Guidelines for Dam Removal Evaluations on Wadeable Streams

Dams with significant impoundments (Dams with significant impoundments are described where: remnant river area / remnant river area + additional area inundated $\leq$.50 (we may want to use retention time?)

Measures of Environmental Quality and Sport Fisheries Assessment Establish 3 treatment sampling sites (1. Upstream of the dam within the impoundment pool. 2. Upstream of the impoundment pool. 3. Downstream of the dam) calculating station lengths based on wadeable guidelines. For sportfisheries assessment expand the station length 3-fold and locate the IBI site in the middle of the expanded station.

Pre-removal

Once, apply baseline guidelines for evaluating wadeable streams habitat and IBI's following the protocols outlined below at all three sampling sites. Continue IBI and sportfisheries sampling annually until removal.

Impoundment Pool Only: Fish fyke nets along the margin of the impoundment (1 net-night/10 acres of impoundment)—consider dropping; and fish lead-less fyke nets at fixed stations ((15 net nights/mile of stream length (or maybe just advise on 10 total) parallel to flow facing downstream) in the remnant river channel during X months. Follow IBI data protocols for recording fyke-net catches. For impoundments <200 acres, electrofish (miniboom) the whole shoreline for sport fisheries assessment and randomly select 15 (each 300' in length) shoreline stations for electrofishing (miniboom) within the impoundment for IBI sampling.

Water Temperature: Deploy water temperature logs above the impoundment section and below the dam during April-November. (or for 1-week periods during spring, summer, and fall).

Post-removal

Once, at least two years after removal apply baseline guidelines for evaluating wadeable streams habitat at all three stations (For the remnant impoundment section calculate a new MSW and sample this "new" station for habitat). Annually, for at least four years following removal, sample for IBI's at the three established stations and sport fish electrofishing at the three expanded stations.

Remnant Impoundment Section only: Annually fish lead-less fyke nets at the same fixed stations ((15 net nights/mile of stream length or maybe just advise on 10 total)) parallel to flow facing downstream) in the remnant river channel during X months.

Water Temperature: Deploy water temperature logs above the impoundment section and below the dam during April-November. (or for 1-week periods during spring, summer, and fall).

Dams without significant impoundments (Dams without significant impoundments are described where: remnant river area / remnant river area + additional area inundated > .50)

Measures of Environmental Quality and Sport Fisheries Assessment

Establish 3 treatment sampling sites (1. Upstream of the dam within the impoundment pool. 2. Upstream of the impoundment pool. 3. Downstream of the dam) calculating station lengths based on wadeable guidelines. For sportfisheries assessment expand the station length 3-fold and locate the IBI site in the middle of the expanded station.

Pre-removal
Once, apply baseline guidelines for evaluating wadeable streams habitat and IBI's following the protocols outlined below at all three sampling sites. Continue IBI and sportfisheries sampling annually until removal.

Post-removal
Once, at least two years after removal, apply baseline guidelines for evaluating wadeable streams habitat. Annually, for at least four years following removal, sample for IBI's at the three established stations and sport fish electrofishing at the three expanded stations.

Guidelines for Passage Evaluations on Wadeable Streams

Establish two sampling stations: 1) Upstream of the impoundment pool. 2) Downstream of the dam). Calculate station lengths based on wadeable guidelines. For sportfisheries assessment expand the station length 3-fold and locate the IBI site in the middle of the expanded station.

Pre-passage
Once, apply baseline guidelines for evaluating wadeable streams habitat and IBI's following the protocols outlined below at both sampling sites. Continue IBI and sportfisheries sampling annually until passage.

Post-passage
Annually, for at least four years following removal, sample for IBI's at the three established stations and sport fish electrofishing at the three expanded stations.

Guidelines for Passage Evaluations on Non-Wadeable Streams

Dams with significant impoundments (Dams with significant impoundments are described where: remnant river area / remnant river area + additional area inundated $\leq$.50)

Establish two sampling stations (each station 1-mile long): 1) Upstream of the impoundment pool. 2) Downstream of the dam.

IBI Data Collection: Sampling should take place during daylight hours, between late May and late September when mid-day water temperatures are consistently above -59 F, and when river flows are near or below normal. Fish should be collected with a standard WDNR, pulsed-DC, "miniboom" boat electroshocker (single Wisconsin-ring boom with 16 droppers, single netter with 3/41' stretch mesh dip net, bcat-hull as cathode, 3500 W generator, output maintained at 3000 W peak (amps **x** volts on control box), 25% duty cycle, 60 Hz pulse rate). Shocking should proceed downstream along one or both shorelines for a total distance of 1 mile. An attempt should be made to collect all fish observed that are above 2" total length. All captured fish should be identified, and then counted and weighed in aggregate by species.

Sport Fisheries Assessment: *Need to discuss*

Dams without significant impoundments (Dams without significant impoundments are described where: remnant river area / remnant river area + additional area inundated > .50)

Establish three sampling stations (each station 1-mile long): 1. Upstream of the dam within the

impoundment pool. 2. Upstream of the impoundment pool. 3. Downstream of the dam)

IBI Data Collection: Sampling should take place during daylight hours, between late May and late September when mid-day water temperatures are consistently above -59 F, and when river flows are near or below normal. Fish should be collected with a standard WDNR, pulsed-DC, "miniboom" boat electroshocker (single Wisconsin-ring boom with 16 droppers, single netter with 3/41' stretch mesh dip net, bcat-hull as cathode, 3500 W generator, output maintained at 3000 W peak (amps **x** volts on control box), 25% duty cycle, 60 Hz pulse rate). Shocking should proceed downstream along one or both shorelines for a total distance of 1 mile. An attempt should be made to collect all fish observed that are above 2" total length. All captured fish should be identified, and then counted and weighed in aggregate by species

Sport Fisheries Assessment: ***Need to discuss***

Guidelines for Evaluating Habitat of Wadable Streams in Wisconsin

Revised June 1999 (Modified from Simonson et. al 1994)

The Wadable Streams Team; Joe Ball, Marty Engel, Steve Galarneau, Mike Miller, Ken Schreiber, Scott Stewart, Li Wang.

OVERALL OBJECTIVES AND SAMPLING DESIGN FOR BASELINE MONITORING OF WADABLE STREAMS

The overall objective of assessing the habitat of wadable streams for baseline monitoring in Wisconsin is to use this information, along with fish and macroinvertebrate community data to provide biological criteria with which to assess the status and trends of the physical and biological integrity of stream resources across the state. This baseline information will allow resource managers to:

1. Classify streams according to their designated aquatic life uses, e.g. coldwater sportfish.
2. Determine if streams are attaining their designated uses.
3. Provide problem identification information as to why some streams are not meeting their designated uses.
4. Provide regulatory assessment information for the issuance of discharge permits, and provide measures of permit effectiveness and regulatory compliance.
5. Provide information for land, and water resource management planning.
6. Provide information on the status and trends of the biological integrity of streams over time and space.
7. Help identify "Least-Impacted Regional Reference Streams," those streams that represent the range of biological conditions found in "least-impacted" streams of the region, data from which will be used as the biological criteria to judge how well similar streams are meeting their designated uses, and provide ways to measure land use impacts to water resources or assess resource management effectiveness.

General Sampling Procedures - Mean stream width (MSW) is an important characteristic of each stream assessment station. The MSW is used to define the length of the station, the distance from the station to unusual features or disturbances (e.g., bridges, etc.), and the spacing of habitat measurements (i.e., distances between transects). The MSW is based on the mean of about **10-15** equally spaced preliminary measurements of stream width from throughout the station (within approximate station boundaries), including all types of macro-habitats. If the water level appears to be substantially (**> 0.15 m**) above normal, sampling should not occur (see Station Summary for determination of water levels). Once the MSW for a station has been determined, this value is used for **all** future habitat sampling, including future years when changes in riparian land use or instream habitat improvements may have caused a change in the actual stream width.

If a stream has well-developed pool-riffle structure, then each station starts and ends at the base of a riffle, even if this requires that stations be somewhat more than 35 times the MSW in length. Stations should not contain permanent tributaries or hydraulic controls (e.g., dams, old bridge abutments), and should be a distance of at least **10 times** the MSW away from bridges.

Habitat within a station is quantified using the transect method. Sampling of stations normally proceeds in an upstream direction and a variety of channel, substrate, and bank characteristics are measured or visually estimated along transects. Several transects are sampled within each station to provide an overall picture of stream habitat. Parameters that are unlikely to vary substantially within a station (flow, water chemistry parameters) are estimated only once for each station.

DATA COLLECTION

Four data sheets are used in the wadable stream habitat evaluation: **Station Summary, Station Map, Station Flow,** and **Transects**. Clean copies and filled-in example data sheets are attached. The first three sheets apply to the whole station, and there is typically only one of each sheet filled out per station (a second **Station**

Map may be needed for stations with diverse habitat). The **Transects** data sheet applies to very short reaches, and typically 12 or more sheets are filled out per station. A list of equipment used for stream habitat evaluations, along with suppliers, is presented in Table 1. Guidelines for filling out each data sheet are given on the following pages.

STATION SUMMARY DATA SHEET

This sheet summarizes location, water characteristics, and large-scale channel and basin characteristics for the entire station. Much of the data on this form are derived from maps or from the other data sheets. The parameters on this sheet are as follows:

LOCATION ----------

Stream Name - The name of the stream as shown on the most recent USGS 7.5" topographic map. The name used here should be identical to that used on the other data sheets, and to that used for all other stations on the same stream. Make sure the spelling of the name is accurate and include all parts of the stream name (e.g., "West Branch", "Middle Fork", "River", "Creek", "Brook", "Run", etc.) to avoid confusion. Other commonly used names for the stream can be written here in parentheses.

Waterbody ID Code - A unique seven-digit number that identifies each stream; all streams, rivers, and lakes in Wisconsin have an assigned number. These numbers are available on the WDNR Intranet, under the listing for "DNR Tabular Database Service" for the WDNR Register of Waterbodies (ROW). As with stream name, waterbody ID code should be the same for all stations on a stream.

Site Mile - The distance along the stream channel from the mouth of the stream to the downstream end of the station. This distance is a useful shorthand for indicating and identifying the location of the station. Site mile should be measured on the most recent USGS 7.5" topographic map to the nearest 0.1 mile using a map wheel.

Station No. - If a stream has two or more stations, the downstream station is number 1, the next upstream is number 2, and so on. If there is only one station, the number is 1.

Date - Fill in the date when the habitat data were collected for the station. To avoid confusion about which is the month and which is the day (e.g., to some people 6/7/90 is June 7 but to others it is July 6), use the YYYYMMDD format (e.g., 19900607 equals June 7, 1990).

Starting Location - A precise narrative description of the point on the stream where the habitat survey began (i.e., the downstream edge of the station). The description should include the exact distance and direction of the start from a "permanent" landmark such as a bridge, building, road marker, rock formation, etc. Avoid using landmarks that might be lost in future years (e.g., don't use tree or fence lines). Make the description as specific and precise as possible so that someone visiting the station for the first time can easily find the starting point. Installation of a permanent stake to mark the downstream end of the station is desirable if conditions permit. Be sure to confer with the landowner if the stake could interfere with the normal use of that area.

Latitude and Longitude – It is important that geographic coordinates of the start and end of the station are recorded, along with the method used to determine latitude and longitude (e.g. USGS map, mapping software, global positioning system (GPS) units). If a GPS unit is used, the geodetic datum upon which the coordinates are based (e.g. North American Datum 1983 (NAD 83), should also be recorded.

Township, Range, Section, 1/16 Section, 1/4 Section - Legal description for the Starting Location of the station within the Public Lands System. These can be determined from recent USGS 7.5" topographic maps or a detailed county map. On a topographic map, a "land locator" template is useful for determining the 1/16 and 1/4 Sections, which are indicated by a compass direction (NW, NE, SW, or SE). Note that in Wisconsin, all Townships are "N" (north), but Range can be either "E" or "W" (east or west). Make sure the appropriate letter is included for both Township and Range.

7.5" Quad Name - The name of the USGS 7.5" topographic map on which the station is found.

Basin Name - The name of the basin in which the station is located.

County - The name of the county in which the station is located.

WATER CHARACTERISTICS----------
Time - The time (in "military" format; i.e., 9:30 am is 0930 hrs. and 9:30 PM is 2130 hrs.) at which measurements of water characteristics are made. All water characteristics should be measured in water of moderate current at least 15 cm above the bottom and 15 cm below the surface (if possible).

Air Temperature - If possible, measure air temperature during the warmest part of the day to estimate maximum values. Take the air temperature in the shade with a **dry** thermometer; evaporation from a wet thermometer will lead to a measured air temperature lower than the true value. Measure to the nearest 1 degree Celsius.

Water Temperature - Take the water temperature in mid-channel, during the warmest part of the day to estimate maximum values, if possible. Measure water temperature away from any large objects that project above the surface. Such objects may act to efficiently transmit heat and influence local water temperature. Avoid areas of the stream where subsurface or bank springs may be present. Measure to the nearest 1 degree Celsius.

