition, some dense clay soils may take a relatively long time to revegetate following a disturbance, resulting in a false appearance of scouring from frequent high flows. Conversations with people living near the stream can be used to corroborate observations regarding stream flashiness or the ability of the stream to maintain sufficient base flow levels.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **5a. Channel Flow Status – Maintained Flow Volume**<br><br>**(Riffle/Run and Glide/Pool Streams)** | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| **SCORE** | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **5b. Channel Flow Status - Flashiness**<br><br>**(Riffle/Run and Glide/Pool Streams)** | Vegetation along the stream banks is complete nearly to the waters edge. Little or no evidence of frequent changes in discharge and/or frequent high water events that scour streambank vegetation. Large woody debris (if present) stable and extending laterally across the stream channel. | Some evidence of bank scour approximately 4-8 inches above the waters surface. Large woody debris (if present) mostly stable and extending partially into the active stream channel | Bank scour evident 9-18 inches above the waters surface. Large woody debris (if present) tend to lay more against the streambank rather than extending into the active channel. | Bank scour severe (>20 inches) along the stream channel. Large woody debris is generally absent from the active channel and/or may exist as woody debris jams along the streambank above the active channel. |
| **SCORE** | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Metric 6 CHANNEL ALTERATION** *Riffle/Run and Glide/Pool Streams*

This metric is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; and when dams and bridges are present. Scouring is often associated with channel alteration, as is a reduction in flow velocity during base flow conditions.

Minimal channel alterations may include short channel sections that have been modified to facilitate road/stream crossings. Estimate and record the length of river/stream/drain that has been recently channelized (within the last 5-10 years) and/or has evidence of actively or somewhat actively maintained stream banks.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | Excellent | Good | Marginal | Poor |
| **6. Channel Alteration**<br><br>**(Riffle/Run and Glide/Pool Streams)** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present. | Channelization is continuous but not recent (> 5 years); embankments without mature trees and dominated by grasses and shrubs. | Stream reach has been recently channelized (<5 years). OR Banks shored with gabion, rock, cement or bare earth. Instream habitat greatly altered or removed entirely. Bank vegetation moderately dense to absent |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 7a FREQUENCY OF RIFFLES (OR BENDS)** *Riffle/Run Streams*

This metric measures the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community.

Measuring the sequencing pattern of the stream is necessary to rate this metric. Estimate the frequency of riffles (or bends) by simply measuring the distance between each occurrence. For riffle/run streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity (see Metric 7b). To gain an appreciation of this metric in some streams, a longer segment or reach than that designated for sampling should be incorporated into the evaluation. In some situations (i.e., larger rivers), this metric may be rated from viewing topographical maps.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | Excellent | Good | Marginal | Poor |
| **7a. Frequency of Riffles (or bends)**<br><br>**(Riffle/Run Stream)** | Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 and 15. | Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 and 25. | Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 7b CHANNEL SINUOSITY** *Glide/Pool Streams*

This metric evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna. The absorption of flow energy by bends protects the stream from excessive erosion and flooding and provides refugia for macroinvertebrates and fish during runoff events.

Measuring the sequencing pattern of the stream is necessary to rate this metric. Channel sinuosity can be estimated by dividing a channel length that includes 2 stream bends by the straight line distance between these 2 points. In some situations (i.e., large rivers), this metric may be rated from viewing topographical maps. To gain an appreciation of this metric in glide/pool streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **7b. Channel +Sinuosity (Glide/Pool Stream)** | The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.) | The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line. | The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. (Note: lack of sinuosity may be due to channelization) | Channel straight; waterway has been channelized for a long distance. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Metric 8 BANK STABILITY (condition of banks)** *Riffle/Run and Glide/Pool Streams*

This metric measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are, therefore, considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of soil movement into the stream and suggest a scarcity of streambank cover and organic input to the stream. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **8. Bank Stability (score each bank)**<br>**Note: determine left or right side by facing downstream**<br>**(Riffle/Run and Glide/Pool Streams)** | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| SCORE ___ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Metric 9 BANK VEGETATIVE PROTECTION** *Riffle/Run and Glide/Pool Streams*

This metric evaluates the degree of vegetative protection afforded to the streambank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This metric supplies information on the ability of the bank to resist erosion, as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. Wetland stream banks (e.g., marsh or swamp) will be dramatically different than the typical climax forest community but are equally protective to the physical and biological community. In contrast, dense monocultures of exotic plant species (i.e., purple loosestrife) do not offer the same degree of protection as a diverse community of native vegetation and should be scored accordingly. In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone.

For this metric, consider the bank condition between the aquatic/terrestrial interface to a point immediately past the streambank/riparian zone interface. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

| Habitat Parameter | Condition Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Excellent | | | Good | | | Marginal | | | Poor | |
| **9. Vegetative Protection (score each bank)**<br><br>**<u>Note: determine left or right side by facing downstream</u>.**<br><br>**(Riffle/Run and Glide/Pool Streams)** | More than 90% of the streambank surfaces and immediate riparian zones covered by vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | | | 70-90% of the streambank surfaces covered by vegetation, but 1 class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | | | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | | | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. | |
| SCORE ___ (LB) | Left Bank | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| SCORE ___ (RB) | Right Bank | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

**Metric 10 RIPARIAN VEGETATIVE ZONE WIDTH** *Riffle/Run and Glide/Pool Streams*

This metric measures the width of natural vegetation from the edge of the streambank out through the riparian zone. The riparian zone prevents a wide range of pollutants from entering a stream from runoff and provides erosion control. In addition, a diverse riparian zone plays an active role in water quality by providing a continuous source of materials and shade that act to stabilize both the physical and biological aspects of the stream environment. A relatively undisturbed riparian zone that has an adequate width will support a robust stream system. Narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the streambank. Residential developments, urban centers, golf courses, and agricultural land uses are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of "old field" (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores.

