Methods for Assessing Habitat in Wadeable Waters

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1. Procedures

1.A. Scope and Applicability

This manual has been developed by the Kentucky Division of Water (KDOW) as guidance for the uniform and accurate evaluation of habitat parameters present in the wadeable waters of Kentucky. The methods defined herein are required for all habitat assessment procedures and QA/QC activities resulting in information that could be used for water quality assessments. Any data submitted to KDOW for review will undergo QA/QC and those identified as not following the methods set forth in this document will be flagged and discarded.

The sources for the collection methods in this SOP are the historical methods used by WQB (KDOW 2008), as well as general methods recommended in the manual "Rapid bioassessment protocols for use in streams and wadeable rivers" (Barbour et al 1999).

1.B. Definitions

SOP – Standard Operating Procedure

QA – Quality Assurance

QC – Quality Control

KDOW – Kentucky Division of Water

WQB – Water Quality Branch

Thalweg – Path of deepest thread of water.

Perennial Stream – Stream that has continuous flow in parts of its bed all year round during years of normal rainfall.

Ephemeral Stream – Stream that only flows for brief periods of time following rainfall events.

Intermittent Stream – Stream that normally ceases flow for weeks or months each year.

BG – Bluegrass Bioregion

MT – Mountain Bioregion

MVIR – Mississippi Valley-Interior River Bioregion

PR – Pennyroyal Bioregion

1.C. Health & Safety Warning

During high flow or runoff events, sampling should be postponed until baseline conditions exist. When these specific events are targeted, field crews shall use best professional judgment to obtain samples (i.e., postponement, high flow equipment, etc.). Waders and specialized wading boots should be utilized when conducting instream sampling to remain dry, but also to provide a barrier from potential in-stream contaminants, and natural irritants (i.e., biting insects, poison ivy). It is recommended that a wading belt be used to reduce the chances of water filling waders during a fall. Boots should have felt or studded soles to reduce the chances of slipping or falling. Investigators should exhibit caution around stream bank mud, boulders, bedrock or large woody debris to reduce the threat of a falling injury.

1.D. General Cautions

The sampling procedures herein require specific training and a demonstration of competency due to the expert judgment exercised during field sampling. It is recommended that individuals conducting habitat assessments should train with KDOW staff (via workshops and/or participating in field sampling) to demonstrate competence.

For special studies, any deviation from the procedures in this document will be noted in study documentation approved by KDOW biologists prior to sampling.

1.E. Personnel Qualifications / Responsibilities

All biologists will meet minimum job classification requirements as specified by the Department of Personnel. Biologists will be certified in first aid, CPR, blood borne pathogens and HAZWOPER (OSHA 1910.120) and recertification will be completed as required. Biologists must have basic knowledge of aquatic organisms and their habitats. In addition, biologists must have knowledge of stream geomorphology and stream physical processes. A KDOW biologist will instruct any other personnel in sample protocol before sampling. At least one KDOW biologist will be present on all sampling events. New training requirements that are identified will be discussed with Section Supervisors and Water Quality Branch Manager.

1.F. Equipment and Supplies

- High or Low Gradient Stream Data Sheet (Appendices 1 and 2)
- Waterproof pen or permanent marker
- Chain of Custody
- Range finder and/or measuring tape
- GPS unit

1.G. Methods

1.G.1. Purpose

A habitat assessment should be conducted at every sampling reach where bioassessments are conducted. Such assessments will allow investigators to evaluate the quality of in stream and riparian habitat. The availability of quality habitat directly influences the biological integrity of the stream reach. Information obtained from the habitat assessment can be used to supplement biological and physicochemical data when determining the overall health of the stream reach and stream-use designation.

Additionally, habitat assessments can be used to document physical changes that occur at a sampling reach over time. In multi-agency monitoring projects (such as watershed monitoring), habitat assessments provide continuity and consistency between all entities involved in monitoring efforts. Habitat assessment procedures follow those outlined in Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour et al. 1999), and as described in the following sections of this manual.

1.G.2. Sampling Periods

Habitat assessment within the designated index periods is critical for accurate evaluation of wadeable streams. Headwater streams (<5mi^2 drainage area), should be sampled from March 1st until May 31st, while wadeable streams (>5mi^2 drainage area) are sampled from June 1st through September 30th. In some cases, assessment outside these index periods is permissible to determine immediate impacts (e.g., chemical spills, leaks, etc.). For routine assessments or baseline data collection, data collected outside of these index periods are considered unacceptable. Also, habitat should not be assessed during periods of excessively high or low flows or within two weeks of a known scouring flow event.