Conductivity - The reporting of this parameter is optional. If reported, measure with a high-quality electronic meter. Most conductivity meters have built-in automatic temperature compensation to 25 C (77 F), but this should be confirmed before using the meter. On some older meters the temperature compensation must be set by hand, and on others, there is no compensation. For the latter meters, conductivity at 25 C can be calculated using procedures outlined in "Standard Methods for the Analysis of Water and Wastewater", a book available at many WDNR offices. Whatever meter is used, it should be calibrated before every use. Measure conductivity in umhos/cm.

Turbidity - The reporting of this parameter is optional. If reported, measure with a high-quality electronic meter, which should be calibrated before every use. Measure and report conductivity in nephelometric turbidity units (NTUs).

Dissolved Oxygen (DO) – The reporting of this parameter is optional. If reported, measure with a high-quality dissolved oxygen meter, which should be air-calibrated before every use. Follow manufacturer's instructions for use and maintenance (e.g., the membrane and electrolyte for the probe should be replaced frequently during field season). Report DO in milligrams per liter (parts per million).

pH – The reporting of this parameter is optional. If reported, measure with a high-quality meter, which should be calibrated routinely. Follow manufacturer's instructions for use and maintenance (e.g., the membrane and electrolyte for the probe should be replaced frequently during field season). Report pH to 0.1 units.

Total Dissolved Solids **–** The reporting of this parameter is optional. If reported, a high-quality meter, which should be calibrated routinely. Follow the manufacturer's instructions for use and maintenance (e.g., the membrane and the electrolyte for the probe should be replaced frequently during the field season).

Dissolved Oxygen Percent Saturation - The reporting of this parameter is optional. If reported, measure with a high-quality dissolved oxygen meter, which should be air-calibrated before every use. Follow manufacturer's instructions for use and maintenance (e.g., the membrane and electrolyte for the probe should be replaced frequently during field season).

Flow - Taken from the **Station Flow** data sheet.

Water Level - An estimate of the level of the stream at the station. Check the appropriate category, and measure the vertical distance (nearest 0.01 m) if "Above" or "Below" normal. If there are areas of stream bed

that are dry but look as if they would normally be underwater, then the water level is "Below"; measure the vertical distance between the current water level and the "Normal" water level. If the stream is flowing over or through areas that have terrestrial vegetation (e.g., grasses, forbs, willows, but not bulrushes and cattails) then the water level is "Above"; measure the vertical depth of water above the normal water line. Otherwise, the water level is "Normal" (at or near baseflow). Sampling should not occur if the water level appears to be substantially (0.15 m) above normal. Note: Channel characteristics rather than the amount of precipitation in the recent past should be used to determine water level. Streams with large amounts of ground water input may retain normal flows well into drought periods. Conversely, such streams may show little response to heavy rains, particularly if the local water table has been greatly lowered by prolonged drought. On the other hand, streams that are runoff dominated may fluctuate greatly in water level in response to short-term wet and dry periods.

CHANNEL AND BASIN CHARACTERISTICS ----------

Stream Widths - This space is provided for the initial determination of Mean Stream Width. About 10-15 equally spaced preliminary measurements of width (nearest 0.1 m) throughout the station should be made to determine the MSW.

Mean Stream Width - This space is provided for the average (nearest 1 m) of the above Stream Width measurements. This value should be used to determine the length of stream to sample and the distance between transects. For further explanation see above (page 2; **General Sampling Procedures**).Transect Spacing - Record the distance (nearest 1 m) between transects. Start the first transect at **1 times** Mean Stream Width from the downstream end of the station, and the rest of the transects are approximately **3 times** the Mean Stream Width from each other.

Station Length - The length of the station, following the center of the stream channel. Measure, using a tape measure, to the nearest 1 m. Generally this will be approximately equal to 35 times the Mean Stream Width.

Channel Condition - A qualitative assessment of whether or not the station has been channelized or ditched (straightened and dredged to create a channel with few bends and generally uniform widths and depths). If the station shows no evidence of channelization, check "Natural". If the station appears to have been channelized many years before, but seems to be returning to a more natural morphology (beginnings of stream meanders or pool-riffle formation evident), check "Old Channelization". If the station appears to have been channelized within the last few years, or there is little evidence of meander or pool-riffle formation, check "Recent Channelization". If the station has been channelized, and is a straight, uniform channel kept in place over long distances by concrete stream banks and/or a concrete bed (or is kept in place by other artificial means, such as metal bulkheads or brick retaining walls), check "Concrete Channel".

Gradient - The overall decrease in elevation (on a per kilometer basis) of the stream over the entire station. Determine from USGS 7.5" topographic maps, using a map wheel. First, find the downstream and upstream ends of the station on the map. Then find the first contour line that **crosses** the stream upstream of the station and the first contour line that **crosses** the stream downstream of the station. For low gradient streams this may require going to additional maps, covering many miles of stream, and possibly including other streams. With the map wheel, determine the distance along the stream channel between these two contour line crossings. Then determine the elevation drop between these two contour lines. The drop in elevation is equal to the total number of contour lines crossing the stream within the station (often zero), plus the contour line immediately above and the contour line immediately below the station, minus one, times the elevation drop between adjacent contour lines (Note: most topographic maps have 10 ft contours, but some have 20 ft contours; check the legend at the bottom of the map). Divide the elevation drop by the distance measured by the map wheel. This is the gradient for the station. Convert feet/mile to m/km by dividing by 5.3.

Stream Order – The reporting of this parameter is optional. A qualitative measure of stream size, based on the

amount of branching of the watershed upstream from the station, using Strahler's modification of Horton's original system. Generally, the higher the order, the larger the stream. Determine from USGS 7.5" topographic maps; usually requires multiple maps because the entire stream network upstream from the station must be examined. In making determinations, all "blue lines" (streams) on the maps, including intermittent streams, are included. The order system is as follows: All streams (including intermittent streams) from their source downstream to their first tributary are **First** order (stream order is "1" on data sheet). When two first order streams meet, the stream below this confluence is **Second** order (stream order is "2"). When two second order streams meet, the stream below this confluence is **Third** order (stream order is "3"), and so on. When two streams of unequal order meet, the stream order below this confluence is equal to the higher of the two orders. For example, if a first and a third order stream meet, the stream below this confluence is third order. Stream order increases only when two streams of equal order meet. Streams sampled as part of the Priority Watershed evaluations are typically second or third order.

Shreve Linkage Number - The reporting of this parameter is optional. Another qualitative measure of stream size or tributary branching, based on the number of first order streams entering the mainstem. Determine from USGS 7.5" topographic maps. The sum of all the first order tributaries entering the stream upstream from the station is recorded. For example, when 2 first order streams join, the linkage number is 2. The linkage remains two until another tributary enters to stream. At that point, the number of first order linkages for that new tributary is added to the existing total. In this example, if another first order tributary enters a stream with a linkage number of 2, the linkage number downstream of that tributary is 3, and so on. If this stream, now with a linkage number of 3, enters a stream with a linkage number of 2, then the linkage number below this confluence will be 5.

Basin Area - The reporting of this parameter is optional. The surface area of the entire watershed upstream from the downstream end of the station. Basin area can often be determined from the book "Drainage Area Data for Wisconsin Streams" (U.S. Geological Survey Open-File Report 83-933), which is available at most WDNR offices. This book gives the drainage area in square miles (divide square miles by 0.3861 to get square kilometers for this data sheet) for many locations on many different streams. If the exact location (within 0.25 miles) of the station is not given in the book, but basin areas for locations downstream **and** upstream of the station are given, then the basin area for the station can be determined by linear interpolation (use the Site Mile for the station and stream miles for the downstream and upstream locations with known basin areas to interpolate). If no data from upstream or downstream locations are available, basin area can be determined by using a planimeter, or by digitizing the area within watershed the boundary on USGS 7.5" topographic map(s).

Sinuosity – The ratio of the stream channel length divided by the stream valley length between the start and end of the station, measured with a map wheel on a USGS 7.5” topographic map.

Mean Distance Between Bends - Taken from the DISTANCE SUMMARY of the **Station Map** data sheet.

Mean Distance Between Riffles - Taken from the DISTANCE SUMMARY of the **Station Map** data sheet.

Total (Sum) Length of All: Riffles Pools Runs - Taken from the DISTANCE SUMMARY of the **Station Map** data sheet.

Mean Length of Individual: Riffles Pools Runs - Taken from the DISTANCE SUMMARY off of the **Station Map** data sheet.

PHOTOGRAPH DOCUMENTATION (Optional) ----------

An accurate time-series of photographs (usually 35mm slides) of the station may be important for documenting changes in habitat that occur over the duration of habitat management projects, or changes in stream habitat associated with changes in watershed land use. Photographs should be taken from the same point in the stream each time the station is sampled. The first photograph taken at each station should be on the **Station**

Summary data sheet, so that subsequent photographs can later be identified as to location. The frame numbers of photographs taken at set locations in the station should be recorded on the **Station Summary** data sheet. Some convenient locations, such as looking upstream at the station from the downstream end of the station and looking downstream from the upstream end of the station, are listed on the data sheet. Additional locations, looking upstream from the upstream end of the station and looking downstream from the downstream end of the station, are included on the data sheet and can be used to document conditions upstream and downstream from the station. Film should be developed promptly and slides should be immediately labelled with Stream Name, Date, Station Number, location within the station (e.g., looking upstream from the upstream end), and any other pertinent information.

Person(s) Who Collected Habitat Data - The **full** names of the person(s) who actually measured or estimated the habitat parameters (water level, substrate coverage, bank vegetation/land use, etc.) during the habitat survey.

COMMENTS/NOTES - Any and all information that seems to be relevant to the habitat survey but is not recorded anywhere else on the data sheets. This information could include weather conditions (especially regarding the last significant precipitation in the watershed), notes on habitat features that were unusual or difficult to interpret, problems with equipment or measurements, and observations on biotic characteristics of the stream and riparian zone. Note model number and serial number (or some other unique identifier) for each of the meters used to determine WATER CHARACTERISTICS. Don't hesitate to make comments; if in doubt, write it down.

STATION MAP DATA SHEET

This data sheet provides a quantitative and visual description of the length and position of the major macro-habitat features of the station (Bends, Pools, Runs, Riffles, Islands, Log jams, Beaver dams). On the front of the sheet, record quantitative measurements, taken with a tape measure to the nearest 1 m, of the length of the feature and its distance from the downstream edge of the station. The back of the sheet is used for a hand-drawn map of the station, showing the downstream and upstream boundaries of the station, the distances to the nearest fixed reference points to the station (e.g., USGS benchmark, bridge, rock formation, etc.), bends within and immediately upstream and downstream of the station (if within 35 stream widths of the station), the first riffles above and below the station (if within 35 stream widths of the station), any islands, logjams, or beaver dams within the station, and any specific habitat or environmental problems within or adjacent to the station. At stations with high macro-habitat heterogeneity, more than one data sheet may be required. The variables on this data sheet are as follows:

Stream - Same as for Stream Name on the **Station Summary** data sheet.

Site Mile - Same as for **Station Summary** data sheet.

Station No. - Same as for **Station Summary** data sheet.

Date - Same as for **Station Summary** data sheet.

Distance From Start (column) - The linear distance, measured to the nearest 1 m with a tape measure following the center of the channel, from the downstream end of the station to the downstream end (or middle, in the case of bends) of each Stream Feature that is encountered. The first value in the Distance From Start column is always "0", in order to indicate the Stream Feature at the beginning of the station. The last value should equal the Station Length, from the **Station Summary** data sheet.

Stream Feature (column) - Record the stream macro-habitats encountered while moving upstream from the downstream end of the station. Macro-habitats include bends, riffles, runs, pools, islands, dams, and logjams, and are defined as:

> **Bends**: Curves in the channel where the channel changes from its prevailing direction by at least **60 degrees**. Distances should be measured to and from the center of the bend. Bend angles can be measured with a compass by subtracting the headings of the channel upstream and downstream from the bend.
>
> **Riffles:** Areas of the stream characterized by shallower than average maximum depths and obvious surface turbulence. Water velocity is faster than average. In large streams and rivers, deep, fast riffles are called rapids. During high flows some riffles may become runs.
>
> **Runs:** Areas of the stream with average maximum depths and little or no surface turbulence. Water velocities may be fast or slow, but the water surface appears generally smooth. Runs with slow velocities are sometimes called glides. During droughts, many shallow runs may become riffles.
>
> **Pools:** Areas of the stream with deeper than average maximum depths, with no obvious surface turbulence or broken water. Water velocities are always slow. The longitudinal profile of the stream bed in a pool is often bowl shaped. "Pocket water" refers to groups of small pools located behind boulders or other obstructions to flow, often in areas of otherwise fast or turbulent flow.
>
> **Islands:** Areas of land between the stream banks that are surrounded on all sides by a substantial portion of the stream's water. Areas with nearly all of the stream's flow on one side and minimal flow on the other are not considered islands. The number, position, size, and shape of islands may vary with

water level. Islands must contain soil or numerous rocks; exposed sand or gravel/cobble bars are considered islands, but boulders that project above the water surface are not.

Dams: Intentional structures (constructed by either humans or beavers) that, when in good repair, completely cross the stream channel and block flow. Usually, dams pool water behind them, and there is a sharp drop in water surface elevation at the dam.