The ability of the riparian zone to protect aquatic environs is based on the collective function of a diverse plant community, water storage capabilities, and to a certain extent, stream width. Therefore, consider the diversity of vegetation, as well as the width of the riparian zone. Grass filter strips, lawns, or lush stream banks are not considered to be part of the riparian zone because they do not offer a significant resource to the physical or biological community. Old field land use, depending on the point of transition between agriculture and a climax riparian community, will offer some to most of the potential resource to the stream. A fully functional riparian zone contains diverse vegetation, including trees, understory shrubs, and nonwoody macrophytes. Small streams (approximately 10 feet wide or less) accompanied by diverse riparian widths of less than 150 feet may be considered as excellent. Wetland riparian zones (e.g., marsh or swamp) will be dramatically different than the typical climax forest community but are equally protective to the physical and biological community.

| Habitat Parameter | Condition Category | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Excellent | | | Good | | | Marginal | | | Poor | |
| **10. Riparian Vegetative Zone Width (score each bank riparian zone)**<br><br>**(Riffle/Run and Glide/Pool Streams)** | Width of riparian zone >150 feet; dominated by vegetation, including trees, understory shrubs, or nonwoody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. Human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | | | Width of riparian zone 75-150 feet; human activities have impacted zone only minimally. | | | Width of riparian zone 10-75 feet; human activities have impacted the composition of the vegetation a great deal. | | | Width of riparian zone <10 feet: little or no riparian vegetation due to human activities. | |
| SCORE ___ (LB) | Left Bank | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 0 |
| SCORE ___ (RB) | Right Bank | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 0 |

## VIII. OVERALL APPLICATION AND INTEGRATION

A. Relationship of Habitat Quality and Biological Condition

The optimum biological community stability and biological diversity of a site for both fish and macroinvertebrates may be determined by the quality of the habitat at that site. Excellent habitat will allow for high quality biological communities. Community responses to minor alteration in habitat are often subtle. As habitat quality continues to decline, however, recognizable and measurable biological changes (impairments) occur. These changes, in the absence of confounding water quality effects, are generally in direct proportion to the degree of habitat change. When habitat becomes severely degraded, changes in the biological communities become harder to recognize and measure. The biological communities existing under these degraded habitat conditions are represented by opportunistic species, which are more tolerant of such habitat perturbations and often insensitive to further habitat degradation. This may result in a poor habitat characterization corresponding to either a moderately or severely impacted biological community depending on the specific site and situation.

In areas of good or excellent habitat, biological communities will reflect degraded conditions when adverse water quality effects exist. As habitat degrades further in the continued presence of water quality problems, such as chemical toxicants or nutrient enrichment, the biological communities may show less dramatic changes as each community becomes dominated by tolerant and opportunistic species.

## IX. QUALITY ASSURANCE/QUALITY CONTROL

As with any scientific study, quality must be assured and tested before the results can be accepted. Quality assurance is accomplished through use of professional and trained biologists, establishment of thorough field training, defined collection guidelines, and comprehensive field documentation and data analysis.

A. Training

All personnel conducting surveys are trained in a consistent manner (preferably by the same person) to ensure that the surveys are conducted properly and in a standardized fashion. At least 1 investigator for each site will be a professional biologist trained and skilled in field aquatic sampling methods and organism identification.

B. Standard Procedures

The standard procedures described in this document are followed in the surveys. Field experience and taxonomic expertise requirements must be met by staff involved in surveys. Any deviations from the procedures should be documented as to the reason for deviation.

Field crew personnel will be alternated to maintain objectivity in the surveys.

C. Documentation

The field data sheets (stream survey cards, Appendix J) are filled out as completely and as accurately as possible to provide a record in support of the survey and analysis conclusions.

Field and laboratory data sheets and final reports are filed in the SWAS raw data files and report files, respectively.

D. Habitat Assessment

All personnel are appropriately trained in the evaluation technique and periodic cross-checks are conducted among personnel to promote consistency.

E. Macroinvertebrate Collections

Data developed during the macroinvertebrate collection efforts are directly comparable to data developed at other sites because: (1) all habitats are sampled at each site, and (2) a uniform method (consistent unit of effort, 300-organism count) is used for data acquisition. To ensure reproducible data, well characterized sites are periodically resampled by a variety of investigators.

F. Fish Collections

Data comparability is maintained by using similar collection methods and sampling effort in water bodies of similar size. Also, where possible, major habitats (riffle, run, pool) are sampled at each site, and the proportion of each habitat type sampled, should be comparable. Data reproducibility is ensured by having a variety of investigators periodically resample well characterized sites.

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**PROCEDURE:**

| Responsibility | Action |
|---|---|
| Surface Water Assessment Section Staff | Site selection, conduct monitoring per the procedure or oversee grantee monitoring per the procedure, calculate habitat and biological community scores and determine condition and WQS attainment for each site within a watershed, data storage and summary for use in rotating basin water quality monitoring reports. |

**APPENDICES:**

Appendix A: Michigan Fish Classified as Intolerant
Appendix B: Michigan Fish Classified as Omnivores
Appendix C: Michigan Fish Classified as Insectivores
Appendix D: Michigan Fish Classified as Piscivores
Appendix E: Michigan Fish Classified as Tolerant
Appendix F: Michigan Fish Classified as Simple Lithophilic Spawners
Appendix G: Fish Measured to Inch Group
Appendix H: Phylogenetic Order for Macroinvertebrates
Appendix I: Surface Dependent Macroinvertebrates
Appendix J: Stream Card

SECTION CHIEF APPROVAL:

Diana Klemans

Diana Klemans, Chief
Surface Water Assessment Section

Appendix A
Michigan Fish Classified as Intolerant

| Common Name | Scientific Name |
|---|---|
| Petromyzontidae (lampreys) | |
| Sea lampey (ammocete) | Petromyzon marinus |
| Silver lamprey (ammocete) | Ichthyomyzon unicuspis |
| Silver lamprey (adult) | Ichthyomyzon unicuspis |
| Northern brook (ammocete) | Ichthyomyzon fossor |
| Northern brook (adult) | Ichthyomyzon fossor |
| Chestnut lamprey (ammocete) | Ichthyomyzon castaneus |
| Chestnut lamprey (adult) | Ichthyomyzon castaneus |
| American brook (ammocete) | Lampetra appendix |
| American brook (adult) | Lampetra appendix |
| | |
| Acipenseridae (sturgeons) | |
| Lake sturgeon | Acipenser fulvescens |
| | |
| Polydontidae (paddlefish) | |
| Paddlefish **(extinct in Michigan)** | Polyodon spathula |
| | |
| Hiodontidae (Mooneyes) | |
| Mooneye | Hiodon tergisus |
| | |
| Salmonidae (trouts) | |
| Rainbow trout | Oncorhynchus mykiss |
| Brown trout | Salmo trutta |
| Brook trout | Salvelinus fontinalis |
| Coho salmon | Oncorhynchus kisutch |
| Chinook salmon | Oncorhynchus tshawytscha |
| Pink salmon | Oncorhynchus gorbuscha |
| Lake herring | Coregonus artedi |
| Lake whitefish | Coregonus cupeaformis |
| Bloater | Coregonus hoyi |
| Deepwater cisco | Coregonus johannae |
| Kiyi | Coregonus kiyi |
| Blackfin cisco | Coregonus nigripinnis |
| Shortnose cisco | Coregonus reighardi |
| Shortjaw cisco | Coregonus zenithicus |
| Pygmy whitefish | Prosopium coulte |
| Round whitefish | Prosopium cylindraceum |
| Atlantic salmon | Salmo salar |
| Lake trout | Salvelinus namaycush |
| Artic grayling **(extinct in Michigan)** | Thymallus arcticus |
| | |
| Esocidae (pikes) | |
| Muskellunge | Esox masquinongy |