1.G.3. High- vs. Low-Gradient Streams

Streams in Kentucky are characterized as high-gradient or low-gradient streams. This stream classification is derived based on flow, and presence or absence of particular types of habitat. High-gradient streams are defined as streams that have velocities greater than 0.013m/sec (0.5ft/sec), exhibit rapid changes in stream gradient and have a high frequency of riffle habitat. These streams are commonly found in the Mountain, Bluegrass and Pennyroyal Bioregions of Kentucky. Low-gradient streams are defined as streams that have velocities less than 0.013m/sec (0.5ft/sec) and naturally lack riffle habitat. These streams are found primarily in the western parts of the state, particularly in the Mississippi Valley and Interior River Bioregion. In addition, it is possible to encounter low-gradient streams in the western part of the Pennyroyal Bioregion (use best professional judgment in determination). **If a high-gradient stream has minimal or completely lacks natural riffle habitat, biologist(s) are to complete a High-Gradient Bioassessment Stream Visit Sheet, and indicate the lack of riffle habitat in Parameter #7 (frequency of riffles). Additionally, note in the margin of the sheet(s) why riffle habitat was lacking (i.e. backwater from the Ohio River). Such notes will assist the biologists in determining biological integrity at a later date.**

An understanding of the differences in high-gradient and low-gradient streams is important as each type has its own Bioassessment Stream Visit Sheet. **Failure to use the proper habitat assessment sheet may result in invalid data which cannot be used in the assessment of biological integrity.**

1.G.4. Filling out a Bioassessment Stream Visit Sheet

The following section(s) explain how to complete each individual portion of the Bioassessment Stream Visit Sheet in high-gradient and low-gradient streams.

1.G.4.1. Header Information

The header information is identical on all sheets and requires sufficient information to identify the station number, stream name; latitude and longitude of the station (using GPS in the field or GIS before leaving the office); location where the site assessment was conducted, date and time of assessment; the name(s) of the investigator(s); and the program for which the data was collected. The investigators are responsible for the quality and integrity of the data. This metadata must be accurate so that valid assessments can be made later.

The stream name assists in the identification of the watershed and tributaries; the location of the sampling station is described in the narrative to help identify access to the station for repeat visits. The station number is a code that is assigned by the agency and is specific to a particular project. The Program/Project section designates the KDOW program that conducted the site assessment and whether or not sampling was conducted for a specific project. The section labeled lat/long contains three (3) spaces designated latitude and longitude for a general location, the downstream limit, and the upstream limit for the sampling reach, respectively. Other information included on the sheet, but not explained in detail here, are county, date, and time (start and finish) of sampling.

1.G.4.2. Canopy Cover

An exposed stream often exhibits increased water temperatures that may be directly or indirectly limiting to some organisms and may be favorable for nuisance algal blooms and decreased dissolved oxygen. Light intensity may be limiting to some organisms and favorable to others. A partially shaded stream generally contains the highest species diversity. In wadeable streams, sufficient shade to maintain temperatures and habitats that will support indigenous organisms is generally created by a 50% to 75% tree canopy. Natural headwater streams should generally have 75% to 100% tree canopy. `

Visually assess the overhead canopy cover throughout the stream reach and estimate the percent canopy shading as fully exposed (0 - 25%), partially exposed (25% - 50%), partially shaded (50% - 75%) or fully shaded (75% - 100%).

1.G.4.3. Stream Type

Note if the stream is perennial, ephemeral, or intermittent. Biological communities inhabiting ephemeral or intermittent streams are markedly different from communities in perennial streams due to unstable water flows. Those communities present in ephemeral and intermittent streams may consist of more tolerant organisms.

1.G.4.4. Weather

Note the present weather conditions on the day of the survey and those immediately preceding the day of the survey. Additionally, note if there has been a scouring rain event within the last 14 days (determination of scouring event is based upon biologist's best professional judgment). This information is important when interpreting the effects of hydrologic events on sampling efforts.

1.G.4.5. Local Watershed Features

Document the prevalent land-use type in the watershed of the sampling station (noting any other land uses in the area which, although not predominant, may potentially affect water quality). These land uses could potentially impact biological communities and water chemistry results.

1.G.4.6. In-stream Features

In-stream Features
In-stream features are measured or estimated within the sampling reach.

