BIOLOGICAL SAMPLING AND PHYSICAL HABITAT ASSESSMENT STANDARD OPERATING PROCEDURE FOR IOWA WADEABLE STREAMS AND RIVERS

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June 30, 1994

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July 24, 2015

Iowa Department of Natural Resources

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Ken Krier, Environmental Specialist	2.0	2015

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1.0 Introduction

The Iowa Department of Natural Resources uses benthic macroinvertebrate and fish sampling data to assess stream biological condition and the support status of designated aquatic life uses (Wilton 2004; IDNR 2013). Stream physical habitat data assist with the interpretation of biological sampling results by quantifying important physical characteristics that influence a stream's ability to support a healthy aquatic community (Heitke et al., 2006; Rowe et al. 2009; Sindt et al., 2012).

This document describes aquatic community sampling and physical habitat assessment procedures currently followed in the Iowa stream biological assessment program. Standardized biological sampling and physical habitat assessment procedures were first established following a pilot sampling study in 1994 (IDNR 1994a, 1994b). The procedure documents were last updated in 2001 (IDNR 2001a; 2001b). The biological sampling and physical habitat assessment procedures described below are evaluated on a continual basis. Revision of this working document will occur periodically to reflect additional changes.

2.0 General Sampling Considerations

Outlined below are the general sampling conditions to consider prior to the commencement of any sampling activities.

2.1 Sampling Season

Wadeable stream biological and physical habitat sampling occurs primarily during an "index period" that lasts from July 15 through October 15. Sampling conditions are usually favorable and fish populations are relatively sedentary during the summer months. Initial temporal assessment work done in the pilot study validated this approach (IDNR 1994a). Depending on sampling goals, the sampling season can begin prior to July 15 and extend past October 15. However, for the sampling data to be considered for IDNR "monitored" Clean Water Act assessment purposes, the index period must be strictly followed.

2.2 Reconnaissance and Landowner Contact

Prior to reconnaissance, attempt to contact all landowners whose property might need to be crossed to access the site. Land ownership and landowner contact information is available via a variety of sources including: county plat maps and directories (public libraries, IDNR 5th floor Wallace Building, County Assessor offices and USDA NRCS-FSA offices) and also on-line databases/directories: County Assessor web sites, White Pages and https://beaconbeta.schneidercorp.com/.

If the landowner(s) cannot be contacted before reconnaissance, attempt to contact the landowner while visiting the site. If landowner permission has not yet been granted, do not trespass to reconnoiter the site. Observe the site from the nearest public access point; general observations about the site can be made by observing the stream from as close to the site as possible.

Once landowner permission has been granted, the site can be reconnoitered. The objectives of site reconnaissance are:

- identify a representative sampling reach within a targeted segment of stream;
- determine the best sampling access point;
- tentatively define sampling reach boundaries;
- assess fish and benthic macroinvertebrate sampling equipment needs; and
- deploy artificial substrates (if required)

Once the landowner(s) have been contacted and the site reconnoitered, complete Field Form A - Reconnaissance/Landowner Contact Form (Appendix 2.2). Ideally, note the best access to the site and include any special directions or requests from the landowner (vehicle access, parking, etc.).

2.3 Sampling Crew

An aquatic biologist with expertise in benthic macroinvertebrate, fish and physical habitat sampling serves as the crew leader and supervises the biological and physical habitat sampling. The crew leader must have expertise in electrofishing and fish identification. The crew leader is also responsible for reviewing sampling duties and safety precautions with the sampling crew before initiating sampling. The size of the crew needed is dependent on stream size and will typically vary from three to six crewmembers. Crewmembers should have a background in aquatic biology and be familiar with benthic macroinvertebrate, fish and physical habitat sampling techniques and also be competent in the identification of common Iowa benthic macroinvertebrates and fish. Training in proper electrofishing, benthic macroinvertebrate and physical habitat sampling techniques is mandatory.

2.4 Sampling Equipment

A complete list of the sampling equipment needed to complete both the biological sampling and physical habitat assessment can be found in Appendix 2.4: Biological and Physical Habitat Sampling Equipment. Not all of the equipment will be needed at every site and the goal of the sampling and the size/complexity of the stream will dictate the sampling equipment needed.

2.5 Field Forms

A complete list of the field forms needed to complete both the biological sampling and physical habitat assessment can be found in Appendix 2.5: Biological and Physical Habitat Field Form List. Not all of the field forms will be needed at every site and the goal of the sampling, location and thermal class of sample stream will dictate the field forms needed.

2.6 Sampling Conditions

Biological and physical habitat sampling commences when stream flow levels are near base flow conditions and the water is sufficiently clear for effective sampling. All sampling activities take place during daylight hours. Safety is the primary consideration in the field because of the use of hazardous sampling methods (e.g., electrofishing) and because field personnel work in physically demanding conditions. IDNR does not condone sampling during inclement weather (e.g., extreme wind, lightning, or rain).

2.6.1 Sampling following High Water or Flood Events

To ensure the validity of sampling results, the following sampling restrictions apply when flood or high water conditions are encountered.

Wadeable streams (~20-500 mi^2 watershed area):

If a flood event (major or minor) occurs between January and June prior to the biological sampling index period (7/15-10/15) wait 4-6 weeks and complete the sampling unless the stream is severely damaged. If the stream is severely damaged, suspend all sampling activity until the next sampling season.

If a major flood event (out of bank, long lived, severe disturbance, etc.) occurs inside the index period (7/15-10/15), suspend sampling until the next calendar year index period.

If a minor flood event (could be out of bank, short lived, gentle rise and fall, etc.) occurs inside the index period, wait 4-6 weeks and complete the sampling.

Headwater (HW) streams (generally <20 mi^2 watershed area):

Regardless of the type of flood event, wait 4-6 weeks and complete the sampling. The only reason HW streams should not be sampled is if they are severely damaged. Incorporate local rainfall amounts and local flows/gage heights in the sampling decision.

Most importantly, provide as much documentation as possible on the sampling sites whether or not they are sampled. Documentation should include: photographs, notes, flood forms, rainfall amounts, flow/stage, etc.

2.6.2 Sampling following Severe Low Water or Drought Events

To ensure the validity of sampling results, the following sampling restrictions apply when drought or extreme low water conditions are encountered.

Reference sites (IDNR stream biological assessment program sites):

At the time of the sampling visit, if there is not enough flow to collect a benthic macroinvertebrate (BM) sample, suspend sampling activities until:

- Later in the same sampling season when there is enough flow to collect a BM sample, provided that the stream did not go dry in the interim or
- The following sampling season if the severe drought and non-flowing situation persists throughout the sampling season.

Due diligence will be required to determine if the stream has maintained flow throughout the sampling season prior to the sampling visit or if the stream went through periods of flowing/non-flowing due to localized rainfall events. Due diligence includes consideration of the following:

- USGS weekly/monthly flow data in the watershed or nearby watersheds;
- USDA (or other) weekly/monthly drought index summaries;
- Watershed tours/stream observations from bridges when visiting nearby sites;
- Local (anecdotal) data from landowners and local city/county/state staff

All other sites:

At the time of the sampling visit only collect the biological sample if the stream appears to be in a "normal" baseflow or a moderately low flow condition. Due diligence (see above) will be required to determine if the stream was dry or intermittent prior to a recent rainfall event.

3.0 Designating the Sampling Reach

All sampling activities occur within a designated sampling reach. Choose a designated sampling reach with habitat characteristics consistent with sampling objectives. In random sampling programs, habitat characteristics are typically not considered because the designated reach is randomly chosen. If the site is a candidate reference site, select a sampling reach that is representative of the most natural, undisturbed stream habitats found in the region. If the sampling reach is meant to represent a certain type of habitat or water quality impact, choose a sampling reach that will encompass that type of impact. Avoid including abrupt changes in channel morphology and riparian land uses within the sampling reach. For example, a length of stream that includes both a section of channelized stream and a section of meandering stream lacks uniformity in channel morphology and would not be considered representative of either type. Avoid stream confluences, major fish passage obstructions and artificial structures (e.g., low head dams, bridges). However, if your sampling program is designed to determine the impact of major fish passage obstructions on the local fish population, see Appendix 3.0: Handling Major Fish Passage Obstructions during Site Selection. At many sites, road crossings are the best access to the sample sites. The sampling reach should be located sufficiently upstream or downstream from the bridge to exclude any artificial habitat or channel straightening associated with the bridge.

3.1 Delineating the Sampling Reaches

A sampling reach length of 150 meters (~492') is the recommended minimum for wadeable streams (OEPA 1989; Meador et. al 1993). The approximate length of the fish sampling reach is between 500' – 1200' depending on the width of the stream and the frequency of repetition of the major types of habitat (e.g., pools, riffles, runs, channel bends). The minimum length of a physical habitat sampling reach shall be 540' regardless of the frequency of habitat repetition.

The mean stream width must be measured or estimated prior to establishing the fish sampling reach length. The mean stream width is then used to calculate the fish sampling reach length by multiplying the mean stream with by 30. This result is the minimum fish sampling reach length and, in meandering streams, should include at least two pool/riffle sequences or two well defined channel bends. It is acceptable to extend the fish sampling reach length to incorporate

pool/riffle sequences or channel bends. It is far superior to sample a reach length that is longer in relation to mean stream width than shorter.

The physical habitat assessment reach is designed to incorporate the fish sampling reach. After the fish sampling reach has been established, choose a physical habitat assessment reach length that will ensure full coverage of the fish sampling reach (i.e., physical habitat assessment reach length $\geq$ fish sampling reach length). To obtain the transect interval for the physical habitat assessment, divide the fish sampling reach length by nine and round the answer up to a multiple of three.

The above guidelines may result in some fish sampling reaches extending longer than 1200' or falling short of 500', due to an erroneous estimate of stream width or because of the actual distance between adequate pool/riffle sequences or channel bends. However, the physical habitat assessment reach length shall never be shorter than 540' and never longer than 1215' based on the guidelines found in Section 6.3 of this document.

3.2 Sequence of Sampling Activities

All sampling activities (fish, benthic macroinvertebrates and physical habitat) are typically completed in one day. The actual time in the field will vary depending on stream size/complexity and number of fish collected. Sampling activities can occur over two consecutive days only if stream conditions remain stable overnight. To minimize the potential impact of one sampling task on all subsequent tasks, Figure 1 contains the recommended sequence of sampling activities (some projects may not require all tasks):

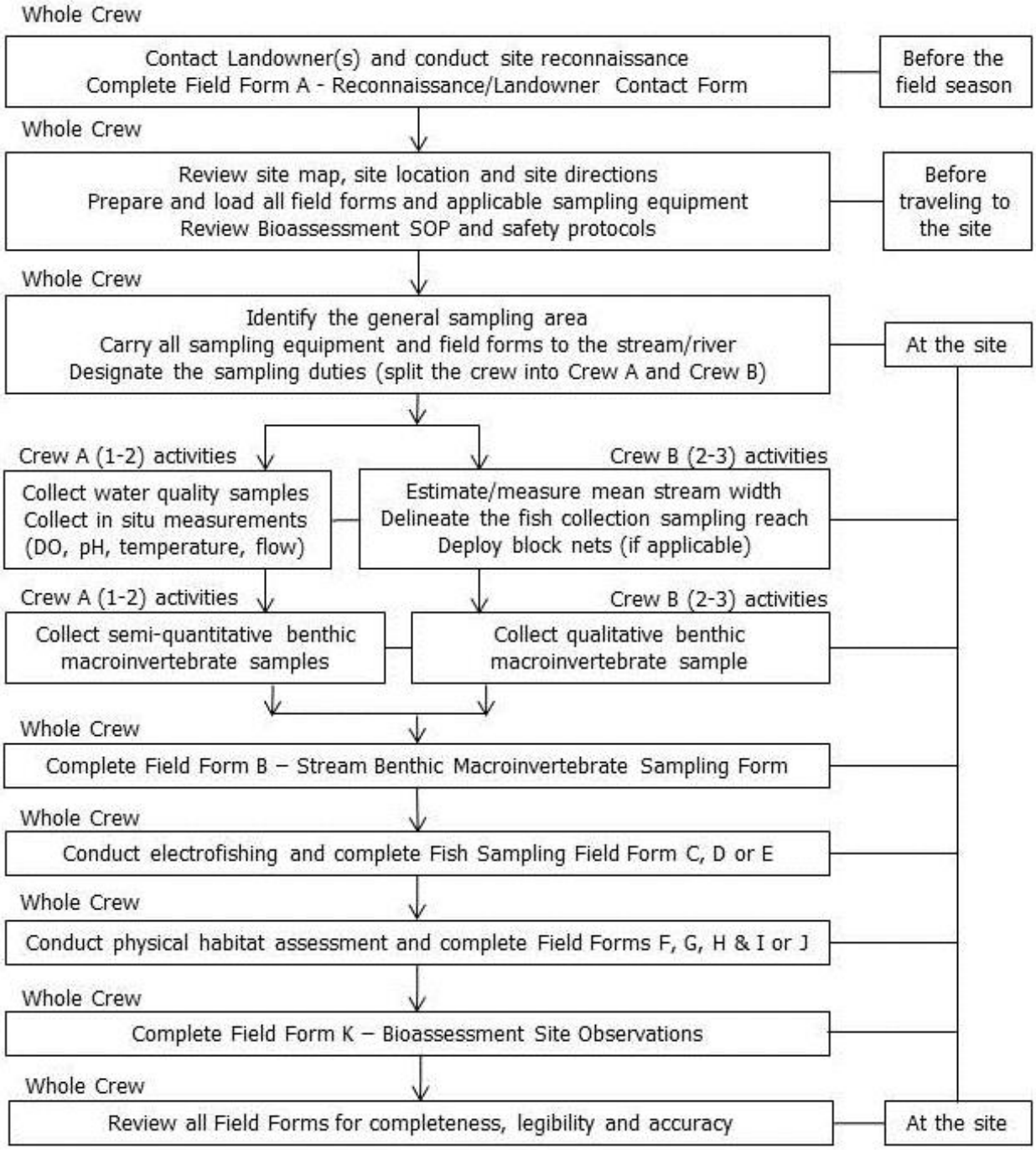

Figure 1: Sequence of sampling activities flow chart for collecting biological samples and conducting physical habitat assessments. Some projects and programs may not require the completion of all the tasks listed.

4.0 Benthic Macroinvertebrate Sampling

One qualitative (multi-habitat) and three semi-quantitative (Hess, Surber or artificial substrate) benthic macroinvertebrate samples are collected from the sampling reach. The qualitative sample data gathered provide a list of the benthic macroinvertebrate taxa sampled from all major types of benthic habitat located in the sampling reach. The semi-quantitative data provide the relative abundance of each taxon sampled from a standardized sample of productive benthic habitat.

4.1 Benthic Macroinvertebrate Sampling Crew and Field Forms

Typically, one crew member completes the semi-quantitative sampling and 2-3 crewmembers complete the qualitative sampling. After collecting the benthic macroinvertebrate samples, Field Form B: Stream Benthic Macroinvertebrate Sampling Form (Appendix 4.1) must be filled out entirely.

4.2 Semi-quantitative Benthic Macroinvertebrate Sampling Procedures

A modified Hess sampler, Surber sampler, or modified Hester-Dendy (multi-plate artificial) substrates, are used to collect the semi-quantitative benthic macroinvertebrate samples. The modified Hess or Surber samplers are used in streams that have productive riffle or run habitat. In streams lacking productive riffle or run habitat, modified Hester-Dendy multi-plate artificial substrates are used for collecting macroinvertebrates. Artificial substrates are routinely deployed during the reconnaissance visit and a 4 to 6 week colonization period is required for their use.

4.2.1 Modified Hess and Surber Samples

The modified Hess sampler is an open-ended mesh-enclosed cylinder. The cylinder is 13” in diameter, 16‟ tall and has a collection net mesh size of 600 microns. The upstream side is a mesh panel that allows water to flow through the sampler while keeping all drifting macroinvertebrates out of the sampler. The downstream side of the cylinder contains a funnel-shaped mesh collection bag. The modified-Hess sampler is most effective in shallow riffles and runs (~0.25’-1.5’) with abundant rock substrates. This sampling device performs well in streams where there is a mixture of substrate particle sizes and the bottom of the sampler can be pushed into the stream bottom to form a good seal.

In low flow situations (~<0.25’), use of a Surber sampler may be necessary because the shallow water renders the modified Hess sampler inoperable. The Surber sampler consists of a 12" x 12" horizontal frame and has a standard size 600 micron net that measures 9" in diameter and 24" long. The Surber sampler is most effective in shallow riffles and runs with abundant rock substrates.

Whenever possible, collect the triplicate modified Hess or Surber samples from the same riffle or run. If the riffle or run is too small to obtain three samples, collect the remaining sample(s) from another suitable riffle or run in the sampling reach. Apply the following protocol when collecting the modified Hess or Surber samples:

- approach the sampling area from downstream to minimize disturbance;
- select the area to place the sampler with the funnel collection bag downstream and push the sampler into the substrate forming a good seal around the bottom;
- carefully wash all cobbles and large gravel within the cylinder and remove all clinging organisms from the substrates before discarding them (using forceps, as needed);
- vigorously agitate the remaining substrate to approximately the same depth as the base of the sampler;
- try to rinse as many macroinvertebrates as possible attached to the inside of the sampler and funnel net down into the collection container (or a central location on the Surber net); and
- transfer the contents of the collection container and all remaining organisms on the inside of the sampler and net into the sample container

Process the triplicate modified-Hess or Surber samples individually and do not composite them. Add 10% formalin solution to the sample containers to field preserve the contents. Label the sample containers with indelible ink. The information on the label must include stream name, sampling date, collector, and sample collection type and number (e.g. Hess 1, Hess 2, and Hess 3). Include the site identification number on the label if it's available prior to sampling.

See Appendix 4.2a for photographs of both the modified Hess and Surber sampling equipment.

4.2.2 Modified Hester-Dendy Multi-plate Artificial Substrates

In streams that lack productive riffle or run habitat, modified Hester-Dendy multi-plate artificial substrates (AS) are used to obtain the semi-quantitative samples. The AS are also used in streams that are too deep to sample with the natural substrate samplers. The AS colonization period lasts a minimum of four weeks up to a maximum of six weeks.

IDNR uses three types of AS depending on stream size:

- standard AS – used in the majority of wadeable streams
- low flow AS – used primarily in headwater streams
- floating AS – used in larger wadeable and non-wadeable streams

4.2.2.1 Standard modified Hester-Dendy multi-plate artificial substrates

Each standard AS consists of (8) ⅛" x 4" x 4" wood plates with ¼" holes drilled in center, (3) ¼", (3) ½" and (1) ¾" thick spacers made from ½"outside diameter PVC,(2) washers, (1) hex nut, (1) wing nut and (1) ¼" X 18-36" threaded steel rod. Construction of the standard AS is as follows (from bottom to top):

thread hex nut down the treaded steel rod ~6", washer, wood plate, ¾" spacer, wood plate, ½" spacer, wood plate, ½" spacer, wood plate, ½" spacer, wood plate, ¼" spacer, wood plate, ¼" spacer, wood plate, ¼" spacer, wood plate, washer, thread wing nut and tighten

See Appendix 4.2b Artificial Substrate Construction Diagrams for more information.

Standard modified Hester-Dendy artificial substrate deployment:

Deploy four standard AS in moderately swift run habitat with firm substrate (sand or sand/gravel, not silt or muck). Careful consideration of the susceptibility to vandalism, sedimentation and damage from high flows is critical in the placement of standard AS. Apply the following deployment criteria to ensure consistent standard AS placement across sampling sites and ecoregions:

- Deploy the standard AS in flowing water with velocities of 0.5 to 1.5 feet per second preferred. However, deployment of the artificial substrates is not limited to this velocity range.
- Deploy the standard AS in runs with depths of one to three feet. Consider flow stability when determining the appropriate distance from the top plate to the surface of the water. Ideally, the standard AS are deployed in the photic zone and deep enough to ensure that they remain submersed throughout the colonization. The bottom plate should be at least three inches, if possible, above the stream bottom to prevent sedimentation of the AS.
- Deploy the standard AS in the thalweg and away from the shore, when possible, to avoid shoreline debris. Place all four of the AS within approximately three to five feet of each other in a diamond pattern when possible. An acceptable alternative to the diamond pattern is to place the AS in an evenly spaced row parallel to the current.