| Common Name | Scientific Name |
| --- | --- |
| Cyprinidae (minnows and carps) | |
| Bigeye chub | Notropis amblops |
| River chub | Nocomis micropogon |
| Pugnose shiner | Notropis anogenus |
| Bigeye shiner | Notropis boops |
| Ironcolor shiner | Notropis chalybaeus |
| Weed shiner | Notropis texanus |
| Blackchin shiner | Notropis heterodon |
| Blacknose shiner | Notropis heterolepis |
| Spottail shiner | Notropis hudsonius |
| Silver shiner | Notropis photogenis |
| Rosyface shiner | Notropis rubellus |
| Southern redbelly dace | Phoxinus erthrogaster |
| Longnose dace | Rhinichthys cataractae |
| Redside dace | Clinostomus elongatus |
| Pearl dace | Margariscus margarita |
| Silver chub | Macrhybopsis storeriana |
| Pugnose minnow | Opsopoedus emiliae |
| | |
| Cottidae (sculpins) | |
| Mottled sculpin | Cottus bairdii |
| Slimy sculpin | Cottus cognatus |
| Spoonhead sculpin | Cottus ricei |
| Deepwater sculpin | Myoxocephalus thompsoni |
| | |
| Catostomidae (suckers) | |
| Longnose sucker | Catostomus catostomus |
| Creek chubsucker | Erimyzon oblongus |
| Northern hog sucker | Hypentelium nigricans |
| Black buffalo | Ictiobus niger |
| | |
| Spotted sucker | Minytrema melanops |
| Silver redhorse | Moxostoma anisurum |
| River redhorse | Moxostoma carinatum |
| Black redhorse | Moxostoma duquesnei |
| Shorthead redhorse | Moxostoma macrolepidotum |
| Greater redhorse | Moxostoma valenciennesi |
| | |
| Ictaluridae (Bullhead, Catfish) | |
| Stonecat | Noturus flavus |
| | |
| Cyprinodontidae (topminnows) | |
| Banded killifish | Fundulus diaphanus |
| | |
| Gasterosteidae (sticklebacks) | |
| Ninespine stickleback | Pungitius pungitius |
| | |
| Centrarchidae (sunfish) | |
| Rock bass | Ambloplites rupestris |
| Smallmouth bass | Micropterus dolomieui |

Appendix A (continued)

| | |
|---|---|
| Percidae (perch) | |
| Eastern sand darter | Ammocrypta pellucida |
| Rainbow darter | Etheostoma caeruleum |
| Iowa darter | Etheostoma exile |
| Least darter | Etheostoma microperca |
| Orangethroat darter | Etheostoma spectabile |
| Banded darter | Etheostoma zonale |
| Channel darter | Percina copelandi |

Appendix B
Michigan Fish Classified as Omnivores

| Common Name | Scientific Name |
|---|---|
| Cyprinidae | |
| Goldfish | Carassius auratus |
| Common Carp | Cyprinus carpio |
| Golden Shiner | Notemigonus crysoleucas |
| Fathead minnow | Pimephales promelas |
| Bluntnose minnow | Pimephales notatus |
| Creek chub | Semotilus atromaculatus |
| Blacknose dace | Rhinichthys atratulus |
| European rudd | Scardinius erthropthalmus |
| Catastomidae | |
| White sucker | Catostomus commersoni |
| Quillback | Carpoides cyprinus |
| Umbridae | |
| Central mudminnow | Umbra limi |
| Ictaluridae | |
| Black Bullhead | Ameiurus melas |
| Brown bullhead | Ameiurus nebulosus |
| Yellow bullhead | Ameiurus natalis |

Appendix C
Michigan Fish Classified as Insectivores

| Common Name | Scientific Name |
|---|---|
| Acipenseridae (sturgeons) | |
| Lake Sturgeon | Acipenser fulvescens |
| Hiodontidae (Mooneyes) | |
| Mooneye | Hiodon tergisus |
| Salmonidae (trouts) | |
| Lake whitefish | Coregonus cupeaformis |
| Pygmy whitefish | Prosopium coulteri |
| Round whitefish | Prosopium cylindraceum |
| Artic grayling **(extinct in Michigan)** | Thymallus arcticus |
| Cyprinidae (minnows and carps) | |
| Lake chub | Couesius plumbeus |
| Bigeye chub | Notropis amblops |
| Hornyhead chub | Nocomis biguttatus |
| River chub | Nocomis micropogon |
| Emerald shiner | Notropis atherinoides |
| Bigeye shiner | Notropis boops |
| Ironcolor shiner | Notropis chalybaeus |
| Common shiner | Luxilus cornutus |
| Striped shiner | Luxilus chrysocephalus |
| Central bigmouth shiner | Notropis dorsalis |
| Blackchin shiner | Notropis heterodon |
| Blacknose shiner | Notropis heterolepis |
| Spottail shiner | Notropis hudsonius |
| Silver shiner | Notropis photogenis |
| Rosyface shiner | Notropis rubellus |
| Spotfin shiner | Cyprinella spilopterus |
| Sand shiner | Notropis stramineus |
| Redfin shiner | Lythrurus umbratilis |
| Mimic shiner | Notropis volucellus |
| Suckermouth minnow | Phenacobius mirabilis |
| Silverjaw minnow | Notropis buccatus |
| Finescale dace | Phoxinus neogaeus |
| Longnose dace | Rhinichthys cataractae |
| Redside dace | Clinostomus elongatus |
| Pearl dace | Margariscus margarita |
| Silver chub | Macrhybopsis storeriana |
| Pugnose minnow | Opsopoedus emiliae |
| Cottidae (sculpins) | |
| Mottled sculpin | Cottus bairdii |
| Slimy sculpin | Cottus cognatus |
| Spoonhead sculpin | Cottus ricei |
| Deepwater sculpin | Myoxocephalus thompsoni |