Log Jam: A group of three or more large diameter (> 20 cm) intermingled logs partially or completely submerged in the channel that substantially alter flow and sedimentation patterns. When large and dense, log jams may be similar to dams in their appearance and impact on the stream.

Length (column) - The length, to the nearest 1 m, of each macro-habitat feature encountered and listed under Stream Feature.

DISTANCE SUMMARY ----------

Distances Between Bends - The linear distance between the middle of one bend and the middle of the next bend upstream. These distances can be obtained from the Distance From Start and Stream Feature columns and from the map on the back of the data sheet. The summary includes the distances between all bends within and adjacent to the station. The first row is the distance between the first bend within the station and the first bend downstream outside of the station, if there is a bend within a distance of 35 times the mean stream width (MSW) from the downstream end of the station. The second row (1st - 2nd) is the distance between the first and second bends upstream of the downstream end of the station, the third row (2nd - 3rd) is the distance between the second and third bends upstream, and so forth. The row "Last - Upstream" is the distance between the upstream-most bend within the station and the first bend upstream out side of the station, if there is a bend within a distance of 35 times the MSW from the upstream end of the station. The "sum" and "mean" rows summarize all the distances between bends.

Distances Between Riffles - The linear distance between the upstream end of one riffle and the downstream end of the next riffle upstream. The actual length of each riffle is **not** included in this distance. Distances can be obtained from the Distance From Start and Stream Feature columns and from the map on the back of the data sheet, and each row is filled in following the same protocol as for Distances Between Bends.

Length of Individual Riffles, Pools, and Runs - The length of each riffle, pool, and run within the station, starting with the downstream-most one of each type and working upstream to the upstream end of the station. These columns can be filled out using the information in the Stream Feature, and Length columns.

STATION FLOW DATA SHEET

This data sheet is used when calculating instantaneous flow rate, also known as discharge. The data on this sheet are from one location within the station that meets several criteria. The location should be in an area of smoothly flowing water with no obvious turbulence (i.e., a run). The channel should be free of obstructions to the flow of water, and flow should be in a uniform downstream direction (i.e., no eddies). Banks should not be undercut, the bottom should be relatively smooth, and depths should change gradually across the stream.

Discharge is measured using a transect technique, with depths and water velocities measured at set intervals across the width of the stream. Once a suitable location has been chosen, a tape measure is used to determine the actual stream width and to provide a guideline for depth and velocity measurements. Depth and velocity should be measured at a minimum of **10 points** along the transect, and all measurements must be very precise. Stream discharge is the sum of the products of depth, velocity, and width interval for each measurement point. The parameters on this data sheet are as follows:

Stream Name - Same as for Stream Name on the **Station Summary** data sheet.

Site Mile - Same as for **Station Summary** data sheet.

Station No. - Same as for **Station Summary** data sheet.

Date - Same as for **Station Summary** data sheet.

Stream Width - The actual width (nearest 0.1 m) of the stream (wetted portion of channel) along the transect.

Distance from Left Bank - The distance (nearest 0.01 m) along the transect line, perpendicular to the direction of flow, from the left bank (looking upstream) at which depth and velocity measurements are made. In streams wider than 3 m, depth and velocity measurements should be taken **every 0.3 m**. In narrower streams, measurements should be taken at evenly spaced intervals that are narrow enough to allow at least **10 separate measurements**. For example, if a stream is 2.1 m wide, then depth and velocity measurements should be taken every 0.2 m.

Depth - The depth (nearest 0.01 m) of the stream at that point. This should be determined with a calibrated wading staff, such as the one used for making velocity measurements.

Velocity - The velocity (nearest 0.01 m/second) of water at that point on the transect. Velocity should be determined with a high quality current (flow) meter, either an electronic or rotating-cup meter, attached to a calibrated, top-setting, wading staff for accurate and precise placement in the water column. In water shallower than **0.8 m**, a single velocity measurement is made at a depth of **60%** of the distance between the water surface and the bottom of the stream. For example, if the water depth is 0.19 m, then velocity is measured 0.11 m below the water surface. In water deeper than 0.8 m, two velocity measurements are made, one at 20% and the other at 80% of the distance between the water surface and the bottom of the stream. The mean of these two measurements is then used in calculations. For example, if the depth is 1.1 m, then velocity measurements are made 0.22 m and 0.9 m below the water surface.

Cell Width - In most instances, the width (nearest 0.01 m) of the interval between the points where velocity and depth are measured. For all but the first and last points on the transect, the cell width for a particular point is equal to one half the distance between it and the previous point plus one half the distance between it and the next point. If points are evenly spaced (e.g., every 0.3 m), this is equivalent to the distance between two points (e.g., 0.3 m). For the first and last points, the cell widths are somewhat different. For the first point (nearest the left bank), the cell width is equal to the distance between the left bank and the first point plus one half the distance between the first and second points. Thus, if the first point is 0.3 m from the left bank, then the cell width for this point is 0.45 m. For the last point (furthest from left bank and closest to right bank), the cell width

is equal to the distance between the right bank and the last point plus one half the distance between the last and next-to-last point. Thus, if the last point is 3.7 m from the left bank, the stream width is 3.8 m, and the interval between points is 0.3 m, then the cell width for this point is 0.25 m.

Product - Depth times velocity times cell width (make sure units are all in meters). Values in the Product column are summed to give the discharge for the station in cubic meters per second.

TRANSECT DATA SHEET

This data sheet is used for recording information from each of several transects within the station. One data sheet is filled out for each transect. The first transect is located a distance of one times the MSW upstream from the downstream end of the station. Subsequent transects are spaced three MSWs apart. Each transect consists of several measurements or visual estimates, made within 0.3 m x 0.3 m quadrates at set intervals, or along the transect line perpendicular to the flow of water. The number of transects, and hence the number of **Transect Data Sheets**, depends on the length of the station, but is always a minimum of 12.

Stream Name - Same as for Stream Name on the **Station Summary** data sheet.

Site Mile - Same as for **Station Summary** data sheet.

Station No. - Same as for **Station Summary** data sheet.

Date - Same as for **Station Summary** data sheet.

Transect No. - The transect at the downstream end of the station is number 1, the next one upstream is 2, the next one upstream from that is 3, and so on. Thus, each transect data sheet for a station should have a different Transect number.

Distance from Start - The linear distance, following the stream channel, from the downstream end of the station ("Start") to the current transect. This should be measured to the nearest 0.1 m with a tape measure. If all transects are positioned three MSWs apart, and Transect No. 1 is located 1 MSW from the downstream end of the station, then Distance from Start should equal [(Transect No. - 1) x (3 x MSW)] + MSW.

Bankfull Stream Depth – The reporting of this parameter is optional. Bankfull is the volume of water that fills the stream channel to the top of its banks but does not overflow onto the flood plain, and on average occurs every 1.5 years. The tops of point bars or central bars within the active stream channel, the height above the stream that exposed plant roots below an intact layer of soil are visible, and the base of mature alder (Alnus spp.), are good indicators of stream water elevation at bankfull. Bankfull stream depth is measured to the nearest .01m at the deepest point in the stream.

Bankfull Stream Width – The reporting of this parameter is optional. Bankfull stream width is measured to the nearest .01m.

Stream Width - Stream width measurements are taken with a tape measure to the nearest 0.1 m, along the transect line. Stream width is the actual wetted width of the channel along the transect. Islands, isolated pools, backwaters not in contact with the stream at the transect, and wetlands or swamps along the stream are not included in the measurement. If Water Level is "Normal" as recorded on the **Station Summary** data sheet, then the Stream Width is considered to be "Normal" as recorded on the **Transect Data Sheet**. If the water level is substantially (> 0.15 m) above "Normal", sampling should not occur.

Habitat Type - Check the habitat type that exists at the transect line. Check only the predominant type, even if more than one type is present. See the definitions for riffle, pool, and run under the **Station Map** data sheet documentation.

Channel Position Measurements - Several characteristics, including Depth, Embeddedness, Substrate, Algae Abundance, Macrophyte Abundance, and Shading/Canopy, are each measured at five positions along the transect line. Four of these positions are evenly spaced across the channel. To determine these four positions, the Current Stream Width along the transect line is divided into fifths (5 equal segments). Starting from the left bank (facing upstream), measurements are made at each of the four boundaries between segments; i.e., at 1/5

the distance between the left and right banks, at 2/5 the distance, 3/5 the distance, and 4/5 the distance. Each measurement is entered in the appropriate column on the form. For example, if the stream is 2.7 m wide, each of the segments is 0.54 m, and depth measurements are taken along the transect at 0.54, 1.08, 1.62, and 2.16 m from the left bank. In addition to these four positions, measurements are also made at the deepest point along the transect line (the thalweg), wherever that point is located. In some instances, the deepest point will be located at one of the four evenly spaced points, and thus values for all four characteristics will be the same. In other instances, the maximum depth of the channel may occur at two or more points. In this case, measurements should be made at the point of maximum depth that is closest to the middle of the channel.

Water Depth - The depth of the stream at each transect point. This should be determined with a meter stick or calibrated wading staff, such as the one used for making velocity measurements, to the nearest 0.01 m.

Depth of Fines & Water - The total depth of the water plus the depth of sand, silt, or other fine sediments (< 2 mm in diameter) that overlay of comprise the stream bed. Measure to the nearest 0.01 m by pushing a meter stick down into the sediment as far as possible. This combined measurement is later converted to depth of fines by subtracting the Water Depth (above).

Embeddedness of Coarse Gravel and Rubble/Cobble - The degree to which coarse **gravel and rubble/cobble (rocks 16 - 260 mm in diameter**) are surrounded by or covered with sand, silt, and other fine substrates < 2 mm in diameter. Visually estimate this parameter to the nearest 5%. Estimate the average value within a 0.3 m x 0.3 m quadrate on the stream bottom centered on the channel position. As a guide for estimation, if embeddedness is 100%, then rocks are completely buried by fine sediments. If embeddedness is 75%, then rocks are completely surrounded and half covered by fine sediment. If embeddedness is 50%, then rocks are surrounded by sediment but their top surfaces are clean. If embeddedness is 25%, then rocks are half surrounded by fine sediment and their top surfaces are clean. If embeddedness is 0 %, then there is essentially no fine sediment surrounding or covering rocks. Do not confuse attached algae on rocks with fine sediment. Embeddedness values are for all areas of the quadrate with coarse gravel or rubble/cobble substrates; if these two substrate types are absent, then put a dash on the data sheet; embeddedness cannot be estimated.

Percent of the Stream Bottom Covered by - A description of the materials that make up the stream bed, also known as substrate, within the area that is covered by water at Normal Water Levels. Visually estimate the percent composition of the surface of the stream bottom within a 0.3 m x 0.3 m quadrate centered on the channel position. If the bottom cannot be seen, use hands and feet to feel the stream bed. The sum of the values for all substrate categories must equal 100 %. Estimate each category to the nearest 5 %; if a category listed on the sheet is not present in the quadrate, enter a zero for that category. If a bottom type that is not listed on the sheet is present, identify the category and record the percentage next to "Other". Whether the surface of the bottom is a mixture of bottom types (e.g., a sand-fine gravel mixture) or a mosaic of types (e.g., a patch of pure sand in one area and a patch or pure fine gravel in an adjacent area), make an estimate of the percent substrate composition of the surface of the stream bed. The substrate categories are as follows:

Bedrock: Solid, uniform rock bottom.

Boulder: Rocks with a maximum length of 0.26-4.10 m.

Rubble/Cobble: Rocks with a maximum of 0.064-0.26 m.

Gravel: Rocks with a maximum length of 0.002-0.064 m.

Sand: Inorganic material smaller than fine gravel but coarser than silt. The material found on a beach. Maximum length of 0.000062 - 0.0019 m (= 0.062 - 1.9 mm).

Silt: Fine inorganic material, typically dark brown in color. Feels greasy and muddy in hands. Loose; does not retain shape when compacted into a ball. Will not support a person's weight when it makes up

the stream bottom. Maximum diameter of 0.004 - 0.061 mm.

Clay: Very fine inorganic material; individual particles barely or not visible to the naked eye. Either dark brown or gray in color. Feels gummy and sticky in hands; slippery when underfoot. Retains shape when compacted, and partially or completely supports a person's weight when it makes up the stream bottom. Maximum diameter of 0.00024 - 0.0005 mm.

Detritus: Partially decayed organic matter such as leaves, sticks, dead macrophytes, etc. When very fine, may appear similar to silt.

ALGAE (%) - A visual estimate (nearest 10%) of attached and filamentous algae within each quadrate. Filamentous Algae is algae attached to the bottom or banks that forms long filaments, and Attached Algae is algae attached to the bottom or banks that forms a mat or crust, but does not form long filaments.

MACROPHYTES (%) - A visual estimate (nearest 10%) of submergent and emergent plants within each quadrate. Submergent and emergent macrophytes are defined under Percent of Stream with Cover, below.

CANOPY/SHADING (%) - The degree to which canopy vegetation intercepts sunlight to the stream channel. Estimate to the nearest 5% at each channel position using a concave Forest Densiometer (if available). The densiometer should be held at elbow height and read facing upstream. If visual estimates of the percent shading of the stream surface within quadrates are made without the aid of a Densiometer, circle SHADING.