See Appendix 4.2c Artificial Substrate Deployment Diagrams for more information.

Determine the deployment current velocity at the AS location, take a photo of the AS and carefully note or benchmark the location from shore. Record the deployment current velocity in the top box of Field Form B: Stream Benthic Macroinvertebrate Sampling Form (Appendix 4.1).

4.2.2.2 Low flow modified Hester-Dendy artificial substrates

The low flow AS are constructed in two pieces (Rod A and Rod B) using the same materials as the standard AS (see above) except (1) ½" spacer is not used and (2) washers, (2) hex nuts and (2) wing nuts are needed. Construction of the low flow AS is as follows (from bottom to top):

Rod A:

thread hex nut ~4" down the threaded steel rod, washer, wood plate, ¾" spacer, wood plate, ¼" spacer, wood plate, ¼" spacer, wood plate, washer, thread wing nut and tighten

Rod B:

thread hex nut ~4" down the threaded steel rod, washer, wood plate, ½" spacer, wood plate, ½" spacer, wood plate, ¼" spacer, wood plate, washer, thread wing nut and tighten

See Appendix 4.2b Artificial Substrate Construction Diagrams for more information.

Low flow modified Hester-Dendy artificial substrate deployment:

- Deploy three low flow AS (3 Rod A + 3 Rod B) in the deepest flowing water in the sampling reach with firm substrate (sand or sand/gravel, not silt or muck). Careful consideration of the susceptibility to vandalism, sedimentation and damage from high flows is critical in the placement of standard AS. Apply the following deployment criteria to ensure consistent standard AS placement across sampling sites and ecoregions:
- Deploy the low flow AS in areas of adequate depth and velocity. The bottom plate should be at least three inches, if possible, above the stream bottom to prevent sedimentation of the low flow AS.
- Deploy the low flow AS in the thalweg and away from the shore, when possible, to avoid shoreline debris. Place all six of the low flow AS within approximately three to five feet of each other in a triangle pattern, if possible. An acceptable alternative to the triangle pattern is to place three pairs of the AS (1 Rod A + 1 Rod B) in an evenly spaced row parallel to the current. Deploying the low flow AS in pairs (AB, AB, etc.) will facilitate easier removal and processing.

See Appendix 4.2c Artificial Substrate Deployment Diagrams for more information.

Determine the deployment current velocity at the AS location, take a photo of the AS and carefully note or benchmark the location from shore. Record the retrieval current velocity in the top box of Field Form B: Stream Benthic Macroinvertebrate Sampling Form (Appendix 4.1).

4.2.2.3 Floating modified Hester-Dendy artificial substrates

The floating modified AS are constructed using the same materials as the standard AS (see above) except a ¼" X 6" eyebolt is substituted for the threaded rod. In addition, rope/cord and anchoring material (e.g. concrete cinder blocks) are required for their use. Construction of the floating AS is as follows (from top to bottom, inverted):

> hold eyebolt by eye with threads facing up, washer to the bottom/eye, wood plate, ¼" spacer, wood plate, ¼" spacer, wood plate, ¼" spacer, wood plate, ½" spacer, wood plate, ½" spacer, wood plate, ½" spacer, wood plate, ¾" spacer, wood plate, washer, thread wing nut and tighten

See Appendix 4.2b Artificial Substrate Construction Diagrams for more information.

After constructing the artificial substrate, seal the cap on an empty gallon jug with silicone. If AS are going to be in navigable water, spray paint the gallon jug neon orange for safety and visibility. Label the orange gallon jug with the name of the responsible party, phone number and something similar to "BUG SAMPLING GEAR – DO NOT DISTURB". Using vinyl coated wire clothesline or something similar, tie one AS to a gallon jug using a secure knot. The AS should freely hang from the jug handle (~2-6" depending on stream conditions). Measure out an appropriate length (depending on depth of the stream) of clothesline and attach one end to a half-cinderblock and the other end to the jug. Repeat three times.

Floating modified Hester-Dendy artificial substrate deployment:

- Deploy four floating AS in an area with adequate velocity (0.5-1.5 ft./sec if possible). Careful consideration of the susceptibility to vandalism, sedimentation and damage from high or low flows is critical in the placement of the floating AS. Methods of deployment include wading or boating to an optimal site and hand placing them in the stream or throwing them off a bridge or stream bank. When throwing them from a bridge or stream bank, be sure to take in account retrieval. Do not throw the AS in water too deep to wade if boat access is not available. Apply the following deployment criteria to ensure consistent floating AS placement across sampling sites and ecoregions:
- Deploy the floating AS in flowing water greater than 3 feet deep. The gallon jug should be floating on the water's surface. The AS should be fully submerged under water and hanging freely below jug. Due diligence is needed to ensure the AS is not too shallow and "surfing" near the surface nor too deep and will become "beached" if water levels drop. Consider flow stability when determining AS location. Placing them in fast flowing water could result in movement downstream, however placing it in shallower water could result in buried AS plates if the water level goes down within the colonization period.
- Deploy the floating AS away from the shore, when possible, to avoid shoreline debris. Place all four of the AS within approximately three to five feet of each other in a diamond pattern.

See Appendix 4.2c Artificial Substrate Deployment Diagrams for more information.

If the river is wadeable, determine the deployment current velocity at the AS location, take a photo of the AS and carefully note or benchmark the location from shore. If the river is non wadeable, it is acceptable to use a nearby, representative velocity measurement or estimation. Record the retrieval current velocity in the top box of Field Form B: Stream Benthic Macroinvertebrate Sampling Form (Appendix 4.1).

To ensure the ability to locate and recover the AS, regardless of the type of AS deployed, use one or more of the following techniques:

- record the GPS coordinates of the AS
- illustrate the location of the AS on a map including distances to landmarks on shore
- use wooden stakes or flagging tape on the stream bank to mark the location of AS

4.2.2.4 Standard and Floating modified Hester-Dendy AS retrieval and processing
Determine the retrieval current velocity at the AS location (downstream or after the AS are processed) and take a photo of the AS. Record the retrieval current velocity in the top box of Field Form B: Stream Benthic Macroinvertebrate Sampling Form (Appendix 4.1).

Retrieve the AS in a downstream to upstream manner. Evaluate the status of the AS and choose the three "best" AS to process. "Best", in this case, implies the AS that are still

completely submersed at time of retrieval, free from an extraordinary amount of silt or debris and in adequate current velocity. Discard the fourth AS only after three acceptable samples have been collected. It is acceptable, in times of compromised sample quality (e.g. buried plates, missing AS, etc.), to combine multiple AS into one sample. The most important thing when encountering this situation is to document exactly what was done. Ultimately, for a Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) to be calculated, one semi-quantitative sample containing $\geq$85 organisms needs to be collected.

Place a 500μm mesh bag over one AS and tightly draw the bag closed at the base to ensure that any dislodged organisms are not lost while the AS is pulled from the stream bed. A 500μm sieve may be used in lieu of the bag in shallow streams (<12"). Remove the AS from the streambed carefully to minimize the loss of benthic macroinvertebrates. Carefully remove any large (i.e. won't fit in sample container) extraneous debris, such as leaves or sticks, residing against the AS before removing the AS from the stream bottom.

Empty the AS and other contents of the collection bag into a standard No.30 brass sieve or white enamel pan containing a small amount of stream water. Remove all clinging organisms from the collection bag with forceps and place in the sample container. Add a small amount of stream water to the sample container so the organisms do not dry out.

Disassemble the AS and remove the benthic macroinvertebrates from the plates by hand picking with forceps and by gently scraping each plate surface with a putty knife or other straight blade. A sieve can be used to rinse extra sediment from the sample. Transfer the pan/sieve contents to a labeled sample container and fill the container with a 10% formalin solution.

Use separately labeled containers for each AS sample. The information on the label must include stream name, sampling date, collector, and sample collection type and number (e.g. AS 1, AS 2, and AS 3). Include the site identification number on the label if it's available prior to sampling.

4.2.2.5 Low flow modified Hester-Dendy artificial substrate retrieval and processing

The retrieval and processing of the low flow AS is nearly identical to the standard and floating AS retrieval and processing (above) with the following exceptions:

- All six of the AS are retrieved and processed
- One Rod A and one Rod B AS are combined into one sample container

4.3 Qualitative Multi-habitat Sampling

Qualitative multi-habitat sampling is conducted on the same day but after, or simultaneous to, the semi-quantitative sampling. The qualitative multi-habitat sampling requires two or more crewmembers and the sampling time allocation is approximately 90 total minutes. For example, two crewmembers sample for 45 minutes each or three crew members sample for 30 minutes each, etc.

4.3.1 Qualitative Multi-habitat Sampling Approach

Subdivide the sampling reach longitudinally (e.g., upstream 1/3rd, middle 1/3rd, downstream 1/3rd) based on the number of crew members. One crew member is responsible for each sampling area. Typically, crew members use standard No.30 brass sieves to collect and concentrate organisms; however, wash buckets, kick-nets, or other sampling gear can also be used. The mesh size of all nets, sieves, wash-buckets, or other sampling gear used in multi-habitat sampling must be between 500-600μm. Collect benthic macroinvertebrates from all accessible types of benthic substrates by handpicking or sieving. Common techniques used to collect benthic macroinvertebrates include:

- sieving the gravel, fine substrate, clay hardpan, and overhanging vegetation;
- disturbing the riffle and rocky run areas by foot and using the sieve to capture drifting benthic macroinvertebrates;
- handpicking benthic macroinvertebrates from large cobbles and boulders, woody debris, and other large substrates found in the stream

It is important to sample as many different substrates as possible by not lingering in one area too long. It is also important to collect as many different types of organisms as possible. Ideally, at least one specimen of all the benthic macroinvertebrate taxa present in the reach will be collected. Because many species are indistinguishable from others in the field, it is important to collect several specimens of each type.

Each crewmember carries a subsample container that serves as a temporary receptacle during sampling. At the end of the allotted sampling time (~90 combined minutes), combine the sample containers into one labeled sample container and fill with a 10% formalin solution. The information on the label must include stream name, sampling date, collector(s), and sample collection type (qualitative). Include the site identification number on the label if it's available prior to sampling.

4.3.2 Qualitative Multi-habitat Sampling Observations and Benthic Habitat Inventory

The bottom box on Field Form B: Stream Benthic Macroinvertebrate Sampling Form (Appendix 4.1) must be filled out entirely after the multi-habitat qualitative sampling has been completed.

The top portion of the bottom box (Qualitative – Multi-Habitat Sampling) contains information about qualitative sampling gear, sampling duration, sample collectors and qualitative sampling effectiveness.

The bottom portion of the bottom box is the Benthic Habitat Inventory which identifies the occurrence of benthic substrates within two types of macrohabitat (i.e., riffle/run and glide/pool) in the sampling reach and ranks the relative abundance of the benthic substrates. First, record each benthic substrate/macrohabitat combination present in the sampling reach on the right two columns of the bottom box. Second, assign rankings for the 5 most common benthic substrates in terms of relative abundance (e.g. surface area) to the other benthic substrates (i.e., 1 = most abundant, 2 = second most abundant, etc.).

4.4 Laboratory Benthic Macroinvertebrate Sample Processing

Field preserved benthic macroinvertebrate samples are processed in a laboratory. See the State Hygienic Laboratory at the University of Iowa, Limnology Section's Standard Operating Procedure for Macroinvertebrate Collection and Analysis (SHL 2014).

5.0 Fish Community Sampling

The sampling methods described below provide a representative, semi-quantitative sample of the fish community inhabiting the sampling reach. The data collected allow the estimate of the following community parameters of the fish sample:

- species composition;
- species relative abundance (i.e., number of fish of each species as a percentage of the total number of captured fish);
- fish abundance (i.e., catch per unit effort);
- proportion of fish with external abnormalities

The methods employed do not provide quantitative information suitable for fish population or biomass estimates.

5.1 Fish Sampling Crew and Field Forms

Fish sampling is normally conducted by a crew ranging from 2-7 people depending on stream size and sampling gear used. The number of crew members required is based on the number and type of electrofishing equipment used. Optimally, for every crew member operating a backpack shocker or barge probe, there should be one crew member netting the fish. After collecting the fish sample, fill out Field Form C, D or E: Fish Sampling Field Form (Appendices 5.1a, 5.1b & 5.1c) entirely.

5.2 Electrofishing Equipment and Effort

Fish community sampling requires the use of direct current electricity supplied by the electrofishing equipment. One backpack shocker is used for approximately every 15 feet of average stream width. However, in deeper streams or streams with complex habitat that have an average stream width of <15', two backpack shockers should be used. It is important to use as many backpack shockers as needed to obtain a representative sample. A barge electrofishing unit, consisting of generator, electrical control box, retractable electrodes, and a live well, is used in relatively deep or wide wadeable streams which cannot be effectively sampled with backpack shockers. Record the equipment used during fish sampling on the Fish Sampling Field Forms C, D or E.

See Appendix 5.2 for photographs of both backpack and barge fish shocking equipment.

5.3 Electrofishing Sampling Approach

Fish sampling occurs in the delineated fish collection sampling reach, generally ranging in length from 500-1200 feet. Refer to section 3.1of this document for the explanation of delineating the fish sampling reach length.

Whenever necessary, the upstream and downstream boundaries of the sampling reach are blocked using block nets (¾" mesh) to prevent highly mobile fish (e.g. Catostomidae species) from leaving the sampling area. It is acceptable to use natural or manmade barriers (e.g. shallow riffles, low water stream crossings) instead of block nets at the upstream and/or downstream fish sampling reach boundaries.

Complete a single pass through the sampling reach proceeding from downstream to upstream to collect fish. It is important to uniformly sample all types of fish habitat. Sample riffles, woody debris snags, and other productive habitats thoroughly by methodically sweeping each area with the shocker electrode(s) in an effort to capture all fish. All stunned fish are collected in 3/16" mesh landing nets and transferred to plastic buckets or holding tanks until processing. To prevent unnecessary fish mortality, provide fresh water periodically and keep captivity time to a minimum. During hot weather or when sampling reaches contain high numbers of fish, stop multiple times during the sampling to identify and enumerate the captured fish. However, the stopping points should be at natural or manmade barriers and not in the middle of pools or deep runs. Release processed fish downstream of the barrier to minimize recapture.

Record the fish sampling reach length on the Fish Sampling Field Form to allow calculations of the catch per unit effort on a linear basis. The actual fish sampling reach length is routinely determined during the physical habitat assessment. The amount of time elapsed during the fish sampling is also recorded on the Fish Sampling Field Forms C, D or E.

5.4 Fish Identification, Enumeration and Examination

At the end of the fish sampling reach length, or each chosen stopping point, identify and enumerate captured fish before releasing. Exclude from the sample all fish that are less than one inch long. In addition, examine each fish for the presence of the following external abnormalities: skeletal Deformities, Eroding fins, Lesions, and Tumors (DELTs). Also, make note of the following issues (non-DELTs): anchor worms, blackspot, leeches, fungus, Ich, blindness, emaciation, external parasites, popeye, swirled scales, wounds, and/or other (describe). Fish examination and DELT coding procedures are adopted from the Ohio EPA fish sampling procedures (OEPA 1989; Appendix 5.4).

Record the number of fish per species on the Fish Sampling Field Form (Field Form C, D or E). Measure/estimate and record the length of game fish in three inch groups (i.e. 1-3", 4-6", etc.). Tally the number of fishes exhibiting DELTs and non-DELTs by species on the Fish Sampling Field Form. Fish taxonomy references should be available in the field (e.g., IDNR 1987) to assist crewmembers with identification. Preserve all unidentifiable/questionable fish in the field with a 10% formalin solution for later laboratory identification by field staff and, if necessary, confirmation by a recognized fish taxonomist. Take photographs of larger specimens as needed to document rare species occurrence or distinguishing characteristics that are needed for subsequent identification. In addition to any unidentifiable/questionable specimens, two representatives of each taxon are preserved with a 10% formalin solution in a separate voucher collection container for long term archival reference. Label both the unknown and voucher collection containers with date, site name, site location, site number (if available) and any other pertinent information.

6.0 Physical Habitat Assessment

Avoid disrupting the sampling reach by performing the physical habitat assessment after the collection of biological samples. Several habitat variables are measured or visually estimated at 10 stream cross-section transects and 18 mini-transects. All transects are evenly spaced throughout the physical habitat assessment reach (Figure 2).

6.1 Physical Habitat Assessment Crew and Field Forms

Crew size required to complete the physical habitat assessment is dependent on stream size. One or two crew member(s) may be able to complete the assessment in small, headwater streams and in larger streams it may be beneficial to have up to five crew members. After completing the physical habitat assessment, Field Forms F-J must be filled out entirely.

6.2 Physical Habitat Assessment Equipment

The required equipment for the physical habitat assessment can be found in Appendix 2.4: Biological and Physical Habitat Sampling Equipment.

6.3 Physical Habitat Assessment Reach Delineation

Estimate or measure the fish sampling reach length and use Table 1 below to determine the proper physical habitat assessment reach length. The physical habitat assessment reach is designed to incorporate, or bracket, the fish sampling reach (i.e., physical habitat assessment reach length $\geq$ fish sampling reach length). The table is intended to simplify the physical habitat assessment transect interval determination; however, any transect interval between 60′ and 135′ that is divisible by three is acceptable.

Table 1. General guidelines for determining the physical habitat assessment reach length and transect interval.

Estimated/Calculated Mean Stream Width (feet)	Min/Max Fish Sampling Reach Lengths (feet)	Physical Habitat Assessment Reach Length (feet)	Transect Interval (feet)	Mini (1/3) Transect Interval (feet)
$\leq$16	$\leq$ 480	540	60	20
17-20	510 - 600	675	75	25
21-25	630 - 750	810	90	30
26-30	780 - 900	945	105	35
31-35	930 - 1050	1080	120	40
$\geq$36	$\geq$ 1080	1215	135	45

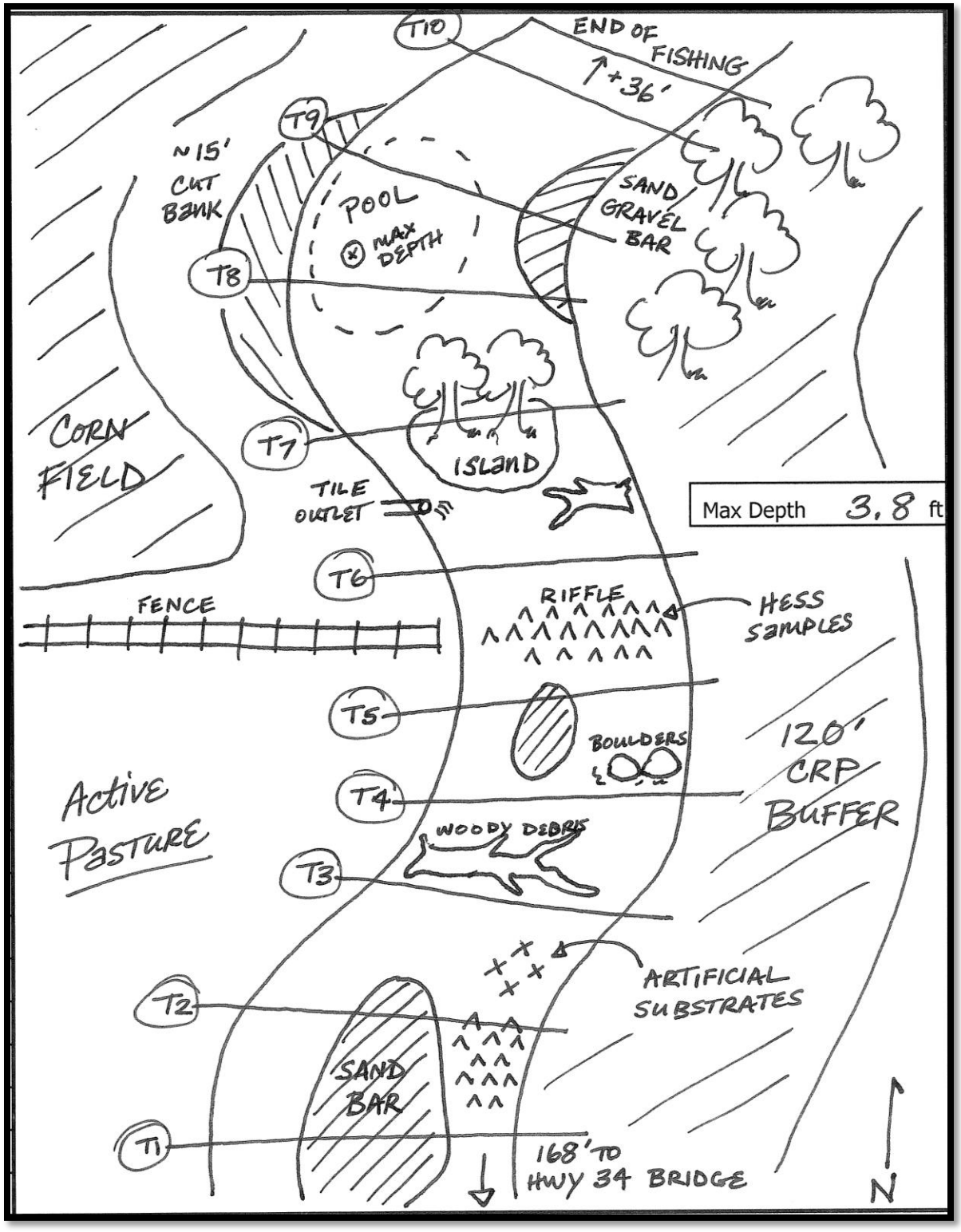

Figure 2. Sketch of the sampling reach from Field Form G – Physical Habitat Assessment Reach Map showing the 10 evenly spaced transects. Two mini-transects (not shown) are spaced evenly between each main transect.