| **Common Name** | **Scientific Name** |
|---|---|
| Catostomidae (suckers) | |
| Longnose sucker | Catostomus catostomus |
| Creek chubsucker | Erimyzon oblongus |
| Lake chubsucker | Erimyzon sucetta |
| Norther hog sucker | Hypentelium nigricans |
| Bigmouth buffalo | Ictiobus cyprinellus |
| Black buffalo | Ictiobus niger |
| Spotted sucker | Minytrema melanops |
| Silver redhorse | Moxostoma anisurum |
| River redhorse | Moxostoma carinatum |
| Black redhorse | Moxostoma duquesnei |
| Golden redhorse | Moxostoma erythrurum |
| Shorthead redhorse | Moxostoma macrolepidotum |
| Greater redhorse | Moxostoma valenciennesi |
| Ictaluridae (Bullhead, Catfish) | |
| Stonecat | Noturus flavus |
| Margined madtom | Noturus insignis |
| Tadpole madtom | Noturus gyrinus |
| Brindled madtom | Noturus miurus |
| Northern madtom | Noturus stigmosus |
| Aphredoderidae (pirate perch) | |
| Pirate perch | Aphredoderus sayanus |
| Atherinidae (silversides) | |
| Brook silversides | Labidesthes sicculus |
| Cyprinodontidae (topminnows) | |
| Banded killifish | Fundulus diaphanus |
| Starhead topminnow | Fundulus dispar |
| Blackstripe topminnow | Fundulus notatus |
| Gasterosteidae (sticklebacks) | |
| Brook stickleback | Culaea inconstans |
| Threespine stickleback | Gasterosteus aculeatus |
| Ninespine stickleback | Pungitius pungitius |
| Centrarchidae (sunfish) | |
| Green sunfish | Lepomis cyanellus |
| Pumpkinseed | Lepomis gibbosus |
| Orangespotted sunfish | Lepomis humilis |
| Bluegill | Lepomis macrochirus |
| Longear sunfish | Lepomis megalotis |
| Redear sunfish | Lepomis microlophus |

| **Common Name** | **Scientific Name** |
| --- | --- |
| Percidae (perch) | |
| Eastern sand darter | *Ammocrypta pellucida* |
| Rainbow darter | *Etheostoma caeruleum* |
| Iowa darter | *Etheostoma exile* |
| Greenside darter | *Etheostoma blennioides* |
| Fantail darter | *Etheostoma flabellare* |
| Least darter | *Etheostoma microperca* |
| Johnny darter | *Etheostoma nigrum* |
| Orangethroat darter | *Etheostoma spectabile* |
| Banded darter | *Etheostoma zonale* |
| Logperch | *Percina caprodes* |
| Channel darter | *Percina copelandi* |
| Blackside darter | *Percina maculata* |
| River darter | *Percina shumardi* |
| Ruffe | *Gymnocephalus cernuus* |
| Percopsidae (Trout-perch) | |
| Trout-perch | *Percopsis omiscomaycus* |
| Sciaenidae (drums) | |
| Freshwater drum | *Aplodinotus grunniens* |
| Gobiidae (gobies) | |
| Round goby | *Neogobius melanostomus* |
| Tubenose goby | *Proterorhinus marmoratus* |
| Poeciliidae (livebearers) | |
| Western mosquitofish | *Gambusia affinis* |

Appendix D

Michigan Fish Classified as Piscivores

| **Common Name** | **Scientific Name** |
|---|---|
| Spotted gar | Lepisosteus oculatus |
| Longnose gar | Lepisosteus osseus |
| Bowfin | Amia calva |
| American eel | Anguilla rostrata |
| Channel catfish | Ictalurus punctatus |
| Flathead catfish | Pylodictis olivaris |
| Grass pickerel | Esox americanus vermiculatus |
| Northern pike | Esox lucius |
| Muskellunge | Esox masquinongy |
| Burbot | Lota lota |
| White perch | Morone americana |
| White bass | Morone chrysops |
| Rock bass | Ambloplites rupestris |
| Largemouth bass | Micropterus salmoides |
| Smallmouth bass | Micropterus dolomieu |
| Walleye | Stizostedion vitreum |
| Sauger | Stizostedion canadense |

Appendix E
Michigan Fish Classified as Tolerant

| Common Name | Scientific Name |
|---|---|
| Amiidae (bowfins) | |
| Bowfin | Amia calva |
| Umbridae (mudminnows) | |
| Central mudminnow | Umbra limi |
| Cyprinidae (minnows and carps) | |
| Goldfish | Carassius auratus |
| Common carp | Cyprinus carpio |
| Creek chub | Semotilus atromaculatus |
| Golden shiner | Notemigonus crysoleucas |
| Fathead minnow | Pimephales promelas |
| Bluntnose minnow | Pimephales notatus |
| Blacknose dace | Rhinichthys atratulus |
| European rudd | Scardinius erythropthalmus |
| Catostomidae (suckers) | |
| White sucker | Catostomus commersoni |
| Ictaluridae (Bullhead, Catfish) | |
| Yellow bullhead | Ameiurus natalis |
| Centrarchidae (sunfish) | |
| Green sunfish | Lepomis cyanellus |
| Percidae (perch) | |
| Johnny darter | Etheostoma nigrum |
| Sciaenidae (drums) | |
| Freshwater drum | Aplodinotus grunniens |

Appendix F
Michigan Fish Classified as Simple Lithophilic Spawners

| **Common Name** | **Scientific Name** |
|---|---|
| Acipenseridae (sturgeons) | |
| Lake sturgeon | Acipenser fulvescens |
| | |
| Polydontidae (paddlefish) | |
| Paddlefish **(extinct in Michigan)** | Polyodon spathula |
| | |
| Hiodontidae (mooneyes) | |
| Mooneye | Hiodon tergisus |
| | |
| Cyprinidae (minnows and carps) | |
| Lake chub | Couesius plumbeus |
| Bigeye shiner | Notropis boops |
| Common shiner | Luxilus cornutus |
| Striped shiner | Luxilus chrysocephalus |
| Silver shiner | Notropis photogenis |
| Rosyface shiner | Notropis rubellus |
| Suckermouth minnow | Phenacobius mirabilis |
| Southern redbelly dace | Phoxinus erthrogaster |
| Blacknose dace | Rhinichthys atratulus |
| Longnose dace | Rhinichthys cataractae |
| Pearl dace | Margariscus margarita |
| | |
| Catostomidae (suckers) | |
| Longnose sucker | Catostomus catostomus |
| White sucker | Catostomus commersoni |
| Northern hog sucker | Hypentelium nigricans |
| Spotted sucker | Minytrema melanops |
| Silver redhorse | Moxostoma anisurum |
| River redhorse | Moxostoma carinatum |
| Black redhorse | Moxostoma duquesnei |
| Golden redhorse | Moxostoma erythrurum |
| Shorthead redhorse | Moxostoma macrolepidotum |
| Greater redhorse | Moxostoma valenciennesi |
| | |
| Percidae (perch) | |
| Rainbow darter | Etheostoma caeruleum |
| Orangethroat darter | Etheostoma spectabile |
| Banded darter | Etheostoma zonale |
| Logperch | Percina caprodes |
| Channel darter | Percina copelandi |
| Blackside darter | Percina maculata |
| River darter | Percina shumardi |
| Sauger | Stizostedion canadense |
| Walleye | Stizostedion vitreum |
| Ruffe | Gymnocephalus cernuus |
| | |
| Gadidae (codfishes) | |
| Burbot | Lota lota |