Cover for Fish - Measurements of the length (m) of cover for fish. That is, objects, channel features, or bank features that provide complete shelter from the current or visual isolation from predators or prey for a fish at least 0.20 m in total length, **in water that is at least 0.30m in depth**. Measure, to the nearest 0.01 m, the length of each cover type along the transect line within a 0.3 m wide band centered on the transect. Actual lengths (m) of each cover type along the transect line are recorded and are later used to determine the percentage (length of cover divided by stream width at the transect, times 100) of the transect with cover. If a cover type is absent, enter a zero. Cover types present but not listed on the sheet should be specified and recorded in the row listed "Other". Habitat improvement devices that provide cover are listed under "Other". Cover types are as follows (note that the depths and distances given all apply to Normal Water Levels):

Undercut Banks: Banks that overhang the water by at least **0.30 m** at a point where the water is at least **0.30 m** deep. To be considered cover, the bottom of the undercut bank must be no more than 0.10 m above the water surface.

Overhanging Vegetation: Thick vegetation overhanging the water that meets the same criteria for cover as Undercut Banks.

Woody Debris: Large pieces or aggregations of smaller pieces of wood (e.g., logs, large tree branches, root tangles) located in or in contact with water at least 0.30 m deep.

Other Debris: Pieces of human-made debris found in or in contact with water at least **0.30 m** deep, that provide shelter or visual isolation for fish. Examples include old tires, abandoned farm implements, and discarded home appliances.

Boulders: Rocks at least the size of small boulders (**> 0.25 m**; see Stream Bottom Types) that are located in or in contact with water at least 0.30 m deep. Large pieces of concrete and other artificial rocky aggregates also belong in this category.

Submerged Macrophytes: Vascular plants that normally have all or nearly all of their biomass below the surface of the water. Examples include Potamogeton, Vallisneria, Elodea, Ceratophyllum, and Myriophyllum. To count as cover, submerged macrophytes must be rooted in water at least 0.30 m

deep and must be dense enough to provide shelter or visual isolation for fish.

Emergent Macrophytes: Vascular plants that normally have a significant portion of their biomass above the surface of the water. Examples include bulrushes, sedges, cattails, and water lilies. To count as cover, emergent macrophytes must be rooted in water at least **0.30 m** deep and must be thick or dense enough to provide shelter or visual isolation for fish.

Bank Erosion - The degree to which each stream bank is susceptible to loss of material when inundated by water (either from precipitation or from stream flow during floods) or subject to heavy winds. More simply, the amount of the bank that is exposed soil. For each bank, along the transect-line, measure the length (nearest 0.01 m) of contiguous bare soil from the stream edge up the bank to the first area of contiguous, well-vegetated soil. Record the length of bare soil for each bank separately. **Patchy clumps of vegetation or other bank features (e.g., exposed rock) must be > 0.5 m long or they are counted in the measurement of bare soil**. If the length of bare soil is > 1 m from the stream, record > 1; if there is no contiguous bare soil, record 0. Also, visually estimate the Percent, to the nearest 10%, of the surface area (essentially the length) of each bank that is bare soil. This estimate requires that the crest of the bank be visually determined, and then the area of bare soil from the stream edge to the crest of the bank is visually estimated. If the bank is not easily discernible, estimate the bank erosion within **5 m** of the stream edge. It may help to measure the length of the entire Bank (from stream edge to the crest of the bank), if easily discernable, and then divide into the length of bare soil to obtain the percent bank erosion.

Riparian Land Use - The amount of various land uses on both banks. In our habitat evaluations, we define "banks" as the land from the edge of the stream at normal water level to a point **5 m inland**, following the contours of the land. This definition avoids confusion in identifying the actual banks. There are two major types of land uses within the riparian zone. **Disturbed Land Uses** are unnatural, human-related uses, while **Undisturbed Land Uses** are characterized by relatively unaltered natural vegetation and soils. Visually estimate each category listed below to the nearest 5% for both banks combined. The sum of estimates must equal 100 %. The land use must be > 1 m wide (along the transect- line) to count. If a category listed on the sheet is not present along the transect, enter a zero for that category. If a category that is not listed on the sheet is present, specify the identity of that category and list the percentage next to "Other". The listed categories are as follows:

Disturbed Land Uses

Cropland: Land that is plowed and planted with crops on a yearly basis or is regularly mowed for hay.

Pasture: Land that is regularly grazed by livestock.

Barnyard: Land that is used to confine and feed high densities of livestock. Also known as feedlots, this land often contains little vegetation and large volumes of manure and mud. Usually associated with farmsteads.

Developed (Commercial/Residential/Urban): Includes lands that have been modified for human use. Buildings used for commerce or industry, plus residential buildings. Includes all roads (paved and unimproved), railroads, paths > 2 m wide, parking lots,and yards, etc. Also, parks, playgrounds, golf courses, ball fields, and associated roads, parking lots, etc.

Undisturbed Land Uses

Meadow: Land dominated by grasses and forbs with few woody plants, which is not subject to regular mowing or grazing by livestock.

Shrub: Land dominated by small (< 3 m high) woody plants, such as alders, honeysuckle. or juvenile

box elders and willows.

Woodland: Land dominated by trees (either coniferous or deciduous), most of which are taller than 3 m.

Wetland: Low-lying land that is covered with standing water for much of the year.

Exposed Rock - Land covered by exposed bedrock outcrops, boulders, rip-rap, gabions, or other natural materials along the banks.

Slumping or "cut" banks with little vegetation and exposed soil eroding into the stream are not considered a separate category but are included with the land use found at the top of the bank. For example, an eroding, bare bank in an otherwise wooded area would be include as **Woodland** land use, while a severely eroding bank in a pasture would be included as **Pasture** land use. If a cut bank with a narrow band (1 m wide) of undisturbed land use (e.g., **Meadow**) at the top of the bank is followed by a disturbed land use (e.g., **Pasture**), the cut bank is included as **Meadow**.

Riparian Buffer Width - Measure the width of contiguous Undisturbed Land Uses (above) from the streams edge out 10 m along the transect-line, following the contours of the land, for both banks. If no undisturbed land uses are directly adjacent to the stream, then the riparian buffer width is 0 m; if undisturbed land uses are present from the stream edge to a point > 10 m, then the riparian buffer width is recorded as > 10 m. Riparian buffer widths 10 m from the stream should be measured to the nearest 1 m.

DATA SUMMARY AND INTERPRETATION

The mean of each habitat variable sampled at the transects should be computed. In the case of variables that are sampled at channel positions along transects, the four values (do not include value from the deepest point) should be averaged for each transect and then these numbers should be averaged for all transects.

FISH HABITAT RATING DATA SHEET

The Fish Habitat Rating (FHR) System was developed to objectively assess the relative condition of fish habitat in small (< 10 m wide) cold- and warm-water streams throughout Wisconsin. The underlying assumption of this index is that habitat quality and diversity influence fish population and community structure and diversity. The FHR-Streams score is intended to rate the ability of the physical habitat to support a diverse, healthy fish community.

The FHR-Streams data sheet rates selected habitat variables. Optimal levels are assigned the highest scores; less desirable levels are assigned lower scores. Levels of each habitat variable are categorized as "Excellent", "Good", "Fair", or "Poor", with a corresponding numerical score. The scores for each variable are summed to obtain a total score, ranging from 0-100. An Overall Rating of "Poor", "Fair", "Good", or "Excellent" is assigned based on the total score.

Riparian Buffer Width - The average width of contiguous undisturbed land uses (meadow, shrubs, woodland, wetland, or exposed rock). A mean value of **> 10 m** is assumed to be optimal.

Bank Erosion - The average length of bank that is bare soil. A mean value < 0.20 m is assumed to be optimal. This corresponds to < 10% bank erosion, assuming an average bank height of 2 m for streams < 10 m wide.

Pool Area - The percent of the stream length in pools. A pool area of 40-60% is assumed to be optimal.

Width-to-Depth Ratio - The average width divided by the average thalweg depth in runs and pools. An optimal value of 7 corresponds to an average thalweg depth in run and pool habitats of about 1.2 m for 10 m wide streams and an average thalweg depth of about 0.25 m in runs and pools of 2 m wide streams.

Riffle-to-Riffle or Bend-to-Bend Ratio - The average distance between riffles or between bends, divided by the average width. The option of using either bends or riffles allows the rating of low gradient streams with very few riffles. If both ratios are calculated, use the best of the two scores on the rating form. Bend-to-Bend Ratio can also be determined from recent aerial photographs. An optimum value of 7 was selected.

Fine Sediments - The percentage of the streambed made up of sand, silt, and/or clay. An optimum value of < 10% was chosen.

Cover For Fish - The percentage of the stream area having shelter for fish. This variable measures the abundance of physical objects that provide shelter for trout or other large fish, in addition to deep, slow velocity habitat measured by Pool Area. An optimum of 15% of the stream area was selected for this variable based on our observations in small Wisconsin streams.

Table 1. Gear used for habitat sampling. This table identifies gear used to sample stream habitat. The addresses and phone numbers of the suppliers are presented at the end of this table.

Item	Supplier
Measuring Tapes - Used for measuring short distances	
Keson - Model OTR - 10m - 165	Forestry Suppliers, Inc. Stock #39972, 165 ft., 50 meters
Flagging Tape - Used for marking habitat stations and fish sampling areas	
Biodegradable (lasts for one year) or Vinyl (for a more permanent mark)	Forestry Suppliers, Inc.
Map Gear - Used for determining gradient, sinuosity, and legal description of areas sampled	
Land Locating Map Template - 40 Acre	Forestry Suppliers, Inc. Stock #45660 - Type A
Map Measurer - PECO Swivel Handle	Forestry Suppliers, Inc. Stock #45240
Clipboard - Used for recording and storing data in the field	
Cruiser Mate Sheet Holder	Forestry Suppliers, Inc. Stock #53282
Meter Sticks - Used for measuring depths and other short (< 1 m) distances	
Yardstick - Meter	University Stores Stock #1382
Paper	
"Rite in the Rain" Water-proof paper	J. L. Darling Corp. 8 1/2" X 11" - White - Sub 24
Camera - Used for documentation photographs of habitat before and after improvement	
35 mm Camera	Any camera store
Film - Color Slide Ektachrome - ASA 100, 200 or Kodachrome ASA 64	
Forest Densiometer - Used to estimate overstory canopy density; more objective and precise than visual estimation of stream shading.	
Spherical Crown Densiometer (Concave)	Forestry Suppliers, Inc.
Topographic Maps - Used for locating sampling sites and determination of station characteristics such as gradient, sinuosity, etc.	
7.5" or 15" Topographic Maps	WI Geological & Natural History Survey

Table 1. Gear used for habitat sampling (continued).

Item	Supplier
Aerial Photographs - Used for station mapping (e.g. bend to bend ratio, sinuosity) and/or documentation of historical conditions at a station	
Aerial Photographs Stabilization and Conservation	WI State Agricultural Service (ASCS)
Statewide Aerial Photo. Program	WI Dept. of Trans., Technical Services
County Plat Books - Used to identify landowners when seeking permission to access streams	
County plat books	Most county extension offices Milwaukee Map Service, Inc. Rockford Map Publishers, Inc.

Addresses

Forestry Suppliers, Inc.
205 West Rankin St.
P. O. Box 8397
Jackson, MS 39204
(800) 647-5368

J. L. Darling Corp.
2212 Port of Tacoma Rd.
Tacoma, WA 98421
(206) 383-1714

Milwaukee Map Services, Inc.
959 N. Mayfair Road
Milwaukee, WI 53226
(414) 774-1300
(800) 525-3822

Rockford Map Publishers, Inc.
P.O. Box 6126
Rockford, IL 61125
(800) 447-2222

University Stores
30 N. Murray St.
Madison, WI 53715
(608) 262-3133

Wisconsin Department of Transportation Technical Services
Box 7916, Room 5B
Madison, WI 53707-7916
(608) 266-0309

Wisconsin Geological and Natural History Survey
3817 Mineral Pt. Rd.
Madison, WI 53705
(608) 262-1705

Wisconsin State Agricultural Stabilization and Conservation Service (ASCS) Office
6515 Watts Road, Room 100
Madison, WI 53719
(608) 264-5323

WADABLE STREAM HABITAT EVALUATION **STATION SUMMARY DATA** WISCONSIN DNR

LOCATION

Stream Name: _____ Waterbody ID Code: _____ Site Mile:_____

Station No: _____ Date (YYYY MM DD): _____ _____ _____ Starting Location: _____

_____

Township: _____ Range: _____ Section: _____ 1/16 Section: _____ 1/4 Section: _____

Latitude – Longitude Method used: ____USGS Map ____Mapping Software (Specify-_____) ____GPS Unit, Datum used:_____

Start Latitude: ___ ___ ° ___ ___ ' ___ ___ " ___ ___ Start Longitude: ___ ___ ___ ° ___ ___ ' ___ ___ " ___ ___

End Latitude: ___ ___ ° ___ ___ ' ___ ___ " ___ ___ End Longitude: ___ ___ ___ ° ___ ___ ' ___ ___ " ___ ___

7.5" Quad Name: _____ Basin Name: _____

Watershed Name:_____ County:_____

WATER CHARACTERISTICS

Time (24 hr clock): _____ Air Temperature (C): _____ Water Temperature (C): _____

Conductivity (umhos @ 25 C): (opt.)_____ Turbidity (NTU): (opt.)_____ Dissolved Oxygen (mg/l): (opt.) _____

Flow (ft^3/sec - from Station Flow sheet): _____

Water Level (check one - measure distance if Above or Below Normal): _____ Normal _____ Below: _____(m) _____ Above:_____(m)

Water Clarity: _____Clear _____Turbid _____Stained

CHANNEL AND BASIN CHARACTERISTICS

Stream Widths (m): _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

Mean Stream Width (m): _____ Transect Spacing (m): _____ Station Length (m): _____

Channel Condition (check one): _____ Natural _____ Old Channelization _____ Recent Channelization _____ Concrete Channel

Percent Channelization: _____ Sinuosity: _____

Gradient (m/km): _____ Stream Order:(opt.) _____ Shreve Linkage No:(opt.) _____ Basin Area (km^2):(opt.) _____

Mean Distance Between Bends (m): _____ Mean Distance Between Riffles (m): _____

Total (Sum) Length (m) of All: Riffles: _____ Pools: _____ Runs: _____

Mean Length (m) of Individual: Riffles: _____ Pools: _____ Runs: _____

PHOTOGRAPH DOCUMENTATION (optional)

Looking Downstream from the Downstream end of Station (from middle of stream): Frame #(s): _____ _____ _____

Looking Upstream from Downstream end of Station (from middle of stream): Frame #(s): _____ _____ _____

Looking Downstream from Upstream end of Station (from middle of stream): Frame #(s): _____ _____ _____

Looking Upstream from the Upstream end of Station (from middle of stream): Frame #(s): _____ _____ _____

Person(s) Who Collected Habitat Data:

_____

COMMENTS/NOTES (Continue on the back of this sheet if necessary):

WADABLE STREAM HABITAT EVALUATION **STATION MAP** (p. ____ of ____) WISCONSIN DNR

Stream Name:_____ Site Mile:_____ Station No.:_____ Date (YYYYMMDD):_____ _____ _____

DISTANCE FROM START (m) | STREAM FEATURE (Bend, RIffle, Pool, Run, Log Jam, etc.)

0

DISTANCE SUMMARY

Distances Between Bends (m):

Downstream - 1st: _____
1st - 2nd: _____
2nd - 3rd: _____
3rd - 4th: _____
4th - 5th: _____
5th - 6th: _____
6th - 7th: _____
7th - 8th: _____
8th - 9th: _____
9th - 10th: _____
10th - 11th: _____
11th - Upstream: _____
Sum: _____
Mean: _____

Distances between Riffles (m):

Downstream - 1st: _____
1st - 2nd: _____
2nd - 3rd: _____
3rd - 4th: _____
4th - 5th: _____
5th - 6th: _____
6th - 7th: _____
7th - 8th: _____
8th - 9th: _____
9th - 10th: _____
10th - 11th: _____
11th - Upstream: _____
Sum: _____
Mean: _____

Length (m) of Individual Riffles, Pools, and Runs

1st Riffle: _____	1st Pool: _____	1st Run: _____
2nd Riffle: _____	2nd Pool: _____	2nd Run: _____
3rd Riffle: _____	3rd Pool: _____	3rd Run: _____
4th Riffle: _____	4th Pool: _____	4th Run: _____
5th Riffle: _____	5th Pool: _____	5th Run: _____
6th Riffle: _____	6th Pool: _____	6th Run: _____
7th Riffle: _____	7th Pool: _____	7th Run: _____
8th Riffle: _____	8th Pool: _____	8th Run: _____
9th Riffle: _____	9th Pool: _____	9th Run: _____
10th Riffle: _____	10th Pool: _____	10th Run: _____
11th Riffle: _____	11th Pool: _____	11th Run: _____
Sum: _____	Sum: _____	Sum: _____
Mean: _____	Mean: _____	Mean: _____

DRAW MAP OF STATION ON BACK OF THIS SHEET (optional)

Stream Name: _____ Site Mile: _____ Station No.: _____ Date (YYYYMM DD):_____ ____ ____

Stream Width (m):_____

Distance from Left Bank: (m)	Depth: (m)	Velocity at 60% of Depth: (m/sec)	Cell Width (m)	Product (Depth x Velocity x Cell Width)

FLOW = Σ PRODUCTS = _____ m^3/sec.
(To convert to cubic feet per second, multiply by 27)

WADABLE STREAMS HABITAT EVALUATION **TRANSECT DATA**
WISCONSIN DNR

Stream Name:_____ Site Mile:_____ Station No.:_____ Date (YYYY MM DD):_____
_____ _____

Transect No.:_____ Distance from Start (m):_____ Stream Width (m): _____

Habitat Type (check): _____Riffle _____Pool _____Run Bankfull Depth (m):(opt.)_____ Bankfull Width (m):(opt.)_____

_____
_____

	Channel Position (fifths of current stream width and deepest point) 1/5	2/5	3/5	4/5	Deep
Water Depth (m)	_____	_____	_____	_____	_____
Depth of Fines & Water (m)	_____	_____	_____	_____	
Embeddedness (nearest 10%) of Coarse Gravel and Rubble/Cobble	_____	_____	_____	_____	

_____
_____

Percent (nearest 10%) of Stream Bottom Covered by:

BEDROCK (solid slab)	_____	_____	_____	_____
BOULDER (>.25 m)	_____	_____	_____	_____
RUBBLE/COBBLE (.065-.24)	_____	_____	_____	_____
GRAVEL (.002-.064)	_____	_____	_____	_____
SAND (.000062-.0019)	_____	_____	_____	_____
SILT (.000004-.000061)	_____	_____	_____	_____
CLAY	_____	_____	_____	_____
DETRITUS	_____	_____	_____	_____
OTHER (Specify-_____)	_____	_____	_____	_____

_____
_____

ALGAE (attached & fila., %)	_____	_____	_____	_____
MACROPHYTES (%)	_____	_____	_____	_____
CANOPY/SHADING (%)	_____	_____	_____	_____

_____
_____

Cover for Fish (m): Length (nearest 0.01 m) of transect (within 0.3 m upstream or downstream) with:

_____Undercut Banks _____Overhanging Vegetation _____Woody Debris _____Other Debris

_____Boulder _____Submerged Macrophytes _____Emergent Macrophytes _____Other (Specify-

_____)

Bank Erosion: Length (nearest 0.01 m), within 1 m of stream, and % of entire bank, along transect, with bare soil:

LEFT: _____ m _____% RIGHT: _____ m _____%

Riparian Land Use: Percent (nearest 10%) of bank (within 5 m of stream edge, along transect) with:

_____Cropland _____Pasture _____Barnyard _____Developed _____Other(Specify-_____)_____

_____Meadow _____Shrubs _____Woodland _____Wetland _____Exposed Rock

---

Riparian Buffer Width (m): Length (nearest 0.1 m) of undisturbed land uses along transect, within 10 m of stream:

LEFT BANK: _____m RIGHT BANK: _____m

Using the Index of Biotic Integrity (IBI) to measure environmental quality in Wadeable Streams of Wisconsin (Lyons, 1992, Lyons et. al, 1996)

Taken from ***Evaluation of the Wisconsin Priority Watershed Program for Improving Fish Communities*,** developed by Lizhu Wang, John Lyons, and Paul Kanehl (Rivers and Streams Group, Fish Research Section, Wisconsin Department of Natural Resources,1350 Femrite Drive, Monona, WI 53716) Revised April 1995 (Modified from Timothy Simonson and John Lyons 1993)

General Sampling Procedures - Mean stream width (MSW) is an important characteristic of each station. The MSW is used to define the length of the station, the distance from the station to unusual features or disturbances (e.g., bridges, etc.), and the spacing of habitat measurements (i.e., distances between transects. See the Fish Habitat Evaluation). The MSW is based on the mean of about 10-15 equally spaced preliminary measurements of stream width from throughout the station (within approximate station boundaries), including all types of macro-habitats. If the water level appears to be substantially (**> 0.15 m**) above normal, sampling should not occur (see Station Summary, Fish Habitat Evaluation, for determination of water levels). Once the MSW for a station has been determined, this value is used for **all** future sampling, including future years when riparian land use or instream habitat improvements may have changed the actual stream width.

Stations on Treatment and Reference stations are each approximately **35** times the MSW in length. This length is based on the distance necessary to capture most species present and on a desire to sample > 3 pool-riffle sequences. If a stream has well-developed pool-riffle structure, then each station starts and ends at the base of a riffle, even if this requires that stations be somewhat more than 35 times the MSW in length. Stations should not contain permanent tributaries or hydraulic controls (e.g., dams, old bridge abutments), and should be a distance of at least 10 times the MSW away from bridges. Habitat should be sampled each time fish are sampled. Sampling of fish is done in the same reach of stream that is sampled for habitat.

Fish community composition and species relative abundance are estimated over the entire length of each station using catch per effort (CPE) sampling procedures. A single electroshocking run is made from the downstream to upstream end of the station. No blocking nets are used. This constitutes the one and only sampling pass. All fish (> 26mm in total length) and crayfish observed are collected. At the end of the pass, all fish and crayfish are counted and weighed, in aggregate, by species. Trout, esocids, carp, creek chubs, catostomids, bullheads and catfishes, centrarchids, and selected percids (non-darters) are measured in total length (Table 1). If > 200 fish are captured of any given species, a random subsample of 200 are measured. For trout, esocids, smallmouth bass, largemouth bass, sauger, and walleye, scales and individual weights are taken from five fish for each 10 mm length interval (Table 1). Fish should be handled carefully to minimize mortality. After processing, fish are released alive back into the station. Small numbers of each species may be preserved as voucher specimens or to check identifications. All crayfish should be retained if reliable field identification is not possible.

DATA COLLECTION

Fish Community Evaluation - Three different data sheets are used in the Fish Community Evaluation: **Station Summary, Catch Summary,** and **Individual Fish Data.** All three sheets apply to the whole station. There is one **Station Summary** sheet per station and one or more of each of the other sheets, depending on the number and diversity of fish captured. Guidelines for filling out each sheet and examples of blank and completed sheets are given on the following pages.

STATION SUMMARY DATA SHEET

This sheet summarizes location, sampling characteristics, and gear used for the entire station. Some of the data on this form are derived from maps or from other data sheets. The location information should be identical to that collected during the Fish Habitat Evaluation. The parameters on this sheet are as follows:

LOCATION ----------

Stream Name - The name of the stream as shown on the most recent USGS 7.5" topographic map. The name used here should be identical to that used on the other data sheets, and to that used for all other stations on the same stream. Make sure the spelling of the name is accurate and include all parts of the stream name (e.g., "West Branch", "Middle Fork", "River", "Creek", "Brook", "Run", etc.) to avoid confusion. Other commonly used names for the stream can be written here in parentheses.

Waterbody ID Code - A unique seven-digit number that identifies each stream; all streams, rivers, and lakes in Wisconsin have an assigned number. These numbers are available from the WDNR Master Waterbody File. As with Stream Name, waterbody ID code should be the same for all stations on a stream.

Site Mile - The distance along the stream channel from the mouth of the stream to the downstream end of the station. This distance is a useful shorthand for indicating and identifying the location of the station. Site mile should be measured on the most recent USGS 7.5" topographic map to the nearest 0.1 mile using a map wheel.

Station No. - If a stream has two or more stations, the downstream station is number 1, the next upstream is number 2, and so on. If there is only one station, the number is 1.

Date - Fill in the date when the fish community data were collected for the station. To avoid confusion about which is the month and which is the day (e.g., to some people 6/7/90 is June 7 but to others it is July 6), use the YYMMDD format (e.g., 900607 equals 7 June 1990).

Starting Location - A precise verbal description of the point on the stream where the fish sampling began (i.e., the downstream edge of the station). The description should include the exact distance and direction from the start to a "permanent" landmark such as a bridge, building, road marker, rock formation, etc. Avoid using landmarks that might be lost during future years (e.g., don't use tree or fence lines). Make the description as specific and precise as possible so that someone visiting the station for the first time can easily find the starting point. Installation of a permanent stake to mark the downstream end of the station is desirable if conditions permit. Be sure to confer with the landowner if the stake could interfere with the normal use of that area.

Township, Range, Section, 1/16 Section, 1/4 Section - Legal description for the Starting Location of the station within the Public Lands System. These can be determined from recent USGS 7.5" topographic maps or a detailed county map. On a topographic map, a "land locator" template is useful for determining the 1/16 and 1/4 Sections, which are indicated by a compass direction (NW, NE, SW, or SE). Note that in Wisconsin, all Townships are "N" (north), but Range can be either "E" or "W" (east or west). Make sure the appropriate letter is included for both Township and Range.

7.5" Quad Name - The name of the most recent USGS 7.5" topographic map on which the station is found.

PW Basin Name - The name of the Priority Watershed (PW) in which the station is found, following the designations of the WDNR Nonpoint Source and Land Management Section (e.g., Lower Grant, Middle Trempealeau, Black Earth Creek, etc.). For Reference Stations, record the name of the Priority Watershed for which it is serving as a reference.

County - The name of the county in which the station is located.

SAMPLING DESCRIPTION ----------

Sampling Type - The type of fish sampling done at the station. Check the appropriate category. Generally, during Priority Watershed evaluations, single pass catch per effort (CPE) sampling is done. In special cases, other types of sampling, such as "Depletion" or "Mark-Recapture" may also be done at a station.

Station Length - The length, following the stream channel, of the station. Measure with a tape measure to the nearest 1 m.

Number of Passes - The total number of times a shocker is passed through the station during fish sampling. Normally, for "CPE" sampling there will be only one upstream pass, and for "Depletion" sampling there will be four or more passes. During depletion sampling, an upstream and then downstream run is usually regarded as "1" pass, but the fish captured are processed separately (see Type of Pass below).

Time - The time range during which the shocking was conducted. "Start" refers to the time when the first shocking pass was started, and "Finish" refers to the time when the last shocking pass was completed. Use military time, to the nearest 10 minutes.

Type of Pass - A description of the direction of sampling through the station during a pass. "Upstream Only" refers to a pass that begins at the downstream end of the station, proceeds upstream, and then ends at the upstream end of the station. This is the type of pass used for "CPE" sampling. "Upstream, then Downstream" refers to a pass that begins at the downstream end of the station, proceeds upstream to the upstream end of the station, and then proceeds back downstream to the downstream end of the station. This is the type of pass used in "Depletion" sampling, and constitutes "1" pass; a minimum of 4 passes are completed for depletion sampling.

GEAR DESCRIPTION ----------

Gear - A description of the number and type of electroshockers used in sampling. Specify the number of each type of gear that applies. Sampling will normally involve one or two backpack shockers or one stream shocker.

Number of Anodes per Unit - The number of anodes per shocker. Normally there is one for backpacks and two or three (three preferred) for stream shockers.

Blocknets - Record the number and mesh size of any blocknets used. For "CPE" sampling, no blocknets are used. For "Depletion" sampling, use a single downstream and a single upstream blocknet. When blocknets are used, the mesh size of each net should be recorded.

For Backpacks and Stream Shockers:

Anode Size - The length of the long axis of the anode (the diamond-shaped or circular stainless steel tip on the hand-held probe), measured with a tape measure to the nearest 0.001 m. If multiple anodes are used on a shocker, they must all have the same Anode Size, Shape, and Material Thickness. Anode Size can be changed (by replacing the tip with a larger tip, or covering part of the tip with electrical tape) if necessary to maintain a relatively constant voltage and amperage.

Anode Material Thickness - The thickness (diameter) of the metal used to form the tip of the anode. Measure with calipers or a ruler to the nearest 0.0001 m.

Anode Shape - The general shape of the metal tip of the anode.

For Mini-Boom Shockers:

Anode Length - The length of the exposed metal portion of the cylindrical dropper(s) that come off the boom and dangles into the water. Measure with a tape measure to the nearest 0.01 m.

Anode Diameter - The outside diameter of the exposed metal portion of the droppers on the front boom. Measure with calipers or a ruler to the nearest 0.001 m.

Number of Front Droppers - The number of individual droppers on the front boom.

METER READINGS ----------

Type of Electroshocker Current - The type of electrical current (AC, DC, or pulsed DC) that the shocker puts into the water (this will often be different from that put out by the generator in the shocker). Check the appropriate category.

Electroshocker Control Box Meter Readings - The typical output readings (i.e., not the extreme high or low readings) observed during sampling. Note the units of amperage and voltage for the meters when recording the meter values. Efforts should be made to keep readings fairly constant during shocking within a station, between stations within a stream, and, if possible, among samples of the same station over time. Preliminary sampling just downstream of the station may be necessary to determine the output readings associated with the most effective shocking. As a rule of thumb, try to keep voltage above 150 V and **average** amperage above 2 A. Voltage can be adjusted by changing the number and surface area of anodes (see below), and amperage can be adjusted by increasing generator output (adjusting generator throttle, using a boost switch if present, or using a generator with a different power rating). For AC or

pulsed DC, some control box output ammeters read peak rather average amperage; if this is the case, this should be noted on the sheet. Peak amperage equals four time average amperage. If output meters are not present or are broken, note this on the sheet. Always try to use shockers with functioning output meters.

If Pulsed DC - This refers to two important parameters, "Pulse Rate" and "Duty Cycle", of pulsed DC current. Some shockers allow values for these parameters to be varied, whereas others have a single fixed value for each parameter. If values can be varied, they should be set to the appropriate level at the beginning of sampling and not changed during sampling. This may require preliminary sampling just outside the station to determine the values where shocking is most effective. The same values should be used for all sampling within a station, between stations within a stream, and among samples of the same station over time. Sampling for many species is most effective and least harmful at Pulse Rates of 40-80 per second and at Duty Cycles of 10-20 %.

COMMENTS/NOTES - Any and all information that seems to be relevant to the fish community survey but is not recorded anywhere else on the data sheets. This information should include weather, water, and habitat conditions (e.g., glare, wind, precipitation, water clarity, unusually deep or shallow areas) and gear performance (e.g., problems with generators or meters) that influenced sampling effectiveness. Any evidence of fish kills (i.e., dead fish in the water or on the bank) or angler use of the stream (e.g., hooks and lines caught in bushes; evidence of cleaned fish on the bank; footprints from waders) should also be noted. Don't hesitate to make comments; if in doubt, write it down.

CATCH SUMMARY DATA SHEET

This data sheet is for summarizing and recording the numbers and aggregate weights, by species, of fish captured during each sampling pass. There should be a separate **Catch Summary** data sheet for each upstream and each downstream run. In other words, if an upstream and then downstream run are completed, the runs should be kept separate; fill out a data sheet for the upstream run, and then fill out an additional data sheet for the downstream run. Thus, depending on the number passes and species captured, there may be more than one of these data sheets for each station. The parameters on this sheet are as follows:

Stream - Same as for **Station Summary** data sheet.

Site Mile - Same as for **Station Summary** data sheet.

Station No. - Same as for **Station Summary** data sheet.

Date - Same as for **Station Summary** data sheet.

Pass Number - The pass that this data sheet refers to. The first pass through a Station is "1", the second pass is "2", the third pass is "3", and so on. For CPE sampling, only one pass is used. For depletion sampling, 4 or more passes should be used.

Pass Direction - Record the direction of the pass (either upstream or downstream) used to capture the fish recorded on this data sheet. There should be a separate **Catch Summary** data sheet for each upstream and downstream run. In other words, if an upstream and downstream run are completed, the runs should be kept separate; fill out a data sheet for the upstream run, and then fill out an additional data sheet for the

downstream run.

Time - The starting and ending time of actual fish shocking for the pass should be recorded here. If the shocking run is interrupted (e.g., to work up fish when the holding tub is too full, or due to equipment failure, etc.) the time of the interruption should be noted as the End time; the time actual shocking was resumed and finally ended should be recorded in the parentheses. Elapsed shocking time (in minutes) should be recorded after Total.

CATCH SUMMARY ----------

This section of the data sheet is used to summarize the identity, total number, total weight, number of fish with deformities, eroded fins, lesions, and tumors (DELT), number of handling mortalities, the number of voucher specimens retained, and the number of marked or recaptured fish for each species captured. For species that are individually measured (Table 1), transcribe these totals from the **Individual Fish** data sheet.

Species - The identity of each species captured during the pass. Only accepted American Fisheries Society common names should be used (see Robins et al. 1991. Common and scientific names of fishes from the United States and Canada. AFS Special Publication No. 20). If any abbreviations are used, they should be used consistently and explained somewhere on this data sheet. If an exact species identity is unknown, identity fish to lowest possible taxon (i.e., to genus or family), and preserve all the specimens of that species for later complete identification.

Number Caught - The total number of a species captured during the pass.

Weight - The total wet weight (g) of all fish of a species captured during the pass. Weigh to the nearest 0.1 g or to the nearest 1 % of total weight, whichever is larger. For example, for a species with an aggregate weight of about 8 g, weigh to the nearest 0.1 g; for a species with an aggregate weight of about 60 g, weigh to the nearest 1 g; for a species with an aggregate weight of about 250 g, weigh to the nearest 3 g; for a species with an aggregate weight of about 1450 g, weigh to the nearest 15 g; and so on. Weigh groups of fish in a net or plastic bag using an appropriately sized Pesola spring balance (Gross weight), and don't forget to subtract the weight of the net or bag (Tare weight) to get the actual weight of the fish (FINAL weight).

Number DELT - The total number of fish of a species that have Deformities, Eroded fins or scales, Lesions, or Tumors ("DELT"). Only obvious deformities, eroded fins or scales, lesions, and tumors observed on live fish should be counted. Electroshocking sometimes causes wounds or burns; do not count these as DELT.

Handling Mortalities - The total number of fish of a species killed as a result of the sampling. Every effort should be made to kill a minimal number of fish, but some mortality is inevitable. Only fish that are definitely dead should be counted.

Number Vouchers - The total number of fish of a species that were retained as vouchers or to check identification. All fish that cannot be identified to species with certainty should be preserved in 10% formalin. Also, up to 25 fish per species should be preserved one time at each station to serve as vouchers and checks on identifications.

Number Marked - The number of fish of a species marked or tagged and released alive (for mark and recapture population estimates or for movement studies) during the pass.

Number Recaptured - The number of fish of a species from the pass which possess a mark or tag from a previous sampling event.

Lab Check (Vouchers) - When voucher specimens are preserved, verify the Number Vouchers retained and record a check in the "Number" column. If the number preserved (after a lab count) does not match the Number Vouchers, record the correct number under Number Vouchers. Verify the identification of vouchers and record a check in the "ID" column. If the field identification (under Species) was incorrect, based on a lab examination, change Species to the correct identification.

INDIVIDUAL FISH DATA SHEET

The Individual Fish Data Sheet is used to record lengths, weights, and other information for individual fish captured during a pass. Thus, depending on the number of fish captured and the number of passes made, there may be from one to more than four of these data sheets for each station. Only fish for which total lengths are to be measured need to be recorded on this sheet (Table 1). Trout, esocids, smallmouth bass, largemouth bass, sauger, and walleye should be measured and weighed individually. Carp, creek chubs, catostomids, bullheads and catfishes, rock bass, sunfish, crappies, and yellow perch should be measured individually in total length and weighed in aggregate (Table 1). All other species not mentioned above should be counted and weighed in aggregate. The total number, aggregate weight, and number DELT, number of handling mortalities, number of vouchers, number marked, and number recaptured of each species should be transcribed to the **Catch Summary** data sheet. The parameters on this sheet are as follows:

Stream - Same as for **Station Summary** data sheet.

Site Mile - Same as for **Station Summary** data sheet.

Station No. - Same as for **Station Summary** data sheet.

Date - Same as for **Station Summary** data sheet.

Pass Number - Same as for **Catch Summary** data sheet.

Pass Direction - Same as for **Catch Summary** data sheet. If an upstream and then downstream run are completed, the runs should be kept separate; fill out a data sheet(s) for the upstream run, and then fill out an additional data sheet(s) for the downstream run.

Species - The identity of each species captured and measured during the pass. To make data summary and computer data entry easier, try to record only one species per **Individual Fish** data sheet. Follow guidelines from the **Catch Summary** data sheet for recording species identities.

Total Length - The distance from the tip of the snout to the posterior tip of the longest caudal (tail) lobe of each individual fish. The caudal lobes should be pinched together slightly when measuring this distance. Measure, to the nearest 0.001 m, using a meter stick or measuring board.

Weight - The wet weight of each individual fish. Weigh to the nearest 0.1 g or 1 % of body weight, whichever is larger (see explanation under Aggregate Weight for the **Catch Summary** data sheet) with an appropriately sized Pesola spring balance. Weights and scales (see below) should only be taken for up to five fish from each 10 mm total length interval, and then only for the following species: trout, esocids, smallmouth and largemouth bass, sauger, and walleye (Table 1). A Tally Sheet (attached) can be used to keep track of the number of fish that have been weighed for each species and size class.

Scales? - An indication (Yes or No) of whether a fish had scales removed and saved. Scales are removed to aid in aging fish. At least 6 scales should be removed from a spot on the right side of the fish, several scale rows above the lateral line at a position just posterior to the tip of the pectoral fin when that fin is laid flat along the body. For each species of fish, always take scales from approximately the same

location. Scales should only be taken from up to 10 fish per 10 mm total length class, and then only for trout, esocids, smallmouth and largemouth bass, sauger and walleye (see "Weight" above). The tally sheet can be used to keep track of the number of fish for each size class that have had scales removed. Scales need not be taken from fish less than 80 mm total length. Scales should be saved in scale envelopes (available from most WDNR offices) that have accurate location, date, species identity, length, weight, and capture information recorded on them.

Marked? - An indication of whether a fish was marked during this pass. A mark might involve clipping a fin, inserting a tag, or both. If a fin was clipped, the identity of the fin should be given in this column using the following codes: UC = upper caudal, LC = lower caudal, RP = right pectoral, LP = left pectoral, RV = right ventral, LV = left ventral, AN = anal fin, DO = dorsal fin. If the fish was tagged, then the color or number (if numbered) of the tag should be recorded here.

Recapture? - An indication of whether a fish captured during this pass had been marked during a previous pass. If the fish had been marked, the mark or tag number should be identified in this column as described under Marked? (see above).

DELT Description - A brief description of the location and type of Deformities, Eroded fins or scales, Lesions, or Tumors ("DELT") observed on a fish. Only obvious DELTs observed on live fish should be recorded. Electroshocking sometimes causes wounds or burns; do not count these as DELTs. If no DELTs were apparent, leave this space blank.

Table 1. Species or groups of species that should be measured individually in total length (mm) and weighted (g), as well as species from which scales should be taken. Individual weights should be recorded for five fish from each 10 mm total length interval. Scales should be taken from five fish for each 10 mm total length interval. All other species not mentioned here should be counted and weighed in aggregate.

Total Lengths Only	Individual Total Lengths, Weights, Individual and Scales
Cyprinids	**Trout**
Carp (Cyprinus carpio)	Rainbow trout (Onchohynchus mykiss)
Creek chub (Semotilus atromaculatus)	Brown trout (Salmo trutta)
	Brook trout (Salvelinus fontinalis)
Catostomids	**Esocids**
Carpsuckers (Carpiodes spp.)	Grass pickeral (Esox americanus)
Longnose sucker (Catostomus catostomus)	Northern pike (Esox lucius)
White sucker (Catostomus commersoni)	Muskellunge (Esox masquinongy)
Blue sucker (Cycleptus elongatus)	
Chubsukers (Erimyzon spp.)	**Centrarchids**
N. hog sucker (Hypentelium nigricans)	Smallmouth bass (Micropterus dolomieu)
Buffalos (Ictiobus spp.)	Largemouth bass (Micropterus salmoides)
Spotted sucker (Minytrema melanops)	
Redhorses (Moxostoma spp.)	**Percids**
	Sauger (Stizostedion canadense)
Ictalurids	Walleye (Stizostedion vitreum)
Bullheads (Ameiurus spp.)	
Channel catfish (Ictalurus punctatus)	
Flathead catfish (Pylodictis olivaris)	
Centrarchids	
Rock bass (Ambloplites rupesteris)	
Sunfish (Lepomis spp.)	
Crappies(Pomoxis spp.)	
Percids	
Yellow perch (Perca flavescens)	

PW FISH COMMUNITY EVALUATION **STATION SUMMARY** **WISCONSIN DNR**

LOCATION

Stream Name: _____ Waterbody ID Code: ____ ____ ____ ____ ____ ____ ____ Site Mile:_____

Station No: _____ Date (YYMMDD): _____ _____ _____ Starting Location: _____

_____

Township: _____ Range: _____ Section: _____ 1/16 Section: _____ 1/4 Section: _____

7.5" Quad Name: _____ PW Basin Name: _____ County: _____

SAMPLING DESCRIPTION

Sampling Type (check one): _____ CPE _____ Depletion _____ Mark-Recapture _____ Other - Specify: _____

Station Length (m): _____ Number of Passes: _____ Time (24 hr clock): Start: _____ Finish: _____

Type of Pass (check one): _____ Upstream Only _____ Upstream, then Downstream _____ Other - Specify: _____

GEAR DESCRIPTION

Gear (indicate number of each type used): _____ Backpack Shockers _____ Stream Shockers _____ Mini-Boom Shockers

_____ Other - Specify: _____

Number of Anodes per Unit: _____

Block nets (indicate number and mesh size): _____ Upstream Block Nets (mesh:_____) _____ Downstream Block Nets (mesh:_____)

For Backpacks and Stream Shockers:

Anode Size (long axis or diameter, m): _____ Anode Material Thickness (diameter: m): _____

Anode Shape (check one): _____ Diamond _____ Hoop _____ Other - Specify: _____

For Mini-Boom Shockers:

Anode (front dropper) Length (m): _____ Anode (front dropper) Diameter (m): _____

Number of Front Droppers: _____

METER READINGS

Type of Electroshocker Current (check one): _____ AC _____ DC _____ Pulsed DC

Electroshocker Control Box Meter Readings: Voltmeter (V): _____ Ammeter (A): _____

If Pulsed DC: Pulse Rate: _____ Duty Cycle (%): _____

COMMENTS/NOTES (Continue on the back of this sheet if necessary):

Revised April 1995

PW FISH COMMUNITY EVALUATION **CATCH SUMMARY (p. ___ of ___)** **WISCONSIN DNR**

Stream: _____ Site Mile: _____ Station No.: _____ Date (YYMMDD): _____ _____ _____ Pass Number:_____

ime: Start:_____ End:_____ (Start:_____ End:_____) Total (min):_____ Pass Direction (up or down): _____

		Weight (g)									
	Number						Lab Check				
Species	Caught	Gross	Tare	FINAL	DELT	Mortalities	Number Vouchers	Handling Marked	Number Recaptured	Number	Number ID (vouchers)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

16

17

18

19

20

21

22

23

24

25

PW FISH COMMUNITY EVALUATION **INDIVIDUAL FISH DATA** **WISCONSIN DNR** **(p. ___ of ___)**

(Carp, Creek chubs, Catostomids, Bullheads and Catfishes, Rock bass, Sunfish, Crappies, Yellow perch)

Stream: ____ **Station No.**: _________ **Date** (YYMMDD):_______ _______ _______

Species: ____ **Species**:

Aggregate Wt. (g)	Total Number	TL (mm)	TL (mm)	TL (mm)	Agg. Wt. (g)	Total No.	TL (mm)	TL (mm)	TL (mm)

PW FISH COMMUNITY EVALUATION **INDIVIDUAL FISH DATA** **WISCONSIN DNR** **(p. ___ of ___)**

(Trouts, Grass pickeral, Northern pike, Muskellunge, Smallmouth bass, Largemouth bass, Sauger, Walleye)

Stream: ____ **Station No.**: ___________ **Date** (YYMMDD):_______ _______ _______

Species	TL (mm)	Wt (g)	Scale	DELT	Species	TL. (mm)	Wt (g)	Scale	DELT

Overview of Potential Impacts to Macroinvertebrate Communities Caused by River Impoundments.

1. Flow Regime.
2. Water Quality.
3. Habitat.
4. Energy Flow.

The alteration of river flow regimes can have multiple impacts on aquatic invertebrate communities. Natural changes in stream flow are an environmental cue to some invertebrate taxa. Changes in flow regime stimulate larval development and emergence of adult forms. Diurnal drift of occurs in many of invertebrates. While it is unclear why invertebrates drift, it is an important dispersal mechanism, and provides food for other invertebrates and fish.

Water quality can have a significant influence on lotic invertebrate communities. Warming of impounded water and associated reductions in dissolved oxygen results in a shift towards an invertebrate community composed of taxa tolerant of lower D.O. Warming of impounded water may alter the rate of macroinvertebrate development.

River habitat particularly sedimentation of impounded areas will significantly alter the invertebrate community found there. Impoundments may also reduce the quantity of sediment flowing downstream which may improve downstream habitat in rivers where sedimentation is impacting the invertebrate community.

Downstream movement of allocthonous inputs can be an important energy source for invertebrates. Invertebrate communities downstream of impoundments may show reduced numbers or productivity if food sources are blocked by impoundments. Conversely, impounded areas that export phytoplankton can cause a downstream increase in “collector” and filter-feeding invertebrate biomass.

BENTHIC INVERTEBRATE SAMPLING - KICK SAMPLES

A. Scope:

Kick-sampling sites are limited to those areas accessible by wading. Many different substrate types and habitats can be sampled with a kick net, as long as organisms can be dislodged from the substrate into the water column for capture in the net. The kick net is especially well adapted to sampling swift current areas in streams and can provide for a rapid assessment of the fauna there with a minimum of effort.

B. Equipment:

The kick net is generally available with a mesh opening size of 800 X 900 microns, or .032 X .036 inches. Smaller mesh openings are advisable, and if available, should be no larger than Standard U.S. #30 mesh (589 microns or .0236 inches). Associated equipment appears below.:

C. Site Selection:

The basic site selection criterion is that sampling sites within a stream reach should have similar habitat characterisics. Of particular importance is substrate and current velocity. Riffles, where flow is rapid and the substrate is composed of coarse gravel and medium rubble/cobble stones, are the preferred sampling habitat.

1. Sample similar habitat at sites if at all possible (for example do not sample a gravel riffle upstream and debris in a slower velocity area downstream);
2. Riffles with coarse gravel and medium sized cobble/rubble substrates are preferred;
3. Sample areas with a flow velocity of at least 1.0 ft/sec., preferably with coarse gravel and medium sized cobble/rubble. In lower velocity streams this may not be feasible but sampling below 0.5 ft/ sec. should be avoided. Slow flowing, silted-bottomed streams presently cannot be evaluated with the biotic index (Hilsenhoff 1987);
4. Avoid areas directly downstream from impoundments or bridges;
5. Avoid sampling silty substrates;

6. Avoid sampling along the stream margins;
7. Avoid sampling macrophytes or filamentous algae if possible;
8. When conducting routine investigations to spot check water quality, the sampling of snags or debris in faster flowing water may be used in the absence of appropriate riffle habitat. However, the investigator should be aware of the problems associated with samples collected from other than riffle habitat. The variability and reliability associated with samples collected from habitats other than riffles can make it difficult to interpret the data;
9. When collecting macroinvertebrate data for enforcement purposes, evaluation of site specific impacts in upstream downstream studies, or other potentially sensitive situations, and comparable riffle habitat is unavailable, the investigator should use artificial substrates to standardize comparisons (1001.6);

D. Replicate Sampling

For routine monitoring replicate samples are not required. When analysis of the data will include metrics more variable than the HBI additional samples may be collected. When conducting investigations for enforcement purposes, evaluation of site specific impacts in upstream/downstream studies, evaluation of site specific improvements in before and after studies, or other potentially sensitive situations the investigator should collect three replicate samples. It may not be necessary to process all samples, but replicates should be available if needed.

E. Sampling Season Considerations

Macroinvertebrate sampling in Wisconsin should generally be conducted during either the fall or spring. **Here we recommend fall.** The fall sampling season should include the months of September and October. The spring sampling season should include the months of April and May (with some restrictions). Samples should be collected in the same season from year to year, if possible, to insure that multi-year data is comparable. Some general considerations should be carefully weighed before deciding which season should be selected.

If the investigator is using macroinvertebrate samples to monitor for lowered dissolved oxygen concentrations associated with organic enrichment or elevated water temperatures, the following considerations should be incorporated into the study design to improve the ability to detect water resource impacts. During summer the effects of organics are at their greatest forcing intolerant species to migrate out of impacted areas, thereby modifying the macroinvertebrate community structure and resulting in water quality ratings that reflect the limiting factors that organically enriched NPS pollution or elevated water temperatures are exerting on the stream or river. During winter and early spring, metabolic activities of bacteria are slowed dramatically by colder water temperatures. As a result, it is unlikely that the organics associated with organic pollution will result in lowered dissolved oxygen levels during these colder months, except in extreme cases. The extended period of time without suppressed dissolved oxygen levels allows intolerant macroinvertebrates to recolonize affected areas during winter and early spring, through the process of drift, making it difficult to determine the true magnitude of impacts with spring samples.

Ammonia toxicity is also more of a threat during summer. During summer, warmer temperatures and higher pH's increase the likelihood that ammonia toxicity will become a limiting factor. The pH of streams may increase as carbon dioxide is used in photosynthesis by locally dense populations of algae and macrophytes (Wetzel 1983). The toxic effects of ammonia are determined by the amount or concentration that remains in the un-ionized state. The concentration of un-ionized ammonia increases with increasing pH and increasing temperature. If manure or other sources of ammonia are equally present throughout the year, they are more likely to be detected using fall samples. However, the effects of short term or temporally isolated large scale sources present at other times of the year may best be detected by using spring sampling if it more closely follows the exposure to or the occurrence of temporarily elevated un-ionized ammonia levels.

The affects of spring flooding, or any other high water event can also result in catastrophic impacts to the macroinvertebrate community. Sampling near the time of a flood event makes it difficult to separate the affects of flooding on community structure from those caused by organic pollution or elevated water temperatures. For this reason, sampling should be avoided until at least 30 days after any major flood event. Spring floods should be accounted for when designing a sampling regime for any watersheds that have suffered from large scale alterations to their natural hydrology.

Summary of Advantages and Disadvantages for Spring and Fall sampling seasons

1. **Spring sampling advantages and disadvantages:**

   Advantages - Spring samples have more mature larvae making identification to species easier or more possible. Short term or temporally isolated impacts which occur during winter or spring are best documented by collecting samples near the time of impact, i.e. spring sampling.
   Disadvantages - Spring samples are more likely to be affected by the catastrophic effects of spring floods. Spring samples are also less likely to reflect localized impacts resulting from organic enrichment because intolerant macroinvertebrates can recolonize impact areas, through the process of drift, as long as colder temperatures limit dissolved oxygen problems and provide temporarily favorable conditions.