6.4 Establishing Transects and Mini-transects

Transects: Establish transect #1 (T1) at the downstream boundary of the delineated fish sampling reach and stretch the fiberglass tape across the stream perpendicular to the main direction of flow (Figure 2). All instream measurements will be made from the downstream side of the measuring tape and the tape shall remain in place until all measurements are recorded. After collecting all the required physical habitat data at T1, progress upstream to the remaining nine transects. Establish new transects by measuring one transect interval upstream from the previous transect following the middle of the channel. If you encounter sharp bends while moving to the next transect line, make sure the mid-channel course of the stream is followed. If the sampling reach is extremely sinuous, it may be necessary to move upstream in short segments in order to move the correct distance following the mid-channel line. The new transect line is established again by stretching the measuring tape across the stream channel perpendicular to the main direction of flow.

Mini-Transects: Two mini-transects will be located between the transects with the mini-transect interval equal to one third of the transect interval. For example, if the transect interval is 90 feet, locate the first mini-transect at 30 feet from the first transect and the second mini-transect at 60 feet from the first transect. It is not necessary to stretch a tape across the stream at the mini-transect locations.

6.5 Recording Physical Habitat Assessment Data on Field Forms

At the top of the physical habitat Field Forms F-J, record the stream/site name, site location, site number (if available) and date. Table 2 explains where in the physical habitat assessment reach and on what field form the physical habitat data will be collected and recorded. For more information on what physical habitat data get recorded where and when on the physical habitat assessment field forms, see Appendix 6.5a Physical Habitat Assessment Flowchart.

Table 2. Matrix indicating on what transect, mini-transects and sampling reach where all five of the Physical Habitat Assessment Field Forms will be used.

Field Form	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	Mini (1/3) Transects	Reach
Field Form F: Stream Transect Habitat Data	X	X	X	X	X	X	X	X	X	X		
Field Form G: Physical Habitat Assessment Reach Map	X	X	X	X	X	X	X	X	X	X	X	X
Field Form H: Visual Riparian Estimates and Human Influence	X				X					X		
Field Forms I & J: Rapid Habitat Assessment Field Forms												X
Field Form K: Bioassessment Site Observations												X

6.5.1 Field Form F: Stream Transect Habitat Data

Collect the following measurements and observations at all 10 stream transects and record sequentially on Field Form F: Stream Transect Habitat Data (Appendix 6.5b).

Stream Width: Measure the wetted channel width (i.e., stream width) to the nearest 0.1' using a fiberglass tape stretched across the stream channel perpendicular to the main axis of flow. Record the measurement in the "*Stream Width*" column on Field Form F: Stream Transect Habitat Data. As a matter of convention, the width of an exposed sediment bar is included in the total stream width measurement; however, the width of an island is subtracted from the stream width measurement. For more information on how to proceed when sediment bars or vegetated islands are encountered during the physical habitat assessment, see Appendix 6.5c: Handling Bars and Islands during Physical Habitat Assessment.

Water Depth: Water depth is measured at five points along each transect line. Substrate type data are collected simultaneously with depth data and the process is described below. Determine the interval between observation points by dividing the stream width by five (i.e., interval is equal to 1/5X stream width). Establish the first sampling point by using a distance equal to 1/2 the interval (i.e., 1/10 X stream width) from the left shore (facing upstream). The remaining four transect points are spaced equidistantly from each other across the stream (i.e., at 3/10, 5/10, 7/10, and 9/10X stream width). For example, if the stream width is 10', the five transect observation points would be located at 1', 3', 5', 7' and 9' from the left shoreline (Figure 3).

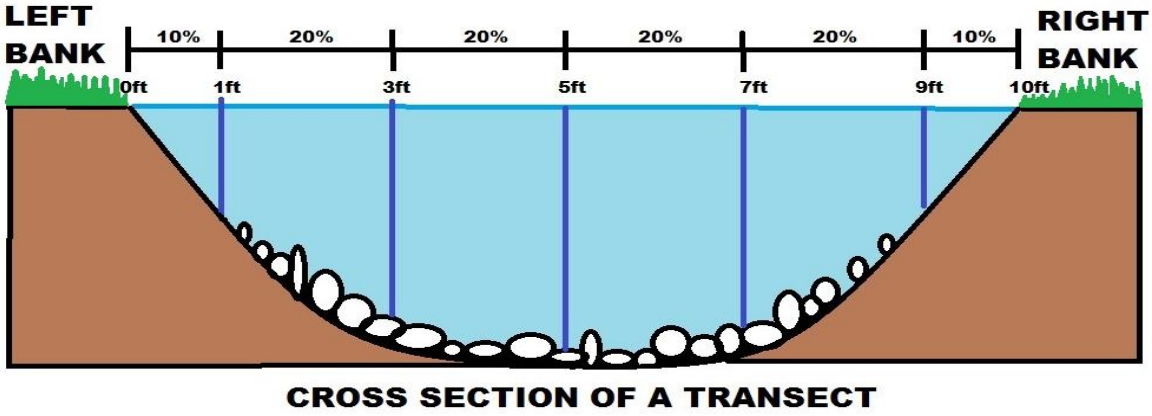

Figure 3. Diagram of a stream cross section (transect) detailing the establishment of the five observation points.

Using a graduated surveyor's rod, measure water depth to the nearest 0.05' at each transect observation point. Take care not to push the staff or rod into the substrate when soft substrates are encountered. Record each measurement on Field Form F: Stream Transect Habitat Data in the "*Depth*" column. Measurements must be made from left to right, facing

upstream from the downstream side of the measuring tape. Record the first measurement on the left side of the transect in the uppermost box, proceeding downward in the *"Depth"* column. If the crew has two surveyor's rods (or other measuring devices), it is allowable to work simultaneously from both sides of the stream toward the middle. Due diligence must be used to ensure that the data are recorded in the correct location on the field forms.

Substrate Type: Looking straight down at the stream bottom below each observation point (directly under the depth measuring equipment and on the transect line) determine the dominant type of substrate, excluding living plant matter (Table 3). When living plant matter is encountered, determine the dominant substrate type that occurs immediately underneath. If two substrate types occur relatively equally (no greater than a 60/40 split) at the observation point, it is allowable to record the combination only if the substrates are gravel or smaller (e.g., silt/sand or sand/gravel). When visibility is obscured, determine substrate type by feeling the bottom or probing it with the wading rod or staff. Using the abbreviations and size criteria listed on Field Form F: Stream Transect Habitat Data, record each substrate observation in the "*Substrate Type*" column. Measurements must be made from left to right, facing upstream. Record the first measurement from the left side of the transect in the uppermost box, proceeding downward in the *"Substrate Type"* column. If the crew has two surveyor's rods (or other measuring devices), it is allowable to work simultaneously from both sides of the stream toward the middle. Due diligence must be used to ensure that the data are recorded in the correct location on the field forms.

Embeddedness Rating: Rate the degree of embeddedness at each transect crossing a shallow riffle or run (mean depth $\leq$1.5') with coarse substrate covering more than 25% of the transect area. Estimate the average percent surface area of coarse substrate particles (i.e., large gravels, cobbles or small boulders) that are surrounded by fine sediments using the following categories: 0-20% (1); 20-40% (2); 40-60% (3); 60-80% (4); and 80-100% (5). Rate the embeddedness of three or more substrate particles along the transect line and record the average embeddedness rating on Field Form F: Stream Transect Habitat Data in the "*Embed*" column. If embeddedness cannot be estimated at a transect, place an 'X' in the "*Embed*" column for that transect.

Instream Fish Cover: The procedure for estimating instream fish cover is similar to the method described by Peck et al. (2003), with the addition of a depth/pool category. The estimation of the type of instream fish cover is further refined by the size of fish to which the cover applies (Table 4). Estimate a distance five meters (~15') upstream and downstream of the transect (Figure 3). Visually examine the wetted channel and banks at the water's edge within this 10m area for the following fish cover types: filamentous algae, macrophytes, woody debris, small brush, trees/roots, overhanging vegetation, undercut banks, boulders, artificial structures, and pools where the stream bottom is not visible under base flow conditions. Using the following 0 – 4 rating scheme estimate the aerial percentage represented by each cover type within the 10m area: 0 = absent, 1 = sparse (>0% to < 10%), 2 = moderate (>10% to 40%), 3 = heavy (>40% to 75%), and 4 = very heavy (>75%). It is permissible for the total aerial percentage for all cover types to equal more than 100% due to potential overlaying of cover types in three-

dimensional space. Record (circle) the rating for each instream cover category on Field Form F: Stream Transect Habitat Data in the "*Instream Cover*" columns.

Table 3. Substrate names, substrate codes and size categories and/or descriptions used to describe the substrate type at each transect observation point. Adapted from Platts et al. (1983) and the USEPA (2007).

Substrate	Substrate Code	Size (diameter)		Description
Bedrock	be	none		bigger than a car
Boulder	bo	>10 in. (250-4000mm)		basketball to a car
Cobble	co	2.5-10 in. (>64-250mm)		tennis ball to basketball
Gravel (Coarse)	gr	0.1-2.5 in.	>16 to 64mm	marble to tennis ball
Gravel (Fine)			>2 to 16mm	lady bug to marble
Sand	sa	>0.06-2mm		smaller than Lady Bug, gritty
Silt	si	>0.004-0.06mm		not gritty between fingers
Clay/Hardpan	cl	0.00024-0.004mm		not gritty, slick feel
Muck	mu	dark, usually odorous and anaerobic sediment		
Detritus	de	partially decomposed organic matter, esp. leaves & plants		
Riprap	ri	concrete, limestone, brick or other block material on stream bank		
Soil	so	e.g., from a recently slumped stream bank		
Wood	wo	woody debris, old or new		
Other		describe in space provided		

Table 4. Explanations of the fish cover categories and minimum fish sizes to which they apply.

Fish Cover Type	Minimum Fish Size*	Description
Filamentous Algae	Juvenile	Filamentous algae long enough (~≥2") to provide cover.
Macrophytes	Juvenile	Rooted aquatic plants long/large enough to provide cover.
Woody Debris	Juvenile	Logs and woody debris that are ≥30cm (~1') in diameter.
Small Brush/ Woody Debris	Juvenile	Logs, brush and other woody debris <30cm (~1') in diameter.
Trees/roots	Juvenile	Trees/roots that are inundated or could become inundated.
Overhanging Vegetation	Juvenile	Living or non-living vegetation within 1m of the water surface.
Undercut Banks	Adult	Undercut banks with a vertical depth of ≥1.5' when measured from underside of the undercut to the bottom of the stream. When inundated it must provide enough cover for an adult fish.
Boulders	Juvenile	Rocks ≥10" (250-4000mm) or the size of a basketball to a car.
Artificial Structures	Juvenile	Purposeful or incidental anthropogenic items (e.g. fish hide or tire).
Pools	Adult	Deeper water areas (≥ 2') with slow to no current velocity.
*Juvenile fish include small-bodied species such as darters and minnows. Adult fish include large-bodied species such as suckers or trout.		

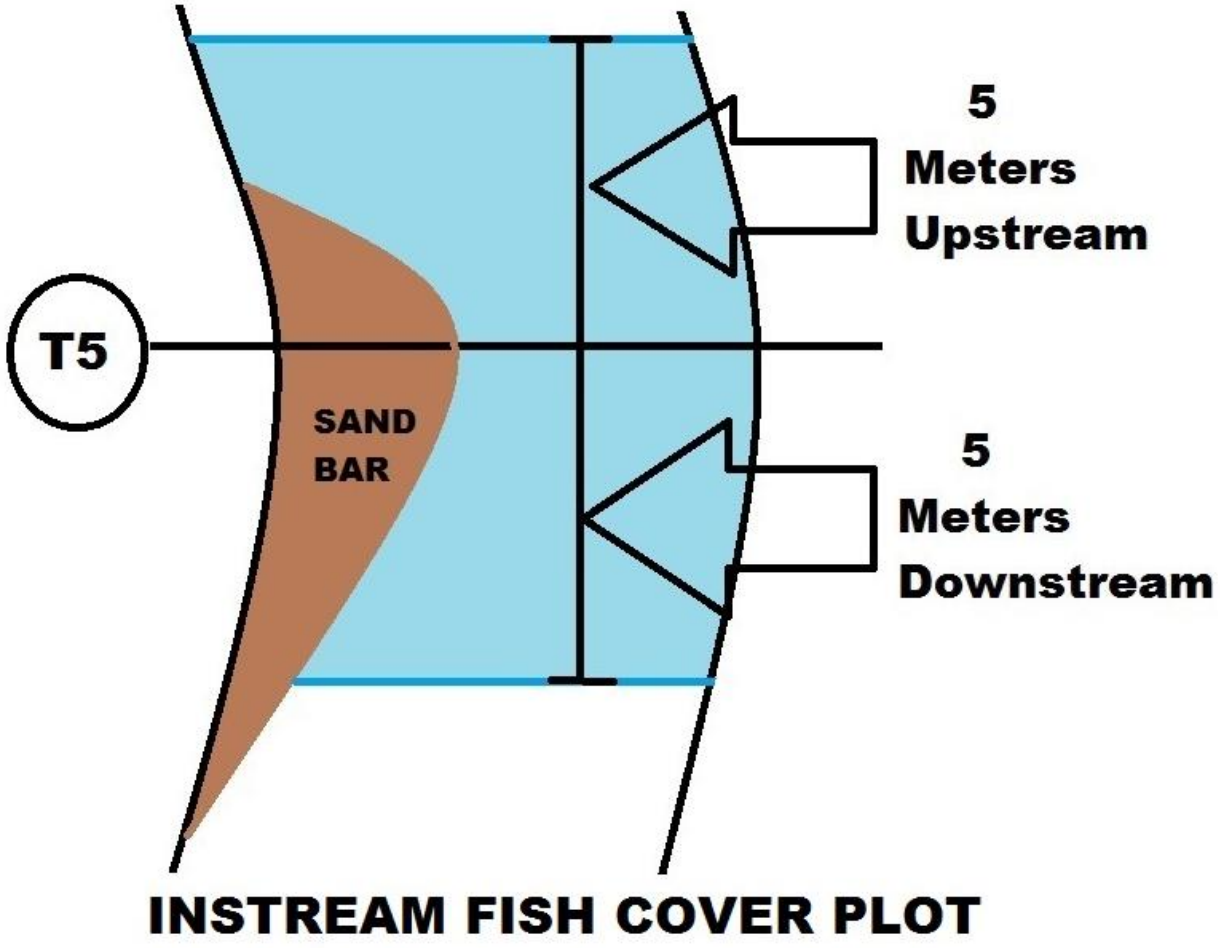

Figure 4. Diagram showing the area above and below the transect (light blue) observed when evaluating the amount of instream fish cover. Only the water and water/bank interface is evaluated for instream fish cover in the plot (sand bar would be excluded in the example).

Stream Bank Angle: Measure the slope of the first five feet of the bank where the transect intersects the left and right stream banks. With the end of the wading rod resting at the edge of the water, lay the wading rod along the bank perpendicular to the stream. Use the clinometer to measure the slope (angle) of the wading rod to the nearest 5 degrees and record the values on Field Form F: Stream Transect Habitat Data in the "*Stream Bank Angle*" columns. The left bank is on the left side of the stream when facing upstream. If the bank is comprised of two different bank sections with two different slopes, measure the slope of the larger of the two sections. If the two bank sections are of equal size, measure the slope of the bank closest to the water. If the bank immediately adjacent to the transect is obstructed by debris, the bank angle can be measured slightly upstream or downstream of the transect. Significant undercut banks (greater than one foot longitudinal undercut) are reported as an angle greater than 90 degrees but less than or equal to 180 degrees. If the undercut bank is not significant (less than one foot longitudinal undercut), disregard the undercut and measure the angle of the remaining bank.

Bare Stream Bank: Estimate the percentage of stream bank that is bare on both the left and right stream banks (facing upstream). Bare stream bank is defined as "not anchored by plant tops or roots, rock (cobble or larger), or artificial material such as concrete riprap." Restrict your observations to the first five feet of stream bank extending back from the shoreline on the transect line. It is beneficial to use the graduated surveyor's rod (or similar equipment) in place for the bank angle measurement to aid in the estimation of the percent bare bank value. Record the estimates of percent bare stream bank (to the nearest 5%) for both the left and right stream banks on Field Form F: Stream Transect Habitat Data in the "*% Bare Stream Bank*" columns.

Number of Open Canopy Observations: At each transect, estimate the amount of open canopy (i.e. not shaded by overhead vegetation) at three places along the transect line using a convex spherical densiometer. The spherical densiometer uses a convex mirror with a grid of horizontal and vertical lines etched on the surface. There are 37 corner and line intersection points in the grid. At the left shoreline face upstream on the downstream side of the measuring tape, hold the densiometer at waist level and view the overhead riparian vegetation canopy reflected onto the mirrored surface. Hold the densitometer level using the bubble level and count the line intersections or corners that are covered by open sky (not covered by overhead vegetation). Record counts on Field Form F: Stream Transect Habitat Data in the "*Sph. Dens. # Open Canopy*" column. Repeat this procedure at the middle of the stream and at the right shoreline and record the observations in the appropriate columns. It is acceptable to have more than one person collecting the number of open canopy observations simultaneously.

6.5.2 Field Form G: Physical Habitat Assessment Reach Map

As the physical habitat assessment proceeds upstream, sketch a map of the sampling reach on Field Form G: Physical Habitat Assessment Reach Map (Appendix 6.5d). Indicate the locations of transects and major habitat features such as channel bends, pools, riffles, sediment bars, and woody debris snags, etc. on the map (Figure 2). Also indicate the locations of the fish

sampling reach boundaries, the stream access point, the deepest spot of the sampling reach, and any landmarks that may be helpful later when returning to the sampling reach. Be sure to indicate the collection location of the semi-quantitative samples and to characterize the riparian vegetation and land uses (Figure 2). Record the UTMs (15T NAD 83) from the center of the channel at T1 and T10. Take a minimum of four photographs of each site. Take two pictures from the downstream reach boundary (T1), with one photo looking upstream and another photo looking downstream. Repeat this procedure at the upstream reach boundary (T10). Mark that pictures have been taken on Field Form G: Physical Habitat Assessment Reach Map and include file names if possible. Photographs of biological specimens, sampling procedures, or unique habitat features are also subjects to consider.

Record the types of macrohabitat, thalweg depth, and the presence of soft or small sediment at each main transect and mini-transect on the left side of Field Form G: Physical Habitat Assessment Reach Map.

Macrohabitat: Visually obtain and record the dominant macrohabitat type in the "*Macro Hab*" column on Field Form G: Physical Habitat Assessment Reach Map using the following abbreviations: po (pool), gl (glide), ri (riffle), or ru (run). If the cross-section is divided relatively equally (no greater than a 60/40 split) between two types of macrohabitats (e.g., 1/2 pool, 1/2 run), it is permissible to record both types in the space provided (pool/run).