# Appendix G

The following fish are to be measured to inch group:

Percidae (Perches)

| | |
|---|---|
| Yellow perch | Perca flavescens |
| Sauger | Stizostedion canadense |
| Walleye | Stizostedion vitreum |

Cyprinidae (minnows)

| | |
|---|---|
| Creek chub | Semotilus atromaculatus |
| Pearl dace | Margariscus margarita |
| Goldfish | Carassius auratus |
| Common carp | Cyprinus carpio |
| Common shiner | Notropis cornutus |
| Hornyhead chub | Nocomis biguttus |
| River chub | Nocomis micropogon |
| Golden shiner | Notemigonus crysoleucas |

All members of the families:

Catostomidae (suckers)
Lepistosteidae (gars)
Amiidae (bowfin)
Anquillidae (eel)
Clupeidae (herring)
Osmeridae (smelts)
Salmonidae (salmon, trouts, whitefish)
Esocidae (pike)
Ictaluridae (bullheads, catfish)
Percichthyidae (temperate basses)
Centrarchidae (sunfishes)
Sciaenidae (drums)

# Appendix H

Phylogenetic order for macroinvertebrates, level of taxonomy, and primary keys to be used for site evaluations.

- Porifera:  Phylum (Pennak, 1989)
- Platyhelminthes
  - Turbellaria:  Class (Pennak, 1989)
- Nematomorpha:  Phylum (Pennak, 1989)
- Bryozoa:  Phylum (Pennak, 1989)
- Annelida
  - Oligochaeta:  Class (Pennak, 1989)
  - Hirudinea:  Class (Klemm, 1972)
- Arthropoda
  - Crustacea
    - Isopoda:  Order (Pennak, 1989)
    - Amphipoda:  Order (Pennak, 1989)
    - Decapoda:  Order (Pennak, 1989)
  - Arachnoidea
    - Hydracarina:  Order (Pennak, 1989)
  - Insecta (Merritt and Cummins, 1996)
    - Ephemeroptera
      - Baetidae:  Family
      - Baetiscidae:  Family
      - Caenidae:  Family
      - Ephemerellidae:  Family
      - Ephemeridae:  Family
      - Heptageniidae:  Family
      - Isonychiidae:  Family
      - Leptophlebiidae:  Family
      - Oligoneuriidae:  Family
      - Polymitarcyidae:  Family
      - Potamanthidae:  Family
      - Siphlonuridae:  Family
      - Tricorythidae:  Family
  - Odonata
    - Zygoptera
      - Calopterygidae:  Family
      - Coenagrionidae:  Family
      - Lestidae:  Family
    - Anisoptera
      - Aeshnidae:  Family
      - Cordulegastridae:  Family
      - Corduliidae:  Family
      - Gomphidae:  Family
      - Libellulidae:  Family
      - Macromiidae:  Family

Plecoptera
- Capniidae: Family
- Chloroperlidae: Family
- Leuctridae: Family
- Nemouridae: Family
- Peltoperlidae: Family
- Perlidae: Family
- Perlodidae: Family
- Pteronarcyidae: Family
- Taeniopterygidae: Family

Hemiptera
- Belostomatidae: Family
- Corixidae: Family
- Gelastocoridae: Family
- Gerridae: Family
- Mesoveliidae: Family
- Naucoridae: Family
- Nepidae: Family
- Notonectidae: Family
- Pleidae: Family
- Veliidae: Family

Megaloptera
- Corydalidae: Family
- Sialidae: Family

Neuroptera
- Sisyridae: Family

Trichoptera
- Beraediae: Family
- Brachycentridae: Family
- Glossosomatidae: Family
- Helicopsychidae: Family
- Hydropsychidae: Family
- Hydroptilidae: Family
- Lepidostomatidae: Family
- Leptoceridae: Family
- Limnephilidae: Family
- Molannidae: Family
- Odontoceridae: Family
- Philopotamidae: Family
- Phryganeidae: Family
- Polycentropodidae: Family
- Psychomyiidae: Family
- Rhyacophilidae: Family
- Sericostomatidae: Family

Lepidoptera
- Noctuidae: Family
- Pyralidae: Family

Coleoptera
- Chrysomelidae: Family
- Curculionidae: Family
- Dryopidae: Family
- Dytiscidae: Family
- Elmidae: Family
- Gyrinidae: Family
- Haliplidae: Family
- Heterocerodea: Family
- Hydrophilidae: Family
- Hydraenidae: Family
- Lampyridae: Family
- Limnichidae: Family
- Noteridae: Family
- Psephenidae: Family
- Ptilodactylidae: Family
- Scirtidae: Family

Diptera
- Athericidae: Family
- Ceratopogonidae: Family
- Chaoboridae: Family
- Chironomidae: Family
- Culicidae: Family
- Dixidae: Family
- Dolichopodidae: Family
- Empididae: Family
- Ephydridae: Family
- Muscidae: Family
- Psychodidae: Family
- Ptychopteridae: Family
- Sciomyzidae: Family
- Simuliidae: Family
- Stratiomyidae: Family
- Syrphidae: Family
- Tabanidae: Family
- Thaumaleidae: Family
- Tipulidae: Family

Mollusca
- Gastropoda: Family (Burch, 1991)
- Pelecypoda: Family (Burch, 1991)

## Appendix I
## Surface Dependant Macroinvertebrates

Hemiptera
- All Families

Coleoptera
- All Adults (other than Elmidae and Dryopidae)
- Dytiscidae larvae
- Hydrophilidae larvae
- Hydraenidae larvae
- Heteroceridae larvae

Diptera
- Culicidae larvae
- Ptychopteridae larvae
- Chaoboridae larvae (except Chaoborus sp.)
- Stratiomyidae
- Dolichopodidae
- Syrphidae