Stream Width
Stream width is measured as the bankfull stage of a representative transect within the sampling reach (measured in feet) (Rosgen 1996). Stream width should be determined using a tape measure, range finder, or other type of measuring device.

Maximum Stream Depth
Maximum stream depth is measured as the vertical distance from water surface to stream bottom at its maximum or deepest spot within the sampling reach (measured in feet). Maximum stream depth should be measured with some type of measuring device (i.e. marked net handle) when possible. If a measuring device is not available, maximum stream depth can be estimated.

Sampling Reach Length
Sampling reach length is measured as the entire length of the stream that was actively sampled (measured in **meters**). The distance of the reach should be measured using a tape measure, range finder, or other type of measuring device prior to the collection of biological samples. At least 100 meters of stream must be actively sampled to adequately assess biological integrity at a site. The stream length should not exceed 300 meters in length so that biological integrity assessment metrics are over-valued. If for some reason a sampling reach is not

between 100 and 300 meters in length, the reasons for this excursion should be documented on the field assessment form. **Failure to document sampling reach length and reasons for any excursions from the required stream reach length may result invalid data which cannot be used in assessment of biological integrity.**

Riffle/Run/Pool or Run/Pool Sequence
The riffle/run/pool sequence measured as the number of each macrohabitat type present within the reach.

Hydraulic Structures
Note the presence of hydraulic structures such as dams, bridge abutments, islands and waterfalls. These structures often form barriers that restrict movement of organisms which could result in the lowering of assessment scores.

Stream Flow
Indicating the level of stream flow (dry, pooled, low, high, normal) is important because it can influence biological communities and water quality (i.e. low or pooled flow can increase chemical parameters in water chemistry samples). Additionally, this information can be used to verify if the data can be used in assessment (i.e. macroinvertebrate samples collected during a high flow event would not be used for assessment purposes because sampling efficiency is lowered).

Riparian Vegetation
Indicate the dominant trees, shrubs and herbaceous plants in the riparian zone. Due to its stabilizing effects as well as its ability to influence water temperatures, a riparian zone of 18 meters or more is preferred. In addition, the number of canopy strata present in the riparian zone should be counted as it is an indication of riparian age and quality (e.g. overstory, understory, herb layer). Dominant riparian species are noted in the provided space.

Channel Alterations
Many activities that alter the stream channel require water quality certification by KDOW and Section 404 permits from the U.S. Army Corps of Engineers. Some of these activities include: dredging, channelization, clear and snag, bridge construction and artificial bank stabilization. Note if any dredging or channel alterations are present (straightening of stream channel). These types of alterations often decrease in-stream habitat and directly influence the presence absence or biological communities.

1.G.4.7. P-Chem (Physicochemical Monitoring)

Measure and record values for each of the water quality parameters indicated (temperature, dissolved oxygen, % saturation, pH, conductivity, and turbidity), using the appropriate calibrated water quality instrument(s). Note the type of instrument, unit number used and date calibrated (KDOW 2009).

1.G.4.8. Sample Collection Verification

Note the types of samples that were collected during the sampling session. Each biological community has a corresponding sampling protocol indicating how and what types of samples were collected. Where applicable, indicate the numbers of samples collected and if duplicate samples were collected. Indicate the lead collector(s) for each sample collection.

1.G.4.9. Substrate Characterization

In general, variations in particle size and type are reflected in flowing bodies of water by gradation of habitat types from stream headwaters to mouth. Each longitudinal gradation in substrate type harbors a characteristic biotic community. The absence of characteristic community members in the presence of a favorable substrate type can be a useful indication of stream disturbance.

For visual estimates of substrate size, a transect is surveyed in a pool (mid-pool) and riffle (mid-riffle) to estimate the substrate by percent particle size and type of material. Results are expressed as percent of total. For a more in-depth analysis of substrate type and abundance, a Wohlman Pebble Count (or equivalent) can be conducted following procedures found in Harrelson et al. (1994) or Wolman (1954). Sample particles are measured against the particle size chart (Table 1) to provide the investigator with a fixed concept of category size. Results are recorded on the habitat assessment sheet. In addition, the estimated percent riffle, run and pool within the sampling reach are recorded.