Thalweg Depth: Measure the deepest location on the transect, or mini-transect, to the nearest 0.05' (this generally occurs when collecting the five water depth values). Record the thalweg depth value in *"Thalweg Depth"* column on Field Form G: Physical Habitat Assessment Reach Map.

Soft/Small Sediment: Record the presence or absence of soft/small sediment by circling Y (yes) or N (no) in the "*Soft/small sediment*" column on Field Form G: Physical Habitat Assessment Reach Map. Soft/small sediment ($\leq$16mm) is determined by feel and includes fine gravel, sand, silt, clay (unconsolidated) and muck (see Table 3). A thin coating (<2 mm) of silt or a silty algae coating over substrate larger than fine gravel does not qualify as soft sediment.

6.5.3 Field Form H: Visual Riparian Estimates and Human Influence

Visual riparian estimates are made on both sides of the stream at the first, fifth, and tenth transect (T1, T5 & T10). The observations are recorded on Field Form H: Visual Riparian Estimates and Human Influence (Appendix 6.5e). This procedure has been adapted and modified from Peck et al. (2003).

Stand at the midpoint on the transect and face the left bank. Estimate a plot area bounded by the shoreline 5m upstream and 5m downstream (10m total) of the transect and 10m back into the riparian zone (Figure 5). The aerial coverage of several classifications of vegetation is estimated within three different layers of the 10m X 10m plot: 1) canopy, 2) understory, and 3) ground cover. The following 0 – 4 rating scheme is used to estimate the percentage of the plot covered by each vegetation type: 0 = absent, 1 = sparse (>0 to < 10%), 2 = moderate (>10% to 40%), 3 = heavy (>40% to 75%), and 4 = very heavy (>75%). The aerial percentage

ratings in each layer are evaluated as if looking down on the plot from above starting at the top (canopy) layer and successively stripping off the layers until the ground level is evaluated. Due to the three-dimensional aspect of the riparian plot, it is possible for the vegetation percentage ratings in any of the layers to add up to more than 100%.

It may be useful to have a crew member standing in the 10mX10m plot area to assist in characterizing the riparian vegetation.

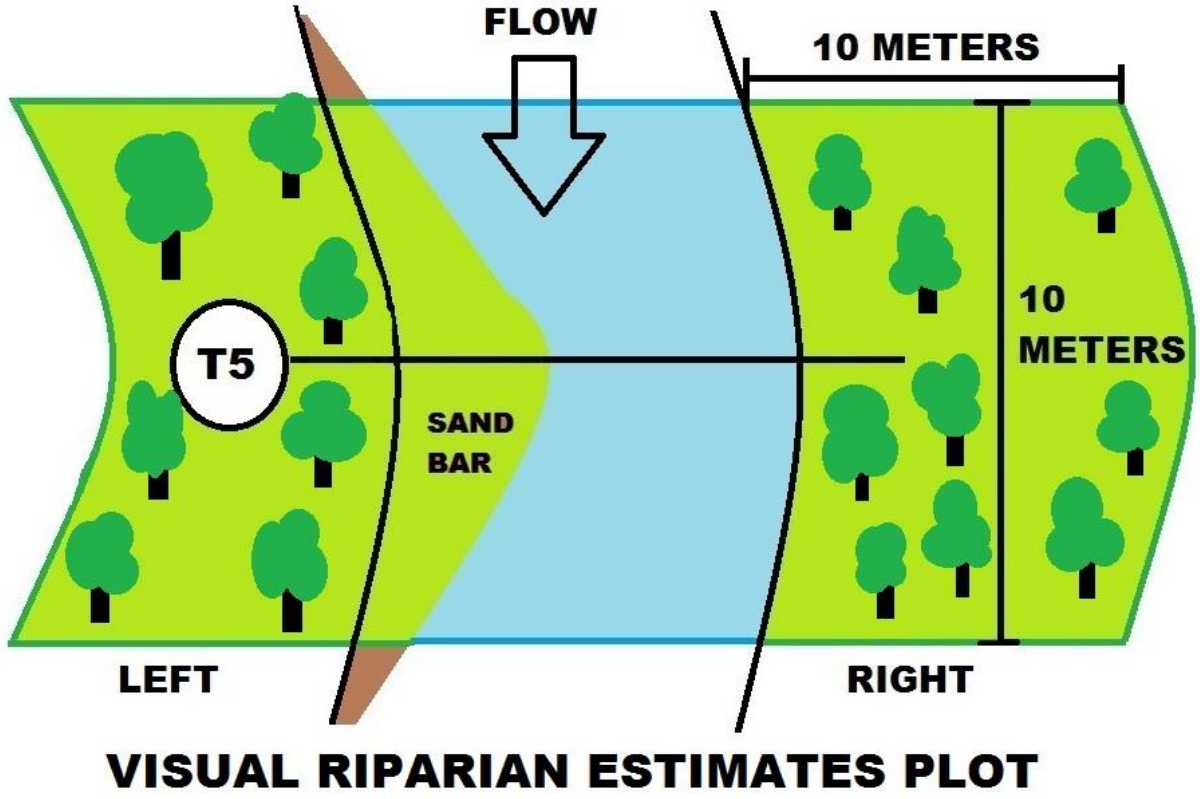

Figure 5. Diagram showing the area on the transect observed (light green) when evaluating the riparian cover. The diagram shown is exaggerated to illustrate that the riparian cover plot is not always square. The plot starts at the water's edge on each side of the stream and extends 10m away from the stream.

Canopy: The first vegetative layer evaluated is the canopy. The vegetation to evaluate must be >5m (~ 15') high. The first decision to make is what is the dominant vegetation type: (D)eciduous, (C)oniferous, Broadleaf (E)vergreen, (M)ixed or (N)one. Next, imagine you are a hawk hovering over the 10mX10m riparian plot. Estimate the amount of the 10mX10m plot that is covered (shaded) by vegetation in the canopy layer only by big trees. Big trees are defined as having a >0.3m (or ~1') diameter at breast height (DBH). After evaluating the big

trees, evaluate the small trees in the canopy layer. Small trees are defined as having a DBH of <0.3m (~1').

Understory: The middle vegetative layer of the riparian vegetation is the understory. Vegetation in this layer must be between 0.5 and 5m tall (~1.5'-15'). Repeat the dominant vegetation procedure from the canopy. Next you will determine the aerial coverage of woody shrubs and saplings in the understory and then the aerial coverage of the non-woody herbaceous plants, grasses and forbs.

Ground Cover: The last vegetative layer of the riparian vegetation is the ground cover. Ground cover is defined as vegetation <0.5 (~1.5') tall. The amount of: 1) woody shrubs and saplings; 2) non-woody herbaceous plants; and 3) barren, bare dirt of duff will be estimated.

Human Influence: Human influence is estimated on each side of the stream at T1, T5 and T10. Stand on the transect line at the left edge of the stream and face the left bank. If topography does not allow the observer to see beyond the riparian plot, the observer must climb the bank. The presence of 13 categories of human influence is identified and their proximity to the stream in lateral distance from the stream edge is estimated. It is important to include all the human influences you can see by looking upstream and downstream of the transect. However, be careful not to look through or over another transect and "double-count" human influences. Double-counting does not apply to continuous linear features such as roads. The occurrences of such features should be recorded at each transect at which the feature is visible. The five proximity classes are: not present (0), on bank (B), within 10m (C), between 10m to 30m (D), and beyond 30m (P) (Table 5). The categories of human influences are listed on Field Form H: Visual Riparian Estimates and Human Influence. Human influences that are observed in more than one proximity class are recorded in the proximity class closest to the stream. Additionally, human influences that are heard or smelled but not seen are not recorded. See Appendix 6.5f - Human Influence Diagram for more information.

Repeat the visual riparian estimate and human influence assessment procedures for the right bank.

Table 5. Proximity classes, abbreviations and descriptions used when estimating human influence. Modified from Peck et al. (2003).

Proximity Class	Proximity Class Abbreviation	Description
Not Present	0	Not present.
On Bank	B	Present in the stream or on the stream bank.
Within 10m	C	Present within 10m of the stream but not on the stream bank.
>10m-30m	D	Present in a 20m zone immediately beyond the 10m class.
>30m	P	Present but not in the areas described above.

6.6 Field Forms I and J: Rapid Habitat Assessment Field Forms

Field Form I: Rapid Habitat Assessment Form: Riffle/Run - Stream (Appendix 6.6a) or Field Form J: Rapid Habitat Assessment Form: Glide/Pool - Stream (Appendix 6.6b) is filled out at each site. Observe the sampling reach during the physical habitat assessment and as a crew, fill out either Field Form I or J at the conclusion of the physical habitat assessment. Follow the procedure described in Peck et al. (2003) to determine which form to use and how to complete the form:

- Determine if the stream segment is predominantly flowing water or slow water habitat. For flowing water habitat use Field Form I, for slow water habitat use the Field Form J.
- Each form lists ten habitat parameters and each parameter is scored for the entire sampling reach.
- Habitat parameters 1 through 7 apply to the entire sampling reach and are scored from 0 (worst) to 20 (best).
- Each bank (entire reach) is scored separately for habitat parameters 8 through 10 and scores range from 0 (worst) to 10 (best).

6.7 Field Form K: Bioassessment Site Observations Field Form

Near the top of the Field Form K: Bioassessment Site Observations Form (Appendix 6.7) is a box with the following observation categories: weather, turbidity, flow level and mussels. Observe those categories and record (circle) one of the appropriate responses provided.

The rest of Field Form K: Bioassessment Site Observations Form is dedicated to capturing the observations made regarding recent flooding/high water activity or a drought/extreme low water situation. The flood observation portion includes questions/categories about: flood elevation, recent out of bank flood evidence and degree and recent stream channel flood evidence and degree. The drought observation portion includes questions/categories about: the severity and the current status of the drought condition.

Observe the sampling reach during the physical habitat assessment and as a crew, fill out Field Form K: Bioassessment Site Observations Form at the conclusion of the physical habitat assessment.

7.0 References

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8.0 Appendices

The following appendices include:

- equipment list of all gear needed to complete a full biological sampling and physical habitat assessment
- field form list of all forms needed to complete a full biological sampling and physical habitat assessment
- information on site selection on streams with major fish passage obstructions
- photos/diagrams of benthic macroinvertebrate sampling gear and artificial substrate deployment strategies
- photos/diagrams of fish sampling gear and information on fish external abnormalities
- physical habitat assessment flowchart
- diagram and information on what to do when encountering a sediment bar or island on a physical habitat assessment transect
- diagram and explanation of human influence proximity classes
- examples of all the field forms needed to complete a full biological sampling and physical habitat assessment

The field form examples in this document as appendices have been re-sized for editorial purposes. For a complete packet of original field forms, please contact any of the following IDNR Water Quality Monitoring & Assessment Section staff:

- Ken Krier (515.725.8380, ken.krier@dnr.iowa.gov)
- Jamie Mootz (515.725.8382, jamie.mootz@dnr.iowa.gov)
- Tom Wilton (515.725.8387, tom.wilton@dnr.iowa.gov)
- Roger Bruner, Supervisor (515.310.0247, roger.bruner@dnr.iowa.gov)

Appendix 2.2. Field Form A: Reconnaissance / Landowner Contact(s)

Field Form A: Reconnaissance / Landowner Contact(s)

Stream Name:			Location:	
Site#:	Date: / /	Comments:		Initials:
Stream/Site Reconnaisance				
Estimated Flow cfs	Substrate composition:		# crew needed:	
Electrofishing Gear (circle)	Backpack (#)	Barge	Boat mounted	
Bug Sampling Gear (circle)	Art. Substrates (LF, Standard, Floating)		Hess	Surber
Estimated Mean Depth (ft):		Estimated Mean Width (ft):		
Was site or X-spot (random surveys) moved? (Y) (N) If yes, draw new X-spot on the map and write the new UTM (NAD83) coordinates here:				
Do you expect this stream to be flowing or have continuous aquatic habitat (connected pools without any discernible flow) from July-October? (Y) (N)				
Access (describe best way to get to and from the site):				
Comments:				
Landowner / Operator Contact Information				
Permission Granted?		Permission Denied?		
(circle one) Owner Operator		Date contacted: / /		Initials:
(circle one) Mr.	Mrs.	Mr. & Mrs.	Ms.	
Primary Contact Name:				
Phone number: ( )		Alternate phone number: ( )		
Address:				
City:		State:	Zip Code:	
Email Address:				
Send copy of results?	Yes	No	Electronic copy	Hard copy
If results are requested, verify the mailing (Street, City, State and Zip) and/or email address is valid.				
Comments:				

Appendix 2.2. Field Form A: Reconnaissance / Landowner Contact(s), continued.

Landowner / Operator Contact Information					
Permission Granted?			Permission Denied?		
(circle one) Owner Operator			Date contacted: / /		Initials:
(circle one)	Mr.	Mrs.	Mr. & Mrs.	Ms.	
Primary Contact Name:					
Phone number: ( )			Alternate phone number: ( )		
Address:					
City:				State:	Zip Code:
Email Address:					
Send copy of results?	Yes	No	Electronic copy		Hard copy
If results are requested, verify the mailing (Street, City, State and Zip) and/or email address is valid.					
Comments:					

Landowner / Operator Contact Information					
Permission Granted?			Permission Denied?		
(circle one) Owner Operator			Date contacted: / /		Initials:
(circle one)	Mr.	Mrs.	Mr. & Mrs.	Ms.	
Primary Contact Name:					
Phone number: ( )			Alternate phone number: ( )		
Address:					
City:				State:	Zip Code:
Email Address:					
Send copy of results?	Yes	No	Electronic copy		Hard copy
If results are requested, verify the mailing (Street, City, State and Zip) and/or email address is valid.					
Comments:					

Landowner / Operator Contact Information					
Permission Granted?			Permission Denied?		
(circle one) Owner Operator			Date contacted: / /		Initials:
(circle one)	Mr.	Mrs.	Mr. & Mrs.	Ms.	
Primary Contact Name:					
Phone number: ( )			Alternate phone number: ( )		
Address:					
City:				State:	Zip Code:
Email Address:					
Send copy of results?	Yes	No	Electronic copy		Hard copy
If results are requested, verify the mailing (Street, City, State and Zip) and/or email address is valid.					
Comments:					

Appendix 2.4: Biological Sampling and Physical Habitat Assessment Equipment List

General Sampling Equipment List

- waders
- field forms (on clipboard)
- pencils
- handheld GPS
- digital camera
- digital rangefinder (optional)

Benthic Macroinvertebrate Sampling Equipment List:

- general benthic macroinvertebrate sampling equipment
    - forceps (6)
    - 10% formalin solution
    - sieves (4)
- semi-quantitative benthic macroinvertebrate sampling equipment
    - Hess sampler
    - Surber sampler
    - Hester-Dendy artificial substrates
    - mesh bag
    - plastic scraper
    - white enamel pan
    - labeled semi-quantitative benthic macroinvertebrate sample containers (3)
- qualitative benthic macroinvertebrate sampling equipment
    - watch
    - plastic collection containers (3)
    - labeled semi-qualitative benthic macroinvertebrate sample container (1)

Fish Sampling/Electrofishing Equipment List:

- back pack shockers (1-3)
    - extra batteries
    - extra probes
- barge shocker (and generator)
    - heavy-duty rubber gloves
    - extra gas for generator
- block nets (2)
- block net stakes (6-8)
- fish ID literature
- capture nets (3)
- unknown/unidentifiable fish container
- voucher specimen container
- 10% formalin
- polarized sunglasses

Physical Habitat Assessment Equipment List:

- 100’ to 300’ fiberglass tape (length depends on stream size)
- stakes to secure fiberglass tape (2)
- graduated wading rods/survey rods (marked with tenths of feet) (2)
- convex spherical densiometers (2)
- clinometers (2)

Appendix 2.5: Biological Sampling and Physical Habitat Assessment Field Form List

Field Form A – Reconnaissance/Landowner Contact Form

Field Form B – Stream Benthic Macroinvertebrate Sampling Form

Field Form C – Stream Fish Sampling Form - Mississippi Drainage Basin

Field Form D – Stream Fish Sampling Form - Missouri Drainage Basin

Field Form E – Stream Fish Sampling Form – Coldwater Stream

Field Form F – Stream Transect Habitat Data

Field Form G – Physical Habitat Assessment Reach Map

Field Form H – Visual Riparian Estimates and Human Influence

Field Form I – Rapid Habitat Assessment Form: Riffle/Run – Stream

Field Form J – Rapid Habitat Assessment Form: Glide/Pool – Stream

Field Form K – Bioassessment Site Observations

Appendix 3.0: Handling Major Fish Passage Obstructions during Site Selection

If part of your sampling program is designed to determine the impact of major fish passage obstructions on the local fish population, it is beneficial to sampling in multiple locations. This major fish passage obstruction site selection protocol was originally developed and contributed by Chris Larson, Southern Iowa Regional Fisheries Supervisor.

The following protocol applies when collecting biological samples and conducting physical assessments on wadeable streams that have a major fish passage obstruction (e.g. low-head dam or steep sloped weir greater than 3 feet in height).

- A minimum of two biological samples and physical habitat assessments shall be collected upstream and downstream of the fish passage obstruction(s).
- One site should be located some distance below the obstruction or the first obstruction if more than one obstruction is present (e.g. site located halfway between stream mouth and first obstruction). This will ensure that the obstruction does not influence the fish sample.
- The second site shall be located upstream of the fish passage obstruction(s) (some streams have multiple obstructions). In the case of streams with multiple obstructions, look for stream reaches that are somewhat "in the middle" of the obstructions but that still have flowing stream characteristics throughout the sampling reach. The start of the sampling reach (Transect 1) should be far enough upstream from the obstruction so the pooling effect of the dam/weir is negated.