APPENDIX J. STREAM CARD

Shaded fields are entered into database

| | |
|---|---|
| STREAM NAME | LOCATION (road crossing) |
| COUNTY/TOWNSHIP | T R S |
| LAT(dd) LONG (dd) | RIVER BASIN |
| STORET # | HUC CODE ECOREGION |
| INVESTIGATOR(S) DATE<br>TIME AM PM | REASON FOR SURVEY<br>☐ Targeted: comment ______________________________<br>☐ Randomized: VSEC # ______________________________<br>VSEC description (eg. cold small) ______________________ |

**WEATHER CONDITIONS**

Current
☐ Sunny
☐ Partly Cloudy
☐ Cloudy
☐ Rainy

Has there been a significant rain in the last 7 days?
☐ Yes ☐ No
☐ Don't Know
Air Temperature _______ °F

**RIPARIAN VEGETATION**

Indicate the dominant type and record the dominant species
☐ Trees ☐ Shrubs Species:
☐ Grasses ☐ Herbaceous
Estimate buffer width (left) _______ft (right) _______ft

**WATERSHED FEATURES**

Predominant Surrounding Land Use
☐ Forest
☐ Commercial
☐ Field/Pasture
☐ Industrial
☐ Agricultural
☐ Residential
☐ Other _______

Local Watershed NPS Pollution
☐ No evidence
☐ Some potential sources
☐ Obvious Sources

Local Watershed Erosion
☐ None
☐ Moderate
☐ Heavy

**STREAM CHARACTERIZATION**

Stream Subsystem
☐ Perennial
☐ Intermittent
☐ Lake Outlet Influenced
☐ Dam Influenced

Stream Origin
☐ Spring Fed
☐ Lake/Pond
☐ Swamp, Marsh, Bog
☐ Mixture of origins
☐ Other _______

Stream Modifications
☐ None
☐ Dredged
☐ Canopy Removal
☐ Snagging
☐ Impounded
☐ Relocated
☐ Bank Stabilization
☐ Habitat Improvement

Stream Type
☐ Coldwater
☐ Warmwater

**INSTREAM FEATURES**

Avg. Stream Width _______ft Avg. Stream Depth _______ft

Surface Velocity _______ft/sec (at thalweg) Est. Flow _______cfs

Est. Survey Reach Length _______ft

Survey Reach Area _______$ft^2$ High Water Mark _______ft

Canopy Cover: _______% Shaded

**AQUATIC VEGETATION**

☐ Rooted emergent ☐ Free Floating
☐ Rooted submergent ☐ Floating algae
☐ Rooted floating ☐ Attached algae

Portion of the reach with aquatic vegetation _______%
Nuisance aquatic plants or slimes present? Yes ☐ No ☐
Dominant species present ___________________________

**WATER QUALITY**

Temperature__________ °F

Water Samples Taken
☐ None ☐ Other _______
☐ GA ☐ GN
☐ MA ☐ MN
☐ VOA ☐ ON

Solids, Turbidity
☐ Clear
☐ Slightly turbid
☐ Turbid
☐ Floating solids
☐ Suspended solids
☐ Settleable solids
☐ Foams

Color
☐ Clear
☐ Stained
☐ Opaque
☐ Colored _______
☐ Other _______

Surface Oils
☐ None
☐ Sheen
☐ Globs
☐ Flecks
☐ Slick
☐ Other _____

Water Odors
☐ Normal/None
☐ Sewage
☐ Petroleum
☐ Chemical
☐ Fishy
☐ Other ______

**SEDIMENT**

Sediment Samples Taken
☐ None ☐ Other_______
☐ MS ☐ GS
☐ VOA ☐ OS/BNA

Looking at stones that are not deeply embedded, are the undersides black in color? ☐Yes ☐No

Oils
☐ Absent
☐ Slight
☐ Moderate
☐ Profuse

Sediment Odors
☐ Normal/None
☐ Sewage
☐ Petroleum
☐ Chemical
☐ Anaerobic
☐ Other________

Deposits
☐ None
☐ Sludge
☐ Sawdust
☐ Paper fiber
☐ Sand
☐ Relict shells
☐ Other _______

APPENDIX J (Continued)

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| Substrate Type | Diameter | % Composition in Sampling Reach | Substrate Type | Characteristic | % Composition in Sampling Reach |
| Bedrock | | | Detritus | Sticks, wood, coarse plant material (CPOM) | |
| Boulder | >10” | | | | |
| Cobble | 2.5”-10” | | Muck-Mud | black, very fine organic (FPOM) | |
| Gravel | 0.1”-2.5” | | | | |
| Sand | Gritty (course) | | Other | | |
| Silt | Gritty (fine) | | | | |
| Clay | slick | | | | |

Proportion of Reach Represented by Stream Morphology Types

☐ Riffle_________%
☐ Run_________%
☐ Pool_________%
☐ Depositional_________%

Additional Structure Available for Macroinvertebrate Colonization

| | Extensive | Moderate | Sparse | Absent |
|---|---|---|---|---|
| Undercut banks | ☐ | ☐ | ☐ | ☐ |
| Overhanging vegetation | ☐ | ☐ | ☐ | ☐ |
| Large woody debris | ☐ | ☐ | ☐ | ☐ |
| Aquatic macrophytes | ☐ | ☐ | ☐ | ☐ |
| Rootwads | ☐ | ☐ | ☐ | ☐ |

SITE LOCATION MAP Draw a map of the site and indicate the areas sampled (or attach a photograph)

☐ Further investigation necessary (explain)
☐ Obvious pollution source/expression

# Appendix J (continued)

Location Sampled__________________________________________________________________ Date__________

Length sampled ___________ Time sampled__________ Gear type (circle): bps stream shocker boat shocker other

| Species<br>length (in) | | | | | | | | | In |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 1 |
| 2 | | | | | | | | | 2 |
| 3 | | | | | | | | | 3 |
| 4 | | | | | | | | | 4 |
| 5 | | | | | | | | | 5 |
| 6 | | | | | | | | | 6 |
| 7 | | | | | | | | | 7 |
| 8 | | | | | | | | | 8 |
| 9 | | | | | | | | | 9 |
| 10 | | | | | | | | | 10 |
| 11 | | | | | | | | | 11 |
| 12 | | | | | | | | | 12 |
| 13 | | | | | | | | | 13 |
| 14 | | | | | | | | | 14 |
| 15 | | | | | | | | | 15 |
| 16 | | | | | | | | | 16 |
| 17 | | | | | | | | | 17 |
| 18 | | | | | | | | | 18 |
| 19 | | | | | | | | | 19 |
| 20 | | | | | | | | | 20 |
| >20 | | | | | | | | | |