Table 1. Substrate particle size chart

Categories	Size (mm)
Fines	< 2 (< .08 in)
Gravel	2 - 16 (.08 - 0.63 in)
Pebble	16 - 64 (0.63 - 2.5 in)
Cobble	64 - 256 (2.5 - 10 in)
Boulders	> 256 (> 10 in)

1.G.4.10. Assessment Procedures

A Habitat assessment should accompany any biological and some water chemistry sampling. Upon arriving at a sampling location, header information (stream name, location, county, date, etc.) is to be completed prior to sampling session. Water chemistry and biological samples are then conducted to allow all biologists to visually assess the entire stream before the assessment is conducted. Once sampling is finished, investigators should conduct a visual based habitat evaluation of the stream reach by filling out the Bioassessment Stream Visit Sheet (Appendices 1 and 2). The habitat assessment is conducted following biological and water chemistry sampling so that the entire stream reach is observed during the collection of biological samples. The habitat

assessment should be conducted by all biologists present to deliberate and reach a consensus of how each parameter is scored.

The visual based habitat evaluation consists of ten parameters that rank in-stream habitat, channel morphology, bank stability and riparian vegetation for each sampling reach. A numerical scale of 0 (lowest) to 20 (highest) is used to rank each parameter (Barbour et al. 1999). For each parameter, the investigators will determine which of the following conditions exist at the sampling reach: Optimal, Suboptimal, Marginal or Poor. A parameter score will then be given within the condition category chosen above: Optimal (20-16), Suboptimal (15-11), Marginal (10-6) or Poor (5-0). The investigators will total all of the parameter ratings to obtain a final habitat ranking (Barbour et al. 1999).

1.G.4.10.a. Habitat Assessment Parameters

These parameters should be evaluated within the sampling reach. All of the areas within the reach should be evaluated together as a composite.

Parameter #1 - Epifaunal Substrate/Available Cover (High and Low Gradient Sheets)

This metric describes the relative quantity and the variety of stable structures, such as cobble, boulders, fallen trees, logs, branches, root mats, undercut banks, aquatic vegetation, etc., that provide refugia, feeding opportunities and sites for spawning and nursery functions. Assessment is a composite of the entire biological sampling reach.

High-Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover Score	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.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1. Epifaunal Substrate/ Available Cover Score	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 and 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 newfall, 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.

Parameter #2 Embeddedness - (High-Gradient Sheet)

The extent to which rocks and snags are covered or sunken into the silt, sand, mud or biofilms (algal, fungal or bacterial mats) of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (for shelter, spawning and egg incubation) is decreased; assess in the upstream or central portions of riffles.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2.Embeddedness Score	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.

Parameter #2 - Pool Substrate Characterization - (Low-Gradient Sheet)

This metric evaluates the type and condition of bottom substrates found in pools of low-gradient streams. 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.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
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 Score	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.

Parameter #3 - Velocity/Depth Regime - (High-Gradient Sheet)

The highest scoring streams in most high-gradient regions will have all of the following patterns of velocity and depth: 1) slow-deep, 2) slow-shallow, 3) fast-deep and 4) fast-shallow. Investigators may have to scale deep and shallow depending upon the stream size; a general guideline is 0.5 m between shallow and deep.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
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 Score	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	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).

Parameter #3 - Pool Variability - (Low-Gradient Sheet)

This metric rates the overall mixture of pool types found in low-gradient streams according to size and depth. The four 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, oblique) greater than half the cross-section of the stream for separating large from small and 1 meter depth separating shallow and deep.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
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 Score	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.

Parameter #4 - Sediment Deposition (High and Low Gradient Sheets)

This metric estimates the amount of sediment that has accumulated in pools and changes that have occurred to the stream bottom as a result of deposition. This may cause 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. Sediment is often found in areas that are obstructed and areas where the stream flow decreases, such as bends. Deposition is a symptom of an unstable and continually changing environment that becomes unsuitable for many organisms. Examine bars/shoals and pool substrates within the biological monitoring station, when assessing this parameter.

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
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 **Score**	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 low-gradient) 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 low-gradient) 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 low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
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 **Score**	Little or no enlargement of islands 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; 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.

Parameter #5 - Channel Flow Status (High and Low Gradient Sheets)

This metric estimates the degree to which the channel is filled with water. The score will change with the seasons. Estimate the percentage of the channel that is wet using the low water mark.

High Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5.Channel Flow Status **Score**	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.

Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status **Score**	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.

The next 5 parameters should evaluate an area from approx. 100-m upstream of the sampling reach through the sampling reach. This whole area should be evaluated as a composite. When determining left and right bank, face downstream.