Appendix 4.1: Field Form B: Stream Benthic Macroinvertebrate Sampling Form

Field Form B: Stream Benthic Macroinvertebrate Sampling Form

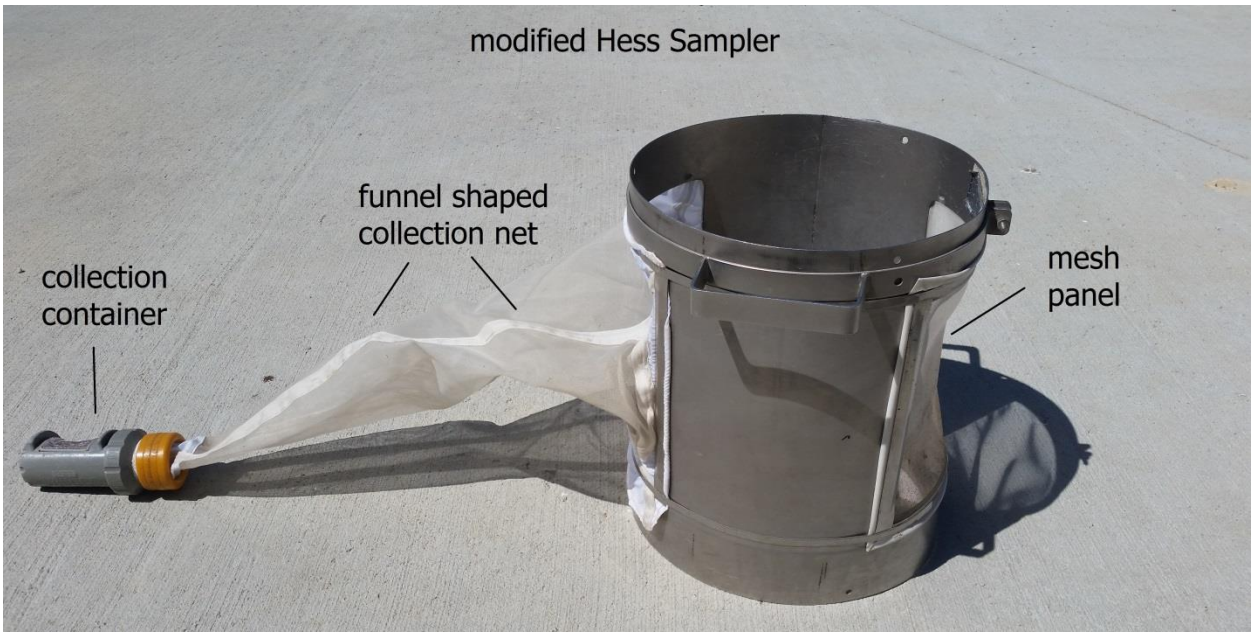
Stream Name:		Location:	
Site#:	Date: / /	Begin Time:	End Time:
Comments:			
AS Deployment velocity:	ft./sec.	Deployment photo taken:	Y / N
AS Retrieval velocity:	ft./sec.	Retrieval photo taken:	Y / N

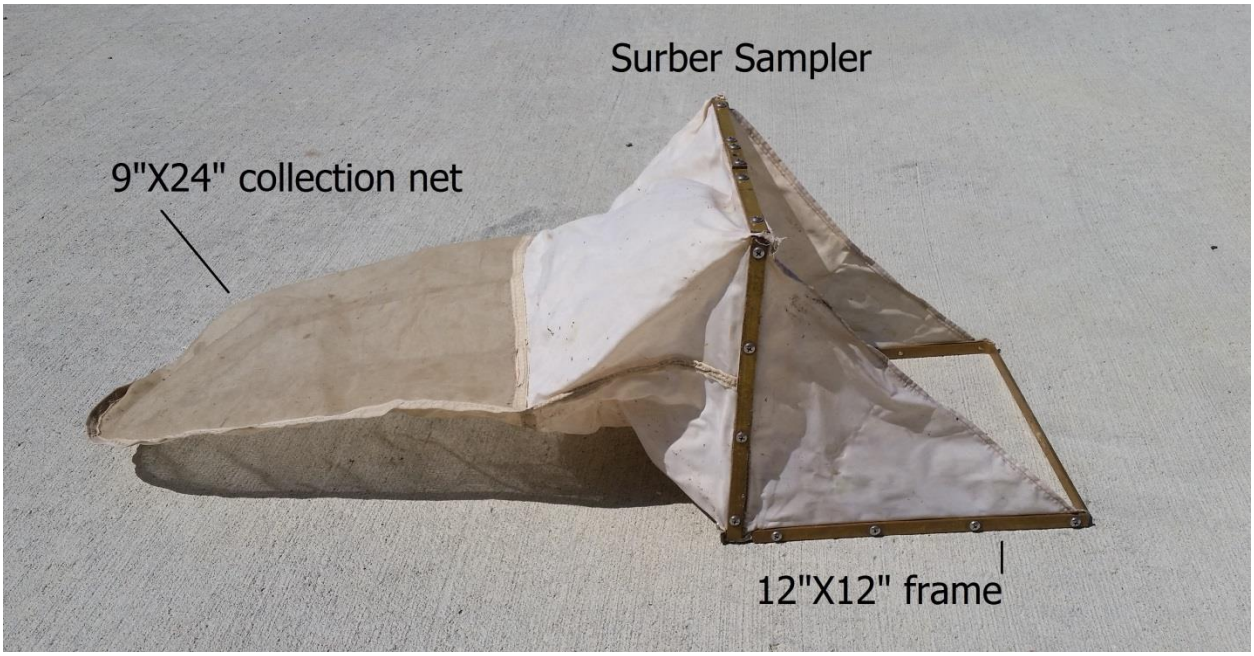
Semi-Quantitative – Single Habitat Sampling			
Sampling Gear (circle): Hess sampler / Surber sampler / Standard AS / Low flow AS / Floating AS			
Sample Collector(s):	Original Preservative: 10% Formalin	Comments:	
Replicate Sample I.D. #s	#1	#2	#3
Dominant Form of Periphyton Growth*	FA / NF	FA / NF	FA / NF
Amount of Periphyton Growth**	LT / MD / MH / HV	LT / MD / MH / HV	LT / MD / MH / HV
Amount of Sedimentation/Embeddedness**	LT / MD / MH / HV	LT / MD / MH / HV	LT / MD / MH / HV
Amount of Macroinvertebrate Colonization**	LT / MD / MH / HV	LT / MD / MH / HV	LT / MD / MH / HV
Semi-Quantitative Sampling effectiveness:	good / fair / poor	good / fair / poor	good / fair / poor
Reason(s) for fair/poor quant sampling effectiveness: high flow / exposed plates / damaged-lost plates / buried plates / excessive filamentous algae / other: _____			
* FA = Filamentous Algae growth and NF = Non-Filamentous algae growth.			
**LT (Light), <25% substrate surface affected; MD (Moderate), 25-50%; MH (Moderately Heavy), 51-75%; HV (Heavy), >75%.			

Qualitative - Multi-Habitat Sampling		
Begin sampling:	End Sampling:	Total Combined Sampling Minutes:
Collectors:		Sampling Gear: Forceps, #30 Sieves, plastic jars
Qualitative Sampling effectiveness: good / fair / poor	Comments:	
Reason(s) for fair/poor qualitative sampling effectiveness: high flow / turbidity / weather / depth		
other:		

Benthic Habitat Inventory			
Abundance Ranking**	Substrate Type	Macro-habitat Type*	
		Pool/Glide	Run/Riffle
	Coarse Rock (cobble, coarse gravel)		
	Woody Debris		
	Streambank Vegetation		
	Fine Sediments (soil, silt, sand, fine gravel)		
	Leaf / Detritus Packs		
	Root Mats / Undercut Banks		
	Vascular Aquatic Vegetation		
	Bedrock and Large Boulders		
	Clay / Hardpan (consolidated)		
	Filamentous Algae		
	Riprap (concrete, limestone, brick, etc.)		
	Other (describe):		
* Place check mark in column corresponding with each macrohabitat/substrate combination present in sampling reach regardless of whether that macro-habitat/substrate type combination was sampled.			
** Rank the five most abundant types of substrate present in the sampling reach (1 = most abundant).			

Appendix 4.2a: Photos of Hess and Surber Sampling Equipment





Appendix 4.2b: Artificial Substrate Construction Diagrams

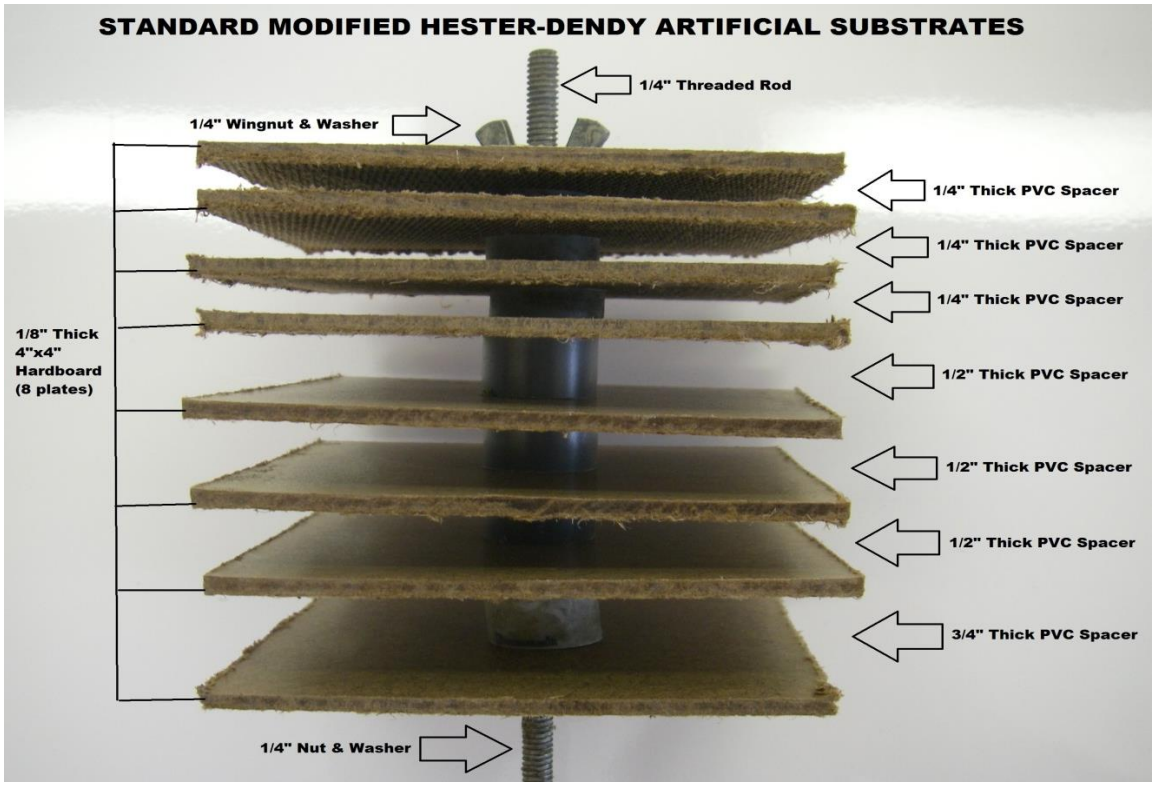


Diagram of a standard modified Hester-Dendy artificial substrate. Replace rod with 6" eyebolt and reverse order of plates for constructing floating modified Hester-Dendy artificial substrates.

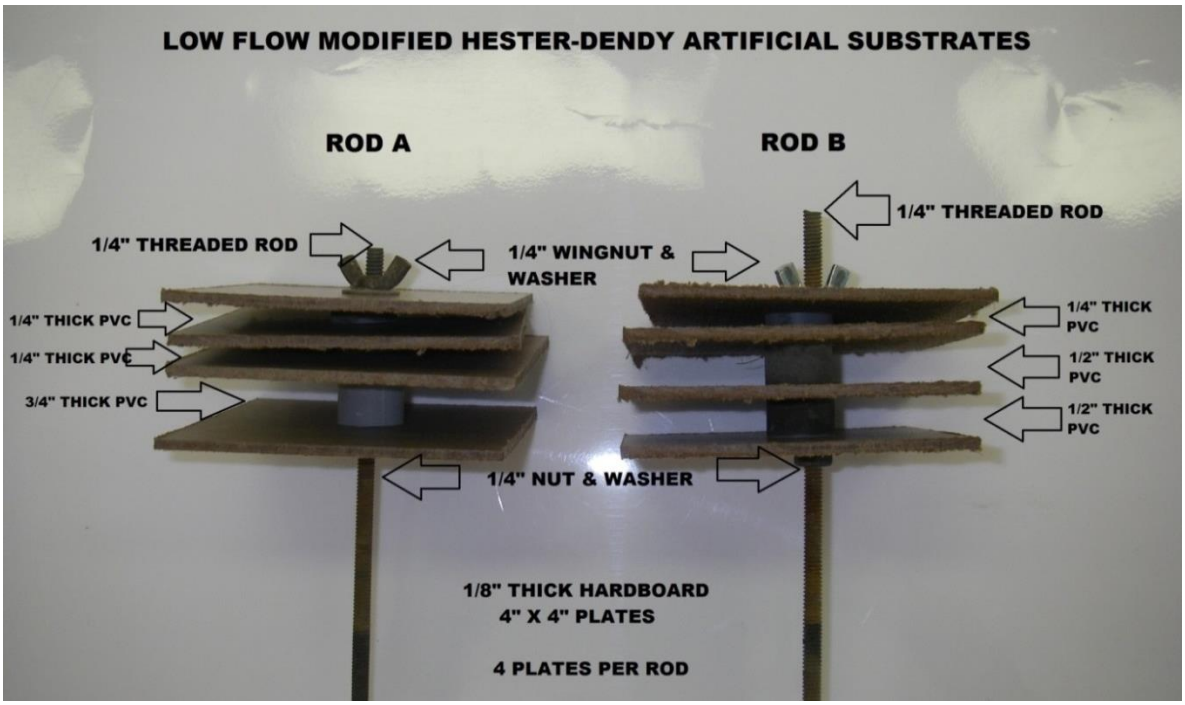
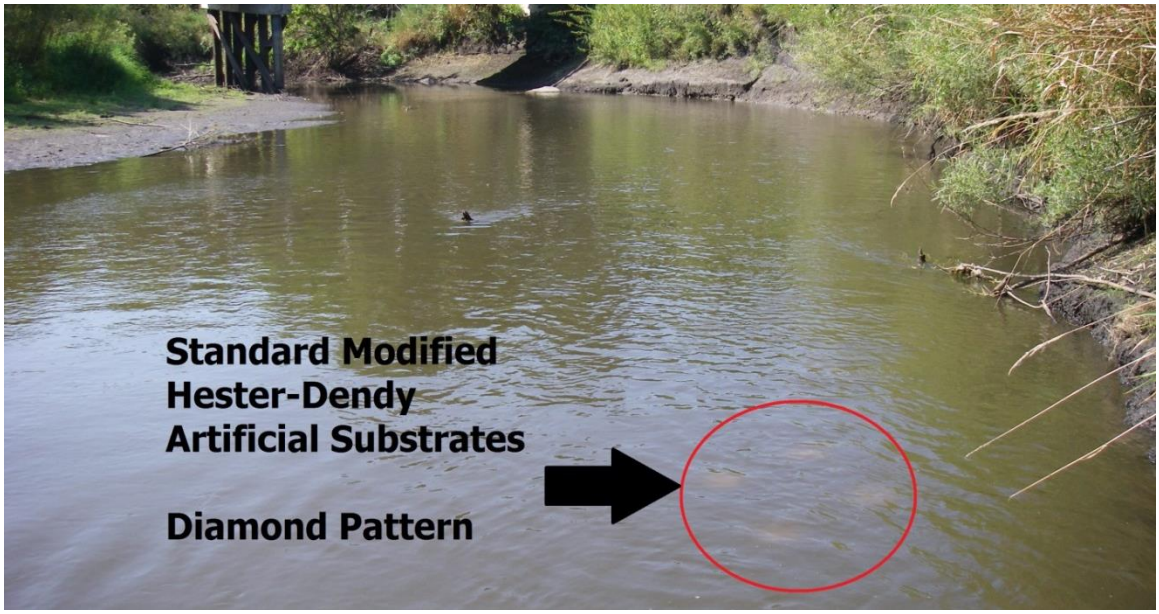
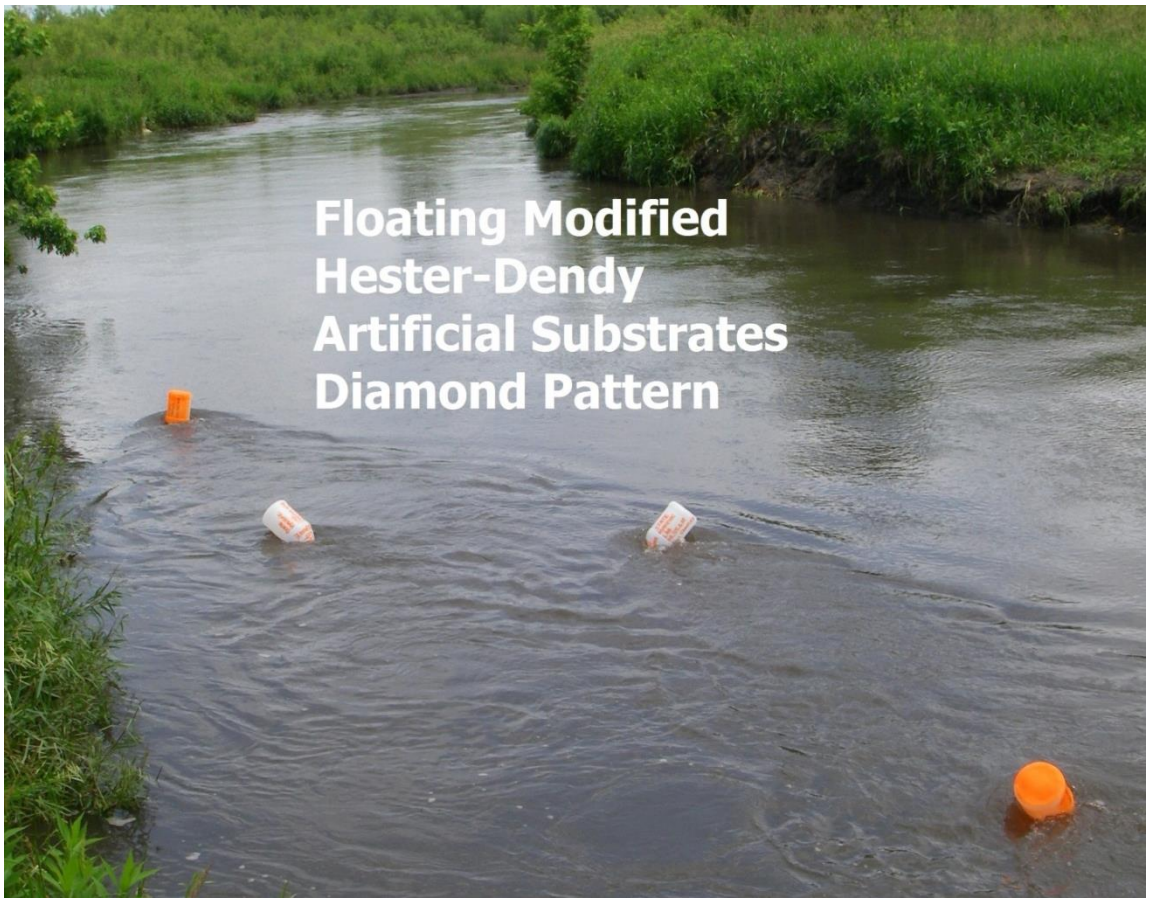


Diagram of the low-flow modified Hester-Dendy artificial substrates.

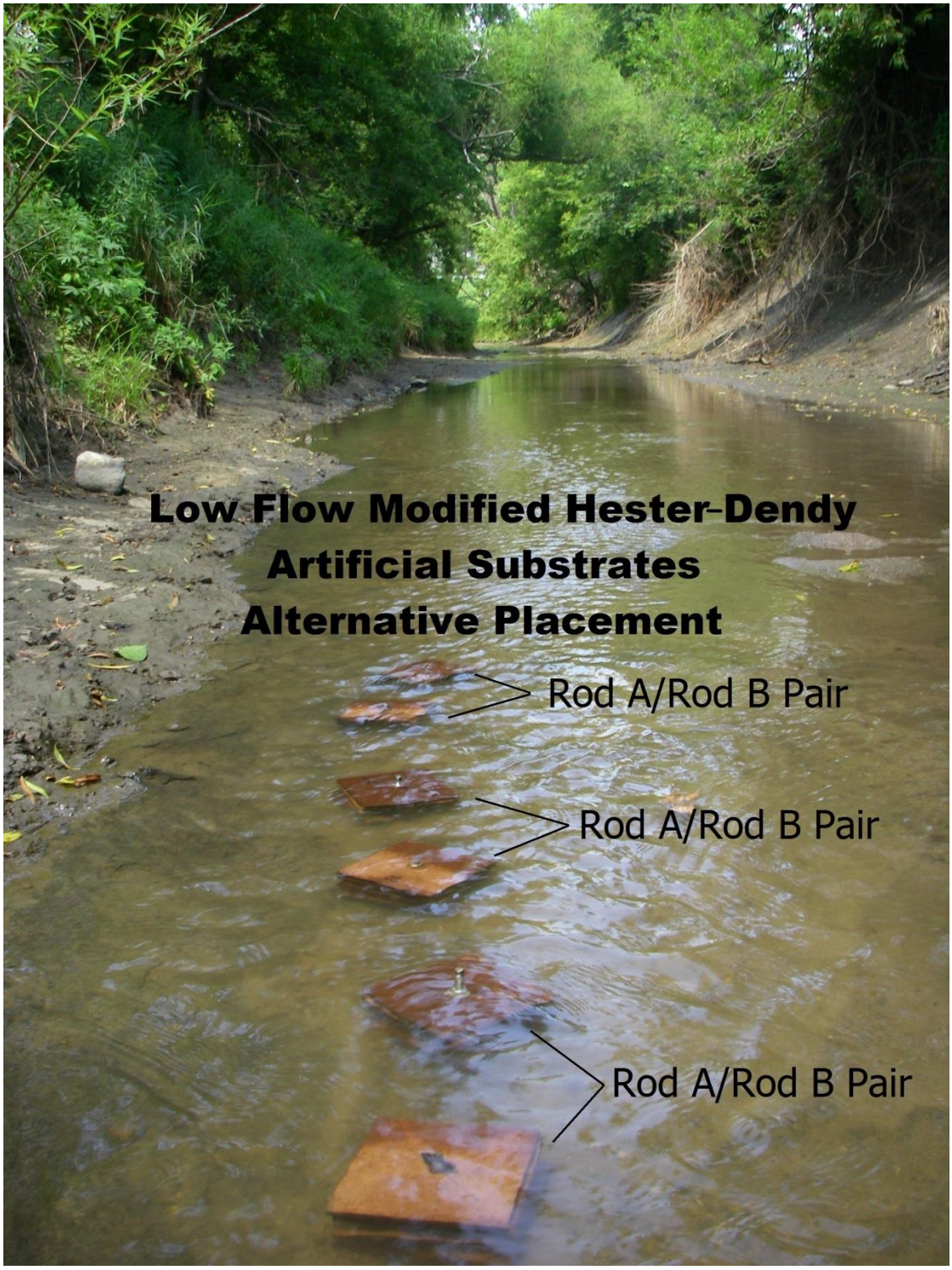
Appendix 4.2c: Artificial Substrate Deployment Photographs





Photographs showing the diamond deployment pattern for standard and floating modified Hester-Dendy artificial substrates.

Appendix 4.2c: Artificial Substrate Deployment Photographs, continued.



Photograph showing the alternative inline deployment pattern for low flow modified Hester-Dendy artificial substrates.

Appendix 5.1a: Field Form C: Stream Fish Sampling Form – Mississippi Drainage Basin

Field Form C: Stream Fish Sampling Form - Mississippi Drainage Basin

Page 1 of 3

Stream Name:		Location:	
Site#:	Date: / /	Begin Time:	End Time:
Shocker(s): towboat / BP(s) 1 2 3		Blocknet(s): Upper: 30' / 60' / none - Lower: 30' / 60' / none	
Overall sampling effectiveness: poor / fair / good		Crew:	Distance sampled:
Reason(s) for fair/poor sampling effectiveness: high flow / depth / equipment / algae /light / turbidity / width / rocks			
Comments:			

Cyprinidae - Minnows	**Count (Tally)**	Anomalies*	unknown	voucher
bigmouth shiner *Notropis dorsalis*				
blacknose dace *Rhinichthys atratulus*				
bluntnose minnow *Pimephales notatus*				
brassy minnow *Hybognathus hankinsoni*				
bullhead minnow *Pimephales vigilax*				
central stoneroller *Campostoma anomalum*				
common carp *Cyprinus carpio*				
common shiner *Luxilus cornutus*				
creek chub *Semotilus atromaculatus*				
emerald shiner *Notropis atherinoides*				
fathead minnow *Pimephales promelas*				
hornyhead chub *Nocomis biguttatus*				
largescale stoneroller *Campostoma oligolepsis*				
longnose dace *Rhinichthys cataractae*				
ozark minnow *Notropis nubilus*				
red shiner *Cyprinella lutrensis*				
rosyface shiner *Notropis rubellus*				
sand shiner *Notropis stramineus*				
s. redbelly dace *Phoxinus erythrogaster*				
spotfin shiner *Cyprinella spilopterus*				
suckermouth minnow *Phenacobius mirabilis*				
Other Cyprinidae:		Anomalies*	unknown	voucher

Appendix 5.1a: Field Form C: Stream Fish Sampling Form – Mississippi Drainage Basin, continued.

Field Form C: Stream Fish Sampling Form - Mississippi Drainage Basin

Page 2 of 3

Stream Name:				Location:					
Site#:	Date: / /		Begin Time:			End Time:			
Catostomidae - Suckers			**Count (Tally)**				Anomalies*	unknown	voucher
bigmouth buffalo *Ictiobus cyprinellus*									
black redhorse *Moxostoma duquesnei*									
Carpoides* (carpsucker) *spp.									
golden redhorse *Moxostoma erythrurum*									
highfin carpsucker *Carpoides velifer*									
Moxostoma* (redhorse) *spp.									
northern hog sucker *Hypentelium nigricans*									
quillback carpsucker *Carpiodes cyprinus*									
river carpsucker *Carpiodes carpio*									
shorthead redhorse *Moxostoma macrolepidotum*									
smallmouth buffalo *Ictiobus bubalus*									
white sucker *Catostomus commersoni*									
Other Catostomidae									
Centrarchidae - sunfishes			**Count (Tally)**				Anomalies*	unknown	voucher
black crappie *Pomoxis nigromeculatus*	1-3"			7-9"					
	4-6"			10+"					
bluegill *Lepomis macrochirus*	1-3"			7-9"					
	4-6"			10+"					
green sunfish *Lepomis cyanellus*									
hybrid sunfish (describe)									
hybrid sunfish (describe)									
largemouth bass *Micropterus salmoides*	1-3"			10-12"					
	4-6"			13-15"					
	7-9"			16+"					
northern rock bass *Ambioplites rupestris*									
orangespotted sunfish *Lepomis humilus*									
pumpkinseed *Lepomis gibbosus*	1-3"		4-6"		7-9"	10+"			
smallmouth bass *Micropterus dolomieui*	1-3"			10-12"					
	4-6"			13-15"					
	7-9"			16+"					
white crappie *Pomoxis annularis*	1-3"			7-9"					
	4-6"			10+"					
Other Centrarchidae									

Appendix 5.1a: Field Form C: Stream Fish Sampling Form – Mississippi Drainage Basin, continued.

Field Form C: Stream Fish Sampling Form - Mississippi Drainage Basin

Page 3 of 3

Stream Name:				Location:						
Site#:	Date: / /		Begin Time:			End Time:				
Ictaluridae - catfishes				**Count (Tally)**				Anomalies*	unknown	voucher
black bullhead *Ameiurus melas*										
channel catfish *Ictalurus punctatus*	1-3"			13-15"						
	4-6"			16-18"						
	7-9"			17-19"						
	10-12"			22+"						
flathead catfish *Pylodictus olivaris*	1-3"			13-15"						
	4-6"			16-18"						
	7-9"			17-19"						
	10-12"			22+"						
slender madtom *Noturus exilis*										
stonecat *Noturus flavus*										
tadpole madtom *Noturus gyrinus*										
yellow bullhead *Ameiurus natalis*										
Other Ictaluridae										
Percidae - perches				**Count (Tally)**				Anomalies*	unknown	voucher
banded darter *Etheostoma zonale*										
blackside darter *Percina maculata*										
fantail darter *Etheostoma flabellare*										
Iowa darter *Etheostoma exile*										
johnny darter *Etheostoma nigrum*										
mud darter *Etheostoma asprigene*										
northern logperch *Percina caprodes*										
orangethroat darter *Etheostoma spectabile*										
rainbow darter *Etheostoma caeruleum*										
slenderhead darter *Percina phoxocephala*										
walleye *Stizostedian vitreum*	1-3"	4-6"	7-9"	10-12"	13-15"	16-18"	19+"			
yellow perch *Perca flavescens*	1-3"		4-6"		7-9"	10+"				
Other Percidae										
Miscellaneous Species				**Count (Tally)**				Anomalies*	unknown	voucher
american brook lamprey *Lampetra appendix*										
blackstripe topminnow *Fundulus notatus*										
brook stickleback *Culaea inconstans*										
brown trout *Salmo trutta*	1-3"	4-6"	7-9"	10-12"	13-15"	16-18"	19+"			
freshwater drum *Aplodinotus grunniens*										
gizzard shad *Dorosoma cepedianum*										
northern pike *Esox lucius*	1-3"	7-9"	10-12"	13-15"	16-18"	19-21"	22+"			
	4-6"									
Jarred unknown/unidentified										

* Anomaly codes: **D**=deformaties; **E**=eroded or frayed fins; **L**=lesions or ulcers; **T**=tumors; **M**=multiple DELTs on same fish; **AL**=Anchor worm-light infestation; **AH**=anchor worm-heavy infestation; **BL**=blackspot-light; **BH**=blackspot-heavy; **CL**=leeches-light; **CH**=leeches-heavy; **F**=fungus; **I**=Ich; **N**=blind; **S**=emaciated; **P**=external parasites; **Y**=popeye; **W**=swirled scales; **Z**=wound, other (describe).

Appendix 5.1b: Field Form D: Stream Fish Sampling Form – Missouri Drainage Basin

Field Form D: Stream Fish Sampling Form - Missouri Drainage Basin

Page 1 of 2

Stream Name:		Location:	
Site#:	Date: / /	Begin Time:	End Time:
Shocker(s): towboat / BP(s) 1 2 3		Blocknet(s): Upper: 30' / 60' / none - Lower: 30' / 60' / none	
Overall sampling effectiveness: poor / fair / good		Crew:	Distance sampled:
Reason(s) for fair/poor sampling effectiveness: high flow / depth / equipment / algae /light / turbidity / width / rocks			
Comments:			

Cyprinidae - Minnows	**Count (Tally)**	Anomalies*	unknown	voucher
bigmouth shiner *Notropis dorsalis*				
blacknose dace *Rhinichthys atratulus*				
bluntnose minnow *Pimephales notatus*				
brassy minnow *Hybognathus hankinsoni*				
central stoneroller *Campostoma anomalum*				
common carp *Cyprinus carpio*				
common shiner *Luxilus cornutus*				
creek chub *Semotilus atromaculatus*				
emerald shiner *Notropis atherinoides*				
fathead minnow *Pimephales promelas*				
flathead chub *Platygobio gracilis*				
hornyhead chub *Nocomis biguttatus*				
***Hybognathus* spp.**				
plains minnow *Hybognathus placitis*				
red shiner *Cyprinella lutrensis*				
sand shiner *Notropis stramineus*				
so. redbelly dace *Phoxinus erythrogaster*				
speckled chub *Macrhybopsis aestivalis*				
spotfin shiner *Cyprinella spilopterus*				
suckermouth minnow *Phenacobius mirabilis*				
Other Cyprinidae:		Anomalies*	unknown	voucher

Appendix 5.1b: Field Form D: Stream Fish Sampling Form – Missouri Drainage Basin, continued.

Field Form D: Stream Fish Sampling Form - Missouri Drainage Basin

Page 2 of 2

Stream Name:					Location:					
Site#:	Date: / /		Begin Time:			End Time:				
Catostomidae - Suckers			**Count (Tally)**					Anomalies*	unknown	voucher
***Carpoides* (carpsucker) spp.**										
quillback carpsucker *Carpiodes cyprinus*										
***Moxostoma* (redhorse) spp.**										
river carpsucker *Carpiodes carpio*										
shorthead redhorse *Moxostoma macrolepidotum*										
white sucker *Catostomus commersoni*										
Other Catostomidae										
Centrarchidae - sunfishes			**Count (Tally)**					Anomalies*	unknown	voucher
black crappie *Pomoxis nigromeculatus*	1-3"		4-6"		7-9"	10+"				
bluegill *Lepomis macrochirus*	1-3"				7-9"					
	4-6"				10+"					
green sunfish *Lepomis cyanellus*										
largemouth bass *Micropterus salmoides*	1-3"				10-12"					
	4-6"				13-15"					
	7-9"				16+"					
orangespotted *sunfish* *Lepomis humilus*										
Other Centrarchidae										
Ictaluridae - catfishes			**Count (Tally)**					Anomalies*	unknown	voucher
black bullhead *Ameiurus melas*										
channel catfish *Ictalurus punctatus*	1-3"				13-15"					
	4-6"				16-18"					
	7-9"				17-19"					
	10-12"				22+"					
flathead catfish *Pylodictus olivaris*	1-3"	7-9"	10-12"	13-15"	16-18"	19-21"	22+"			
	4-6"									
slender madtom *Noturus exilis*										
stonecat *Noturus flavus*										
tadpole madtom *Noturus gyrinus*										
yellow bullhead *Ameiurus natalis*										
Other Ictaluridae										
Percidae - perches			**Count (Tally)**					Anomalies*	unknown	voucher
Iowa darter *Etheostoma exile*										
johnny darter *Etheostoma nigrum*										
walleye	1-3"	4-6"	7-9"	10-12"	13-15"	16-18"	19+"			
yellow perch *Perca flavescens*	1-3"		4-6"		7-9"	10+"				
Other Percidae										
Miscellaneous Species			**Count (Tally)**					Anomalies*	unknown	voucher
brook stickleback *Culaea inconstans*										
freshwater drum *Aplodinotus grunniens*										
gizzard shad *Dorosoma cepedianum*										
northern pike *Esox lucius*	1-3"	7-9"	10-12"	13-15"	16-18"	19-21"	22+"			
	4-6"									
Jarred unknown/unidentified										

* Anomaly codes: **D**=deformaties; **E**=eroded or frayed fins; **L**=lesions or ulcers; **T**=tumors; **M**=multiple DELTs on same fish; **AL**=Anchor worm-light infestation; **AH**=anchor worm-heavy infestation; **BL**=blackspot-light; **BH**=blackspot-heavy; **CL**=leeches-light; **CH**=leeches-heavy; **F**=fungus; **I**=Ich; **N**=blind; **S**=emaciated; **P**=external parasites; **Y**=popeye; **W**=swirled scales; **Z**=wound, other (describe).

Appendix 5.1c: Field Form E: Stream Fish Sampling Form – Coldwater Streams

Field Form E: Stream Fish Sampling Form - Coldwater Streams

Page 1 of 2

Stream Name:		Location:	
Site#:	Date: / /	Begin Time:	End Time:
Shocker(s): towboat / BP(s) 1 2 3		Blocknet(s): Upper: 30' / 60' / none - Lower: 30' / 60' / none	
Overall sampling effectiveness: poor / fair / good		Crew:	Distance sampled:
Reason(s) for fair/poor sampling effectiveness: high flow / depth / equipment / algae /light / turbidity / width / rocks			
Comments:			

Cyprinidae - Minnows	**Count (Tally)**	Anomalies*	unknown	voucher
bigmouth shiner *Notropis dorsalis*				
blacknose dace *Rhinichthys atratulus*				
bluntnose minnow *Pimephales notatus*				
brassy minnow *Hybognathus hankinsoni*				
central stoneroller *Campostoma anomalum*				
common shiner *Luxilus cornutus*				
creek chub *Semotilus atromaculatus*				
fathead minnow *Pimephales promelas*				
hornyhead chub *Nocomis biguttatis*				
longnose dace *Rhinichthys cataractae*				
so. redbelly dace *Phoxinus erythrogaster*				
suckermouth minnow *Phenacobius mirabilis*				
Other Cyprinidae:		Anomalies*	unknown	voucher

Cottidae - sculpins	**Count (Tally)**	Anomalies*	unknown	voucher
mottled sculpin *Cottus bairdi*				
slimy sculpin *Cottus cognatus*				
***Cottus* (Sculpin) spp**				

Appendix 5.1c: Field Form E: Stream Fish Sampling Form – Coldwater Streams, continued.

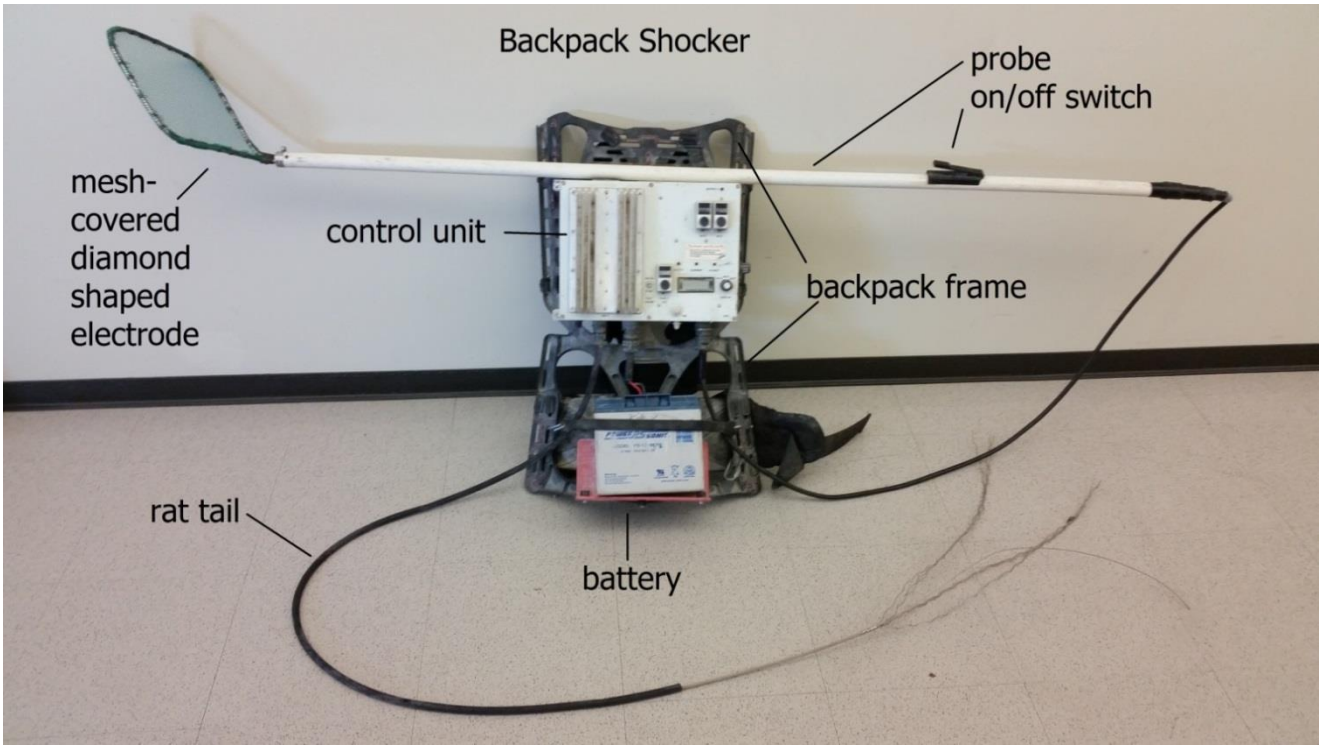
Field Form E: Stream Fish Sampling Form - Coldwater Streams

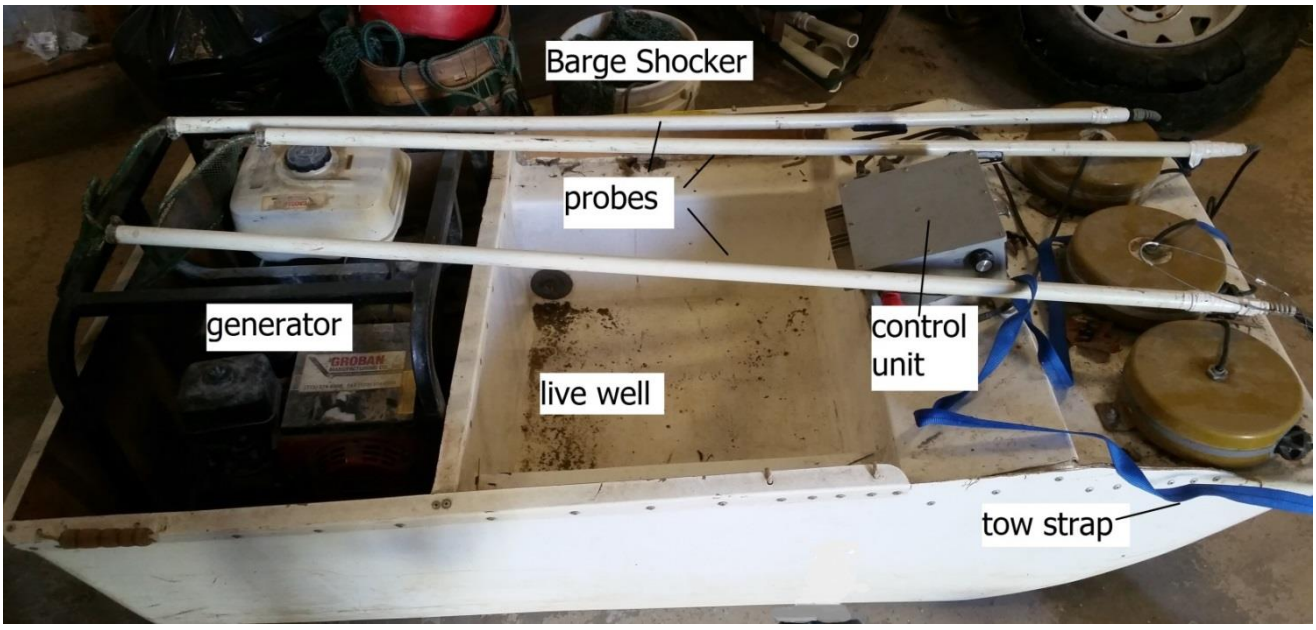
Page 2 of 2

Stream Name:			Location:				
Site#:	Date: / /	Begin Time:		End Time:			
Catostomidae - Suckers		**Count (Tally)**			Anomalies*	unknown	voucher
golden redhorse *Moxostoma erythrurum*							
***Moxostoma* (redhorse) spp.**							
shorthead redhorse *Moxostoma macrolepidotum*							
white sucker *Catostomus commersoni*							
Other Catostomidae							
Salmonidae - trout		**Count (Tally)**			Anomalies*	unknown	voucher
brook trout *Salvelinus fontinalis*	1-3"		13-15"				
	4-6"		16-18"				
	7-9"		17-19"				
	10-12"		22+"				
brown trout *Salmo trutta*	1-3"		13-15"				
	4-6"		16-18"				
	7-9"		17-19"				
	10-12"		22+"				
rainbow trout *Oncorhynchus mykiss*	1-3"		13-15"				
	4-6"		16-18"				
	7-9"		17-19"				
	10-12"		22+"				
Other Salmonidae							
Centrarchidae - sunfishes		**Count (Tally)**			Anomalies*	unknown	voucher
green sunfish *Lepomis cyanellus*							
Other Centrarchidae							
Percidae - perches		**Count (Tally)**			Anomalies*	unknown	voucher
blackside darter *Percina maculata*							
fantail darter *Etheostoma flabellare*							
Iowa darter *Etheostoma exile*							
johnny darter *Etheostoma nigrum*							
northern logperch *Percina caprodes*							
Other Percidae							
Miscellaneous Species		**Count (Tally)**			Anomalies*	unknown	voucher
american brook lamprey *Lampetra appendix*							
brook stickleback *Culaea inconstans*							
burbot *Lota lota*							
stonecat Noturus flavus							
Jarred unknown/unidentified							

* Anomaly codes: **D**=deformaties; **E**=eroded or frayed fins; **L**=lesions or ulcers; **T**=tumors; **M**=multiple DELTs on same fish; **AL**=Anchor worm-light infestation; **AH**=anchor worm-heavy infestation; **BL**=blackspot-light; **BH**=blackspot-heavy; **CL**=leeches-light; **CH**=leeches-heavy; **F**=fungus; **I**=Ich; **N**=blind; **S**=emaciated; **P**=external parasites; **Y**=popeye; **W**=swirled scales; **Z**=wound, other (describe).

Appendix 5.2: Photos of Backpack and Barge Fish Shocking Equipment





Appendix 5.4: Methods for Examination of Fish External Abnormalities - Adopted from the Ohio EPA

External Abnormalities - All fish that are captured are examined for the presence of gross external anomalies and their occurrence is recorded on the fish sampling field forms (Appendices 5.1a, 5.1b and 5.1c) and subsequently entered into the BioNet database. In order to standardize the procedure for counting and identifying anomalies the following criteria should be followed.

All fish are examined for gross external anomalies. These are anomalies that are visible to the naked eye when the fish are captured, identified, and counted. Table 1 lists the types of anomalies which are recorded on the fish sampling field forms (Appendices 5.1a, 5.1b and 5.1c) and subsequently entered into BioNet. Exact counts of anomalies present (i.e. the number of tumors, lesions, etc. per fish) are not made; however, light and heavy infestations are noted for certain types of anomalies (Table 1). An external anomaly is defined as the presence of an externally visible skin or subcutaneous disorder. Ultimately the number and percentage of DELTs and non-DELTs are computed and recorded into BioNet. Then the total percent anomalies for a specific type of anomaly or group of anomalies can be calculated for one or more sites.

The following is a review of some anomalies commonly encountered in freshwater fishes. These characteristics should be used in determining the types of external anomalies present and in coding the fish sampling field forms (Appendices 5.1a, 5.1b and 5.1c).

1. Deformities - These can affect the head, spinal vertebrae, fins, stomach shape, and have a variety of causes including toxic chemicals, viruses, bacteria, (e.g. *Mycobacterium* spp.), infections, and protozoan parasites (e.g. *Myxosoma carebaiis*; Post 1983). Fish with extruded eyes (see Popeye disease) or obvious injuries should not be included.

2. Eroded fins - These are the result of a chronic disease principally caused by flexibacteria invading the fins causing a necrosis of the tissue (Post 1983). Necrosis of the fins may also be caused by gryodactylids, a small trematode parasite. When necrosis occurs in the tissue at the base of the caudal fin, it is referred to as peduncle disease. Erosions also occur on the preopercle and operculum and these should be included. In Ohio streams and rivers this anomaly is generally absent in least impacted fish communities, but can have a high incidence in polluted areas. It occurs most frequently in areas with multiple stresses, particularly low or marginal dissolved oxygen (D.O.) or high temperatures in combination with chronic toxicity (Pippy and Hare 1969; Sniezko 1962).

3. Lesions and ulcers - These appear as open sores or exposed tissue and can be caused by viral (e.g. *Lymphocystis* sp.) and bacterial (e.g. *Flexibacter columnaris*, *Aeromonas* spp., *Vibrio* sp.) infections. Prominent bloody areas on fish should also be included. Small, characteristic sores left by anchor worms and leeches should not be included unless they are enlarged by this infection. Obvious injuries, however, should not be included unless they too, are likewise infected. As with eroded fins, lesions often times appear in areas impacted by multiple stresses, particularly marginal D.O. in combination with sublethal levels of toxics.

4. Tumors - These result from the loss of carefully regulated cellular proliferative growth in tissue and are generally referred to as neoplasia (Post 1983). In wild fish populations, tumors can be the result of exposure to toxic chemicals. Baumann *et al*. (1987) identified polynuclear aromatic hydrocarbons (PAHs) as the cause of hepatic tumors in brown bullheads in the Black River (Ohio). Viral infections (e.g. Lymphocystis) can also cause tumors. Parasites (e.g. *Glugea anomala* and *Ceratomyxa shasta*; Post 1983) may cause tumor like masses, but these should not be considered as tumors. Parasite masses can be squeezed and broken between the thumb and forefinger; whereas true tumors are firm and not easily broken (P. Baumann, pers. comm.).

5. Anchor worm (*Lernaea cyprinacea*) - This is a common parasitic copepod and can be identified by the presence of an adult female which appears as a slender, worm-like body with the head attached (buried) in the flesh of the fish. A small, characteristic sore is left after the anchor worm detaches. Attachment sites are included in the determination of light and heavy infestations. If the formed attachment site becomes infected and enlarged as the result of an infection, it should be recorded as a lesion.

6. Black spot - This disease is common on fish in Ohio streams and is caused by the larval stage of a trematode parasite (e.g. *Uvulifer ambloplitis* and *Crassiphiala bulboglossa*). They are easily identified as small black cysts (approximately the size of a pin head) on the skin and fins. Black spot has been reported as being most prevalent on fish inhabiting relatively shallow stream and lake habitats which have an abundance of aquatic vegetation with snails and fish eating birds, two of its intermediate animal hosts. It may also increase in frequency in mildly polluted streams or where fish are crowded due to intermittent pooling.

7. Leeches - These parasites belong to the family Piscicolidae and are usually greenish brown in color and 5-25 mm long (Allison *et al*. 1977). Leeches can be identified by the presence of two suckers (one on each end) and the ability to contract or elongate their body. They may occur almost anywhere on the external surface of fish, but are most frequently seen on the anterioventral surface of bullheads (*Ictaluras* spp.). Field investigators should become familiar with the small sores or scars left by leeches as these are included in the determination of light and heavy infestations. If these sores become enlarged and infected they are also regarded as lesions. Leeches are seldom harmful to fish unless the infestation is very heavy.

8. Fungus - This is a growth that can appear on a fish's body as a white cottony growth and is most frequently caused by *Saprolegnia parasitica*. This fungus usually attacks an injured or open area of the fish and can eventually cause further disease or death.

9. Ich or *Icthyophthirus multifilis* - This is a protozoan that manifests itself on a fish's skin and fins as a white spotting. This disease rarely occurs in wild fish populations.

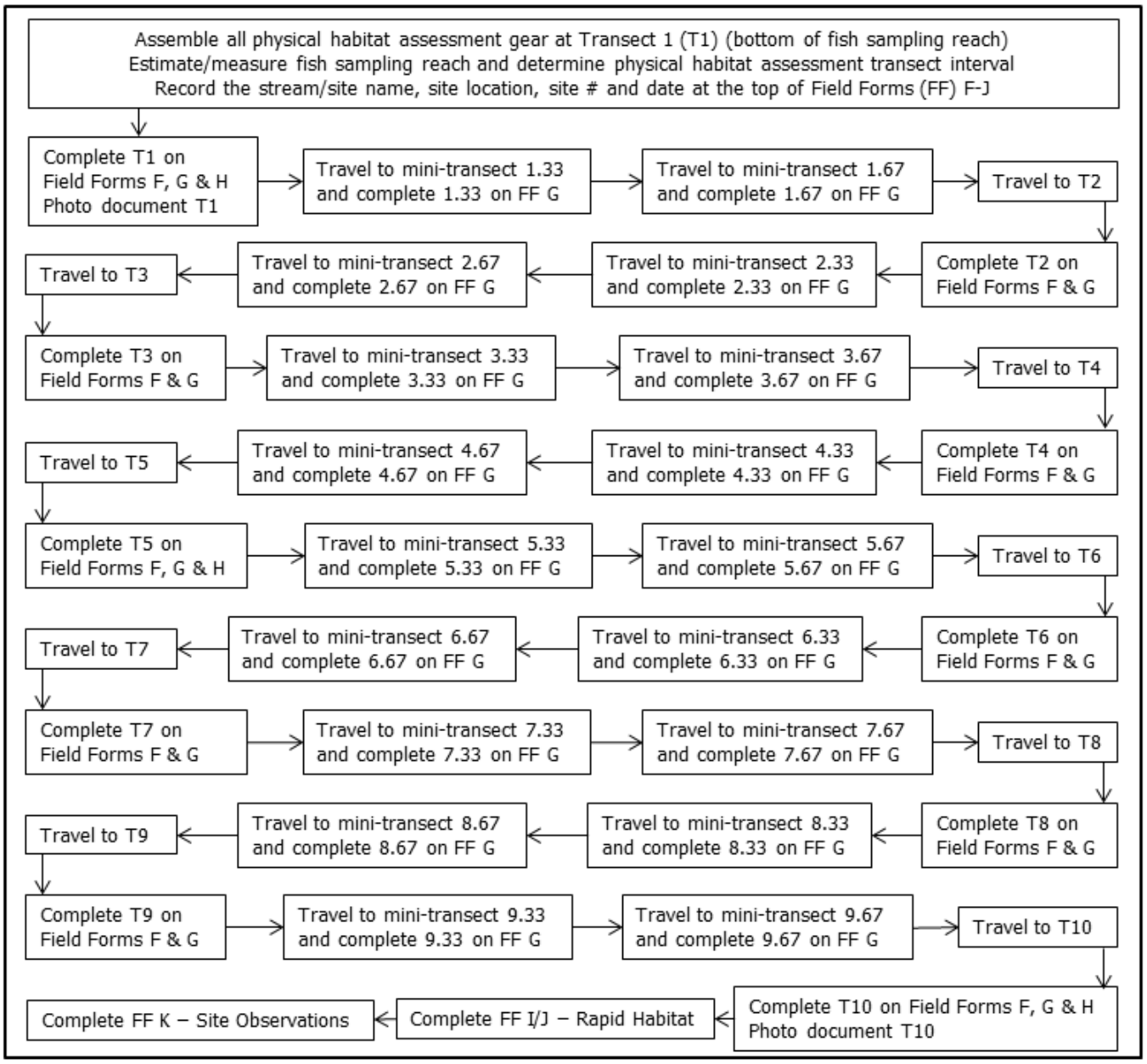
10. Popeye - This disease is generally identified by bulging eyes and can be caused by gas accumulation in areas where the water is gas supersaturated. It occurs most frequently in Ohio as the result of fluid accumulation from viral infection, nematodes (Philometra sp.), or certain trematode larvae (Rogers and Plumb 1977).

Information on external anomalies is recorded because many are either caused or exacerbated by environmental factors and often times indicate the presence of multiple, sublethal stresses. Komanda (1980) found that morphological abnormalities are uncommon in unimpacted, natural fish populations. The effects of temperature, salinity, dissolved oxygen, diet, chemicals, organic wastes, etc., especially during the ontogeny and larval stages of fishes can be the cause of many types of anomalies (Berra and Au, 1981). The presence of anomalies on fish may act as an index of pollution stress. A high frequency of DELT anomalies (deformities, eroded fins, lesions, and tumors) is a good indication of stress caused by sublethal stresses, intermittent stresses, and chemically contaminated substrates. The percent DELT anomalies is a metric of the IBI (Ohio EPA 1987). Field investigators are urged to refer to texts on fish health for further information and pictures of specific anomalies. If necessary, affected fish should be preserved for laboratory examination.

Table 1. Anomaly codes utilized to record external anomalies on fish.

Anomaly Code	Description of the anomalies.
D	Deformities of the head, skeleton, fins, and other body parts.
E	Eroded fins.
L	Lesions, ulcers.
T	Tumors.
M	Multiple DELT anomalies (e.g. lesions and tumors, etc.) on the same individual fish.
AL	Anchor worm - Light infestation: fish with five or fewer attached worms and/or previous attachment sites.
AH	Anchor worm - Heavy infestation: fish with six or more attached worms and/or previous attachment sites.
BL	Black spot - Light infestation: spots do not cover most of the body with the average distance between spots greater than the diameter of the eye.
BH	Black spot - Heavy infestation: spots cover most of the body and fins with the average distance between spots less than or equal to the diameter of the eye.
CL	Leeches - light infestation: fish with five or fewer attached leeches and/or previous attachment sites.
CH	Leeches - heavy infestation: fish with six or more attached leeches and/or previous attachment sites.
F	Fungus.
I	Ich (*Icthyophthirus multifilis*).
N	Blind - one or both eyes; includes missing and grown over eyes (does not include eyes missing due to Popeye disease).
S	Emaciated (poor condition, thin, lacking form).
P	External parasites (other than those already specified).
W	Swirled scales.
Y	Popeye disease.
Z	Wound, other, not included above.

Appendix 6.5a: Physical Habitat Assessment Flowchart



Appendix 6.5b: Field Form F: Stream Transect Habitat Data

Field Form F: Stream Transect Habitat Data (Page 1 of 2)

Stream Name:														Location:								
Site#:			Date: / /											Comments:								
Transect #	Stream		Substrate Type*	Embeddedness (circle)**	Instream Fish Cover*** (circle one ranking in each category)										Stream Bank Angle		% Bare Stream Bank		Densiometer #Open Canopy (#Open/37)		
	Width (ft)	Depth (ft)			Filamen-tous Algae	Macro-phytes	Woody Debris >0.3m diam.	Small Brush <0.3m diam.	Trees/ Roots	Over-hanging Veg	Under-cut Banks	Boulders	Artificial Structure	Depth/ Pool	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Mid	Right Bank
1				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
2				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
3				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
4				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
5				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							

*Substrate Types: be=bedrock; bo=boulder; cl=clay/hardpan; co=cobble; de=detritus; gr=gravel; mu=muck; ri=riprap; sa=sand; si=silt; so=soil; wo=wood; other (describe).

**Embeddedness Ratings: 1=0-20%; 2=20-40%; 3=40-60%; 4=60-80%; 5=80-100% (Riffle or run transects only, $\leq$ 1.5' depth & $\geq$ 25% of run/riffle with cobble)

***Instream Cover Ranking Categories: 0 = absent, 1 = sparse (<10%), 2 = moderate (10-40%), 3 = heavy (40-75%), 4 = very heavy (>75%).

Appendix 6.5b: Field Form F: Stream Transect Habitat Data, continued.

Field Form F: Stream Transect Habitat Data (Page 2 of 2)

Stream Name:													Location:						
Site#:			Date: / /										Comments:						
Transect #	Stream		Substrate Type*	Embeddedness (circle)**	Instream Fish Cover*** (circle one ranking in each category)										Stream Bank Angle		% Bare Stream Bank		Densiometer #Open Canopy (#Open/37)		
	Width (ft)	Depth (ft)			Filamen-tous Algae	Macro-phytes	Woody Debris >0.3m diam.	Small Brush <0.3m diam.	Trees/ Roots	Over-hanging Veg	Under-cut Banks	Boulders	Artificial Structure	Depth/ Pool	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Mid	Right Bank
6				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
7				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
8				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
9				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							
10				1	0	0	0	0	0	0	0	0	0	0							
				2	1	1	1	1	1	1	1	1	1	1							
				3	2	2	2	2	2	2	2	2	2	2							
				4	3	3	3	3	3	3	3	3	3	3							
				5	4	4	4	4	4	4	4	4	4	4							

*Substrate Types: be=bedrock; bo=boulder; cl=clay/hardpan; co=cobble; de=detritus; gr=gravel; mu=muck; ri=riprap; sa=sand; si=silt; so=soil; wo=wood; other (describe).

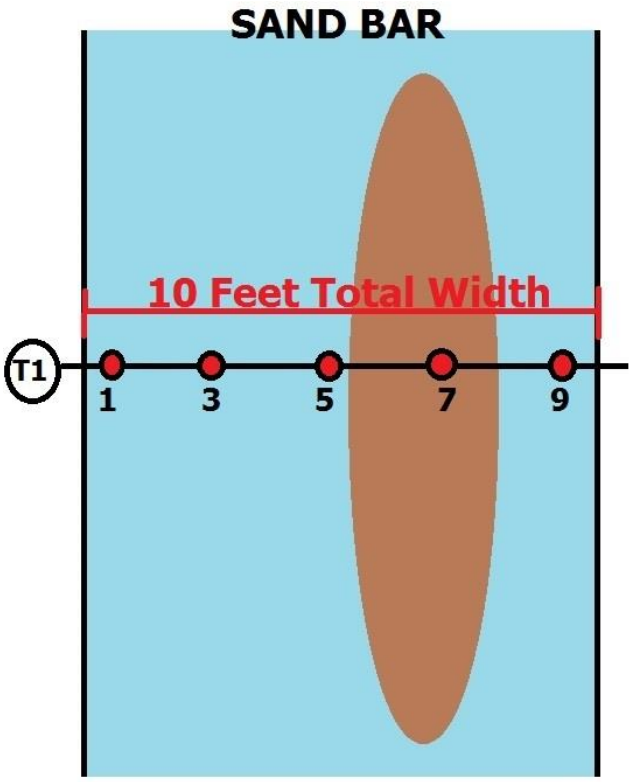
**Embeddedness Ratings: 1=0-20%; 2=20-40%; 3=40-60%; 4=60-80%; 5=80-100% (Riffle or run transects only, ≤ 1.5′ depth & ≥ 25% of run/riffle with cobble)

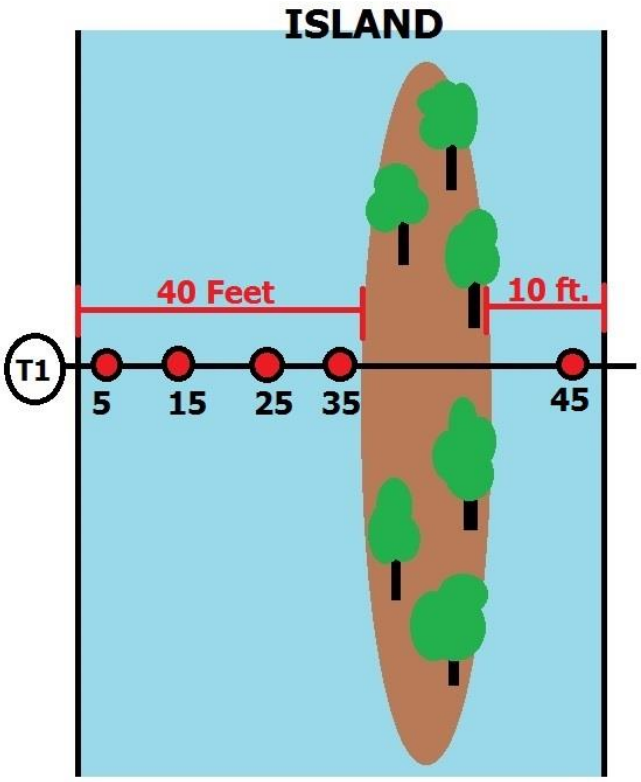
***Instream Cover Ranking Categories: 0 = absent, 1 = sparse (<10%), 2 = moderate (10-40%), 3 = heavy (40-75%), 4 = very heavy (>75%).

Appendix 6.5c: Handling Bars and Islands during Physical Habitat Assessment

Sediment bars: Sediment bars are composed of rock, sand, or silt deposits and are surrounded by water on all sides. Sediment bars differ from islands in that they are inundated during minor episodes of elevated stream flow and lack permanent terrestrial vegetation.

Islands: Islands generally have higher elevation than a sediment bar and contain permanent, woody vegetation. Islands are also surrounded by water on all sides but are only inundated during a major flood event.





When a sediment (sand, silt or gravel) bar falls on the transect, stretch the tape across the stream including the sediment bar. Calculate the stream width and observation points as if the sediment bar was absent. If an observation point falls on the sediment bar, the water depth is '0' and the substrate is whatever is directly under the pole at the observation point.

When an island falls on the transect, measure the stream width on both sides of the island and add the two values to determine total stream width. Calculate the observation points from the total stream width. Start from the left side of the stream and begin recording all the transect observations. If the observation falls on the island, measure the distance from the last observation point to the left side of the island. Proceed to the right side of the island and measure the remaining distance needed between observation points.

Appendix 6.5d: Physical Habitat Assessment Reach Map

Field Form G: Physical Habitat Assessment Reach Map

Stream Name:				Location:					
Site#:		Date: / /		Est. Mean Stream Width (ft):			Transect Interval (ft):		
Tran-sect#	*Macro-habitat	Thalweg Depth (ft)	**Soft/ small sediment	T10 Photo looking upstream			Transect 10 15T NAD83 UTMs		
				T10 Photo looking downstream					
10			Y N						
9.67			Y N						
9.33			Y N						
9			Y N						
8.67			Y N						
8.33			Y N						
8			Y N						
7.67			Y N						
7.33			Y N						
7			Y N						
6.67			Y N						
6.33			Y N					Max Depth	ft
6			Y N						
5.67			Y N						
5.33			Y N						
5			Y N						
4.67			Y N						
4.33			Y N						
4			Y N						
3.67			Y N						
3.33			Y N						
3			Y N						
2.67			Y N						
2.33			Y N						
2			Y N						
1.67			Y N						
1.33			Y N						
1			Y N						
Mapping Instructions:				T1 Photo looking upstream			Transect 1 15T NAD83 UTMs		
				T1 Photo looking downstream					

*Macrohabitat abbreviations: po=pool; ri=riffle; ru=run; gl=glide; ra=rapid

**Record (Y/N) soft/small sediment (< fine gravel determined by feel). A thin coating of silt or algae over cobble does not qualify.

Start at bottom of fish sampling reach, indicate location of T1 in relation to permanent benchmark & stream access.

Indicate position of each transect in the sampling reach, starting with T1 and progressing upstream to T10.

Sketch major habitat features such as channel bends, riffles, large pools, woody debris snags, sediment bars, islands ,etc.

Indicate where semi-quant BM samples were collected and the start and finish of electrofishing including measurements.

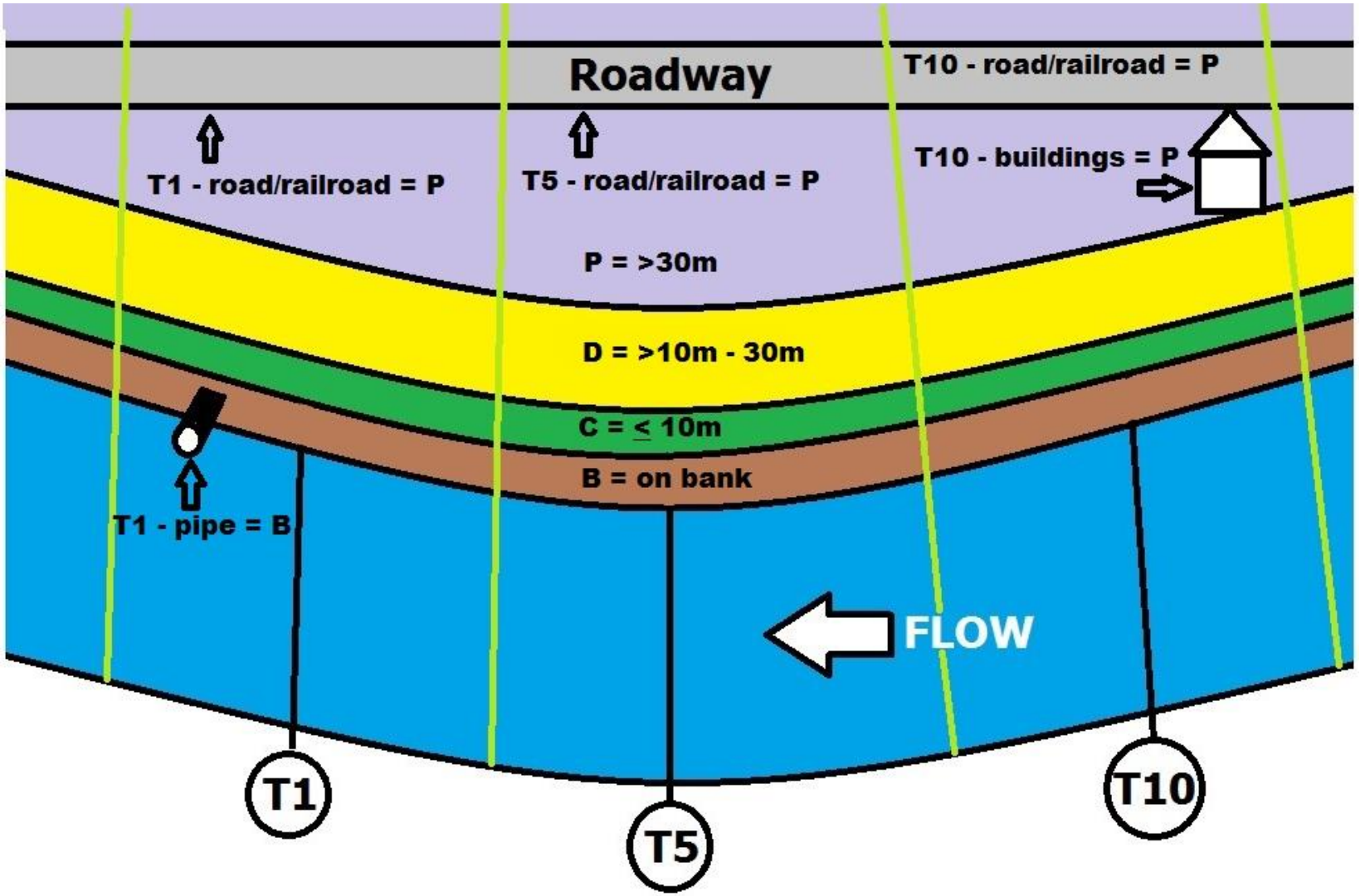
Indicate deepest spot of the sampling reach on the map & record the depth. Characterize riparian vegetation & land uses.

Appendix 6.5e: Field Form H: Visual Riparian Estimates and Human Influence

Field Form H: Visual Riparian Estimates and Human Influences

Stream Name:											Location:																					
Site#:	Date: / /										Comments:																					
TRANSECT 1 (T1)											**TRANSECT 5 (T5)**											**TRANSECT 10 (T10)**									
VEG. COVER	LEFT BANK					RIGHT BANK					VEG. COVER	LEFT BANK					RIGHT BANK					VEG. COVER	LEFT BANK					RIGHT BANK			
CANOPY (>5m or ~15' high)											CANOPY (>5m or ~15' high)											CANOPY (>5m or ~15' high)									
Vegetation type*	D	C	E	M	N	D	C	E	M	N	Vegetation type	D	C	E	M	N	D	C	E	M	N	Vegetation type	D	C	E	M	N	D	C	E	M	N
BIG trees:trunk >0.3 DBH**	0	1	2	3	4	0	1	2	3	4	BIG trees: trunk >0.3 DBH	0	1	2	3	4	0	1	2	3	4	BIG trees: trunk >0.3 DBH	0	1	2	3	4	0	1	2	3	4
SMALL trees: trunk <0.3 DBH	0	1	2	3	4	0	1	2	3	4	SMALL trees: trunk <0.3 DBH	0	1	2	3	4	0	1	2	3	4	SMALL trees: trunk <0.3 DBH	0	1	2	3	4	0	1	2	3	4
UNDERSTORY (0.5-5m or ~1.5-15' high)											UNDERSTORY (0.5-5m or ~1.5-15' high)											UNDERSTORY (0.5-5m or ~1.5-15' high)									
Vegetation type	D	C	E	M	N	D	C	E	M	N	Vegetation type	D	C	E	M	N	D	C	E	M	N	Vegetation type	D	C	E	M	N	D	C	E	M	N
Woody Shrubs & Samplings	0	1	2	3	4	0	1	2	3	4	Woody Shrubs & Samplings	0	1	2	3	4	0	1	2	3	4	Woody Shrubs & Samplings	0	1	2	3	4	0	1	2	3	4
Non-Wdy Herbs, Grasses & Forbs	0	1	2	3	4	0	1	2	3	4	Non-Wdy Herbs, Grasses & Forbs	0	1	2	3	4	0	1	2	3	4	Non-Wdy Herbs, Grasses & Forbs	0	1	2	3	4	0	1	2	3	4
GROUND COVER (<0.5m or ~1.5' high)											GROUND COVER (<0.5m or ~1.5' high)											GROUND COVER (<0.5m or ~1.5' high)									
Woody Shrubs & Samplings	0	1	2	3	4	0	1	2	3	4	Woody Shrubs & Samplings	0	1	2	3	4	0	1	2	3	4	Woody Shrubs & Samplings	0	1	2	3	4	0	1	2	3	4
Non-Wdy Hrbs, Grasses & Forbs	0	1	2	3	4	0	1	2	3	4	Non-Wdy Hrbs, Grasses & Forbs	0	1	2	3	4	0	1	2	3	4	Non-Wdy Hrbs, Grasses & Forbs	0	1	2	3	4	0	1	2	3	4
Barren, Bare Dirt or Duff	0	1	2	3	4	0	1	2	3	4	Barren, Bare Dirt or Duff	0	1	2	3	4	0	1	2	3	4	Barren, Bare Dirt or Duff	0	1	2	3	4	0	1	2	3	4
HUMAN INFLUENCE***	LEFT BANK					RIGHT BANK					HUMAN INFLUENCE	LEFT BANK					RIGHT BANK					HUMAN INFLUENCE	LEFT BANK					RIGHT BANK			
Wall/Dike/ Riprap/Dam	0	B	C	D	P	0	B	C	D	P	Wall/Dike/ Riprap/Dam	0	B	C	D	P	0	B	C	D	P	Wall/Dike/ Riprap/Dam	0	B	C	D	P	0	B	C	D	P
Buildings	0	B	C	D	P	0	B	C	D	P	Buildings	0	B	C	D	P	0	B	C	D	P	Buildings	0	B	C	D	P	0	B	C	D	P
Confinement operation	0	B	C	D	P	0	B	C	D	P	Confinement operation	0	B	C	D	P	0	B	C	D	P	Confinement operation	0	B	C	D	P	0	B	C	D	P
Open feedlot	0	B	C	D	P	0	B	C	D	P	Open feedlot	0	B	C	D	P	0	B	C	D	P	Open feedlot	0	B	C	D	P	0	B	C	D	P
Pavement/ Cleared Lot	0	B	C	D	P	0	B	C	D	P	Pavement/ Cleared Lot	0	B	C	D	P	0	B	C	D	P	Pavement/ Cleared Lot	0	B	C	D	P	0	B	C	D	P
Road/Railroad	0	B	C	D	P	0	B	C	D	P	Road/Railroad	0	B	C	D	P	0	B	C	D	P	Road/Railroad	0	B	C	D	P	0	B	C	D	P
Pipes (Inlet/Outlet)	0	B	C	D	P	0	B	C	D	P	Pipes (Inlet/Outlet)	0	B	C	D	P	0	B	C	D	P	Pipes (Inlet/Outlet)	0	B	C	D	P	0	B	C	D	P
Landfill/Trash	0	B	C	D	P	0	B	C	D	P	Landfill/Trash	0	B	C	D	P	0	B	C	D	P	Landfill/Trash	0	B	C	D	P	0	B	C	D	P
Park/Lawn	0	B	C	D	P	0	B	C	D	P	Park/Lawn	0	B	C	D	P	0	B	C	D	P	Park/Lawn	0	B	C	D	P	0	B	C	D	P
Row Crops	0	B	C	D	P	0	B	C	D	P	Row Crops	0	B	C	D	P	0	B	C	D	P	Row Crops	0	B	C	D	P	0	B	C	D	P
Pasture/Range/ Hay Field	0	B	C	D	P	0	B	C	D	P	Pasture/Range/ Hay Field	0	B	C	D	P	0	B	C	D	P	Pasture/Range/ Hay Field	0	B	C	D	P	0	B	C	D	P
Logging Activity	0	B	C	D	P	0	B	C	D	P	Logging Activity	0	B	C	D	P	0	B	C	D	P	Logging Activity	0	B	C	D	P	0	B	C	D	P
Mining Activity	0	B	C	D	P	0	B	C	D	P	Mining Activity	0	B	C	D	P	0	B	C	D	P	Mining Activity	0	B	C	D	P	0	B	C	D	P
*Vegetation Type: D = Deciduous, C = Coniferous, E = Broadleaf Evergreen, M = Mixed and N = None																																
**Visual Riparian Estimates: 0 = absent (0%), 1 = sparse (<10%), 2 = moderate (10-40%), 3 = heavy (40-75%) and 4 = very heavy (>75%)																																
***Human Influence Proximity Classes: 0 = Not Present (in plot area or beyond), B = on bank, C = within 10m, D = between 10 - 30m and P = >30m																																

Appendix 6.5f: Human Influence Diagram



Continuous linear human influences (roadway in the diagram) are recorded when seen from a transect and are not subject to "double counting".

Single human influences (pipe and building in the diagram) are only recorded on the nearest transect even if seen from multiple transects.

If human influences (linear or single) are present in multiple classes (B, C, D or P), they are recorded in the class nearest the stream.

Appendix 6.6a: Field Form I: Rapid Habitat Assessment Form: Riffle/Run - Stream

Reviewed by (Initials): _____

RAPID HABITAT ASSESSMENT FORM: RIFFLE/RUN - STREAM

SITE ID: _____ DATE: ___ / ___ / 2 0 ___

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUB-OPTIMAL	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 maintainance 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% 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 four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is less than 0.3 m/s, deep is greater than 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).
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 increases 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
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills over 75% of the available channel; or less than 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:	20 19 18 17 16	15 14 13 12 11	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 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.
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

3099

04/14/2000 2000 Riffle Run - Modified 3/10/15 by IDNR - switched bank perspective.

Appendix 6.6a: Field Form I: Rapid Habitat Assessment Form: Riffle/Run – Stream, continued.

Reviewed by (Initials): _____

RAPID HABITAT ASSESSMENT FORM: RIFFLE/RUN (continued) - STREAM

SITE ID: _____ DATE: ___/___/20___

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream greater than 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 width of stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by width of stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by width of stream is a ratio of over 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) NOTE: Determine left or right side by facing upstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. Less than 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.
Left Bank Score:	Left Bank: 10 9	8 7 6	5 4 3	2 1 0
Right Bank Score:	Right Bank: 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	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% if the streambank 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 streambank surfaces covered by vegetation; disruptions 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.
Left Bank Score:	Left Bank: 10 9	8 7 6	5 4 3	2 1 0
Right Bank Score:	Right Bank: 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)	Width of riparian zone greater than 18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted the 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 less than 6 meters; little or no riparian vegetation due to human activities.
Left Bank Score:	Left Bank: 10 9	8 7 6	5 4 3	2 1 0
Right Bank Score:	Right Bank: 10 9	8 7 6	5 4 3	2 1 0

04/14/2000 2000 Riffle Run - Modified 3/10/15 by IDNR - switched bank perspective.

Appendix 6.6b: Field Form J: Rapid Habitat Assessment Form: Glide/Pool – Stream

Reviewed by (Initials): _____

RAPID HABITAT ASSESSMENT FORM: GLIDE/POOL - STREAMS

SITE ID: _____ DATE: ___/___/20___

HABITAT PARAMETER	CATEGORY			
	OPTIMAL	SUB-OPTIMAL	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 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.
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 shallows.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or 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 islands or point bars and less than 20% of the bottom affected by sediment deposition.	Some new increases 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
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills over 75% of the available channel; or less than 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:	20 19 18 17 16	15 14 13 12 11	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 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.
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

1476

04/14/2000 2000 Glide Pool - Modified 3/10/15 by IDNR - switched bank perspective.

Appendix 6.6b: Field Form J: Rapid Habitat Assessment Form: Glide/Pool – Stream, continued.

Reviewed by (Initials): _____

RAPID HABITAT ASSESSMENT FORM: GLIDE/POOL (continued) - STREAMS

SITE ID: _____ DATE: ____ / ____ / 2 0 ____

HABITAT PARAMETER	CATEGORY			
	OPTIMAL	SUB-OPTIMAL	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.	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) NOTE: Determine left or right side by facing upstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. Less than 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.
Left Bank Score:	Left Bank: 10 9	8 7 6	5 4 3	2 1 0
Right Bank Score:	Right Bank: 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	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% if the streambank 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 streambank surfaces covered by vegetation; disruptions 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.
Left Bank Score:	Left Bank: 10 9	8 7 6	5 4 3	2 1 0
Right Bank Score:	Right Bank: 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetation Zone Width (score each bank)	Width of riparian zone greater than 18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted the 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 less than 6 meters; little or no riparian vegetation due to human activities.
Left Bank Score:	Left Bank: 10 9	8 7 6	5 4 3	2 1 0
Right Bank Score:	Right Bank: 10 9	8 7 6	5 4 3	2 1 0

04/14/2000 2000 Glide Pool - Modified 3/10/15 by IDNR - switched bank perspective.

Appendix 6.7: Field Form K: Bioassessment Site Observations

Field Form K: Bioassessment Site Observations

Stream Name:					Location:					
Site#:		Date: / /			Air Temperature (F):					
Comments:										
General Observations (place check mark next to one category per general observation)										
Weather:		Clear		Partly Cloudy		Overcast		Rain/Drizzle		
Turbidity:		Clear		Low		Moderate		High		
Flow Level:		None/Stagnant		Low		Baseflow		Moderate		High
Mussels:		Live		Fresh Shells		Old Shells		None		
Flood Observations										
Flood Elevation: Did recent (current year) flood water spill over banks onto floodplain/riparian zone?										
check one		Unknown		Neither side of stream		One side of stream		Both sides of stream		
(ft)	Vertical height of representative bank									
(ft)	Estimated maximum elevation of new flood debris above bank									
(ft)	Estimated maximum elevation of new flood debris above baseflow stream level									
Recent (current year) evidence of flood water above/outside stream banks? (check all that apply)										
	Evidence of veg. die-off/loss from flood inundation					Recent sediment deposition on floodplain				
	Other (describe):									
Recent (current year) evidence of impacts within stream channel? (check all that apply)										
	Significant deposition/enlargement of gravel/rock bars									
	Significant deposition/enlargement of sand bars									
	Significant bank erosion/slumping									
	Large woody debris dams									
	Significant alteration/movement of channel features (e.g. pools and riffles)									
	Other (describe):									
Rate degree of flood disturbance within stream channel:										
check one		None		Low		Medium		High		
Rate degree of flood disturbance in floodplain/riparian zone:										
check one		None		Low		Medium		High		
Comments:										
Drought/Extended Low Flow Observations										
Rate the severity of the current drought/extreme low flow condition:										
check one		None		Low		Medium		High		
Current drought/extreme low flow condition? (check all that apply)										
	shallow, flowing water			intermittent pools		no water		terrestrial veg in channel		
	Other (describe):									