**For individuals >20" record actual length**

| Species<br>length (in) | | | | | | | | | In |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 1 |
| 2 | | | | | | | | | 2 |
| 3 | | | | | | | | | 3 |
| 4 | | | | | | | | | 4 |
| 5 | | | | | | | | | 5 |
| 6 | | | | | | | | | 6 |
| 7 | | | | | | | | | 7 |
| 8 | | | | | | | | | 8 |
| 9 | | | | | | | | | 9 |
| 10 | | | | | | | | | 10 |
| 11 | | | | | | | | | 11 |
| 12 | | | | | | | | | 12 |
| 13 | | | | | | | | | 13 |
| 14 | | | | | | | | | 14 |
| 15 | | | | | | | | | 15 |
| 16 | | | | | | | | | 16 |
| 17 | | | | | | | | | 17 |
| 18 | | | | | | | | | 18 |
| 19 | | | | | | | | | 19 |
| 20 | | | | | | | | | 20 |
| >20 | | | | | | | | | |

Number of Anomalies_________ Number/Species of tagged/fin clipped fish____________

Description:

# Appendix J (continued)

| Species<br>length (in) | | | | | | | | | In |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 1 |
| 2 | | | | | | | | | 2 |
| 3 | | | | | | | | | 3 |
| 4 | | | | | | | | | 4 |
| 5 | | | | | | | | | 5 |
| 6 | | | | | | | | | 6 |
| 7 | | | | | | | | | 7 |
| 8 | | | | | | | | | 8 |
| 9 | | | | | | | | | 9 |
| 10 | | | | | | | | | 10 |
| 11 | | | | | | | | | 11 |
| 12 | | | | | | | | | 12 |
| 13 | | | | | | | | | 13 |
| 14 | | | | | | | | | 14 |
| 15 | | | | | | | | | 15 |
| 16 | | | | | | | | | 16 |
| 17 | | | | | | | | | 17 |
| 18 | | | | | | | | | 18 |
| 19 | | | | | | | | | 19 |
| 20 | | | | | | | | | 20 |
| >20 | | | | | | | | | |

**For individuals >20" record actual length**

| Species<br>length (in) | | | | | | | | | In |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 1 |
| 2 | | | | | | | | | 2 |
| 3 | | | | | | | | | 3 |
| 4 | | | | | | | | | 4 |
| 5 | | | | | | | | | 5 |
| 6 | | | | | | | | | 6 |
| 7 | | | | | | | | | 7 |
| 8 | | | | | | | | | 8 |
| 9 | | | | | | | | | 9 |
| 10 | | | | | | | | | 10 |
| 11 | | | | | | | | | 11 |
| 12 | | | | | | | | | 12 |
| 13 | | | | | | | | | 13 |
| 14 | | | | | | | | | 14 |
| 15 | | | | | | | | | 15 |
| 16 | | | | | | | | | 16 |
| 17 | | | | | | | | | 17 |
| 18 | | | | | | | | | 18 |
| 19 | | | | | | | | | 19 |
| 20 | | | | | | | | | 20 |
| >20 | | | | | | | | | |

Additional station comments:

# Appendix J (continued)

## FISH

Station Number:
Length Sampled (ft):
Area Sampled (sq ft):
Sampling Time: # Probes: Gear: boat / ss / bps
# Passes:
Number of Anomalies:
Comments:

---

**Petromyzontidae (Lampreys)**
Sea lamprey (a/l) _____
Silver lamprey (a/l) _____
Northern brook lamprey (a/l) _____
Chestnut lamprey (a/l) _____
American brook lamprey (a/l) _____
**Lepisosteidae (Gars)**
*Spotted gar _____
*Longnose gar _____
**Amiidae (Bowfins)**
*Bowfin _____
**Clupeidae (Herrings)**
*Alewife _____
*Gizzard shad _____
**Salmonidae (Salmon/Trout)**
*Rainbow trout _____
*Brown trout _____
*Brook trout _____
*Coho _____
*Chinook _____
**Umbridae (Mudminnow)**
Central mudminnow _____
**Esocidae (Pike)**
*Grass pike _____
*Northern pike _____
*Muskellunge _____
**Cyprinidae (Minnows and Carp)**
Central stoneroller _____
Lake chub _____
*Goldfish _____
*Carp _____
Bigeye chub _____
*Horneyhead chub _____
*River chub _____
*Creek chub _____
*Golden shiner _____
Pugnose shiner _____
Emerald shiner _____
Bigeye shiner _____
Ironcolor shiner _____
*Common shiner _____
Central bigmouth shiner _____
Blackchin shiner _____
Blacknose shiner _____
Spottail shiner _____
Silver shiner _____
Rosyface shiner _____
Spotfin shiner _____
Sand shiner _____
Redfin shiner _____
Mimic shiner _____
Brassy minnow _____
Fathead minnow _____
Bluntnose minnow _____
Suckermouth minnow _____
Silverjaw minnow _____
Northern redbelly dace _____
Southern redbelly dace _____
Finescale dace _____
Blacknose dace _____
Longnose dace _____
Redside dace _____
*Pearl dace _____
**Cottidae (Sculpins)**
Mottled sculpin _____
Slimy sculpin _____
**Catostomidae (Suckers)**
*Longnose sucker _____
*White sucker _____
*Creek chubsucker _____
*Lake chubsucker _____
*Northern hog sucker _____
*Spotted sucker _____
*Silver redhorse _____
*River redhorse _____
*Black redhorse _____
*Golden redhorse _____
*Shorthead redhorse _____
*Greater redhorse _____
**Ictaluridae (Bullhead/Catfish)**
*Black bullhead _____
*Brown bullhead _____
*Yellow bullhead _____
Stonecat _____
Tadpole madtom _____
Brindled madtom _____
*Channel catfish _____
*Flathead catfish _____
**Aphredoderidae (Pirate perch)**
Pirate perch _____
**Atherinidae (Silversides)**
Brook silverside _____
**Cyprinodontidae (Topminnows)**
Banded killifish _____
Blackstripe topminnow _____
**Gasterosteidae (Sticklebacks)**
Brook stickleback _____
Threespine stickleback _____
**Perchicthyidae (Temp. bass)**
*White bass _____
*White perch _____
**Centrarchidae (Sunfishes)**
*Rock bass _____
*Green sunfish _____
*Pumpkinseed _____
*Warmouth _____
*Orangespotted sunfish _____
*Bluegill _____
*Longear sunfish _____
*White crappie _____
*Black crappie _____
*Largemouth bass _____
*Smallmouth bass _____
**Percidae (Perch)**
N. sand darter _____
Rainbow darter _____
Iowa darter _____
Greenside darter _____
Fantail darter _____
Orangethroat darter _____
Johnny darter _____
Blackside darter _____
Logperch _____
*Yellow perch _____
*Walleye _____
**Percopsidae (Trout-perch)**
Trout-perch _____
**Anguillidae (Eels)**
*American eel _____
**Gadidae (Cod)**
*Burbot _____
**Sciaenidae (Drums)**
*Freshwater drum _____
**Cobitidae (Loaches)**
Oriental weatherfish _____
**Other family/species:**
_________________ _____
_________________ _____
_________________ _____

* = Measure length

Appendix J (continued)

## HABITAT ASSESSMENT FIELD DATA SHEET - RIFFLE/RUN STREAMS

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **1. Epifaunal Substrate/ Available Cover** | Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient). | 40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **2. Embeddedness** | Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **3. Velocity/Depth Regime** | All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is <1.0 f/s, deep is >2 ft.). | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/depth regime (usually slow-deep). |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **4. Sediment Deposition** | Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **5a. Channel Flow Status - Maintained Flow Volume** | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| SCORE | **10 9** | 8 7 6 | 5 4 3 | 2 1 0 |
| **5b. Channel Flow Status – Flashiness** | Vegetation along the stream bank is complete nearly to the waters edge. Little or no evidence of frequent changes in discharge and/or frequent high water events that scour stream bank vegetation. Channel retention devices (if present) stable and extending laterally across the stream channel. | Some evidence of bank scour approximately 4-8 inches above the waters surface. Channel retention devices (if present) mostly stable and extending partially into the active stream channel. | Bank scour evidence 9-18 inches above the waters surface. Channel retention devices (if present) tend to lay more against the stream bank rather than extending into the active channel. | Bank scour (>20 inches) along the stream channel. Channel retention devices are generally absent from the active channel and/or may exist as woody debris jams along the stream bank above the active channel. |
| SCORE | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

| Habitat Parameter | Condition Category: Excellent | Good | Marginal | Poor |
|---|---|---|---|---|
| **6. Channel Alteration** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging (greater than past 20 yr) may be present, but recent channelization is not present. | Channelization is continuous but not recent (>5 years). Embankments without mature trees and dominated by grasses and shrubs. | Stream reach has been recently channelized (<5 years) . OR Banks shored with gabion, rock, cement or bare earth. Instream habitat greatly altered or removed entirely. Bank vegetation moderately dense to absent. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **7. Frequency of Riffles (or bends)** | Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15. | Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. | Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **8. Bank Stability** (score each bank)<br><br>Note: determine left or right side by facing downstream. | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| SCORE_____(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE_____(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **9. Vegetative Protection** (score each bank) | More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the stream bank surfaces covered by native vegetation, but 1 class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height. |
| SCORE_____(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE_____(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **10. Riparian Vegetative Zone Width** (score each bank riparian zone) | Width of riparian zone >150 feet and dominated by native vegetation including trees, shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. Human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Width of riparian zone 75-150 feet; human activities have impacted zone only minimally. | Width of riparian zone 10-75 feet; human activities have impacted zone a great deal. | Width of riparian zone <10 feet; little or no riparian vegetation due to human activities. |
| SCORE_____(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE_____(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Total Score_____________**

Appendix J (continued)

## HABITAT ASSESSMENT FIELD DATA SHEET - GLIDE/POOL STREAMS

| Habitat Parameter | Condition Category: Excellent | Good | Marginal | Poor |
|---|---|---|---|---|
| **1. Epifaunal Substrate/ Available Cover** | Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient). | 30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **2. Pool Substrate Characterization** | Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common. | Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present. | All mud or clay or sand bottom; little or no root mat; no submerged vegetation. | Hard-pan clay or bedrock; no root mat or vegetation. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **3. Pool Variability** | Even mix of large-shallow, large-deep, small-shallow, small-deep pools present. | Majority of pools large-deep; very few shallow. | Shallow pools much more prevalent than deep pools. | Majority of pools small-shallow or pools absent. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **4. Sediment Deposition** | Little or no enlargement of island or point bars and less than <20% of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 20-50% of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **5a. Channel Flow Status - Maintained Flow Volume** | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| SCORE | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **5b. Channel Flow Status – Flashiness** | Vegetation along the stream bank is complete nearly to the waters edge. Little or no evidence of frequent changes in discharge and/or frequent high water events that scours stream bank vegetation. Large woody debris (if present) stable and extending laterally across the stream channel. | Some evidence of bank scour approximately 4-8 inches above the waters surface. Large woody debris (if present) mostly stable and extending partially into the active stream channel. | Bank scour evidence 9-18 inches above the waters surface. Large woody debris (if present) tend to lay more against the stream bank rather than extending into the active channel. | Bank scour (>20 inches) along the stream channel. . Large woody debris are generally absent from the active channel and/or may exist as woody debris jams along the stream bank above the active channel. |
| SCORE | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **6. Channel Alteration** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging (greater than past 20 yr) may be present, but recent channelization is not present. | Channelization is continuous but not recent (>5 years). Embankments without mature trees and dominated by grasses and shrubs. | Stream reach has been recently channelized (<5 years) . OR Banks shored with gabion, rock, cement or bare earth. Instream habitat greatly altered or removed entirely. Bank vegetation moderately dense to absent. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

Appendix J (continued)

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Excellent** | **Good** | **Marginal** | **Poor** |
| **7. Channel Sinuosity** | The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note – channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas). | The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line. | The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. (Note: lack of sinuosity may be due to channelization) | Channel straight; waterway has been channelized for a long distance. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **8. Bank Stability** (score each bank) | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| SCORE _____ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE _____ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **9. Vegetative Protection** (score each bank)<br><br>Note: determine left or right side by facing downstream | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but 1 class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation has been removed to 2 inches or less in average stubble height. |
| SCORE _____ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE _____ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **10. Riparian Vegetative Zone Width** (score each bank riparian zone) | Width of riparian zone >150 feet and dominated by native vegetation including trees, shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. Human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Width of riparian zone 75-150 feet; human activities have impacted zone only minimally. | Width of riparian zone 10-75 feet; human activities have impacted zone a great deal. | Width of riparian zone <10 feet; little or no riparian vegetation due to human activities. |
| SCORE _____ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE _____ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Total Score_____________**