Parameter #6 - Channel Alteration (High and Low Gradient Sheets)

This metric characterizes the large-scale, direct changes in the shape of the stream channel. Channel alteration is present when 1) artificial embankments, rip-rap and other forms of bank stabilization or structures are present, 2) the stream is very straight for significant distances because of channelization, 3) dams and bridges are present that obstruct flow and/or 4) dredging or other substrate mining activities are occurring or have occurred.

High and Low Gradient:

Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration **Score**	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, (>20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.

Parameter #7 - Frequency of Riffles (or Bends) - (High-Gradient Sheet)

This metric estimates the sequence of riffles and thus the heterogeneity occurring in a stream. Estimate riffle frequency by determining the ratio of distance between riffles divided by the width of the stream. An average of the riffle ratios is determined for biological monitoring reach and the upstream segment.

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
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) **Score**	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.

Parameter #7 - Channel Sinuosity - (Low Gradient Sheet)

This metric characterizes the meandering or sinuosity of the low-gradient stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when water levels in the stream fluctuate as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding, and provides refugia for benthic invertebrates and fish during storm events.

To gain an appreciation of this parameter in low-gradient streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In "oxbow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions in these streams are shifting channels and bends, and alteration is usually in the form of flow regulation and diversion. A stable channel is one that does not exhibit progressive changes in slope, shape or dimensions, although short-term variations may occur during floods (Gordon et al. 1992).

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity **Score**	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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.

Parameter #8 - Bank Stability (High and Low Gradient Sheets)

This metric estimates whether the stream banks are eroded or have the potential to erode. Each bank is scored independently from 10-0.

High and Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8.Bank Stability LB RB	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.

Parameter #9 – Bank Vegetative Protection (High and Low Gradient Sheets)

This metric estimates the amount of vegetative protection afforded to the stream and the near stream portion of the riparian zone. Each bank is scored independently from 10-0. Determine what vegetative types (trees, understory shrubs, herbs and non-woody macrophysics) are present on each bank. Those stream banks with diverse vegetation types provide better erosion protection and provide more of a variety of allochthonous food material. Native vegetation scores higher than invasive or non-native vegetation.

High and Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection LB RB	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 one 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 5 centimeters or less in average stubble height.

Parameter #10 - Riparian Vegetative Zone Width (High and Low Gradient Sheets)

This metric estimates the width of the natural vegetation from the edge of the stream bank through the riparian zone. The presence of old fields, paths, walkways, etc., in otherwise undisturbed riparian zones may be judged to be inconsequential to highly destructive to the riparian zone. Each bank is scored independently from 10-0.

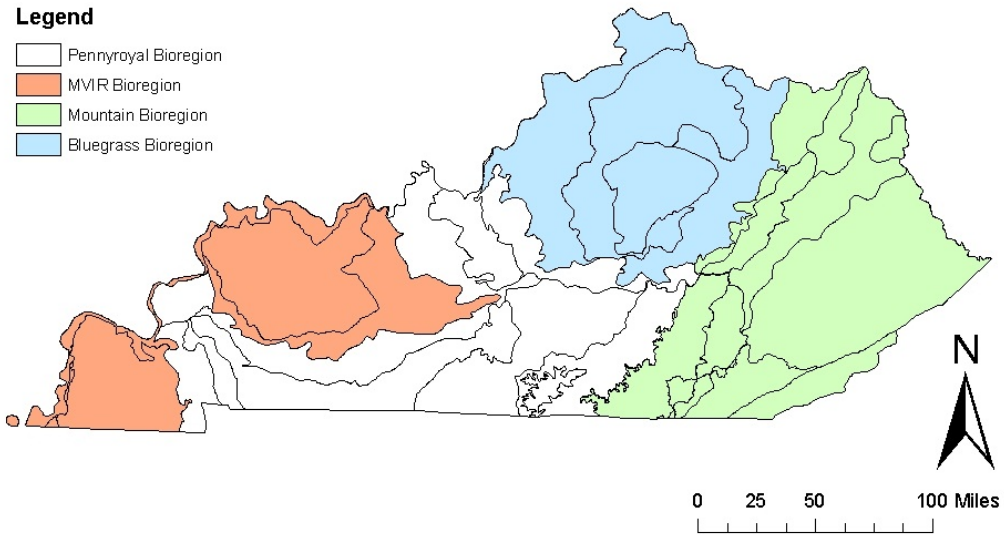
High and Low Gradient:

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width LB RB	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.