2. **Fall sampling advantages and disadvantages:**

   Advantages - Fall samples are less likely to biased by the catastrophic effects of spring floods. Fall samples are more likely to reflect the impacts organic enrichment is exerting on water quality; because, they more closely follow the summertime stresses associated with NPS pollution while limiting the time which has elapsed in which favorable conditions have existed for the migration of intolerant species into impacted areas.
   Disadvantages - Immature larvae may make identification to species level impossible; however, in most cases insects collected in September and October should be identifiable by a qualified taxonomist.
   Other seasonal concerns should be addressed by adjusting the timing of sampling (Hilsenhoff 1988).Spring sample collection should be completed before degree day accumulations of mean air temperatures above 4.5 C reach 440 in warmwater streams, and 1050 in coldwater streams that remain below 20 C.Sampling in fall may begin 60 days after the 440 degree day accumulation in warmwater streams and 45 days after the 1050 degree day in coldwater streams.

F. Sampling Methods

Sample with kick net by holding the net firmly against the substrate and disturbing the substrate upstream, approximately a full arms length, from the net with your feet to dislodge macroinvertebrates. Do not try to push the net through the substrate. Let the macroinvertebrates wash downstream into the net.
Try to exert equal sampling effort spatially and temporally. Attempt to sample in riffle areas whenever possible. Do not sample areas at the site with flow velocity less than 0.5 ft/sec., or areas with substrate composed of sediment. Sampling near the stream margins should be avoided.
When replicate samples are to be taken, sample from downstream to upstream to insure that an undisturbed area is sampled for each replicate sample. A stream reach should also be sampled from downstream to upstream if sites are close together.

Number of Macroinvertebrates/Sample Volume:

A minimum of 125 macroinvertebrates that have Biotic Index values should be sampled at each site. A sample containing 8-ounces of sample debris (a standard 16-ounce sample jar half filled) should contain enough macroinvertebrates, and such a sample should take less than 5 minutes to collect (Hilsenhoff 1987).

G. Sample Handling, Preservation, and Documentation:

1. After the sample is collected, rinse sediment from the net by forcefully swishing the net through the water a few times.
2. Visually inspect the net contents to insure that at least 100 arthropods with Biotic Index values were collected. If it is determined that insufficient numbers exist after initial sampling efforts sampling should be extended for a second period of equal duration and noted on the bench sheet. If insufficient numbers exist after completion of the second sampling effort, stop collecting and preserve the sample. Insufficient numbers may indicate a water quality problem and should be noted.
3. Remove sticks, rocks, and large undecomposed leaves from the rest of the debris after removing any attached macroinvertebrates and include them with the rest of the sample debris in the net.
4. Transfer the debris and macroinvertebrates to a wide-mouth jar of sufficient size. The sample debris should occupy less than 1/3 the sample jars volume. Ensure that both the container and lid are appropriately labeled. Labels

should contain at least the following information: sample I.D. number, replicate number, waterbody name, and a split designation if a single sample's contents had to be placed in separate containers due to volume constraints i.e. container #1 of sample # 960510-16-05 Replicate #3. An internal label, using bond paper and pencil, should also be placed within the container. Include all macroinvertebrates clinging to the net that are larger than 3mm long and all adult Elmidae. Initially preserve the sample with 80-85% alcohol (either Isopropyl or Ethanol). Ensure that the sample container is filled to the top with alcohol. Be sure to tightly seal the sample containers after preservation and gently invert several times to mix thoroughly while avoiding the damage associated with over agitation. Within 24 hours the sample must be represerved with new 80-85% alcohol. Samples containing large volumes of filamentous algae or other organic materials should be preserved and represerved with 90-95% alcohol.

5.

BENTHIC INVERTEBRATE SAMPLING - SEDIMENT GRABS (DREDGES)

H. Scope:

Grabs are designed to penetrate river or impoundment substrate and collect a sample with a spring or gravity operated closing mechanism, usually operated remotely by the investigator. Grabs are especially well suited for sampling impounded areas that are too deep to wade.

Data from grabs are considered quantitative, in that the sampling area is defined by the dimensions of the grab and organism density can be calculated. In addition, other measures and indices that are applied to qualitative data can also be applied to data from grabs, such as diversity and similarity indices, indicator organism schemes, and relative abundance ratios.

I. Equipment:

Three types of grabs are commonly used by Department investigators Eckman, Petersen, and PONAR. Each type not only has advantages in certain situations, but data from different types are not comparable due to differences in penetration depths and volume collected. In general, Eckman grabs are best suited for soft substrates, like mud, while the PONAR and Petersen dredges are better suited for harder substrates. An added advantage of the PONAR is the addition of a screened top to minimize a hydraulic "shock wave" on descent, which can cause a disturbance of materials and organisms on the surface of soft substrates and cause sampling error.

A problem common to all grabs is incomplete closure of the jaws due to obstructions like rocks, sticks, etc. Of the three grabs considered above, the PONAR has the greatest ability to shear obstructing materials and completely close on retrieval. Additional equipment is needed for sampling benthos with grabs, as indicated below.

J. Collection Procedure:

Collection procedures will vary slightly, depending upon the type of grab used, due to differences in closing mechanisms. In general, procedures are as follows:

1. Position boat over sample site (or locate over sample site on the ice or by wading). Be careful not to disturb the sampling area while anchoring the boat.
2. Have large metal bucket ready to accept entire contents of grab quickly upon retrieval.
3. Set closing mechanism and lower grab to substrate, being careful to avoid a hydraulic shock wave caused by too rapid of a descent near the bottom.
4. Initiate closure mechanism of grab.
5. Retrieve grab at a steady rate and immediately position over metal bucket. If jaws are not completely closed due to obstructions, discard entire grab contents away from sampling area and try again. Make sure to move the sampling site at least several feet away from the previous attempt(s) to avoid sampling a previously disturbed area.
6. Empty entire contents of grab into metal bucket.

K. Sample Handling and Preservation:

After grab contents are placed into the metal bucket, a reduction in sample volume is usually desirable. For very soft, mucky substrates, add clear water to the bucket

and pour small volumes of the mud water mixture into a #30 mesh sieve bucket. Swirl the bucket to enhance drainage of water and fines. Continue adding water to the sample bucket and pouring off portions through the sieve bucket until the entire sample has passed through the sieve screen. Concentrate remaining materials on the screen by holding the sieve bucket screen parallel to the lake or stream surface and quickly pushing the screen just into the water's surface, while at the same time moving the bucket forward to arm's length, where it is then removed from the water and the cycle repeated. Repeat this circular motion of the bucket several times until all material and organisms are concentrated in a small area of the screen for easy removal by hand to a sample container. Be sure to remove as much material and all organisms from the sieve screen as possible.

For coarser substrates, less water needs to be added before sieving, and sieving is accomplished more rapidly due to the lack of fine material that has to be passed through the sieve screen.

After the screen contents are placed into a suitable sized sample container and labeled, add 95% ethanol (ETOH) as a preservative. Enough 95% ETOH should be added to double the volume of the sample material and water in the container. If the sample contains a large proportion of sand or gravel, less 95% ETOH is needed to preserve the samples. Gently shake the sample container after adding ETOH to ensure thorough mixing of the alcohol and sample material. Rose Bengal dye (at 100 mg/1) may be added to the 95% ETOH prior to sample preservation to facilitate laboratory sorting of dyed organisms from sample material.

L. Documentation:

Information about the sample site and collection procedures are recorded on Department Form 3200-81, Macroinvertebrate Field and Bench Sheet. It is very important to label the specimen container(s) from each site with the corresponding Sample ID number that appears on Form 3200-81 for that site.

1. Data reporting.

Data from grabs are defined as quantitative, in that organism density or standing crop may be calculated. Prior to collecting samples, however, the investigator must decide how many samples to collect at each site to obtain statistically reliable estimates of organism density. Usually, many more samples than can be realistically collected and processed are required to produce reliable density data, due to the patchy distributions of most benthos communities. Refer to Elliott (1977) for a complete discussion of this topic and methods for calculating the required number of samples.

In spite of the limitations associated with obtaining reliable quantitative data, grabs are a necessity in deep water. Data from grabs can also be used in the same manner as qualitative techniques to calculate water quality and similarity indices, and other measures like relative abundance and indicator organism schemes.

M. Sample Quality Assurance:

The main concern with quality assurance of grab samples of benthos is to prevent carryover of organisms from one sample to the next. Carryover is prevented by careful washing and inspection of collection devices and sieve screens after each sample collection.

Another concern is disturbance of sample sites prior to and during sample collection. Anchoring a boat over the sample site must be done carefully to avoid physical disturbance of the area to be sampled. Mobile invertebrates may leave the area or others may be carried off site by water currents generated by anchoring, causing sample error. A similar problem can occur from the grab impacting the substrate.

If the jaws don't close successfully on retrieval, another sample must be attempted at the same site. It is very important to move successive sampling attempts several feet away from all preceding attempts to avoid sampling previously disturbed substrates.

BENTHIC INVERTEBRATE SAMPLING - ARTIFICIAL SUBSTRATES

N. Scope:

Artificial substrate samplers can be used in almost any stream or river habitat, either suspended in the water column or anchored to the bottom. They are left in the water for relatively long time periods to be colonized by drifting or swimming organisms. While there are several disadvantages to using artificial substrates over samples from natural substrates, one significant advantage is the elimination of differences in substrate type between sampling stations. Data comparisons between stations are, therefore, simplified.

O. Equipment:

Several different designs of artificial substrates are available, but only two common types will be described here. Other types are described in the scientific literature.

Multi-plate artificial substrate samplers are a series of circular 3-inch diameter hardboard discs, separated by spacers and fastened together through their centers to a threaded eyebolt. Surface area can be easily determined to allow calculation of quantitative data. Samplers exposed to toxicants and/or oils should not be reused.

The other common type is the rock basket sampler, a cylindrical chrome plated basket (barbecue basket) filled with 2 to 3-inch diameter rocks or rock-like material. It is more difficult to calculate surface area for rock basket samplers, but the rocks simulate natural substrates better than multi-plate samplers.

1. Labeled sample containers large enough to enclose contents of rock basket type artificial substrates.
2. 95% ETOH.
3. Forms 3200-81, one per sample site.

P. Collection Procedure:

Artificial substrates, regardless of the type, are anchored or suspended at the sample site and left for varying time periods to be colonized by drifting or swimming organisms. Placement within the water column depends upon the objectives of the study. There is no common standard for exposure time, but several weeks is generally regarded as sufficient (6 weeks according to Weber, 1973). Whatever the exposure time, data should not be compared between samplers exposed for different lengths of time. During retrieval, a U.S. Standard #30 mesh or finer dip net should be used to enclose the sampler and reduce organism escape.

Q. Sample Handling and Preservation:

After retrieval, multi-plate samplers are usually placed into a container large enough to hold the assembled sampler and preserved with 70% ethanol. If stored in 70% ETOH, the handboard plates of the sampler will absorb ETOH and become unsuitable for reuse.

Alternatively, store samplers sieved, in refrigerated water from the sampling site. Processing should proceed within 24 hours of storage.

Rock basket type samplers are either emptied of rocks and the rocks preserved in 70% ETOH, or the rocks are scrubbed free of organisms (in a water filled pan) with a soft brush and only the organisms and loosened materials are preserved.

With all artificial substrate types, the enclosing net used during retrieval should be inspected for invertebrates and the recovered invertebrates included in the sample.

R. Documentation:

Information about the sample site and collection procedures are recorded on Department Form 3200-81, Macroinvertebrate Field and Bench Sheet. It is very important to label the specimen container(s) from each site with the corresponding Sample ID number that appears on Form 3200-81 for that site.

S. Sample Processing:

1. Sorting and subsampling.

For quantitative work, the surface area of the artificial substrate sampler must be determined to allow for calculation of organism density per unit surface area. Organisms are then picked free from the artificial substrate surfaces and preserved in 70% ETOH.

With multi-plate samplers, the sampler is disassembled and each plate and spacer is inspected with the aid of a low power magnifier. All target invertebrates are then removed for preserved storage in 70% ETOH. The ETOH remaining within the sample containers is then poured through a #30 mesh sieve and all retained macroinvertebrates are included in the sample. The inside of the emptied sample container should also be inspected for invertebrates to be included in the sample.

For rock basket samplers, rocks stored in preservative are treated similarly to the plates of the multi-plate sampler in the above example. If only the organisms and associated materials from the rock surfaces were retained in ETOH, the ETOH/organism mixture is passed through a #30 mesh sieve. The retained organisms and debris are then transferred to a white pan for sorting, with the aid of a low power magnification device.

T. Sample Quality Assurance:

To ensure good data from artificial substrate samples, the investigator should be aware of the following:

1. Multi-plate samplers or others made from porous materials should not be reused after exposure to toxins in water or storage in preservatives.
2. Samplers to be reused must be inspected carefully to remove all organisms to prevent carryover to successive sample sites or exposure periods.
3. Samplers should be enclosed during retrieval within a net having a mesh size at least as fine as U.S. Standard #30 or small enough to retain target organisms.
4. Artificial substrates do not sample all organisms found on natural substrates with equal efficiency. Use caution when interpreting data from artificial substrate samples. Refer to Chapter 5 of Downing (1984) for a more.complete discussion.