1.G.4.10.b.. Habitat Rating Development

Habitat evaluations were conducted at biological sampling sites in the Green and Tradewater River basins for 2001, the Big Sandy and Little Sandy River basins for 2002, the Kentucky River basin for 2003, the Licking and Salt River basins for 2004, the Cumberland and the Tennessee and Mississippi River basins for 2005 using the Rapid Bioassessment Protocols format. Historical and current reference reach habitat data were used to produce habitat criteria for the bioregions of Kentucky. The scores for all reference reach stations were ranked and divided into percentiles. The lower quartile (25th percentile) could be considered the dividing line between those habitats fully supporting and those partially supporting biotic integrity. Habitats could be considered poor if they fall below the lowest reference condition score for that area. For assessment purposes, habitat scoring criteria are grouped in the same manner as Bioregions (Figure 1).

Figure 1. Designated Habitat Bioregions of Kentucky



For the Bluegrass (BG) Bioregion, reference sites were divided into wadeable and headwater based upon drainage area. Those above five square miles were considered wadeable and below five square miles headwater. Headwater streams in this large Ecoregion have a tendency to score higher on certain metrics (i.e. frequency of riffles, bank stability, riparian zone width) than wadeable streams as a result of intensive land use activities (e.g. residential areas, horse farms, etc.). This bias was reflected in final habitat scores. Therefore, separate habitat criteria were developed for wadeable and headwater streams.

Biosurveys conducted within the Pennyroyal (PR) Bioregion use high-gradient habitat assessment sheets. Streams within this bioregion are characterized by having well-developed macrohabitats (riffle, run, pool). Generally, the habitat assessments in this Ecoregion score higher than other bioregions found in Kentucky, except the Mountains.

Streams sampled within the Mississippi Valley Loess Plains and Interior River Valleys and Hills Ecoregions were generally low-gradient streams with very few riffles. These Ecoregions were combined to form the Mississippi Valley-Interior Rivers (MVIR) Bioregion. Low-gradient habitat assessment sheets were used in these Ecoregions to evaluate the available habitat. Additionally, in low-gradient sections of Interior Plateau and mountainous streams, low-gradient habitat assessment sheets were used.

Mountainous Ecoregions of the Commonwealth provided similar habitat opportunities for aquatic community colonization and use. Habitat scores from reference sites in the Central Appalachian, Southwestern Appalachian and Western Allegheny Ecoregions reflected these similarities. Therefore, habitat data from all of these Ecoregions were combined to develop habitat criteria for the Mountains (MT).

Table 2 includes guidelines for narrative habitat ratings that can be used to determine whether the sampling reach is rated as good, fair or poor.

Table 2. Scoring for narrative habitat ratings.

Bioregion	Rating	Area Scoring	
		Headwater (<5.0 mi^2)	Wadeable (>5.0 mi^2)
Bluegrass (BG)	Good	≥ 156	≥ 130
	Fair	142 - 155	114-129
	Poor	≤ 141	≤ 113
Pennyroyal (PR)	Good	≥ 146	≥ 146
	Fair	132 - 145	132 - 145
	Poor	≤ 131	≤ 131
Mississippi Valley Interior River (MVIR)	Good	≥ 135	≥ 135
	Fair	114 - 134	114 - 134
	Poor	≤ 113	≤ 113
Mountain (MT)	Good	≥ 160	≥ 160
	Fair	117-159	117 - 159
	Poor	≤ 116	≤ 116

2. Quality Control and Quality Assurance

For each KDOW program conducting RBP assessments, five percent of samples collected within one year will be duplicated to evaluate precision and repeatability of the technique and the sampling crew. The samples will be selected randomly by numbering each collected site as 1-X. Sites will then be chosen for replication using a random numbers table or other random numbering method. If possible, replicates will be collected by the same biologist(s) within the same index period. Results will be considered acceptable if the same narrative habitat assessment rating is attained. If this does not occur, all biologists will meet to assess the issue and take corrective actions which will be documented with other QA files.

3. References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J. B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates, and fish, second edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, D.C.

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Appendix 1. High Gradient Bioassessment Stream Visit Sheet

High Gradient Bioassessment Stream Visit Sheet

STREAM NAME:	**LOCATION:**	
STATION #:	**COUNTY:**	**PROGRAM:** **PROJECT:**
INVESTIGATORS: Verify Site LAT/LONG vs GPS ☐YES ☐NO ☐N/A	**DATE:**	**TIME (24hr)** **Start:** **Finish:**

	Station	**Reach** Downstream	Upstream
LAT			
LONG			

CANOPY COVER::
- ☐ Fully Exposed (0-25%)
- ☐ Partially Exposed (25-50%)
- ☐ Partially Shaded (50-75%)
- ☐ Fully Shaded (75-100%)

STREAM TYPE:
- ☐ Perennial
- ☐ Ephemeral
- ☐ Intermittent

WEATHER
Has there been a scouring rain in the last 14 days?
☐ Yes ☐ No

Now	Past 24 hours
☐	☐ Heavy rain
☐	☐ Steady rain
☐	☐ Intermittent showers
☐	☐ Clear/sunny
☐	☐ Cloudy

LOCAL WATERSHED FEATUREES (Predominant Surrounding Land Use):

☐ Surface Mining	☐ Construction	☐ Forest
☐ Deep Mining	☐ Commercial	☐ Pasture/Grazing
☐ Oil Wells	☐ Industrial	☐ Silviculture
☐ Land Disposal	☐ Row Crops	☐ Urban Runoff/Storm Sewers
☐ Residential		

INSTREAM FEATURES
Stream Width _____ ft
Maximum Depth _____ ft
Reach Length _____m

Riffle/Run/Pool Sequence
(No. Sampled in Reach)

_____Riffle _____Run _____Pool

HYDRAULIC STRUCTURES
- ☐ Dams
- ☐ Bridge Abutments
- ☐ Island
- ☐ Waterfalls
- ☐ Other:

STREAM FLOW
- ☐ Dry
- ☐ Pooled
- ☐ Low
- ☐ High
- ☐ Normal

RIPARIAN VEGETATION
Dominate Type:
☐ Trees ☐ Herbaceous
☐ Grasses ☐ Shrubs
Number of strata ____ Dom. Tree/Shrub Taxa

CHANNEL ALTERATIONS
- ☐ Dredging
- ☐ Channelization
- (☐Full ☐Partial)

P-CHEM Instrument Used: _____ Date Calibrated: _____

Temp(^oC)_____ D.O. (mg/l)_____ %Saturation_____ pH(S.U.)_____ Cond._____ Turb._____

Sample Collection Verification

Algae	Sample: ☐ QualMHC ☐ Other ☐ Visual Assessment	Lead Collector:
Fish	☐BPEF ☐ Seine ☐ Other Time: BPEF_____ Seine_____	Lead Collector:
Habitat	☐ RBP ☐ Substrate ☐ Other:	Lead Collector:
Invertebrates	☐ $1m^2$ ☐ Qual ☐ Other: ☐ 20 Jab (#Jabs: Cobble_____ Snags_____ Veg. Banks_____ Sand_____ Macrophytes_____ Other _____)	Lead Collector:
Tissue:	No. of Samples collected_____ Sp:	Lead Collector:
Water Chem	☐ Acid/Alk ☐ Bulk ☐ Nutrients ☐ Metals ☐ Low Hg ☐ Herbicides ☐ Pesticides ☐ Ortho P ☐ Other:	Lead Collector:

Duplicate Samples Taken:

Substrate Characterization

Substrate ☐Est. ☐P.C.	**Riffle_____%**	**Run_____%**	**Pool_____%**	**Reach Total**
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)				
Gravel (2-64 mm)				
Cobble (64 – 256 mm)				
Boulders (>256 mm)				
Bedrock				

NOTES/COMMENTS:

SITE NOT SAMPLED:

☐ Land owner denial ☐ Dry ☐Too deep/Impounded

☐ Site not found/Secluded ☐Unsafe

☐ Other (indicate under comments)

RBP High Gradient Habitat

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover Score	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.
2.Embeddedness Score	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.
3.Velocity/ Depth Regime Score	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	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).
4. Sediment Deposition Score	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 low-gradient) 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 low-gradient) 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 low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5.Channel Flow Status Score	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.
6.Channel Alteration Score	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 may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
7.Frequency of Riffles (or bends) Score	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.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8.Bank Stability LB / RB	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.
9. Vegetative Protection LB / RB	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 one 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 5 centimeters or less in average stubble height.
10. Riparian Vegetative Zone Width LB / RB	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.

Total Score

NOTES/COMMENTS:

Appendix 2. Low Gradient Bioassessment Stream Visit Sheet

Low Gradient Bioassessment Stream Visit Sheet

STREAM NAME:	**LOCATION:**	
STATION #:	**COUNTY:**	**PROGRAM:** **PROJECT:**
INVESTIGATORS: Verify Site LAT/LONG vs GPS ☐YES ☐NO ☐N/A	**DATE:**	**TIME (24hr)** **Start:** **Finish:**

	Station	**Reach** **Downstream**	**Upstream**
LAT			
LONG			

CANOPY COVER::
- ☐ Fully Exposed (0-25%)
- ☐ Partially Exposed (25-50%)
- ☐ Partially Shaded (50-75%)
- ☐ Fully Shaded (75-100%)

STREAM TYPE:
- ☐ Perennial
- ☐ Ephemeral
- ☐ Intermittent

WEATHER
Has there been a scouring rain in the last 14 days?
☐ Yes ☐ No

Now	Past 24 hours
☐	☐ Heavy rain
☐	☐ Steady rain
☐	☐ Intermittent showers
☐	☐ Clear/sunny
☐	☐ Cloudy

LOCAL WATERSHED FEATUREES (Predominant Surrounding Land Use):

☐ Surface Mining	☐ Construction	☐ Forest
☐ Deep Mining	☐ Commercial	☐ Pasture/Grazing
☐ Oil Wells	☐ Industrial	☐ Silviculture
☐ Land Disposal	☐ Row Crops	☐ Urban Runoff/Storm Sewers
☐ Residential		

INSTREAM FEATURES
Stream Width _____ ft
Maximum Depth _____ ft
Reach Length _____m

Riffle/Run/Pool Sequence
(No. Sampled in Reach)
_____Riffle _____Run _____Pool

HYDRAULIC STRUCTURES
- ☐ Dams
- ☐ Bridge Abutments
- ☐ Island
- ☐ Waterfalls
- ☐ Other:

STREAM FLOW
- ☐ Dry
- ☐ Pooled
- ☐ Low
- ☐ High
- ☐ Normal

RIPARIAN VEGETATION
Dominate Type:
☐ Trees ☐ Herbaceous
☐ Grasses ☐ Shrubs
Number of strata ____ Dom. Tree/Shrub Taxa

CHANNEL ALTERATIONS
- ☐ Dredging
- ☐ Channelization
- (☐Full ☐Partial)

P-CHEM Instrument Used: _____ Date Calibrated: _____

Temp(°C)_____ D.O. (mg/l)_____ %Saturation_____ pH(S.U.)_____ Cond._____ Turb._____

Sample Collection Verification

Algae	Sample: ☐ QualMHC ☐ Other ☐ Visual Assessment	Lead Collector:
Fish	☐BPEF ☐ Seine ☐ Other Time: BPEF_____ Seine_____	Lead Collector:
Habitat	☐ RBP ☐ Substrate ☐ Other:	Lead Collector:
Invertebrates	☐ 1m^2 ☐ Qual ☐ Other: ☐ 20 Jab (#Jabs: Cobble_____ Snags_____ Veg. Banks_____ Sand_____ Macrophytes_____ Other _____)	Lead Collector:
Tissue:	No. of Samples collected_____ Sp:	Lead Collector:
Water Chem	☐ Acid/Alk ☐ Bulk ☐ Nutrients ☐ Metals ☐ Low Hg ☐ Herbicides ☐ Pesticides ☐ Ortho P ☐ Other:	Lead Collector:

Duplicate Samples Taken:

Substrate Characterization

Substrate ☐Est. ☐P.C.	**Riffle_____%**	**Run_____%**	**Pool_____%**	**Reach Total**
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)				
Gravel (2-64 mm)				
Cobble (64 – 256 mm)				
Boulders (>256 mm)				
Bedrock				

NOTES/COMMENTS:

SITE NOT SAMPLED:

☐ Land owner denial ☐ Dry ☐Too deep/Impounded

☐ Site not found/Secluded ☐Unsafe

☐ Other (indicate under comments)

RBP Low Gradient Habitat

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1. Epifaunal Substrate/ Available Cover **Score**	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 and 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 newfall, 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.
2. Pool Substrate Characterization **Score**	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.
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.
4. Sediment Deposition **Score**	Little or no enlargement of islands 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; 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5. Channel Flow Status **Score**	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.
6. Channel Alteration **Score**	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, (>20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
7. Channel Sinuosity **Score**	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 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8. Bank Stability LB RB	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.
9. Vegetative Protection LB RB	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 one 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 5 centimeters or less in average stubble height.
10. Riparian Vegetative Zone Width LB RB	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.

Total Score

NOTES/COMMENTS: