Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota

Sample Collection, Sample Processing, and Calculation of Indices of Biotic Integrity for Qualitative Multihabitat Samples

Minnesota Pollution Control Agency

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Contents

Introduction

This document describes the protocols for sampling macroinvertebrates from lotic waters (e.g., streams, rivers, and ditches), processing samples, and calculating index of biotic integrity (IBI) scores. These methods must be followed for the data to be used as part of 1) assessment of aquatic life (Class 2) beneficial uses as part of the intensive watershed monitoring program, 2) data supplementation to aid the stressor identification process, 3) development of regional biological criteria, and 4) calibration of biological criteria. The use of biological data for determining attainment or nonattainment of beneficial uses, including the use of IBIs, is described in Minn. R. 7050.0150, subp. 6. A description of how biological information is used for assessment of beneficial uses is described in the 2016 Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment 305(b) Report and 303(d) List (MPCA 2016). Before using these standard operating procedures (SOPs), field crews, sample processors and others involved in the collection of macroinvertebrate data should familiarize themselves with these protocols.

Macroinvertebrate community sampling protocol for stream monitoring sites

This section describes the methods used by the Minnesota Pollution Control Agency's (MPCA) Biological Monitoring Program to collect macroinvertebrate community information at stream monitoring sites for the purpose of assessing water quality and developing biological criteria. This procedure applies to all wadeable and non-wadeable monitoring sites in which stream macroinvertebrates are to be collected for the development of biological criteria or the assessment of water quality.

Definitions

Integrated monitoring: A stream monitoring technique to assess water quality using chemical, biological and physical indicators.

Biological Criteria: Narrative expressions or numerical values that describe the reference biological integrity of a specified habitat. Biological criteria are the benchmarks for judging the condition of aquatic communities.

Qualitative Multi-habitat Sample (QMH): A method of sampling macroinvertebrates which involves sampling a variety of macroinvertebrate habitats, including the following: rocky substrates, including riffles and runs, submerged and emergent aquatic vegetation, undercut banks, overhanging vegetation, woody debris, and leaf packs.

Intensive Watershed Monitoring: A watershed monitoring plan designed to assess the aquatic health of major watersheds through intensive biological and water chemistry sampling. This intensive approach allows assessment of watersheds for aquatic life, aquatic recreation, and aquatic consumption use support of the state's streams in each of the state's 80 major watersheds on a rotating 10-year cycle.

Requirements

Qualifications of crew leaders: The crew leader must be a professional aquatic biologist with a minimum of a Bachelor of Science degree in biology with an aquatic entomology, invertebrate zoology, fisheries, or closely related specialization, or equivalent experience in a related field. Additionally, they should have previous professional experience working as a field biologist, including sampling macroinvertebrates, and conducting habitat assessments. Field crew leaders must possess excellent map reading skills, have a demonstrated proficiency in the use of a GPS (Global Positioning System), and have good interpersonal skills for communicating with landowners and other interested stakeholders.

Qualifications of field technicians/interns: A field technician/intern must have at least one year of college education and had coursework in environmental and/or biological science.

General qualifications: All personnel conducting this procedure must have the ability to perform rigorous physical activity. It is often necessary to wade through streams and/or wetlands, canoe, or hike for long distances to reach a sampling site.

Responsibilities

Field crew leader: Ensures that data generated using this procedure meet the standards and objectives of the integrated stream monitoring program and carries out the procedures outlined in this section.

Technicians/interns: Carries out the procedures outlined in this section, including maintenance and stocking of equipment, data collection and recording.

Quality Assurance and Quality Control

Compliance with this procedure will be maintained through annual internal reviews. Technical personnel will conduct periodic self-checks by comparing their results with other trained personnel. Calibration and maintenance of equipment will be conducted according to the guidelines specified in the manufacturer manuals.

In addition to adhering to the specific requirements of this sampling protocol and any supplementary site specific procedures, the Quality Assurance (QA) and Quality Control (QC) requirements for this protocol are as follows:

1. Control of Deviations: Deviations from the procedure shall be sufficiently documented to allow repetition of the activity as actually performed.
2. QC Samples: 5-10 percent of all sites sampled in any given year are resampled as a means of determining sampling variability.
3. Verification: The field crew leader will conduct periodic reviews of field personnel to ensure that technical personnel are following the procedures according to this SOP.

Training

All personnel, including experienced staff, will receive annual instruction from a trainer designated by the program manager. Major revisions in this protocol require that all personnel be re-trained in the revised protocol by experienced personnel. Training activities will include instruction in the field, as well as a field test to ensure that personnel can implement this procedure. The field crew leader will provide instruction in the field to untrained personnel, such as interns and technicians, to ensure they can effectively execute this procedure.

Macroinvertebrate sampling procedures

A. Equipment list

Verify that all necessary items are present before commencement of this procedure (Table 1).

Table 1. Equipment List – This table identifies all equipment needed in the field in order to implement the sampling protocol as described.

√	*Item and purpose*
	Two D-frame dipnets with 500 micron mesh nets, equivalent to Wildco, turtox design – for collection of inverts
	Two sieve buckets with 500 micron sieves – for reducing debris in sample
	Stream Invertebrate Visit Form – for recording data
	Stream Verification Form (electronic or hardcopy) – for navigating to sampling station
	Maps of stream reach (aerial imagery & 1:24,000 USGS topographical map) – for navigating to sampling station
	Minnesota Atlas and Gazetteer (Delorme) – for navigating to sampling station
	Pencils – for filling out forms
	Permanent/Alcohol proof marker – for labeling jar and voucher tags
	Internal and External macroinvertebrate sample identification labels – to label sample containers
	100% reagent alcohol, (adequate volume to preserve 4 days of samples, ca. 10-15 gallons) – for preserving sample specimens
	Waterproof notebook – for making observations
	Chest waders – for safety during sampling
	Rain-gear – for comfort during sampling during inclement weather
	Camera – to document site conditions
	Plastic Sample Jars; wide-mouth, minimum 1 L capacity – for storing preserved specimens
	Box or crate - to store sample jars
	Canoe or Kayak if needed – for access to sampling station
	Backpack – carry equipment to and from a site

B. Data collection method

The location and length of the sampling reach is determined during site reconnaissance (see MPCA 2014b [Reconnaissance Procedures for Initial Visit to Stream Monitoring Sites]). The reach length, 35 times the mean stream width (MSW), is based on the distance necessary to capture a representative and repeatable sample of the fish community within a stream segment (Lyons 1992). Reach lengths are a minimum of 150 meters and a maximum of 500 meters. Sampling is conducted during daylight hours within the summer index period of late-July through October. Sampling should occur when streams are at or near base-flow because flood or drought events can have an effect on macroinvertebrate community structure and sampling efficiency.

Macroinvertebrate community sampling is conducted in conjunction with the water chemistry and physical habitat assessment protocols (see MPCA 2014c [Water Chemistry Assessment Protocol for Stream Monitoring Sites] and MPCA 2014d [MPCA Stream Habitat Assessment (MSHA) Protocol for Stream Monitoring Sites]). Additional protocols that may be used during a site visit include: MPCA 2012 [Stream Condition and Stressor Identification (SCSI) protocol for Stream Monitoring Sites] and MPCA 2014e [Channel Condition and Stability Index (CCSI): MPCA protocol for assessing the Geomorphic

Condition and Stability of Low-Gradient Alluvial Streams]. Macroinvertebrate sampling should occur after water chemistry collection so as not to disrupt the sediments prior to collecting water samples. However, the macroinvertebrate sampling should be conducted prior to any physical habitat assessment so as not to disturb the macroinvertebrate community prior to sampling.

C. Assessing stream habitats

Before sampling can begin, the crew leader and field technician must determine which habitats are present in the reach. This should be a cooperative effort. This is done by walking the sample reach and determining which productive habitats dominate the stream reach. A site visit form should be filled out during this process or immediately following sample collection. Ideally the stream should be viewed from the top of the stream bank, but this is generally the exception rather than the rule. For this reason, care should be taken to walk along the stream edge or any streamside exposed areas. If this is not possible, stay to one side of the stream so as to disturb as little substrate as possible.

NOTE

Sampling should be conducted in a downstream to upstream fashion, it will save time to start the initial visual inspection of the stream from the upstream end of the sampling reach and walk downstream. This will allow you to start sampling at the downstream end of the reach as soon the inspection is completed.

The multi-habitat method entails collecting a composite sample from up to five different habitat types. The goal of this method is to get a sample representative of the macroinvertebrate community of a particular sampling reach, it is also to collect and process that sample in a time and cost effective manner. For that reason, the habitats described below are relatively non-specific, being chosen to represent broad categories rather than microhabitats. Every broad category includes numerous microhabitats, some of which will not be sampled. It is to the discretion of the sampler which microhabitats are most representative of a reach. As a general rule, sample in a manner that reflects the most common microhabitat of any given broad habitat category. The habitats to be sampled include:

Hard bottom (riffle/cobble/boulder)

This category is intended to cover all hard, rocky substrates, not just riffles. Runs and wadeable pools often have suitable “hard” substrates, and should not be excluded from sampling. The surfaces of large boulders and areas of flat, exposed bedrock are generally quite unproductive, avoid including these habitats in the sampling area if possible. This is a general rule, if a particular stream has productive exposed bedrock, or boulder surfaces, those habitats should be considered sampleable.

Aquatic macrophytes (submerged/emergent vegetation)

Any vegetation found at or below the water surface should be considered in this category. Emergent vegetation is included because all emergent plants have stems that extend below the water surface, serving as suitable substrate for macroinvertebrates. Do not sample the emergent portion of any plant.

Undercut banks (undercut banks/overhanging vegetation)

This category is meant to cover in-bank or near-bank habitats, shaded areas away from the main channel that typically are buffered from high water velocities.

Snags (snags/rootwads)

Snags include any piece of large woody debris found in the stream channel. Logs, tree trunks, entire trees, tree branches, large pieces of bark, and dense accumulations of twigs should all be considered snags. Rootwads are masses of roots extending from the stream bank into the water.

Leaf packs

Leaf packs are dense accumulations of leaves typically present in the early spring and late fall They are found in deposition zones, generally near stream banks, around logjams, or in current breaks behind large boulders.

It can be difficult to estimate total stream coverage of certain habitats due to their appearance as linear or two dimensional features. Undercut banks and overhanging vegetation can appear as linear features despite their depth, while snags, woody debris, vegetation mats, and emergent vegetation can appear flat despite their three dimensional nature. For these reasons, best professional judgment must be used to determine what level of effort is adequate to equal one "sample effort" for any given substrate. Keep in mind that this method is considered qualitative, rulers and grids are not necessary to effectively implement this procedure.

D. Sampling macroinvertebrates

After the number of productive sampleable habitats have been determined, the sampling team should proceed in a downstream to upstream manner, sampling the habitats present. Sampling consists of dividing 20 sampling efforts equally among the dominant, productive habitats present in the reach. If 2 habitats are present, each habitat should receive 10 sampling efforts. If 3 habitats are present, each habitat should receive 7 sampling efforts. If a productive habitat is present in a reach but not in great enough abundance to receive an equal proportion of sampling efforts, it should be thoroughly sampled and the remaining samples should be divided among the remaining habitat types present.

NOTE

In order to get complete samples, the contents of the D-net should be emptied into a sieve bucket frequently. This prevents the back flow of water resulting from a clogged net. In larger streams, it is convenient for each sampler to have a sieve bucket. This allows samplers to sample independent of each other, avoiding frequent stream crossings, which can alter the stream bed.

A sample effort is defined as taking a single dip or sweep in a common habitat. A sweep is taken by placing the D-net on the substrate and disturbing the area directly in front of the net opening equal to the net width, ca. 1 ft^2. The net should be swept several times over the same area to ensure that an adequate sample is collected. Each effort should cover approximately 0.09 m^2 of substrate. Total area sampled is ca. 1.8 m^2. The following describes how to sample each habitat:

Hard bottom

Riffles and rocky runs are basically two dimensional areas, and should be thought of as such when trying to determine how dominant the riffle habitat is in a stream. It must be kept in mind that riffles are often the most productive and diverse habitat in the reach, relatively speaking.

The field personnel must be careful to not oversample riffles. The purpose of this method is to get a representative sample. Sampling in this habitat type is relatively simple. The D-net should be placed firmly and squarely on the substrate downstream of the area to be sampled. If the water is shallow enough, the area directly in front of the net should be disturbed with the hands, taking care to wash large rocks off directly into the net. If the water is too deep for this, kicking the substrate in front of the net is adequate. Watch for stoneflies and mayflies trying to crawl out of the net.

Vegetation

Aquatic vegetation is either completely submerged, mostly submerged and partially floating on the water's surface, or partially submerged and mostly extended above the water's surface. Things like pondweed, coontail, and milfoil tend to clump and float at the water's surface. These types of plants should be sampled with an upward sweep of the net. If the net fills with weeds, the weeds should be hand washed vigorously or jostled in the net for a few moments and then discarded. Emergent plants such as reed canary grass and various plants in the rush family, should be sampled with horizontal and vertical sweeps of the net until it is felt that the area being swept has been adequately sampled. Plants like floating bur reed and water celery tend to float in long strands with the current. They can be floating on the surface or completely submerged. These plants should be sampled as emergent plants with horizontal and vertical sweeps in a downstream to upstream motion.

Undercut banks/ Overhanging vegetation

Undercut banks and overhanging vegetation follow the line of the stream bank. Undercut banks can vary in how undercut they are. An additional problem is that many banks appear undercut, but when investigated prove not to be. For these reasons, banks should be prodded to determine how deeply they are undercut. Overhanging vegetation should be treated the same way. Sampling should consist of upward thrusts of the net, beating the undercut portion of the bank or the overhanging vegetation, so as to dislodge any clinging organisms.

Snags

Snags and rootwads can be large or small, long or wide, simple or twisted masses of logs or twigs that do not have any consistent shape. Best professional judgment must be used to determine what a "sampling effort" is. Approximating the amount of sampleable surface area is a sensible method with larger tree trunks or branches. Masses of smaller branches and twigs must be estimated. Given their variable nature, there is not one best method for sampling snags. Using something like a toilet brush or kitchen brush works well for large pieces of wood, whereas kicking and beating with the net works best for masses of smaller branches.

Leaf packs

One square foot of leaf pack surface area that has two cubic feet of leaf underneath should be sampled near the surface, whereas a shallow leaf pack can be sampled in its entirety. Sweeping to the bottom of every leaf pack could create a disproportionately large amount of sample volume being collected for relatively small sample area. In most situations leaf packs will not be dominate enough to be included in a sample. If leaf packs are sampled, it is suggested that time be spent streamside washing macroinvertebrates off of leaves and discarding the leaves, as a leaf pack sample can easily become overwhelmingly large.

NOTE

While sampling, it may become necessary to clean the sample of muddy, fine sediment. This can be done by filling the sieve bucket with clean water and allowing the resulting mucky water to drain. Care must be taken not twist and turn the bucket too much, as this can damage some macroinvertebrates.

E. Preserving the sample

Once sampling is complete, the sample material should be preserved as quickly as possible. Transfer the sample material from the sieve bucket to the sample containers. Sample containers should contain no more than 30% of their volume as wet weight. Fill sample containers with 100% reagent alcohol to a level that ensures a final alcohol concentration of at least 70%. Be sure to thoroughly clean the bucket and sampling nets of all macroinvertebrates. The use of forceps might be necessary to dislodge some of the smaller organisms.

F. Labeling the sample

Fill out internal and external sample labels for each sample container using preprinted sample labels (see Appendix A). Be sure to use water and alcohol proof writing medium.

G. Stream invertebrate visit form

The "Stream Invertebrate Visit Form" should be filled out during the streamside survey, or notes should be taken on field note books and transferred to visit forms.

Macroinvertebrate sample processing and Quality Assurance/Quality Control procedures

These procedures are used for the processing and identification of freshwater macroinvertebrates. The procedures may be used by any person who has received training in processing samples. A laboratory staff member qualified to perform QC checks must be present when samples are processed by an inexperienced staff member, or when QC checks are needed for an experienced sorter's samples. This staff person is qualified by achieving a mean sorting efficiency of at least 90% over the previous 6 months.

Different sample processing methods may be used for different sample types or for different projects. The SOPs described in this document are for the sampling of lotic waters for the assessment of aquatic life beneficial uses (as described in 7050.0222, subparts 2c, 2d, 3c, 3d, 4c, and 4d). These macroinvertebrate samples use a 300 count subsample (tolerance of +/- 10%) with a Large/Rare search. For all methods described, some organisms are picked from the sample, but not counted (e.g., copepods and cladocerans). In addition, only aquatic and semiaquatic taxa are counted as part of the sample. The list of macroinvertebrates that are counted are listed in Appendix E.

Sample cleaning and preparation for subsampling

A. Equipment list

Verify that all necessary items are present before commencement of this procedure (Table 2).

Table 2. Sample preparation materials list.

√	*Item*
	Caton screen(s)
	plastic holding tray(s) for Caton screen(s)
	1000 ml Nalgene jars
	ethanol
	scissors
	scoops
	spoons
	spatula
	latex gloves
	assorted scrapers
	3x lighted magnifier

√	***Item***
	500 micron soil sieve
	sample splitting pan (for samples with large volumes)

NOTE

Be sure that all sorting equipment is thoroughly cleaned and free of organisms before beginning the preparation procedure.

B. General preparation procedure

1. Gently mix each sample in its jar(s).
2. Decant alcohol while pouring the sample out of each jar, using the 500 micron soil sieve (US #35) and the plastic Caton holding tray or 5 gallon bucket in the rinsing sink. If the sample is contained in several jars, empty and wash each jar one at a time. If the alcohol is not excessively stained or diluted, retain it for reuse as preservative for unsorted portion of sample, otherwise, discard the alcohol down the rinsing sink drain.
3. Pour the sample out into the 500 micron sieve, and retrieve all internal sample labels. Rinse all debris and organisms from the labels into the sieve.
4. Retrieve and save all labels. Check to make sure that the internal labels correspond with the bench sheet and the inventory. Labels are to be stapled to the back lower left of bench sheet once they are dried.
5. Gently rinse the sample jar, retaining all contents on the sieve.
6. Using the 500 micron sieve, gently wash the sample, running cold tap water over it to remove any fine material.
7. Transfer the sieve contents onto the Caton screen. If there are several sample jars, empty each onto the Caton screen as rinsing proceeds.
8. Rinse the sieve onto the Caton screen to collect any organisms or debris that may have been retained in the sieve. Inspect the sieve with the 3x lighted magnifier. Be sure the sieve is clean to prevent cross contamination between samples. Place all organisms retrieved from the sieve onto the Caton screen.
9. Place the Caton screen into the plastic holding tray. Add enough water to spread the sample evenly over the Caton screen. (Note: the water level should be close to the top of the plastic tray.) Move the sample into the corners of the pan using your hands, forceps, or other equipment. Agitate the tray and screen to help spread the sample. If the sample is composed of different types of material, be sure that there is thorough mixing of all types.
10. Remove large objects (sticks, stones, etc.) and examine them, using the 3x lighted magnifier when necessary. If organisms are found on these items, remove them and add them to the sample material on the Caton screen.
11. Lift the Caton screen out of the plastic tray to drain. Pour off the water from the plastic tray and set the screen back into the tray. Add just enough water to the tray so that it barely covers the screen while it is in the tray. Be careful not to add so much water that the sample material floats around.

C. Procedure precautions and exceptions

1. Never allow a sample to dry out during any stage of preparation or sorting.
2. Before beginning sample preparation, and after completion of preparation, be sure to examine sieves, Caton screens, spatulas, spoons, scoops, and all other materials to make sure that no organisms or sample residues are adhering to surfaces. These precautions prevent cross-contamination between samples.
3. Sample preparation and sorting is often complicated by the materials present in the samples. In every case, your goal is to mix materials as thoroughly as possible and randomly distribute mixed

materials over the Caton screen. Do not keep disparate materials separate. Consider cutting materials with scissors before distributing them.

4. Woody chunks often appear clean, but if you crack them open, they often have macroinvertebrates that have burrowed into them.
5. Be aware of stony caddisfly cases, which can be very small.
6. If a sample is to be fully-picked, you do not need to distribute the sample as carefully as when a random sub-sample is needed.
7. If the ADAPTATION FOR LARGE VOLUMES, ADAPTATION FOR SMALL VOLUMES, or ELUTRIATION procedures are used, you must carefully document this on the bench sheet, and give accurate characterizations of the number of grids sorted (out of a total of 30) or the proportion of sample used.

D. Adaptation for large sample volumes

When the sample is contained in more than three jars, or is made up of an unusually large volume of material (the goal is to reduce the volume of material from a selected grid such that it will fit in a petri dish), use the following procedure to split the sample:

1. Rinse the contents of each jar one at a time, using the 500 micron sieve.
2. Empty the sieve contents into the splitting pan; repeat until all jars have been sieved, rinsed, and emptied into the splitting pan.
3. Using your hands or any other suitable equipment, mix the sample thoroughly in the splitting pan. Ensure that the sample is mixed well and evenly distributed in the splitting pan. If the sample is composed of different types of material, be sure that there is thorough mixing of all types. If necessary, add water to the sample to facilitate mixing, but don't overdo it, since too much water will make the sample difficult to split.
4. Once the sample is thoroughly mixed and evenly distributed, divide the sample in half using the spatula. You may need to use scissors as well for this step. Move material to the left and right of a line down the middle of the sample material.
5. Using the spatula and scissors if necessary, split the halves of the sample into quarters.
6. Using spoons and scoops, return three of the quarters to three separate jars. Carefully label these jars and keep them at your work station, away from other samples or archive material.
7. Pour the remaining quarter of the sample into the Caton screen, and spread it evenly using the General Preparation Procedures.
8. Carefully rinse the splitting pan and the 500 micron sieve to prevent contamination of the next sample.

NOTE

When samples are split in this way, each grid you remove during sorting procedures constitutes 1 of 120 grids, or ¼ of a grid when the 30 grid standard is used. Use of this procedure must be documented on the bench sheet (Appendix B). The "number of grids sorted" and/or the "sample proportion used" calculations must be accurately described, to document how much of the sample was used to produce the required subsample size.

E. Adaptation for small sample volume

When the sample contains very small amounts of material (especially Surber or Hess samples that are not composites):

1. Rinse the sample in the 500 micron sieve, transfer the sample onto the Caton screen, and rinse the sieve as for the General Preparation Procedures.
2. Place the Caton screen into the plastic tray, and add just enough water to “float” the sample material above the screen.
3. Using scoops, spatulas, or other appropriate equipment, move the sample material into half of the Caton screen, or, if necessary, into a quarter of the screen.

Note

When samples are condensed in this way, each grid you remove during sorting procedures constitutes a multiple number of grids when the 30 grid standard is used. For example, a single grid from half of the Caton tray must be recorded as 2 grids. Use of this procedure must be documented on the bench sheet (Appendix B). The “number of grids sorted” and/or the “sample proportion used” calculations must be accurately described, to document how much of the sample was used to produce the required subsample size.

Sorting and subsampling

A. Equipment list

Verify that all necessary items are present before commencement of this procedure (Table 3).

Table 3. Sample sorting and subsampling materials list.

√	*Item*
	Caton screen and plastic holding tray, with mixed and randomly distributed sample material prepared with the procedures above
	Caton cookie-cutter and other appropriate grid delineation equipment
	An assortment of tweezers and forceps
	Dissecting needles
	Caton scoops, spoons, spatulas, and other appropriate equipment to lift sample materials out of the Caton screen
	Ethanol and water in labeled wash bottles
	Petri dishes
	Dissecting microscope (10x – 30x) with fiberoptic illuminator
	Vials and caps or stoppers
	Labels for each vial and jar
	Vial rack
	Correctly selected bench sheet
	Pencil
	Mechanical counters
	Magnifying lamp
	Jar(s) for sorted substrate
	Jar(s) for unsorted substrate

B. Rules for picking and counting organisms

ALL organisms should be removed from the sample substrate using the following rules:

1. Cladocerans and copepods *are not to be counted* AND if they are very abundant, they may be left behind in the substrate. If the sample is processed this way, record it on the bench sheet (Appendix B), and name the organisms that have been left behind.
2. Even organisms that are probably too small for definitive identification must be removed from the substrate. These organisms are to be placed in the vial(s) for the taxonomists.
3. As long as the head of an organism is present, it is to be picked for the taxonomists.
4. Do not pick or count fragments such as legs, antennae, gills, etc. if the head of the organism is not present. Do not pick or count obviously empty snail or clam shells or insect exuvia.
5. For worms, attempt to remove and count only whole organisms and fragments that include the head; do not pick or count fragments that do not include the head.
6. Organisms should be sorted into appropriate groups and each group placed in its own vial.
7. All vials should be labeled using pre-printed labels available for each project. In addition, the "picked but not counted" organism vial should be identified as such.

C. Sample sorting procedure

1. Use a random number generator, such as a pair of dice, to select a grid for sorting.
2. Use the Caton cookie-cutter device to delineate the selected grid, moving the sample material very slightly to push the material in the selected grid together, in order to make it easier to remove it from the tray.
3. Using a scoop, scraper, spoon, or other appropriate equipment, lift the grid contents into a petri dish, and add water from a wash bottle to the sample material to avoid desiccation and to disperse the material in the petri dish. Depending on the consistency of the sample material, it may be necessary to use scissors during these steps.
4. Examine the Caton screen for any remaining organisms. Use the following rules when dealing with organisms that lie on the line between two grids:
    a. An organism belongs to the grid where its head is.
    b. If you cannot determine where the head is, the organism belongs to the grid containing most of its body.
    c. If part of an organism's head is on either side of the line, pick the organism if the line is on the "top" of the grid or the right side of the grid.
5. Examine the sample material in the petri dish under the microscope, and determine as closely as possible whether there are a large number of macroinvertebrates present. Estimate as closely as possible whether ¼ or more of the target number of organisms would be picked if the sample material from the selected grid were picked in its entirety.
    d. If there are clearly less than ¼ of the target number, proceed to pick through this sample material: go to step 6.
    e. If there are clearly more than ¼ of the target number, use the "Sorting Procedure for High Organism Density" below.

NOTE

If you determine that there are very few organisms in the initial grid, more than one grid can be removed from the Caton screen before sorting. Place the materials from each randomly selected grid in separate petri dishes with water. Be sure not to let these sample fractions dry out or get spilled. Place a label in each petri dish to properly identify each grid. It is also acceptable to combine the contents of several grids for sorting if you determine that the density of organisms is low and that combining grids will not result in sorting more organisms than the target.

6. Remove the macroinvertebrates from the sample material in each grid, using forceps. Place organisms for identification in the taxonomy vial(s). Place organisms that are to be excluded (not included in the taxonomic targets list [Appendix E]) in a separate vial. Sort through the substrate material thoroughly.
7. Using mechanical counters, keep a running count of the total number of organisms picked, as well as a separate count of the number of chironomids and the number of worms.
8. When the substrate from the first grid has been completely picked, empty the sorted substrate into a labeled jar and preserve this material with recycled ethanol. This material will be used for quality control checks.
9. Continue random selection and sorting of grids until the target number of organisms is attained. This includes a specific target of 300 organisms AND a complete pick of the final grid. To accomplish this, proceed as follows:
   a. If completion of a grid results in a number that falls within the target tolerance, you are finished.
   b. If completion of the final grid will apparently result in a number that exceeds the target tolerance, place the organisms picked from the final grid into a separate vial. You must randomly remove organisms from this group so that the tolerance is not exceeded. Use the following procedure to **ADJUST THE TOTAL COUNT TO CONFORM TO TARGET AND TOLERANCE**:
      i. Completely pick the final grid and place all of the organisms from this grid together into their own vial.
      ii. Place the substrate from the final grid into the QC jar containing sorted substrate from all other grids.
      iii. Using a petri dish scribed with “pie slices,” pour out the organisms from the final grid, and distribute them evenly in the petri dish. Use an appropriate petri dish, that is, one scribed with a number of pie slices appropriate to the number of organisms that are to be removed from the total number.
      iv. Randomly select a pie slice by using a random number generator, such as dice, and remove all of the organisms from the associated pie slice, counting the removed organisms as you go. Continue random selection of pie slices and removal of organisms until the number of organisms in the final subsample will be within the protocol tolerance for the project.
      v. Place all removed organisms back into the unsorted substrate.
      vi. Sort or place all organisms left in the petri dish in to the labeled vial(s) for taxonomy.
10. To complete the sample sorting, all unsorted substrate should be re-preserved in the original sample jar(s). Use recycled alcohol for re-preservation, and make sure that the jar is appropriately labeled. Store the unsorted substrate in the area reserved for unsorted substrate for the project.
11. Sorted substrate should be properly labeled and placed on the shelf reserved for sorting QAs.
12. Vials for taxonomists should all be appropriately labeled and banded together. Indicate on the bench sheet (Appendix B) the number of vials you have used for the sample. Place the vials in the

section of the tech refrigerator reserved for samples that have been sorted but not yet QA'd. These samples should not go to the taxonomy department until the sorted substrate QA is completed and the recovered organisms included with the taxonomy vials.

13. The bench sheet should be filled out during and after sample processing. Include the following information on the bench sheet in the spaces provided:
    f. Initials of the sorting technician.
    g. Date of sorting.
    h. The number of hours (to the nearest ¼ hour) spent doing the entire sorting procedure, including rectification of a failed QA.
    i. The number of grids sorted, and the number of grids occupied by the entire sample.
    j. A preliminary count of the total number of picked and counted organisms, a count of the number of picked chironomids, and a count of the number of picked worms.
    k. An analysis of the components of substrate encountered in the whole sample (i.e., before sieving and rinsing).
    l. Information about special sample handling. For example, you should record things such as whether the sample was split, or whether large amounts of material (e.g., grasses, cobbles, etc.) were removed before the sample was placed in the Caton tray.
    m. Difficulties encountered during sample processing, such as spills, rotten organisms, inappropriate sample odors or substrate components, etc.

D. Sorting procedure for high organism density

When the sample material in the first randomly selected grid contains more than ¼ of the target number of organisms:

1. In the petri dish, divide the sample material from the first grid into quarters, using a spatula, scraper, or other appropriate equipment.
2. Make a random selection of one of the quarters, and lift it into a separate petri dish. Place the remaining 3 quarters into the jar for unsorted substrate.
3. Proceed to pick the organisms from the selected quarter grid.
4. Make a random selection of another grid from the Caton tray and proceed as above.
5. If the first quarter grid contains the target number of organisms, you should select and sort a second quarter grid. This will likely result in exceedance of the target and tolerance. Use the procedure for "**ADJUST THE TOTAL COUNT TO CONFORM TO TARGET AND TOLERANCE"** above.
6. If using the ADAPTATION FOR LARGE SAMPLE VOLUMES (see the section **Sample cleaning and preparation for subsampling** above): there will be sample fractions in jars as a result of the initial sample splitting procedure. If the target number of organisms is not attained by fully sorting the contents of the first Caton tray, empty and disperse a second sample quarter onto the Caton screen, and proceed using the General Preparation Procedure above. If necessary, use the third and fourth sample quarters in sequence until the target is reached, or the entire sample is sorted.

E. Sorting procedures precautions and exceptions

1. Do not re-disperse the sample across the Caton screen after removing any portion of the sample.
2. AT ***ALL*** TIMES, PREVENT DESICCATION OF ALL SAMPLE FRACTIONS (i.e., Caton tray contents, contents of all petri dishes and vials). Also prevent contamination of the sample by organisms such as fruit and house flies.
3. The number of grids sorted must be clearly recorded on the bench sheet (Appendix B). If a special procedure was used, i.e., for large sample volumes or small sample volumes, the proportion of

sample used must be calculated using the appropriate correction factors for partial grids or multiple grids.

4. Although partial sorting is typically necessary, it should be avoided if possible. Ideally, samples should be finished the same day they are begun. Sample sorting by multiple technicians should also be avoided. If it is necessary to store a partially sorted sample, it is important to stabilize the substrate material on the Caton screen so that the grids selected and removed remain distinct. The Caton tray should be completely covered and preservative or water adjusted so that sample desiccation does not occur. (The threat of sample desiccation is another reason why it is important to split large volume samples so that they "fit" into a Caton tray without being "top heavy."). The covered Caton tray must be refrigerated until sorting is completed. A label with the date and time that the sample was placed in the refrigerator should be attached to the covered tray such that it is clearly visible. Keep the bench sheet at your work station, but clearly indicate where the bench sheet is. For example, if you store bench sheets in a drawer, place a permanent label on the drawer indicating that you keep them there. A partially sorted sample should remain in the refrigerator for as little time as possible; generally no more than 24 – 36 hours. Technicians should check the dates on stored samples, and if a sample has been stored for more than 36 hours, the water or preservative in the Caton tray should be checked and adjusted if necessary.
5. You should always record the total number of grids on the bench sheet, being especially careful to note when the sorted "grids" are actually fractions of a regular Caton grid. Also record special procedures that you may have followed, such as the procedure for high organism density. The total number of grids you record must accurately reflect the proportion of the total sample volume you sorted to obtain the target number of organisms.
6. Before checking out another sample to work on, be sure that your work station has been cleared of all materials related to the prior sample. There should be no jars, vials, labels, or other materials related to any other sample at your workstation before you bring another sample there.

F. Large/rare search

The MPCA sorting procedure includes a Large/Rare search. Use the following general procedure, unless the project specifications call for a different procedure.

The goal of the Large/Rare search is to add organisms which may not have been collected in the random subsampling procedure:

1. It may be useful to review the organisms collected during the random subsampling procedure before doing the Large/Rare search.
2. Once sorting and subsampling procedures are finished, the remaining unsorted substrate should be searched, using the magnifying lamp, for 5 to 10 minutes.
3. Organisms that did not occur in the random subsampling should be collected and placed in a vial, appropriately labeled with the sample identifier numbers, but also labeled "L/R," so that it is not confused with the organisms collected during the random subsampling procedure.
4. It may be difficult to differentiate between organisms already collected in the random subsampling and those found in the Large/Rare search. If there is doubt about whether an organism has already been collected, it should be included in the Large/Rare vial just to be safe.
5. It is only necessary to collect a single specimen of a Large/Rare organism, even if it is found to occur more than once in the unsorted substrate. However, try to collect the best possible specimens.
6. If a sample has been split because of large sample volume, all of the unsorted substrate must be included in the Large/Rare search. Sample fractions may be searched one at a time, or all together in

separate Caton screens. For large volume samples, the Large/Rare search may need more than 5-10 minutes.

7. Count the Large/Rare specimens as they are placed in the vial, and record the number of organisms included in the appropriate place on the bench sheet (Appendix B).
8. If the sorting QA/QC procedures have not yet been done on the sample, the number of L/R organisms is not to be included in the calculation of sorting efficiency.

Quality assurance for sorting and subsampling

These procedures are used to check sorting efficiency. This should be tracked for each technician and for each project. The procedures may be used by a laboratory staff member qualified to perform quality control (QC) checks. This staff person is qualified by achieving a mean sorting efficiency of at least 90% over the previous 6 months. All sorted samples should be checked for sorting efficiency as soon as possible after sorting has taken place:

1. Equipment and materials:
    a. Similar to General Preparation Procedure and Sorting Procedure above.
2. All of the sorted substrate from the selected sample is poured out and evenly distributed in the Caton screen, using the General Preparation Procedure methods.
3. Twenty percent of the sorted substrate will be examined under the dissecting scope by the QC technician. Lift the contents of the appropriate number of randomly selected grids into petri dishes and carefully examine the substrate for missed organisms.
4. Any missed organisms should be enumerated and placed into a separate, labeled vial for taxonomy. Record the number of recovered organisms on the bench sheet (Appendix B). This number is added to the final sorted count of the sample.
5. Sorting efficiency is calculated using the following basic formula:

    $$\text{Percent sorting efficiency} = (A / A + B) \times 100$$

    where: A is the number of organisms found by the sorting technician, and B is the number of missed organisms found by the QC technician

    Since during sample processing, only 20% of the sorted substrate is typically examined, the basic formula must be adapted to account for this proportion. For example, if 20% of the sample was resorted, 20% of the actual total number of organisms picked for the subsample is calculated and reported by the sorting technician. This number is used for A in the formula above.
6. A sample passes the QC check if the sorting efficiency equals or exceeds 90%.
7. If a sample fails the QC check, the failure must be rectified: the sorting technician must resort all of the substrate remaining in the Caton tray. Place recovered organisms into labeled vials for taxonomy.
8. If the addition of recovered organisms results in exceedance of the tolerance for the target number, the sample must be reduced in size using the ADJUSTMENT OF TOTAL COUNT TO CONFORM TO TARGET AND TOLERANCE above.
9. The QA technician should record QA check information in the appropriate spaces on the sample bench sheet (Appendix B). Recorded information should include:
    a. The initials of the tech performing the QA check.
    b. The proportion of the sorted substrate examined for the QA check (usually this is 20%, but may differ from this proportion in some circumstances).

c. The number of organisms recovered from the examined substrate, and the percentage of total organisms this represents (this percentage is the sorting efficiency). This calculation is based on the proportion of sorted substrate examined and an equal proportion of the number of organisms picked by the sorting technician.
d. A "pass" or "fail" determination based on the results of the above calculation.
e. Whether or not rectification was performed, if a "fail" results.
f. The amount of time, to the nearest ¼ hour, spent on the QA procedure (not including rectification).

Macroinvertebrate identification and enumeration

A. Taxonomist requirements

Identification of macroinvertebrates needs to be performed by trained taxonomists. This includes a lead taxonomist and other taxonomists that fulfill the following roles and have with the following qualifications:

1. LEAD TAXONOMIST

a. <u>Roles:</u> Provides identification, taxonomic oversight, internal QC, and problem specimen identification.
b. <u>Qualifications:</u> Must have at least one year's experience with fauna from the Midwestern United States; Masters Degree or Ph.D. in one of the following areas: Water Resources Science; Zoology; Biology or Ecology; 10 Years of taxonomic experience working with aquatic macroinvertebrates; Certifications: Society for Freshwater Science (SFS) Genus-level, Chironomidae EAST, EPT Genera EAST.

2) TAXONOMIST

a. <u>Roles:</u> Provides identification of macroinvertebrate samples.
b. <u>Qualifications:</u> Must have at least one year's experience with fauna from the Midwestern United States; B.A. or B.S. in Biological Area (i.e., Biology, Ecology, Environmental Studies); 1 Year of taxonomic experience working with aquatic macroinvertebrates; Certifications: Society for Freshwater Science (SFS) Genus-level, Chironomidae EAST, EPT Genera EAST

B. Equipment list

Verify that all necessary items are present before commencement of this procedure (Table 4).

Table 4. Macroinvertebrate identification and enumeration materials list.

√	*Item*
	Waterproof paper labels and water/solvent proof marker
	80 percent ethanol
	Squeeze bottles (for ethanol and water)
	4 oz. jars, with plastic or foam-line cap
	Dissecting scope with a 10x minimum power
	Fine tipped forceps, watchmaker type
	Vials, with polyseal caps -2,4, and 8 dram

C. General sample identification procedure

1. Empty contents of the taxonomy vial(s) into a petri-dish.
2. To facilitate identification, sort organisms according to major taxonomic groups (i.e., Plecoptera, Trichoptera, or Coleoptera). Different groups can be placed in separate, 60mm petri-dishes or kept separate in several larger petri-dishes.
3. Identify organisms to the target taxonomic level (see Appendix E for taxonomic targets). The desired level is genus for many taxa, although this varies depending on the feasibility and need for finer taxonomic resolution.
4. Organisms should be counted as they are identified, and removed to another dish or placed back in the sample vial to avoid miscounting.

Note
Final identifications are to be made by experienced taxonomists. Preliminary identifications made by interns, or inexperienced taxonomists must be verified by a staff member whose name appears on the macroinvertebrate QC list. When making identifications, the taxonomist should refer to taxonomic reference materials. Many taxonomic references contain high quality pictures, but identifications are never to be made using pictures alone. The proper way to make an identification includes taking a specimen through a dichotomous key, checking range distribution, checking habitat preference, and checking for seasonal emergence and growth patterns. If any questions remain about the identity of a specimen, consult another staff taxonomist, or a regional or taxonomic group specialist.

5. When large numbers of individual taxa are present, a laboratory counter should be used to keep a running total. Counters should be labeled to avoid confusion if using more than one counter.
6. If an organism is encountered for the first time in the laboratory, remove it to its own vial for inclusion in the voucher collection. Make a note of this on the Invertebrate Identification and Enumeration Sheet (Appendix B).

D. Large/rare sample identification

1. The Large/Rare sample should be identified and enumerated separate from the main sub-sample.
2. Sort organisms according to major taxonomic groups (i.e., Plecoptera, Trichoptera, or Coleoptera)
3. Different groups can be placed in separate, 60-mm petri dishes or kept separate in several larger petri-dishes.
4. Identify organisms to the lowest practical taxonomic level (see Appendix E for taxonomic targets). The desired level is genus for many taxa, although this varies depending on the feasibility and need for finer taxonomic resolution.
5. Organisms should be counted as they are identified, and removed to another dish or placed back in the sample vial to avoid miscounting.
6. Record numbers of Large/Rare organisms in the Large/Rare column of the macroinvertebrate identification bench sheet (Appendix B).

Note
It is imperative that organisms which are a part of the Large/Rare sample are kept separate from the multihabitat subsample and quantitative sample. Large/Rare organisms are only used in taxa richness measures, so it is most important that their presence is noted.

Quality Assurance/Quality Control procedure for macroinvertebrate identification

It is required that 10% of all samples are sent to an external lab for an additional check on taxonomy. The goal of this additional step is to ensure that the lab is following updated taxonomic rules, to improve on lab taxonomy, and correct any persistent taxonomic errors.

Calculation of Minnesota Macroinvertebrate IBIs

The Index of Biotic Integrity (IBI) is one of the primary tools used by the Minnesota Pollution Control Agency (MPCA) to determine if streams are meeting their aquatic life use goals. Calculation of an IBI involves the synthesis of macroinvertebrate community information into a numerical expression of stream health. In order to apply the MPCA Macroinvertebrate IBI (MIBI) to a macroinvertebrate dataset, it is essential that all data is collected using MPCA field and laboratory protocols (See protocols above). This section details the process for calculating the Minnesota MIBIs from raw macroinvertebrate samples.

Summary of MIBI development

To account for natural differences in macroinvertebrates communities in Minnesota, streams are assigned to different stream types. These stream types use different MIBI models and biocriteria to determine the condition of the macroinvertebrate assemblage and their attainment or nonattainment of the aquatic life beneficial use. The MPCA stratified Minnesota streams into nine macroinvertebrate stream types based on the expected natural composition of stream macroinvertebrates (Table 5). Stream type is differentiated by drainage area, geographic region, thermal regime, and gradient. These stream types are used to determine thresholds (i.e., biocriteria) that interpret the calculated MIBI as meeting or exceeding the aquatic life use goal. MIBIs were developed from five individual macroinvertebrate stream groups, with large rivers, wadeable high gradient and wadeable low gradient stream types each being combined for the purposes of metric testing and evaluation. A complete description of the development of MIBIs can be found in MPCA (2014a).

Table 5. List of MIBI groups, stream types, and stream type descriptions.

MIBI Group	Stream Type	Stream Type Geographic Description	Drainage Area
Large Rivers	1 - Northern Forest Rivers	Rivers in the Laurentian Mixed Forest Province	>=500 Sq. Miles
	2 - Prairie and Southern Forest Rivers	Rivers in the Eastern Broadleaf Forest, Prairie Parklands, and Tall Aspen Parklands ecological provinces	>=500 Sq. Miles
Wadeable High-Gradient Streams (RR)	3 - Northern Forest Streams RR	High Gradient streams in the Laurentian Mixed Forest ecological province, excluding streams in HUC 07030005	<500 Sq. Miles
	5 - Southern Streams RR	High Gradient Streams in the Eastern Broadleaf Forest, Prairie Parklands, and Tall Aspen Parklands ecological provinces, as well as streams in HUC 07030005	<500 Sq. Miles
Wadeable	4 - Northern Forest Streams GP	Low Gradient streams in the Laurentian Mixed Forest ecological province, excluding streams in HUC 07030005	<500 Sq. Miles

MIBI Group	Stream Type	Stream Type Geographic Description	Drainage Area
Low-Gradient Streams (GP)	6 - Southern Forest Streams GP	Low Gradient Streams in the Eastern Broadleaf Forest, as well as streams in HUC 07030005	<500 Sq. Miles
	7 - Prairie Streams GP	Low Gradient Streams in the Prairie Parklands, and Tall Aspen Parklands ecological provinces	<500 Sq. Miles
Northern Coldwater Streams	8 - Northern Coldwater	Coldwater Streams in northern portions of Minnesota, characterized by the Laurentian Mixed Forest ecological province. Excluding streams in HUC 07030005	N/A
Southern Coldwater Streams	9 - Southern Coldwater	Coldwater Streams in southern portions of Minnesota, characterized by the Eastern Broadleaf Forest, Prairie Parkland, and Tall Aspen Parklands ecological provinces. Including streams in HUC 07030005	N/A

Determining stream type

Prior to calculating an MIBI score for a given sampling location, the stream reach must be categorized into a macroinvertebrate stream type. This requires a determination of the drainage area, geographic region, thermal regime, and gradient for a stream site. Determination of each of these stream characteristics is described below and a dichotomous key for stream type determination is provided in Appendix C.

Drainage area - Drainage area must be determined for all stream reaches sampled. There is one large river MIBI applied to rivers greater than 500 square miles (although determination of the applicable biocriterion also requires determination of region membership). All other stream types apply to streams less than 500 square miles.

Region – The macroinvertebrate stream types follow a geographic framework based on the Minnesota Department of Natural Resources Ecological Classification system. The only exception is the portion of the Laurentian Mixed Forest which falls in the St. Croix River – Stillwater watershed (HUC 07030005) and is grouped with southern stream types. Figure 1 shows the geographic framework used for the purpose of assessment and biocriteria development.

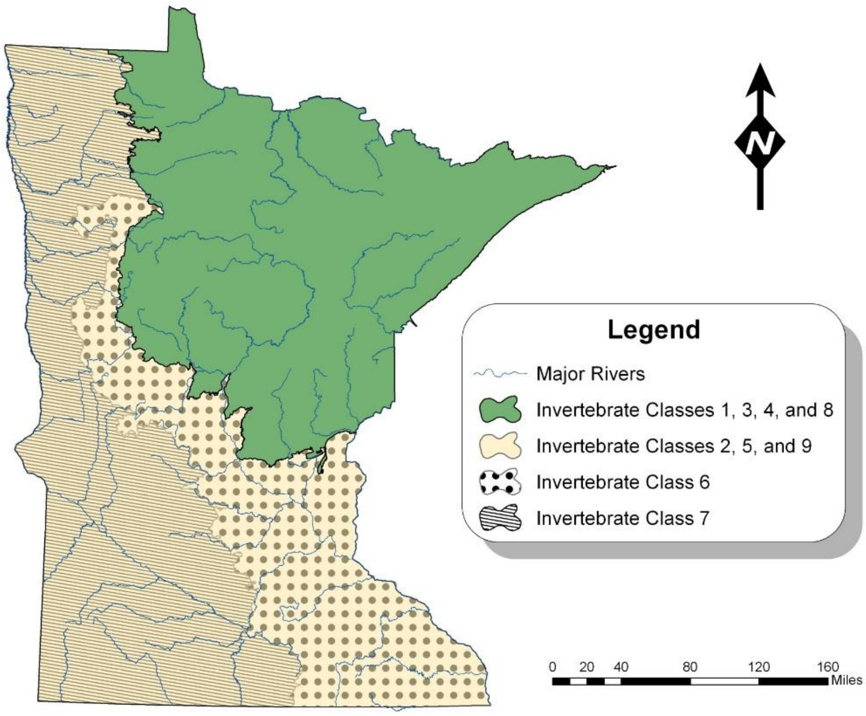

Figure 1. Map of ecological provinces associated with MPCA macroinvertebrate indices of biological integrity (MIBIs).

Temperature – For purposes of the application of stream water quality standards, the MPCA recognizes two temperature stream types: 1) warmwater/coolwater (Classes 2Bd, 2B, and 2C) and 2) coldwater (Class 2A). Similarly, temperature regime was a primary factor in the development of stream types used for MIBI development. The determination of a stream's coldwater designation can be found in Minn. R. 7050.0470.

Gradient – Two of the five MIBI stream groups are categorized using stream gradient. Gradient is determined based on flow conditions and the presence of riffles. If a stream reach includes riffles as representative habitat, and has flow adequate to create an environment supportive of riffle dwelling organisms, then a stream would be considered as high gradient, or riffle/run (RR). If these conditions are not met, then a stream is considered low gradient, or glide/pool (GP). Table 6 outlines criteria used by the MPCA to determine gradient category.

Table 6. Dichotomous key for determining stream type membership.

Riffle/Run (RR) vs. Glide Pool (GP) Designation Guidance		
Criteria	Yes	No
1. Has the sampler indicated on the stream visit form that 'riffle/run' is the 'Dominant invertebrate habitat in reach'?	**RR**	**#2**
2. In the mulithabitat sample, was any portion collected from riffles or rocky runs?	**go to #3**	**GP**
3. Was there a riffle present in the sample reach?	**go to #4**	**GP**
4. Flow over riffle perceptible?	**go to #5**	**GP**
5. # 'Riffle/run, rocky substrate' samples > 4?	**RR**	**go to #6**
6. Use a weight of evidence approach pulling in comments from macroinvertebrate visit form, habitat data from fish visit, sample reach photos, aerial photos, and geomorphology GIS layer to address the following:		
	RR	**GP**
Extent of riffle in sample reach (%)	≥ 5%	< 5%
Gradient of sample reach	> 1	≤ 1
Evidence from site photos or aerial photos of obvious high-gradient stream segments.		

Data collection and organization

In order to calculate a Minnesota MIBI score for a macroinvertebrate sample, data must be collected and processed using MPCA protocols (see protocol sections above). In order to calculate metric values it is necessary to use the same taxonomic targets and taxonomic attributes used by the MPCA. These attributes have been assigned using a variety of external sources, as well internally calculated tolerance values (Appendix D). Attributes used in the calculation of metric values include taxonomy, functional feeding group, tolerance related to general disturbance, tolerance related to thermal regime, habitat, and longevity.

Counting taxa: In order to correctly calculate the value of richness or relative richness metrics, taxa must be counted in a consistent manner. The target taxonomic level of determination is genus for the majority of organisms that will be encountered in a typical stream sample. Appendix E includes a table with the taxonomic target for organisms used in calculating the metrics that comprise the Minnesota MIBIs. In the process of identifying a sample, it is common to have organisms identified to multiple levels within a taxonomic group, i.e., distinct family, genus and species level identifications for organisms within the same family. When this happens, only organisms at the highest level (typically genus) should be considered when counting distinct taxa. If species-level identifications are made, they must be grouped at the genus level for the purpose of metric calculation. Likewise, if individuals are left at the family level due to poor condition or early instar, while individuals within the family are identified to a higher level, .e.g., genus, the family-level identification should not be counted.

Calculating metric and IBIs scores

Metric values are the raw numeric expression of taxonomic or autecological information at either the community or individual level. Metric values are derived for each target metric group as explained in the Metric Type descriptions below. The tables in Appendix F detail the metrics for each metric group, including the information needed to calculate each metric value.

Metric types

Richness — Richness metrics are calculated based on the taxonomic richness of the target group identified for the metric. When calculating richness, only taxa determined to be countable, as described above, are to be considered. Richness groups can be defined by taxonomy, tolerance, life habit, functional feeding group, or other meaningful autecological classifications. Example metric – Intolerant Taxa: if there are 20 countable intolerant taxa in a sample, the “Intolerant Taxa” metric value would be 20.

Relative richness (percent taxa) – Relative richness metrics are calculated based on the taxonomic richness of the target group identified for the metric, relative to total taxonomic richness in the sample. When calculating, relative richness only taxa determined to be countable, as described above, are to be considered. The groups can be defined by taxonomy, tolerance, life habitat, functional feeding group, or other meaningful autecological classifications. Example metric – Clinger Percent Taxa: if there are 6 countable clinger taxa in a sample with 24 total countable taxa, the “Clinger % Taxa” metric value would be 25% (6/24).

Relative abundance – Relative abundance metrics are calculated based on the abundance of the target group identified for the metric, relative to total sample abundance. When calculating relative abundance, all individuals that meet the group criteria are to be tallied, not only those that are considered countable, as with richness metrics. The groups can be defined by taxonomy, tolerance, life habit, functional feeding group, or other meaningful autecological classifications. Example metric – Percent Plecoptera: if there are 50 Plecoptera individuals in a sample with 350 total individuals, the “Percent Plecoptera” metric value would be 14.3% (50/350).

Ratio – Ratio metrics represent the ratio of one group to another. The ratio can be an expression of richness or abundance. The only ratio metric calculated for a Minnesota MIBI, is the Chironomidae:Diptera ratio metric. This metric is the ratio of Chironomidae abundance to total Diptera abundance. Example metric – Chironomidae:Diptera: if there are 50 Chironomidae individuals in a sample with 65 total Diptera individuals, the “Chironomidae:Diptera” metric value would be 0.77 (50/65).

Biotic index – A biotic index is calculated by determining the abundance weighted average of the tolerance values of each taxon present in a sample that has been assigned a tolerance value. When calculating a biotic index, abundances should be summed up to the highest level to which a tolerance value is assigned, i.e., if a tolerance value is not assigned to a taxon identified to a higher taxonomic resolution it should be summed with the next lowest taxonomic group. There are two Biotic Index metrics calculated for Minnesota MIBIs, the Minnesota Hilsenhoff Biotic Index and the Minnesota Coldwater Biotic index. The tolerance values used in these calculations were derived from data collected as part of the MPCA biomonitoring effort, and supplemented with other national or regional tolerance values where necessary. The tolerance values can be found in the table in Appendix D.

Calculating metric scores

Metric scores are derived from metric values. Metric scores range from 0 to 10, and their derivation is as follows:

> Step 1 – Metric value transformation. Transformation is applied to correct skewed metrics. If indicated in the metric table for the relevant MIBI (Appendix F), the metric value should be transformed using the indicated transformation.
>
> Step 2 – Drainage area correction. Drainage area correction is applied to remove a metrics relationship with drainage area. Drainage area corrected metrics are only tabulated for the Southern Coldwater MIBI. If indicated in Appendix F, Table 5 the metric value should be corrected using the drainage area for the sample location, and the slope and constant provided. The correction is calculated as follows:
>
> Corrected metric value = (metric value)-(((slope)*$\log_{10}$(drainage area))+constant)
>
> Step 3 – Scaling metric values from 0 to 10 points. Each metric is scored on a continuous scale from 0 to 10. There are two ways to score a metric, depending on the metrics predicted response to disturbance (Appendix F). Metrics that respond negatively to disturbance will have metrics scores positively correlated with metric values (positive metrics). Metrics that respond positively to disturbance will have metric scores inversely related to metric values (negative metrics). In order to limit the effect of extreme values when deriving metric scoring criteria, upper and lower limits were established by determining the 5^{th} and 95^{th} percentiles of each metric. These limits are documented as ceiling and floor values in Appendix F. The documented limits reflect the limits of the metric value; for the purposes of scoring, the limits must be treated similar to the metric value if a needed transformation is indicated. For positive metrics, values less than the 5th percentile (minimum) are given a score of 0, those with values greater than the 95^{th} percentile (maximum) are given a score of 10, and metric scores in between are interpolated linearly. For negative metrics, values less than the 5th percentile (minimum) are given a score of 10, those with values greater than the 95^{th} percentile (maximum) are given a score of 0, and metric scores in between are interpolated linearly. The formulas for calculating metric scores are as follows:

Formula for calculating positive metric scores: $metric\ score = \frac{metric\ value - 5th\ percentile\ value}{95th\ percentile\ value - 5th\ percentile\ value} * 10$

Formula for calculating negative metric scores: $metric\ score = \frac{95th\ percentile\ value - metric\ value}{95th\ percentile\ value - 5th\ percentile\ value} * 10$

Calculating IBI scores

Calculation of the MIBI score for a stream sample is done by summing the metric scores and scaling the summed scores to maximum score of 100. The formula for scaling IBI scores is as follows:

Formula for scaling summed metrics score to 100: $IBI\ score = sum\ of\ metric\ scores * \frac{10}{\#\ metrics\ in\ IBI}$

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Appendix A: Field visit form and field data labels for collecting macroinvertebrates from Minnesota streams

MPCA Stream Monitoring Program

STREAM INVERTEBRATE VISIT FORM

Stream Name:		**Date:**
Field Number:	**County:**	**Crew:**
Water Chemistry	Tape Down: ___.____ (1/100ths ft)	Location: ______________________

Time: (24 hr) ___:___ Air Temp:______ (ºC) Water Temp:______ (ºC) Conductivity: __________ (umhos@25ºC)

DO: __________(mg/L) DO % Saturation:____________ pH:_________ Secchi -Tube: __________ (cm)

Water Level: Normal Below _______ (m) Above _______ (m) Color ______________ (pcu)

*****If Flagging is not found or if establishing a new site, fill out GPS info*****

Coordinates	**LATITUDE**	**LONGITUTDE**	**Time:**
Field GPS:	_____ . _________	_____ . _________	**Name:**

Notes:

Stream Classification Information

Flow	Flow over riffle(s)	High / Med / Low / NA	Channel	Excavated, trapezoidal channel	%
	Flow at reach constriction	High / Med / Low / NA		Shallow excavation, channelized wetland	%
	Flow over run	High / Med / Low / NA		Natural channel	%
	General flow pattern	High / Med / Low / NA	Vegetation	Emergent, aquatic vegetation in channel	Ext / Mod / Sparse / NA
	Intermittent sections	Yes / No		Emergent, aquatic vegetation along bank	Ext / Mod / Sparse / NA
Habitat	Riffle (with flow) present in reach ☐			Floating or submerged aquatic vegetation	Ext / Mod / Sparse / NA
	Riffle (with flow) present outside of reach ☐ (riffles do not include riprap associated with bridges or bank stabilization)			Loosely attached filamentous algae	Ext / Mod / Sparse / NA
				Firmly attached algae or submerged veg	Ext / Mod / Sparse / NA
	Dominant invertebrate habitat (circle two) Riffle | Rocky Run-Pool | Aquatic Macrophyte | Bank-Overhanging Veg | Wood | Leaf				
Substrate	Dominant Run Substrate	bedrock / boulder / cobble / gravel / sand / silt			
	Dominant Pool Substrate	bedrock / boulder / cobble / gravel / sand / silt			
	Dominant Substrate receiving flow	bedrock / boulder / cobble / gravel / sand / silt			
	Dominant Substrate in reach	bedrock / boulder / cobble / gravel / sand / silt			

☐ Stream displays a typical riffle-run pool morphology ☐ adequate flow to maintain riffle organisms ☐ inadequate flow to maintain riffle organisms

☐ Stream has adquate flow to maintain riffle organism, but does not have suitable coarse substrate to support these assemblages (riffles, rock substrate in runs or pools)

☐ Stream has adquate flow to maintain riffle dwelling organism, woody debris has replaced rocks as primary coarse substrate

☐ Stream is low gradient, stream bed is predominately fine substrate, inadequate flow to maintain riffle organisms

Invertebrate Sample Information

Qualitative Multi-Habitat Sample (QMH)

Divide 20 samples equally among habitat types present in the reach. If three habitat types are present take 7 samples in each of the three dominant habitats (for a total of 21). If a habitat is present, but not in abundance to sample in equal proportion to other habitats, sample as much as possible and divide the remaining samples between the dominant habitat types.

✔	Habitat			#Samples
☐	rock riffle/run	Flow adequate to carry insects into net		
	rock substrate	Artificial flow needed to carry insect into net		
☐	aquatic macrophyte			
☐	undercut bank, overhanging veg			
☐	snag, woody debris, root wad			
☐	leaf pack			

Number of multihabitat containers: _____

Additional Biological Information

Presence of freshwater sponge ----------- yes / no

Presence of exotic species --------------- yes / no

Name of exotic(s) if present:

(voucher a specimen if not present in sample)

Presence of mussels ---------------------yes / no

Description of mussel density and/or mussel bed location:

Notes

Pictures #: __ DD __ DU __ MD __ MU __ UD __ UU

Stream Sample External Label:

MPCA Bioassessment – Invertebrate Sample
Sample Preservative - 100% reagent alcohol / 10% formalin
Sample Type: QMH / RTH
Sample Composition: Riffle / Bank / Wood / Veg
Date ____/____/20___ (mm/dd/yyyy)
Station Name ___________________________
Station ID __________________
Site Visit 1 / 2 Sample Jar ___ of ___
Collectors ____________________________

Stream Sample Internal Label:

Invertebrate Sample – sample type __________
Site Name:______________________________
Field Number_____________________________
Date:_____/_____/_____ Bottle No. _____of____
Collected by: ___________________________
____

Appendix B: Examples of macroinvertebrate sorting and identification bench sheets

-MPCA Biological Monitoring Program-

Macroinvertebrate Sample Sorting Bench Sheet

Field Number	Sample Date	Sample Type *	# Sample Bottles	Sample Sorting Date		# Organisms Picked	# Squares Picked**	L/R (y/n)	Chiro toVial (y/n)
				Begin	End				

* QMH, QR, HD, WTL

** Applies only to samples being subsampled

-MPCA Biological Monitoring Program-

Macroinvertebrate Sorting QC Form

Sample Field Number	Sampling Date	Sample Type	Initials of QC Sorter	# Organisms found in QC	# Organisms originally found in sample	Sorting Efficiency	Date QC Sort Completed

-MPCA Biological Monitoring Program-

Macroinvertebrate Identification Lab Bench Sheet

Field Number	**Sample Date**
Site Name	**Taxonomist:**
Sample Type QMH* QR HD other____________	**Date of Sample ID:** _____/_____/_____

*A processed QMH sample consists of 2 parts, the subsample(ss) and large/rare (l/r), both parts must be identified

Order/Family	Genus	Species/Notes	ss	l/r
Ephemeroptera				
Baetiscidae	Baetisca			
Caenidae	Bracycercus			
	Caenis			
Ephemerellidae	Attenella			
	Ephemerella			
	Serratella			
Ephemeridae	Ephemera			
	Hexagenia			
Leptohyphidae	Tricorythodes			
Leptophlebiidae	Leptophlebia			
	Paraleptophlebia			
Polymitarcidae	Ephoron			
Potamanthidae	Anthopotamus			
Heptageniidae	Epeorus			
	Heptagenia			
	Stenacron			
	Stenonema			
Isonychiidae	Isonychia			
Ametropodidae	Ametropus			
Baetidae	Acerpenna			
	Baetis			
	Callibaetis			
	Heterocloeon			
notes/additional taxa				
Plecoptera				
Leuctridae				
Taeniopterygidae				
Perlidae	Acroneuria			
	Agnetina			
	Attaneuria			
	Neoperla			
	Paragnetina			
	Perlinella			
Perlodidae				
Pteronarcyidae	Pteronarcys			
notes/additional taxa				
Lepidoptera				
Pyralidae	Paraponyx			
	Petrophila			
notes/additional taxa				
Megaloptera				
Corydalidae	Chauliodes			
	Corydalus			
	Nigronia			
Sialidae	Sialis			
notes/additional taxa				
Isopoda				
Asselidae	Asselus			
notes/additional taxa				

Order/Family	Genus	Species/Notes	ss	l/r
Odonata				
Calopterygidae	Calopteryx			
	Hetaerina			
Coenagrionidae	Argia			
	Enallagma			
	Nehalennia			
Lestidae	Lestes			
Aeshnidae	Aeschna			
	Anax			
	Basiaeschna			
	Boyeria			
Cordulegastridae	Cordulegaster			
Corduliidae	Cordulia			
	Dorocordulia			
	Epitheca			
	Somatochlora			
Gomphidae	Dromogomphus			
	Gomphurus			
	Gomphus			
	Hagenius			
	Ophiogomphus			
	Phanogomphus			
	Progomphus			
notes/additional taxa				
Hemiptera				
Belostomatidae	Belstoma			
	Corixidae			
Corixidae	Hesperocorixa			
	Sigara			
	Trichocorixa			
Nepidae	Ranatra			
Notonectidae	Buenoa			
	Notonecta			
notes/additional taxa				
Amphipoda				
Talitridae	Hyallela	azteca		
Gammaridae	Gammarus			
notes/additional taxa				
Decapoda				
Cambaridae	Cambarus			
	Orconectes			
	Procambarus			
notes/additional taxa				
Pelecypoda				
Sphaeriidae				
Corbiculidae				
Unionidae				
notes/additional taxa				

entered into DataInverts by______ --- (initials) date_________

Order/Family	Genus	Species/Notes	ss	l/r
Trichoptera				
Dipseudopsidae	Phylocentropus			
Hydropsycidae	Ceratopsyche			
	Cheumatopsyche			
	Diplectrona			
	Hydropsyche			
	Potamyia			
Philopotamidae	Chimarra			
	Dolophilodes			
Polycentropodidae	Cernotina			
	Cyrnellus			
	Neureclipsis			
	Paranyctiophylax			
	Polycentropus			
Psychomyiidae	Lype			
	Psychomyia			
Glossosomatidae	Agapetus			
	Glossosoma			
	Protoptila			
Hydroptilidae	Hydroptila			
	Leucotrichia			
	Mayatrichia			
	Oxyethira			
	Orthotrichia			
Rhyacophilidae	Rhyacophila			
Brachyecentridae	Brachycentrus			
	Micrasema			
Helicopsychidae	Helicopsyche			
Lepidostomatidae	Lepidostoma			
Leptoceridae	Ceraclea			
	Leptocerus			
	Mystacides			
	Nectopsyche			
	Oecetis			
	Trianodes			
Limnephilidae	Limnephilus			
	Hydatophylax			
Molannidae	Molanna			
Phryganeidae	Phryganea			
	Ptilostomis			
Sericostomatidae	Agarodes			
notes/additional taxa				
Gastropoda				
Ancylidae	Ferrissia			
Planorbidae	Helisoma			
	Promentus			
	Planorbula			
	Gyraulus			
Vivaparidae	Campeloma			
Lymnaeidae	Lymnaea			
	Bulimnea			
	Fossaria			
Hydrobiidae	Amnicola			
Pleuroceridae	Pleurocera			
Physidae	Physa			
notes/additional taxa				

Order/Family	Genus	Species/Notes	ss	l/r
Diptera				
Ceratopogonidae	Alluaudomyia			
	Atrichopogon			
	Bezzia			
	Ceratopogon			
	Culicoides			
	Nilobezzia			
	Palpomyia			
	Probezzia			
	Sphaeromias			
Chironomidae	G.			
Dixidae	Dixa			
	Dixella			
Simuliidae	Simulium			
Tipulidae	Antocha			
	Dicranota			
	Hexatoma			
	Limnophila			
	Limonia			
	Pilaria			
	Tipula			
Athericidae	Atherix			
Empididae	Hemerodromia			
Tabanidae	Chrysops			
	Tabanus			
notes/additional taxa				
Coleoptera				
Dytiscidae	Agabus			
	Laccophilus			
	Liodessus			
Gyrinidae	Dineutus			
	Gyrinus			
Elmidae	Ancyronyx			
	Dubiraphia			
	Macronychus			
	Optioservus			
	Stenelmis			
Hydrophilidae	Berosus			
	Helocombus			
	Laccobius			
	Sperchopsis			
	Tropisternus			
Annelida	Oligochaeta			
	Hirudinea			
notes/additional taxa				
Hydracarina (trombidoformes, acarina)				
Nematoda				
notes/additional taxa				

entered into DataInverts by______ --- (initials) date_________

-MPCA Biological Monitoring Program-

Macroinvertebrate Identification QC Form

Field Number	Sample Date	Identifiers' Initials		Discrepancies		Comments	Total # of Conflicts	Total # of Taxa	Precision	
		Original ID	QC ID	Original Identification	QC Identification				Original ID	QC ID

Appendix C: Dichotomous key for determining macroinvertebrate stream type membership

1a. Drainage area >500 mi^2 .... Rivers 2
1b. Drainage area <500 mi^2 .... Streams 3

Rivers

2a. Sampling site located in the Laurentian Mixed Forest Province .... **Northern Forest Rivers**
2b. Sampling site located in the Eastern Broadleaf Forest, Prairie Parklands, or Tall Aspen Parklands province .... **Prairie and Southern Forest Rivers**

Streams

3a. Sampling site is in a designated coldwater stream (Class 2A) .... Coldwater Streams 4
3b. Sampling site is in a designated warm/cool waters stream (Class 2Bd, 2B, 2C) .... Warmwater and Coolwater Streams 5

Coldwater Streams

4a. Sampling site is in the Laurentian Mixed Forest ecological province (excluding streams in HUC 07030005) .... **Northern Coldwater Streams**
4b. Sampling site is in the Eastern Broadleaf Forest, Prairie Parkland, or Tall Aspen Parklands province (including streams in HUC 07030005) .... **Southern Coldwater Streams**

Warmwater and Coolwater Streams

5a. Sampling site is high gradient (riffle/run; see Table 6) .... High Gradient Streams 6
5b. Sampling site is low gradient (glide/pool; see Table 6) .... Low Gradient Streams 7

High Gradient (RR) Streams

6a. Sampling site is in the Laurentian Mixed Forest ecological province (excluding streams in HUC 07030005) .... **Northern Forest Streams RR**
6b. Sampling site is in the Eastern Broadleaf Forest, Prairie Parkland, or Tall Aspen Parklands province (including streams in HUC 07030005) .... **Southern Streams RR**

Low Gradient (GP) Streams

7a. Sampling site is in the Laurentian Mixed Forest ecological province (excluding streams in HUC 07030005) .... **Northern Forest Streams GP**
7b. Sampling site is in the Eastern Broadleaf Forest province (including streams in HUC 07030005) .... **Southern Forest Streams GP**
7c. Sampling site is in the Prairie Parkland or Tall Aspen Parklands province .... **Prairie Streams GP**

Appendix D: Taxonomic trait information

The following table includes a list of the macroinvertebrate taxa in the MPCA database and their associated taxonomic traits. The taxonomic traits in this database are derived from several sources including: Merritt and Cummins (1996), Barbour et al. (1999), Poff et al. (2006) and the Freshwater Biological Traits Database (https://www.epa.gov/risk/freshwater-biological-traits-database-traits). The Minnesota Tolerance and Coldwater Tolerance values are Minnesota specific and were developed using Minnesota's biological monitoring database. The fields in this table are as follows:

TSN (Taxonomic Serial Number): The TSN is a unique identifier that for a scientific name that does not include information on the status, rank, or taxonomic position of the organism. See the Integrated Taxonomic Information System (ITIS) (https://www.itis.gov/) for more information.

Name1: This field includes the scientific name of the taxon. Depending on the taxon, this field can include any taxonomic level from genus to phylum.

Name2: This field includes the species name if available.

FFG (Functional Feeding Group): This field classifies aquatic macroinvertebrates by their method of food acquisition and functional role in aquatic food webs. Abbreviations: cf = collector-filterer, cg = collector-gatherer, hb = herbivore, pa = parasite, pr = predator, sc = scraper, and sh = shredder.

Habit: This field refers to how a macroinvertebrate moves in the aquatic environment and where they find food. Abbreviations: burr = burrower, clim = climber, skat = skater, spra = sprawler, and swim = swimmer.

MN Tolerance: Tolerance values were calculated using the weighted average of a general disturbance measure where taxa relative abundance was the weighting factor. The general disturbance measure was the first principal component of a principal components analysis of six disturbance variables including Minnesota's Human Disturbance Score (HDS), the Minnesota Stream Habitat Assessment score, total phosphorus, total suspended solids, NH_4, and nitrate/nitrite.

Coldwater Tolerance: Coldwater sensitivity values were calculated using the weighted average of stream temperatures where taxa relative abundance was the weighting factor.

LongLived: These are macroinvertebrates that are relatively long-lived with a life cycle of more than 1 year (i.e., semivoltine).

Some fields in this table are blank due to a lack of autecological information on the taxa or in the case of the "MN Tolerance" and Coldwater Tolerance" metrics, an insufficient number of occurrences of these taxa to calculate these values. In some cases, the attributes for lower taxonomic units (e.g., species) are derived from higher taxonomic units due to the lack of the information at finer taxonomic resolutions.

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
-65	*Acentrella*	*rallatoma*	cg	swim		20.96	FALSE
-64	*Kloosia*		cg	burr	6.00		FALSE
-63	*Anafroptilum*		cg	swim	4.29		FALSE
-62	*Kribiodorum*	*perpulchra*	cg	burr			FALSE
-61	*Allocladius*		cg	spra			FALSE
-51	*Neostempellina*	*reissi*	cf	burr			FALSE
-49	*Kribiodorum*	*perpulchrum*	cg	burr			FALSE
-48	*Kribiodorum*		cg	burr			FALSE
-47	*Radotanypus*		pr	spra			FALSE
-45	*Pericoma / Telmatoscopus*		cg	burr	4.00		FALSE
-36	*Thienemannimyia Gr.*		pr		7.90	20.07	FALSE
-20	*Bezzia/Palpomyia*		pr	spra	6.00	19.10	FALSE
-19	*Odontomyia /Hedriodiscus*		cg	clim			FALSE
-8	*Phanogomphus*		pr	burr	5.00		TRUE
48739	Hydrozoa		pr				FALSE
50844	Hydridae		pr		9.36	21.03	FALSE
50845	Hydra		pr		9.25	22.02	FALSE
53964	Turbellaria		pr	spra	4.00		FALSE
57577	*Prostoma*		pr				FALSE
59490	Nematoda		pr		5.00		FALSE
64183	Nematomorpha		pr	burr	5.00		FALSE
64357	Annelida						FALSE
68422	Oligochaeta		cg	burr	6.00		FALSE
68440	Lumbriculidae		cg	burr	6.00		FALSE
68441	*Lumbriculus*		cg	burr	6.00		FALSE
68450	*Stylodrilus*		cg	burr			FALSE
68531	*Enchytraeus*		cg	burr	6.00		FALSE
68541	*Henlea*		cg	burr			FALSE
68544	*Mesenchytraeus*		cg	burr	6.00		FALSE
68638	*Limnodrilus*		cg	burr	6.00		FALSE
68679	*Aulodrilus*		cg	burr	6.00		FALSE
68779	*Bothrioneurum*	*vejdovskyanum*	cg	burr			FALSE
68780	*Spirosperma*		cg	burr	6.00		FALSE
68794	*Quistadrilus*	*multisetosus*	cg	burr	6.00		FALSE
68839	*Rhyacodrilus*		cg	burr	6.00		FALSE
68854	Naididae		cg	burr	6.00		FALSE
68856	*Slavina*	*appendiculata*	cg	burr	6.00		FALSE
68871	*Stylaria*		cg	burr	6.00		FALSE
68872	*Stylaria*	*lacustris*	cg	burr			FALSE
68876	*Pristina*		cg	burr	6.00		FALSE
68898	*Dero*		cg	burr	6.00		FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
68934	*Chaetogaster*		cg	burr	6.00		FALSE
68946	*Nais*		cg	burr	6.00		FALSE
68995	*Ophidonais*		cg	burr	6.00		FALSE
68996	*Ophidonais*	*serpentina*	cg	burr	6.00		FALSE
69021	*Bratislavia*		cg	burr	6.00		FALSE
69168	Branchiobdellida		cg	clim			FALSE
69169	Branchiobdellidae		cg	clim	9.00	21.85	FALSE
69180	*Branchiobdella*		cg	burr			FALSE
69290	Hirudinea		pr	swim	10.00		FALSE
69357	Glossiphoniidae		pr	clim	6.19	20.20	FALSE
69363	*Placobdella*		pr	clim	6.00		FALSE
69366	*Placobdella*	*ornata*	pr	clim	6.00		FALSE
69367	*Placobdella*	*multilineata*	pr	clim	6.00		FALSE
69369	*Placobdella*	*hollensis*	pr	clim	6.00		FALSE
69380	*Glossiphonia*		pr	clim			FALSE
69381	*Glossiphonia*	*complanata*	pr	clim			FALSE
69389	*Alboglossiphonia*	*heteroclita*	pr	clim			FALSE
69396	*Helobdella*		pr	clim	6.30	20.10	FALSE
69397	*Helobdella*	*elongata*	pr	clim	6.30	20.10	FALSE
69398	*Helobdella*	*stagnalis*	pr	clim	6.30	20.10	FALSE
69403	*Helobdella*	*papillata*	pr	clim	6.30	20.10	FALSE
69407	Hirudinidae		pr	swim	7.00		FALSE
69408	*Haemopis*		pr	swim			FALSE
69438	Erpobdellidae		pr	swim	4.19	18.12	FALSE
69444	*Erpobdella*		pr	swim		19.12	FALSE
69455	*Nephelopsis*		pr	swim	6.06	17.05	FALSE
69456	*Nephelopsis*	*obscura*	pr	swim	6.06	17.05	FALSE
69459	Gastropoda		sc		7.00		FALSE
70304	Viviparidae		sc	clim	1.56	20.23	FALSE
70305	*Viviparus*		sc	clim	1.00		FALSE
70311	*Campeloma*		sc	clim	2.47	18.49	TRUE
70312	*Campeloma*	*decisum*	sc	clim	2.47	18.49	TRUE
70328	*Cipangopaludina*		sc	clim			FALSE
70345	Valvatidae		sc	clim	6.78	22.49	TRUE
70346	*Valvata*		sc	clim	6.80	22.50	TRUE
70354	*Valvata*	*tricarinata*	sc	clim	6.80	22.50	TRUE
70359	*Valvata*	*lewisi*	sc	clim	6.80	22.50	TRUE
70493	Hydrobiidae		sc	clim	4.56	20.81	FALSE
70505	*Probythinella*		sc	clim			FALSE
70605	*Fontigens*		sc	clim			FALSE
70736	*Pomatiopsis*		sc	clim			FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
70747	*Amnicola*		sc	clim	2.98	21.28	FALSE
70794	*Bithynia*	*tentaculata*	sc	clim			FALSE
71541	Pleuroceridae		sc	clim	5.00		FALSE
71542	*Goniobasis*		sc	clim			FALSE
71549	*Pleurocera*		sc	clim	3.70		TRUE
71550	*Pleurocera*	*acuta*	sc	clim	3.70		TRUE
76483	Lymnaeidae		sc	clim	9.59	20.14	FALSE
76484	*Lymnaea*		sc	clim	7.16		FALSE
76487	*Lymnaea*	*stagnalis*	sc	clim	7.16		TRUE
76497	*Fossaria*		sc	clim	6.36	19.88	FALSE
76528	*Pseudosuccinea*		sc	clim	9.41	20.89	FALSE
76529	*Pseudosuccinea*	*columella*	sc	clim	9.41	20.89	FALSE
76532	*Bulimnaea*		sc	clim			FALSE
76533	*Bulimnaea*	*megasoma*	sc	clim			FALSE
76534	*Stagnicola*		sc	clim	10.00	19.80	FALSE
76568	Ancylidae		sc	clim	7.07	20.97	FALSE
76569	*Ferrissia*		sc	clim	7.07	20.97	FALSE
76577	*Laevapex*	*fuscus*	sc	clim			FALSE
76591	Planorbidae		sc	clim	8.17	20.33	FALSE
76592	*Gyraulus*		sc	clim	8.21	19.72	FALSE
76599	*Helisoma*		sc	clim	7.36	21.16	TRUE
76600	*Helisoma*	*anceps*	sc	clim	7.36	21.16	FALSE
76621	*Promenetus*		sc	clim	6.83	18.70	FALSE
76622	*Promenetus*	*exacuous*	sc	clim	6.83	18.70	FALSE
76625	*Promenetus*	*umbilicatellus*	sc	clim	6.83	18.70	FALSE
76626	*Menetus*		sc	clim	5.48		FALSE
76629	*Planorbula*		sc	clim	9.11	20.12	FALSE
76630	*Planorbula*	*armigera*	sc	clim	9.11	20.12	FALSE
76643	*Micromenetus*		sc	clim			FALSE
76654	*Planorbella*		sc	clim	10.00	20.84	FALSE
76658	*Planorbella*	*campanulata*	sc	clim	10.00	20.84	TRUE
76671	*Planorbella*	*trivolvis*	sc	clim	10.00	20.84	FALSE
76676	Physidae		sc	clim	10.00	20.35	FALSE
76677	*Physa*		sc	clim	10.00	20.35	FALSE
76683	*Physa*	*integra*	sc	clim	10.00	20.35	FALSE
76695	*Aplexa*		sc	clim			FALSE
76697	*Aplexa*	*elongata*	sc	clim			FALSE
76698	*Physella*		sc	clim	8.00		FALSE
79118	Bivalvia		cf		8.00		TRUE
79913	Unionidae		cf	burr	1.13		TRUE
79951	*Elliptio*		cf	burr	8.00		FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
79986	*Lampsilis*		cf	burr			TRUE
80170	*Proptera*		cf	burr			FALSE
80297	*Elliptoideus*		hb	burr			FALSE
81339	*Dreissena*	*polymorpha*	cf	clng			FALSE
81381	Corbiculidae		cf	burr	6.00		FALSE
81388	Pisidiidae		cf	burr	7.82	20.46	FALSE
81391	*Sphaerium*		cf	burr	4.70		FALSE
81400	*Pisidium*		cf	burr	4.60		FALSE
84195	Ostracoda		cg		8.00		FALSE
85257	Copepoda		cg				FALSE
92120	Isopoda		cg		8.00		FALSE
92657	Asellidae		cg	spra	7.69	19.42	FALSE
92658	*Asellus*		cg	spra	6.49	19.88	FALSE
92666	*Lirceus*		cg	spra	8.00		FALSE
92686	*Caecidotea*		cg	spra	8.23	19.19	FALSE
93294	Amphipoda		cg	spra	4.00		FALSE
93745	Gammaridae		cg		6.05	17.00	FALSE
93773	*Gammarus*		cg	spra	6.05	17.00	FALSE
93790	*Gammarus*	*pseudolimnaeus*	cg	spra	6.05	17.00	FALSE
94025	*Hyalella*		cg	spra	7.30	21.43	FALSE
94026	*Hyalella*	*azteca*	cg	spra	7.30	21.43	FALSE
95081	*Crangonyx*		cg	spra	5.26	19.98	FALSE
95599	Decapoda		sh		8.00		TRUE
97336	Cambaridae		cg	spra	9.85	20.66	TRUE
97337	*Cambarus*		cg	spra	6.00		TRUE
97338	*Cambarus*	*diogenes*	cg		6.00		TRUE
97421	*Orconectes*		cg	spra	9.41	20.85	TRUE
97424	*Orconectes*	*rusticus*	cg		9.41	20.85	TRUE
97425	*Orconectes*	*virilis*	cg		9.41	20.85	TRUE
97446	*Orconectes*	*immunis*	cg		9.41	20.85	TRUE
97490	*Procambarus*		cg	spra	6.00		TRUE
99237	Collembola		cg				FALSE
99246	*Isotomurus*		cg	skat			FALSE
99643	*Entomobryidae*		cg	skat			FALSE
100502	Ephemeroptera		cg		4.00		FALSE
100504	Heptageniidae		sc	clng	7.63	20.78	FALSE
100507	*Stenonema*		sc	clng	6.94	21.06	FALSE
100516	*Stenonema*	*femoratum*	sc	clng	6.94	21.06	FALSE
100548	*Stenonema*	*vicarium*	sc	clng	6.94	21.06	FALSE
100572	*Rhithrogena*		pr	clng	0.00	17.61	FALSE
100602	*Heptagenia*		sc	clng	9.46	20.07	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
100626	*Epeorus*		cg	clng	0.00	19.11	FALSE
100649	*Epeorus*	*vitreus*	cg	clng	0.00	19.11	FALSE
100676	*Leucrocuta*		sc	clng	8.46	20.67	FALSE
100692	*Nixe*		pr	clng	0.00		FALSE
100713	*Stenacron*		cg	clng	7.25	20.47	FALSE
100714	*Stenacron*	*interpunctatum*	cg	clng	7.25	20.47	FALSE
100742	*Stenacron*	*minnetonka*	cg	clng	7.25	20.47	FALSE
100744	*Macdunnoa*		sc	clng			FALSE
100749	*Raptoheptagenia*		pr	swim			FALSE
100755	Baetidae		cg	swim	7.19	19.44	FALSE
100771	*Pseudocloeon*		sc	swim	8.96	20.55	FALSE
100794	*Heterocloeon*		sc	swim	0.18		FALSE
100796	*Heterocloeon*	*curiosum*	sc	swim	0.18		FALSE
100800	*Baetis*		cg	swim	6.78	18.29	FALSE
100801	*Acentrella*		cg	swim	8.46	20.96	FALSE
100808	*Baetis*	*intercalaris*	cg	clng	6.78	18.29	FALSE
100817	*Baetis*	*tricaudatus*	cg	spra	6.78	18.29	FALSE
100825	*Baetis*	*brunneicolor*	cg	clng	6.78	18.29	FALSE
100835	*Baetis*	*flavistriga*	cg	clng	6.78	18.29	FALSE
100873	*Centroptilum*		cg	swim	6.06	20.64	FALSE
100899	*Paracloeodes*		sc	swim	5.87	22.75	FALSE
100901	*Paracloeodes*	*minutus*	sc	swim	5.87	22.75	FALSE
100903	*Callibaetis*		cg	swim	10.00	21.68	FALSE
100951	Siphlonuridae		cg	swim	7.00		FALSE
100953	*Siphlonurus*		cg	swim	7.00		FALSE
100987	*Acanthametropus*		pr	swim	1.00		FALSE
100996	*Ameletus*		sc	swim	0.00		FALSE
101041	*Isonychia*		cf	swim	8.47	21.44	FALSE
101045	*Isonychia*	*bicolor*	cf	swim	8.47	21.44	FALSE
101057	*Isonychia*	*rufa*	cf	swim	8.47	21.44	FALSE
101062	*Isonychia*	*sicca*	cf	swim	8.47	21.44	FALSE
101078	Metretopodidae		pr	swim	1.00	19.80	FALSE
101079	*Siphloplecton*		cg	swim	1.00	19.80	FALSE
101084	*Siphloplecton*	*interlineatum*	cg	swim	1.00	19.80	FALSE
101095	Leptophlebiidae		cg	clng	3.27	19.91	FALSE
101096	*Traverella*		pr	clng			FALSE
101108	*Choroterpes*		cg	clng	2.00		FALSE
101122	*Habrophlebiodes*		sc	swim	6.00		FALSE
101148	*Leptophlebia*		cg	swim	3.36	20.40	FALSE
101153	*Leptophlebia*	*cupida*	cg	swim	3.36	20.40	FALSE
101183	*Habrophlebia*		cg	swim	1.00		FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
101187	*Paraleptophlebia*		cg	swim	3.80	19.77	FALSE
101232	Ephemerellidae		cg	clng	1.00	19.75	FALSE
101233	*Ephemerella*		cg	clng	0.26	18.69	FALSE
101241	*Ephemerella*	*subvaria*	cg	clng	0.26	18.69	FALSE
101255	*Ephemerella*	*aurivillii*	cg	clng	0.26	18.69	FALSE
101276	*Ephemerella*	*excrucians*	cg	clng	0.26	18.69	FALSE
101282	*Ephemerella*	*invaria*	cg	clng	0.26	18.69	FALSE
101317	*Timpanoga*		cg	clng	7.00		FALSE
101324	*Eurylophella*		cg	clng	1.34	20.68	FALSE
101326	*Eurylophella*	*temporalis*	cg	clng	1.34	20.68	FALSE
101332	*Eurylophella*	*funeralis*	cg	clng	1.34	20.68	TRUE
101334	*Eurylophella*	*bicolor*	cg	clng	1.34	20.68	FALSE
101338	*Attenella*		cg	spra	0.00		FALSE
101340	*Attenella*	*attenuata*	cg	clng	0.00		FALSE
101360	*Dannella*		cg	swim			FALSE
101395	*Serratella*		cg	clng	0.56	18.97	FALSE
101405	*Tricorythodes*		cg	spra	8.81	21.87	FALSE
101429	*Leptohyphes*		pr	clng	4.00		FALSE
101461	*Neoephemera*		cg	clng			FALSE
101466	*Neoephemera*	*bicolor*	cg	clng			FALSE
101467	Caenidae		cg	spra	8.80	21.47	FALSE
101468	*Brachycercus*		cg	spra	7.40		FALSE
101478	*Caenis*		cg	spra	8.79	21.47	FALSE
101479	*Caenis*	*tardata*	cg	spra	8.79	21.47	FALSE
101483	*Caenis*	*diminuta*	cg	spra	8.79	21.47	FALSE
101486	*Caenis*	*hilaris*	cg	burr	8.79	21.47	FALSE
101488	*Caenis*	*latipennis*	cg	spra	8.79	21.47	FALSE
101494	*Baetisca*		cg	swim	7.36	20.77	FALSE
101504	*Baetisca*	*lacustris*	cg	spra	7.36	20.77	FALSE
101505	*Baetisca*	*laurentina*	cg	spra	7.36	20.77	FALSE
101525	Ephemeridae		cg	burr	9.39	21.08	FALSE
101526	*Ephemera*		cg	burr	3.87	20.47	TRUE
101530	*Ephemera*	*simulans*	cg	burr	3.87	20.47	TRUE
101535	*Ephemera*	*varia*	cg	burr	3.87	20.47	TRUE
101537	*Hexagenia*		cg	burr	9.78	21.31	FALSE
101538	*Hexagenia*	*bilineata*	cg	burr	9.78	21.31	FALSE
101552	*Hexagenia*	*limbata*	cg	burr	9.78	21.31	TRUE
101566	*Litobrancha*			burr			FALSE
101569	Polymitarcyidae		cg	burr	7.35	21.03	FALSE
101570	*Ephoron*		cg	burr	7.38	21.09	FALSE
101571	*Ephoron*	*album*	cg	burr	7.38	21.09	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
101593	Odonata		pr	clim			FALSE
101594	Anisoptera		pr		6.00		FALSE
101596	Aeshnidae		pr	clim	7.38	19.64	TRUE
101597	*Anax*		pr	clim	8.13	21.55	TRUE
101598	*Anax*	*junius*	pr	clim	8.13	21.55	TRUE
101603	*Aeshna*		pr	clim	7.99	19.17	TRUE
101605	*Aeshna*	*umbrosa*	pr	clim	7.99	19.17	TRUE
101607	*Aeshna*	*verticalis*	pr	clim	7.99	19.17	TRUE
101609	*Aeshna*	*constricta*	pr	clim	7.99	19.17	TRUE
101634	*Gomphaeschna*		pr	clim	4.00		TRUE
101635	*Gomphaeschna*	*furcillata*	pr	clim	4.00		TRUE
101645	*Boyeria*		pr	clim	5.33	19.35	TRUE
101646	*Boyeria*	*grafiana*	pr	clim	5.33	19.35	TRUE
101647	*Boyeria*	*vinosa*	pr	clim	5.33	19.35	TRUE
101648	*Basiaeschna*		pr	clim	6.00	21.80	TRUE
101649	*Basiaeschna*	*janata*	pr	clim	6.00	21.80	TRUE
101653	*Nasiaeschna*		pr	clim	4.00		TRUE
101664	Gomphidae		pr	burr	3.75	20.66	TRUE
101665	*Gomphus*		pr	burr	7.11	21.09	TRUE
101666	*Stylurus*		pr	burr			TRUE
101672	*Gomphus*	*viridifrons*	pr	burr	7.11	21.09	TRUE
101685	*Gomphus*	*lividus*	pr	burr	7.11	21.09	TRUE
101700	*Gomphus*	*graslinellus*	pr	burr	7.11	21.09	TRUE
101718	*Progomphus*		pr	burr	1.00		TRUE
101725	*Erpetogomphus*		pr	burr	5.00		TRUE
101726	*Erpetogomphus*	*designatus*	pr	burr	5.00		FALSE
101730	*Dromogomphus*		pr	burr	3.00		TRUE
101734	*Hagenius*		pr	spra	1.00		TRUE
101735	*Hagenius*	*brevistylus*	pr	burr	1.00		TRUE
101738	*Ophiogomphus*		pr	burr	0.00	19.65	TRUE
101740	*Ophiogomphus*	*rupinsulensis*	pr	burr	0.00	19.65	TRUE
101745	*Ophiogomphus*	*carolus*	pr	burr	0.00	19.65	TRUE
101755	*Ophiogomphus*	*colubrinus*	pr	burr	0.00	19.65	TRUE
101770	*Arigomphus*		pr	burr	6.00		TRUE
101797	Libellulidae		pr	spra	7.17	21.38	FALSE
101803	*Perithemis*		pr	spra	6.85		FALSE
101808	*Plathemis*		pr	spra	8.00		FALSE
101809	*Plathemis*	*lydia*	pr	spra	8.00		FALSE
101851	*Didymops*		pr	spra	4.00		TRUE
101852	*Didymops*	*transversa*	pr	spra	4.00		TRUE
101854	*Dorocordulia*		pr	spra	5.00		TRUE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
101856	*Dorocordulia*	*libera*	pr	spra	5.00		TRUE
101885	*Leucorrhinia*		pr	clim	9.00		FALSE
101893	*Libellula*		pr	spra	9.00		FALSE
101896	*Libellula*	*quadrimaculata*	pr	spra	9.00		FALSE
101918	*Macromia*		pr	spra	0.82	19.60	TRUE
101921	*Macromia*	*illinoiensis*	pr	spra	0.82	19.60	TRUE
101922	*Macromia*	*taeniolata*	pr	spra	0.82	19.60	TRUE
101934	*Neurocordulia*		pr	clim	3.54	19.19	TRUE
101936	*Neurocordulia*	*molesta*	pr	clim	3.54	19.19	TRUE
101937	*Neurocordulia*	*yamaskanensis*	pr	clim	3.54	19.19	TRUE
101940	*Neurocordulia*	*xanthosoma*	pr	clim	3.54	19.19	TRUE
101947	*Somatochlora*		pr	spra	5.14	20.46	TRUE
101955	*Somatochlora*	*elongata*	pr	spra	5.14	20.46	TRUE
101958	*Somatochlora*	*minor*	pr	spra	5.14	20.46	TRUE
101960	*Somatochlora*	*walshii*	pr	spra	5.14	20.46	TRUE
101976	*Sympetrum*		pr	spra	10.00		FALSE
101978	*Sympetrum*	*corruptum*	pr	spra	10.00		FALSE
101979	*Sympetrum*	*vicinum*	pr	spra	10.00		FALSE
101981	*Sympetrum*	*obstrusum*	pr	spra	10.00		FALSE
101990	*Sympetrum*	*semicinctum*	pr	spra	10.00		FALSE
102014	*Cordulia*		pr	spra			TRUE
102015	*Cordulia*	*shurtleffi*	pr	spra			TRUE
102020	Corduliidae		pr	clim	3.88	19.87	TRUE
102026	Cordulegastridae		pr	burr	0.00		TRUE
102027	*Cordulegaster*		pr	burr	0.00		TRUE
102029	*Cordulegaster*	*erronea*	pr	burr	0.00		TRUE
102031	*Cordulegaster*	*maculata*	pr	burr	0.00		TRUE
102035	*Epitheca*		pr	clim	4.13		TRUE
102036	*Epitheca*	*canis*	pr	clim	4.13		TRUE
102043	Calopterygidae		pr	clim	5.85	20.60	FALSE
102048	*Hetaerina*		pr	clim	7.85	22.55	FALSE
102049	*Hetaerina*	*titia*	pr	clim	7.85	22.55	FALSE
102050	*Hetaerina*	*americana*	pr	clim	7.85	22.55	FALSE
102052	*Calopteryx*		pr	clim	5.03	20.42	TRUE
102055	*Calopteryx*	*maculata*	pr	clim	5.03	20.42	TRUE
102056	*Calopteryx*	*aequabilis*	pr	clim	5.03	20.42	TRUE
102058	Lestidae		pr	clim	9.00		FALSE
102059	*Archilestes*		pr	clim	7.00		FALSE
102061	*Lestes*		pr	clim	9.00		FALSE
102069	*Lestes*	*inaequalis*	pr	clim	9.00		FALSE
102077	Coenagrionidae		pr	clim	9.73	21.66	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
102078	*Ischnura*		pr	clim	9.99	21.56	FALSE
102079	*Ischnura*	*verticalis*	pr	clim	9.99	21.56	FALSE
102082	*Ischnura*	*posita*	pr	clim	9.99	21.56	FALSE
102093	*Amphiagrion*		pr	clim	9.00		FALSE
102095	*Amphiagrion*	*saucium*	pr	clim	9.00		FALSE
102102	*Enallagma*		pr	clim	9.17	21.85	FALSE
102108	*Enallagma*	*divagans*	pr	clim	9.17	21.85	FALSE
102115	*Enallagma*	*signatum*	pr	clim	9.17	21.85	FALSE
102122	*Enallagma*	*civile*	pr	clim	9.17	21.85	FALSE
102124	*Enallagma*	*cyathigerum*	pr	clim	9.17	21.85	FALSE
102125	*Enallagma*	*basidens*	pr	clim	9.17	21.85	FALSE
102133	*Chromagrion*		pr	clim	2.12		FALSE
102134	*Chromagrion*	*conditum*	pr	clim	2.12		FALSE
102135	*Nehalennia*		pr	clim	7.00		FALSE
102139	*Argia*		pr	clim	10.00	21.30	FALSE
102140	*Argia*	*apicalis*	pr	clng	10.00	21.30	FALSE
102143	*Argia*	*fumipennis*	pr	clng	10.00	21.30	FALSE
102155	*Coenagrion*		pr	clim	8.00		FALSE
102467	Plecoptera		pr	clng	8.00		FALSE
102470	Pteronarcidae		sh	clng	5.83	18.98	TRUE
102471	*Pteronarcys*		sh	clng	5.83	18.98	TRUE
102517	Nemouridae		sh	clng	1.00		FALSE
102540	*Amphinemura*		sh	spra	3.00		FALSE
102556	*Soyedina*		sh	spra	0.00		FALSE
102567	*Malenka*		sh	spra			FALSE
102643	Capniidae		sh	spra	0.15	16.30	FALSE
102788	Taeniopterygidae		sh	spra	2.52	21.05	FALSE
102789	*Taeniopteryx*		sh	spra	2.67	21.56	FALSE
102804	*Paracapnia*		sh	spra	0.33		FALSE
102840	Leuctridae		sh	clng	0.02	18.56	FALSE
102844	*Leuctra*		sh	spra	0.00		FALSE
102887	*Paraleuctra*		sh	spra	0.00		FALSE
102914	Perlidae		pr	clng	2.88	20.09	TRUE
102917	*Acroneuria*		pr	clng	2.40	20.07	TRUE
102918	*Acroneuria*	*lycorias*	pr	clng	2.40	20.07	TRUE
102919	*Acroneuria*	*abnormis*	pr	clng	2.40	20.07	TRUE
102922	*Acroneuria*	*carolinensis*	pr	clng	2.40	20.07	TRUE
102942	*Neoperla*		pr	clng	2.02		FALSE
102945	*Neoperla*	*stewarti*	pr	clng	2.02		FALSE
102954	*Attaneuria*		pr	clng	1.00		TRUE
102955	*Attaneuria*	*ruralis*	pr	clng	1.00		TRUE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
102962	*Paragnetina*		pr	clng	3.29	19.56	TRUE
102968	*Paragnetina*	*media*	pr	clng	3.29	19.56	TRUE
102975	*Agnetina*		pr	clng	4.24	21.40	TRUE
102979	*Agnetina*	*capitata*	pr	clng	4.24	21.40	TRUE
102994	Perlodidae		pr	clng	2.68	18.75	FALSE
102995	*Isoperla*		pr	clng	4.17	18.90	FALSE
103124	*Isogenoides*		pr	clng	0.00		FALSE
103202	Chloroperlidae		pr	clng	1.00		FALSE
103203	*Alloperla*		pr	clng	0.00		FALSE
103212	*Alloperla*	*usa*	pr	clng	0.00		FALSE
103244	*Perlinella*		pr	clng	1.00		FALSE
103246	*Perlinella*	*dryma*	pr	clng	1.00		FALSE
103251	*Perlesta*		pr	clng	6.81	19.76	FALSE
103273	*Sweltsa*		pr	clng	1.00		FALSE
103359	Hemiptera		pr	clim			FALSE
103364	Corixidae		pr	swim	8.68	21.38	FALSE
103369	*Sigara*		hb	swim	7.74	21.00	FALSE
103382	*Sigara*	*grossolineata*	hb	swim	7.74	21.00	FALSE
103402	*Sigara*	*lineata*	hb	swim	7.74	21.00	FALSE
103403	*Sigara*	*trilineata*	hb	swim	7.74	21.00	FALSE
103423	*Trichocorixa*		pr	swim	10.00	21.34	FALSE
103444	*Hesperocorixa*		hb	swim	4.53	21.42	FALSE
103460	*Hesperocorixa*	*kennicotti*	hb	swim	4.53	21.42	FALSE
103484	*Corisella*		pr	swim			FALSE
103491	*Palmacorixa*		pr	swim	9.48	22.66	FALSE
103501	*Cenocorixa*		pr	swim	8.00		FALSE
103514	*Callicorixa*		pr	swim	4.33		FALSE
103517	*Callicorixa*	*audeni*	pr	swim	4.33		FALSE
103525	*Cymatia*		pr	swim	9.00		FALSE
103526	*Cymatia*	*americana*	pr	swim	9.00		FALSE
103557	Notonectidae		pr	swim	6.57	21.40	FALSE
103558	*Notonecta*		pr	swim	6.77	21.22	FALSE
103583	*Buenoa*		pr	swim	7.00		FALSE
103602	Pleidae		pr	swim	8.90	21.83	FALSE
103603	*Neoplea*		pr	swim	8.92	21.85	FALSE
103604	*Neoplea*	*striola*	pr	swim	8.92	21.85	FALSE
103665	*Pelocoris*		pr	clim	7.00		FALSE
103683	Belostomatidae		pr	clim	9.33	20.96	FALSE
103684	*Belostoma*		pr	clim	9.34	20.96	FALSE
103689	*Belostoma*	*flumineum*	pr	clim	9.34	20.96	FALSE
103699	*Lethocerus*		pr	clim	6.87		TRUE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
103709	*Lethocerus*	*americanus*	pr	clim	6.87		TRUE
103748	*Ranatra*		pr	clim	10.00	21.05	FALSE
103765	*Nepa*		pr	clim	7.00		FALSE
103766	*Nepa*	*apiculata*	pr	clim	7.00		FALSE
103801	Gerridae		pr	skat	7.26	19.44	FALSE
103802	*Rheumatobates*		pr	skat	6.02	19.71	FALSE
103811	*Trepobates*		pr	skat	8.00		FALSE
103829	*Gerris*		pr	skat	6.89	20.17	FALSE
103857	*Metrobates*		pr	skat	6.00		FALSE
103872	*Limnoporus*		pr	skat	5.41		FALSE
103882	*Neogerris*	*hesione*	pr	skat			FALSE
103885	Veliidae		pr	skat	5.68	20.15	FALSE
103886	*Rhagovelia*		pr	skat	4.79	20.92	FALSE
103900	*Microvelia*		pr	skat	3.90	20.31	FALSE
103939	*Hydrometra*		pr	skat			FALSE
103954	*Mesovelia*		pr	skat	9.29	20.83	FALSE
103964	Hebridae		pr	clim			FALSE
103983	*Merragata*		pr	skat			FALSE
103990	Macroveliidae		pr	clim			FALSE
104063	Saldidae		pr	clim	10.00		FALSE
104140	*Saldula*		pr	clim			FALSE
109191	Aphididae		hb				FALSE
109216	Coleoptera		pr				FALSE
111857	Haliplidae		hb	clng	8.52	20.87	FALSE
111858	*Haliplus*		sh	clim	8.66	20.80	FALSE
111883	*Haliplus*	*immaculicollis*	sh	swim	8.66	20.80	FALSE
111923	*Peltodytes*		sh	clim	8.02	21.10	FALSE
111963	Dytiscidae		pr	swim	7.70	21.13	FALSE
111966	*Agabus*		pr	swim	5.15	18.68	FALSE
112072	*Agabetes*		pr	swim			FALSE
112074	*Acilius*		pr	swim			FALSE
112086	*Rhantus*		pr	swim	5.00		FALSE
112109	*Thermonectus*		pr	swim	5.00		FALSE
112118	*Dytiscus*		pr	swim	5.00		FALSE
112145	*Desmopachria*		pr	swim	10.00	23.72	FALSE
112148	*Desmopachria*	*convexa*	pr	swim	10.00	23.72	FALSE
112165	*Graphoderus*		pr	swim			FALSE
112172	*Hydaticus*		pr	swim	5.00		FALSE
112181	*Ilybius*		pr	swim	5.08	18.79	FALSE
112200	*Hygrotus*		pr	swim	10.00	21.71	FALSE
112278	*Laccophilus*		pr	swim	8.88	24.08	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
112314	*Oreodytes*		sh	swim	5.00		FALSE
112364	*Cybister*		pr	swim			FALSE
112371	*Coptotomus*		pr	swim	7.40	20.07	FALSE
112379	*Colymbetes*		pr	swim	5.00		FALSE
112390	*Hydroporus*		pr	swim	7.56	19.82	FALSE
112561	*Copelatus*		pr	swim	5.00		FALSE
112575	*Uvarus*		pr	swim	7.21		FALSE
112580	*Liodessus*		pr	swim	6.18	21.34	FALSE
112653	Gyrinidae		pr	swim	5.28	20.17	FALSE
112654	*Gyrinus*		pr	swim	5.31	19.98	FALSE
112711	*Dineutus*		pr	swim	5.00		FALSE
112756	Hydraenidae		pr	clng	5.06	20.15	FALSE
112757	*Hydraena*		pr	clng	4.41	20.03	FALSE
112777	*Ochthebius*		sc	clng	9.79	20.39	FALSE
112811	Hydrophilidae		pr	swim	8.50	20.62	FALSE
112812	*Berosus*		hb	swim	5.03	21.32	FALSE
112858	*Laccobius*		hb		3.88	20.32	FALSE
112878	*Anacaena*			burr	6.02	20.11	FALSE
112909	*Paracymus*		pr	clng	8.16	20.78	FALSE
112931	*Sperchopsis*		cg	clng	5.00		FALSE
112932	*Sperchopsis*	*tessellata*	cg	clng	6.00		FALSE
112938	*Tropisternus*		pr	clim	9.42	20.98	FALSE
112973	*Enochrus*		cg	burr	10.00	21.19	FALSE
113017	*Cymbiodyta*		cg	burr	5.00		FALSE
113106	*Helophorus*		sh	swim	10.00	19.93	FALSE
113148	*Helocombus*		cg	clng			FALSE
113150	*Helochares*		cg				FALSE
113166	*Hydrochus*		sh	clim	9.25	21.91	FALSE
113190	*Hydrochara*		cg	swim			FALSE
113196	*Hydrobius*		pr	clim	5.94	20.56	FALSE
113204	*Hydrophilus*		pr	swim			FALSE
113220	*Crenitis*		pr	burr	4.34	19.37	FALSE
113265	Staphylinidae		pr	clng	8.00		FALSE
113576	*Stenus*		pr	skat	8.00		FALSE
113835	Lampyridae				0.00		FALSE
113924	Scirtidae		sc	clim	8.52	21.66	FALSE
113929	*Scirtes*		sh	clim	8.22	21.44	FALSE
113948	*Cyphon*		sc	clim	9.97	21.63	FALSE
113999	Dryopidae		sc	clng	7.38	18.52	TRUE
114006	*Helichus*		sh	clng	7.38	18.53	TRUE
114069	Psephenidae		sc	clng	0.00	20.25	TRUE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
114087	*Ectopria*		sc	clng	0.00	20.25	TRUE
114093	Elmidae		cg	clng	8.16	20.93	TRUE
114095	*Stenelmis*		sc	clng	8.30	21.83	TRUE
114102	*Stenelmis*	*crenata*	cg	clng	8.30	21.83	TRUE
114126	*Dubiraphia*		cg	clng	9.26	21.06	TRUE
114146	*Microcylloepus*		cg	clng	3.00		TRUE
114147	*Microcylloepus*	*pusillus*	cg	clng	3.00		TRUE
114177	*Optioservus*		sc	clng	3.08	19.22	TRUE
114190	*Optioservus*	*fastiditus*	sc	clng	3.08	19.22	TRUE
114194	*Ancyronyx*	*variegatus*	cg	clng	5.01	20.48	TRUE
114212	*Macronychus*		cg	clng	7.21	20.80	TRUE
114213	*Macronychus*	*glabratus*	cg	clng	7.21	20.80	TRUE
114509	Chrysomelidae		sh	clng	6.00		FALSE
114666	Curculionidae		sh	clng	6.00		FALSE
114690	*Listronotus*		sh	clng			FALSE
114838	*Lixus*		sh	clng			FALSE
114999	Neuroptera		pr				FALSE
115001	Sialidae		pr	burr	5.65	19.72	TRUE
115002	*Sialis*		pr	burr	5.65	19.72	TRUE
115023	Corydalidae		pr	clng	2.92	19.90	TRUE
115024	*Chauliodes*		pr	clng	5.80	20.11	TRUE
115028	*Nigronia*		pr	clng	0.41	19.47	TRUE
115033	*Corydalus*		pr	clng	6.00		TRUE
115085	Sisyridae		pr	clim	5.00		FALSE
115086	*Climacia*		pr	clim	8.00		FALSE
115087	*Climacia*	*areolaris*	pr		8.00		FALSE
115090	*Sisyra*		pr	clim			FALSE
115095	Trichoptera		un				FALSE
115097	*Rhyacophila*		pr	clng	0.00	16.70	FALSE
115099	*Rhyacophila*	*angelita*	pr		0.00	16.70	FALSE
115133	*Rhyacophila*	*fuscula*	cg	clng	0.00	16.70	FALSE
115147	*Rhyacophila*	*minor*	pr	clng	0.00	16.70	FALSE
115150	*Rhyacophila*	*invaria*	pr	clng	0.00	16.70	FALSE
115221	*Protoptila*		pr	clng	1.40	21.56	FALSE
115257	Philopotamidae		cf	clng	0.00	20.01	FALSE
115273	*Chimarra*		cf	clng	0.00	20.31	FALSE
115276	*Chimarra*	*obscura*	cf	clng	0.00	20.31	FALSE
115278	*Chimarra*	*aterrima*	cf	clng	0.00	20.31	FALSE
115279	*Chimarra*	*socia*	cf	clng	0.00	20.31	FALSE
115319	*Dolophilodes*		cf	clng	0.00	17.40	FALSE
115322	*Dolophilodes*	*distinctus*	cf	clng	0.00	17.40	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
115334	Psychomyiidae		cg	clng	3.90	19.53	FALSE
115335	*Psychomyia*		cg	clng	4.14	20.33	FALSE
115341	*Psychomyia*	*flavida*	cg	clng	4.14	20.33	FALSE
115361	*Phylocentropus*		cf	clng	1.24		FALSE
115364	*Phylocentropus*	*placidus*	cf	clng	1.24		FALSE
115373	*Cernotina*		pr	clng	1.04	17.98	FALSE
115391	*Lype*		sc	burr	3.10	18.51	FALSE
115392	*Lype*	*diversa*	sc	spra	3.10	18.51	FALSE
115398	Hydropsychidae		cf	clng	7.55	20.26	FALSE
115399	*Diplectrona*		cf	clng	0.00		FALSE
115402	*Diplectrona*	*modesta*	cf	clng	0.00		FALSE
115408	*Cheumatopsyche*		cf	clng	8.05	20.59	FALSE
115453	*Hydropsyche*		cf	clng	7.81	21.21	FALSE
115454	*Hydropsyche*	*betteni*	cf	clng	7.81	21.21	FALSE
115458	*Hydropsyche*	*bidens*	cf	clng	7.81	21.21	FALSE
115461	*Hydropsyche*	*cuanis*	cf	clng	7.81	21.21	FALSE
115465	*Hydropsyche*	*dicantha*	cf	clng	7.81	21.21	FALSE
115468	*Hydropsyche*	*frisoni*	cf	clng	7.81	21.21	FALSE
115469	*Hydropsyche*	*hageni*	cf	clng	7.81	21.21	FALSE
115471	*Hydropsyche*	*incommoda*	cf	clng	7.81	21.21	FALSE
115477	*Hydropsyche*	*phalerata*	cf	clng	7.81	21.21	FALSE
115480	*Hydropsyche*	*scalaris*	cf	clng	7.81	21.21	FALSE
115481	*Hydropsyche*	*simulans*	cf	clng	7.81	21.21	FALSE
115482	*Hydropsyche*	*valanis*	cf	clng	7.81	21.21	FALSE
115487	*Hydropsyche*	*placoda*	cf	clng	7.81	21.21	FALSE
115551	*Potamyia*		cf	clng	8.53	22.07	FALSE
115552	*Potamyia*	*flava*	cf	clng	8.53	22.07	FALSE
115556	*Parapsyche*		cf	clng	1.00		FALSE
115557	*Parapsyche*	*apicalis*		clng			FALSE
115570	*Ceratopsyche*		cf	clng	6.61	19.32	FALSE
115571	*Ceratopsyche*	*alternans*	cf	clng	6.61	19.32	FALSE
115575	*Ceratopsyche*	*vexa*		clng	6.61	19.32	FALSE
115577	*Ceratopsyche*	*bronta*	cf	clng	6.61	19.32	FALSE
115580	*Ceratopsyche*	*morosa*	cf	clng	6.61	19.32	FALSE
115586	*Ceratopsyche*	*slossonae*	cf	clng	6.61	19.32	FALSE
115589	*Ceratopsyche*	*sparna*	cf	clng	6.61	19.32	FALSE
115592	*Ceratopsyche*	*walkeri*	cf	clng	6.61	19.32	FALSE
115596	*Ceratopsyche*	*alhedra*	cf	clng	6.61	19.32	FALSE
115603	*Macrostemum*		cf	clng	0.35	23.17	FALSE
115606	*Macrostemum*	*zebratum*	cf	clng	0.35	23.17	FALSE
115629	Hydroptilidae		hb	clim	6.47	20.69	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
115630	*Leucotrichia*		sc	clng	0.75	21.48	FALSE
115631	*Leucotrichia*	*pictipes*	sc	clng	0.75	21.48	FALSE
115635	*Agraylea*		cf	clim	8.00		FALSE
115641	*Hydroptila*		hb	clng	7.58	20.65	FALSE
115714	*Ochrotrichia*		cg	clng	10.00	23.88	FALSE
115779	*Oxyethira*		cg	clim	1.37	20.50	FALSE
115811	*Mayatrichia*		sc	clng	7.97	22.89	FALSE
115812	*Mayatrichia*	*ayama*	sc	clng	7.97	22.89	FALSE
115817	*Stactobiella*		sh	clim	2.00		FALSE
115823	*Ithytrichia*		pr	clng			FALSE
115824	*Ithytrichia*	*clavata*	sc	clng			FALSE
115826	*Dibusa*		pr	clng	6.00		FALSE
115828	*Orthotrichia*		hb	clng	6.00		FALSE
115833	*Neotrichia*		sc	clng	9.00		FALSE
115867	Phryganeidae		sh	clim	3.93	19.98	FALSE
115868	*Ptilostomis*		sh	clng	4.40	19.50	FALSE
115882	*Agrypnia*		sh	clim			FALSE
115888	*Fabria*	*inornatus*					FALSE
115892	*Phryganea*		sh	clim	1.61	22.02	FALSE
115900	*Oligostomis*		pr	clim	2.00		FALSE
115911	*Banksiola*		sh	clim			FALSE
115933	Limnephilidae		sh	clim	3.45	19.19	FALSE
115934	*Goeridae*		sc	clng		17.03	FALSE
115935	*Apatania*		pr	clng	1.00		FALSE
115956	*Anabolia*		sh	spra			FALSE
115974	*Psychoglypha*		sh	spra	1.00		FALSE
115981	*Psychoglypha*	*subborealis*	cg	spra	2.00		FALSE
115989	*Pseudostenophylax*		sh	spra			FALSE
115995	*Hydatophylax*		sh	spra	2.63	19.44	FALSE
115997	*Hydatophylax*	*argus*	sh	spra	2.63	19.44	FALSE
116001	*Hesperophylax*		sh	spra	2.67	13.03	FALSE
116008	*Hesperophylax*	*designatus*		spra	2.67	13.03	FALSE
116030	*Glyphopsyche*		sh	clng	3.31	18.53	FALSE
116031	*Glyphopsyche*	*irrorata*		clng	3.31	18.53	FALSE
116046	*Neophylax*		sc	clng	3.15	19.76	FALSE
116047	*Neophylax*	*concinnus*	sc	clng	3.15	19.76	FALSE
116049	*Neophylax*	*fuscus*	sc	clng	3.15	19.76	FALSE
116050	*Neophylax*	*mitchelli*	sc	clng	3.15	19.76	FALSE
116053	*Neophylax*	*aniqua*	sc	clng	3.15	19.76	FALSE
116057	*Neophylax*	*oligius*	sc	clng	3.15	19.76	FALSE
116069	*Limnephilus*		sh	spra	3.71	17.32	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
116221	*Asynarchus*			clim			FALSE
116304	*Frenesia*	*missa*					FALSE
116407	*Platycentropus*		sh	clim			FALSE
116409	*Pycnopsyche*		sh	spra	4.55	21.70	FALSE
116423	*Goera*		sc	clng	0.00		FALSE
116426	*Goera*	*stylata*	sc	clng	0.00		FALSE
116432	*Nemotaulius*		sh	spra	5.50	22.41	FALSE
116434	*Nemotaulius*	*hostilis*	sh	spra	5.50	22.41	FALSE
116473	Molannidae		sc	spra	1.81	20.04	FALSE
116474	*Molanna*		sc	spra	2.40	20.18	FALSE
116496	Odontoceridae		sc	spra	0.00		FALSE
116503	*Psilotreta*	*indecisa*					FALSE
116547	Leptoceridae		cg	clim	6.78	21.43	FALSE
116548	*Setodes*		cg	spra	0.13		FALSE
116565	*Triaenodes*		sh	swim	5.61	22.17	FALSE
116598	*Mystacides*		cg	spra	3.08	20.97	FALSE
116607	*Oecetis*		pr	clng	4.31	20.78	FALSE
116608	*Oecetis*	*avara*	pr	clng	4.31	20.78	FALSE
116609	*Oecetis*	*cinerascens*	pr		4.31	20.78	FALSE
116631	*Oecetis*	*nocturna*	pr	spra	4.31	20.78	FALSE
116636	*Oecetis*	*persimilis*	pr	swim	4.31	20.78	FALSE
116644	*Oecetis*	*immobilis*	pr		4.31	20.78	FALSE
116651	*Nectopsyche*		sh	clim	9.93	21.99	FALSE
116659	*Nectopsyche*	*exquisita*	sh	clim	9.93	21.99	FALSE
116661	*Nectopsyche*	*candida*	sh	clim	9.93	21.99	FALSE
116663	*Nectopsyche*	*diarina*	sh	clim	9.93	21.99	FALSE
116677	*Leptocerus*		sh	swim	4.00		FALSE
116678	*Leptocerus*	*americanus*	sh	swim	4.00		FALSE
116684	*Ceraclea*		cg	clng	2.45	20.30	FALSE
116793	Lepidostomatidae		sh	clim	0.12	18.43	FALSE
116794	*Lepidostoma*		sh	clim	0.12	18.42	FALSE
116905	Brachycentridae		cf	clng	4.68	18.04	FALSE
116906	*Brachycentrus*		cf	clng	5.14	17.78	FALSE
116910	*Brachycentrus*	*numerosus*	cf	clng	5.14	17.78	FALSE
116912	*Brachycentrus*	*americanus*	cf	clng	5.14	17.78	FALSE
116918	*Brachycentrus*	*occidentalis*	cf		5.14	17.78	FALSE
116958	*Micrasema*		sh	clng	0.67	18.83	FALSE
116961	*Micrasema*	*rusticum*	cg	clng	0.67	18.83	FALSE
116964	*Micrasema*	*sprulesi*	sh	clng	0.67	18.83	FALSE
116965	*Micrasema*	*rickeri*	cg	clng	0.67	18.83	FALSE
116969	*Micrasema*	*gelidum*	sh	clng	0.67	18.83	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
116982	Sericostomatidae		sh	spra	0.00	20.50	FALSE
116983	*Agarodes*		sh	spra	0.00	19.73	FALSE
116984	*Agarodes*	*distinctus*	sh	spra	0.00	19.73	FALSE
117015	Helicopsychidae		sc	clng	2.69	20.78	FALSE
117016	*Helicopsyche*		sc	clng	2.61	20.78	FALSE
117020	*Helicopsyche*	*borealis*	sc	clng	2.61	20.78	FALSE
117043	Polycentropodidae		cf	clng	3.01	20.30	FALSE
117044	*Polycentropus*		pr	clng	3.20	20.45	FALSE
117091	*Cyrnellus*		cf	clng	8.00		FALSE
117092	*Cyrnellus*	*fraternus*	cf	clng	8.00		FALSE
117095	*Neureclipsis*		cf	clng	1.13	20.21	FALSE
117104	*Nyctiophylax*		pr	clng	4.38	21.53	FALSE
117120	Glossosomatidae		sc	clng	1.29	17.12	FALSE
117121	*Agapetus*		sc	clng	0.00		FALSE
117159	*Glossosoma*		sc	clng	1.14	17.12	FALSE
117162	*Glossosoma*	*intermedium*	sc	clng	1.14	17.12	FALSE
117164	*Glossosoma*	*nigrior*		clng	1.14	17.12	FALSE
117196	*Glossosoma*	*lividum*	sc	clng	1.14	17.12	FALSE
117232	Lepidoptera		sh		6.00		FALSE
117297	Arctiidae		sh		5.00		FALSE
117318	Noctuidae		sh	burr	6.00		FALSE
117641	Pyralidae		sh	spra	7.69	21.06	FALSE
117642	*Paraponyx*		sh	clng	1.54	20.51	FALSE
117654	*Synclita*		sh	clim			FALSE
117659	*Nymphula*		sh	clim			FALSE
117665	*Elophila*		sh				FALSE
117672	*Munroessa*		sh	clim	2.30		FALSE
117682	*Petrophila*		sc	clim	2.23	21.66	FALSE
117714	*Parapoynx*		sh	clim			FALSE
117741	*Acentria*		sh	clim	1.00		FALSE
118746	*Nepticula*		sh	burr			FALSE
118831	Diptera		un		7.00		FALSE
118840	Tipulidae		sh	burr	5.80	19.05	FALSE
118890	*Holorusia*		sh	burr			FALSE
119008	*Prionocera*		sh	burr	3.00		FALSE
119037	*Tipula*		sh	burr	6.29	20.09	FALSE
119654	Limoniinae		cg		5.00		FALSE
119656	*Antocha*		cg	clng	4.07	18.13	FALSE
119690	*Helius*		cg	burr	4.00		FALSE
119704	*Limonia*		sh	burr	6.87	18.27	FALSE
120094	*Hexatoma*		pr	burr	8.07	20.49	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
120164	*Limnophila*		pr	burr	7.30	17.07	FALSE
120335	*Pilaria*		pr	burr	5.31	17.90	FALSE
120365	*Pseudolimnophila*		pr	burr	2.00		FALSE
120387	*Ulomorpha*			burr			FALSE
120488	*Cryptolabis*		sh	burr	3.00		FALSE
120503	*Erioptera*		cg	burr	5.08	17.74	FALSE
120640	*Gonomyia*		cg	burr	3.00		FALSE
120732	*Hesperoconopa*		cg	burr	1.00		FALSE
120830	*Ormosia*		cg	burr	6.50		FALSE
121027	*Dicranota*		pr	burr	3.98	18.31	FALSE
125351	Psychodidae		cg	burr	9.06	18.97	FALSE
125468	*Psychoda*		cg	burr	8.41	19.19	FALSE
125514	*Pericoma*		cg	burr	7.59	19.26	FALSE
125763	Ptychopteridae		cg	burr	4.51		FALSE
125765	*Bittacomorpha*		cg	burr	7.00		FALSE
125786	*Ptychoptera*		cg	burr	4.51		FALSE
125799	Tanyderidae		cg	spra	5.00		FALSE
125809	Dixidae		cg	swim	4.51	19.03	FALSE
125810	*Dixa*		cg	clim	5.20	17.82	FALSE
125854	*Dixella*		cg	swim	4.27	19.47	FALSE
125886	Chaoboridae		pr	spra	8.22	19.41	FALSE
125888	*Eucorethra*		pr	swim	7.00		FALSE
125893	*Mochlonyx*		pr				FALSE
125904	*Chaoborus*		pr	spra	8.45	19.37	FALSE
125930	Culicidae		cg	swim	7.96	20.69	FALSE
125956	*Anopheles*		cf	swim	8.06	20.57	FALSE
126234	*Aedes*		cf	swim	6.39	20.67	FALSE
126424	*Coquillettidia*		cf				FALSE
126429	*Culiseta*		cg	swim			FALSE
126455	*Culex*		cf	swim	8.22	22.23	FALSE
126575	*Uranotaenia*		cf	swim			FALSE
126580	*Uranotaenia*	*sapphirina*	cf				FALSE
126621	*Ochlerotatus*		cf				FALSE
126640	Simuliidae		cf	clng	6.38	18.79	FALSE
126648	Prosimuliini						FALSE
126774	*Simulium*		cf	clng	6.37	18.76	FALSE
126838	*Simulium*	*luggeri*	cf	clng	6.37	18.76	FALSE
126903	*Simulium*	*vittatum*	cf	clng	6.37	18.76	FALSE
127076	Ceratopogonidae		pr	spra	5.68	20.33	FALSE
127112	Forcipomyiinae		pr	spra	6.00	22.00	FALSE
127113	*Atrichopogon*		cg	clng	7.76	20.82	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
127152	*Forcipomyia*		sc	burr	7.12	21.35	FALSE
127278	*Dasyhelea*		cg	spra	5.68	20.85	FALSE
127338	Ceratopogoninae		pr	burr	6.00	20.00	FALSE
127340	*Culicoides*		pr	burr	5.68	20.53	FALSE
127533	*Alluaudomyia*		pr	burr	6.00		FALSE
127564	*Ceratopogon*		pr	burr	6.12	18.35	FALSE
127575	*Monohelea*		pr	burr			FALSE
127614	*Serromyia*		pr	burr	5.90	20.50	FALSE
127619	*Stilobezzia*		pr	spra			FALSE
127649	*Clinohelea*		pr	burr			FALSE
127702	*Mallochohelea*		pr	burr	6.62	21.94	FALSE
127720	*Nilobezzia*		pr	burr	6.00		FALSE
127729	*Probezzia*		pr	burr	2.53	20.07	FALSE
127761	*Sphaeromias*		pr	burr	3.78	19.26	FALSE
127778	*Bezzia*		pr	spra	5.21	20.36	FALSE
127859	*Palpomyia*		pr	burr	6.00		FALSE
127917	Chironomidae		cg		7.80	20.14	FALSE
127962	*Lasiodiamesa*		cg,sc	spra			FALSE
127994	Tanypodinae		pr	burr	6.00	21.00	FALSE
127996	*Clinotanypus*		pr	burr	3.30	20.95	FALSE
128021	*Apsectrotanypus*		pr	burr	2.00		FALSE
128034	*Macropelopia*		pr	spra	7.00		FALSE
128037	*Macropelopia*	*decedens*	pr	spra	7.00		FALSE
128048	*Psectrotanypus*		pr	spra	8.10		FALSE
128070	*Natarsia*		pr	spra	2.84	19.91	FALSE
128079	*Ablabesmyia*		pr	spra	7.38	20.72	FALSE
128130	*Conchapelopia*		pr	spra	8.67	19.36	FALSE
128131	*Helopelopia*		pr	spra			FALSE
128161	*Guttipelopia*		pr	spra	2.94	18.01	FALSE
128170	*Krenopelopia*		pr	spra			FALSE
128173	*Labrundinia*		pr	spra	9.88	20.37	FALSE
128174	*Labrundinia*	*becki*	pr	spra	9.88	20.37	FALSE
128183	*Larsia*		pr	spra	7.69	21.98	FALSE
128202	*Nilotanypus*		pr	spra	5.63	20.98	FALSE
128207	*Paramerina*		pr	spra	7.35	19.21	FALSE
128215	*Pentaneura*		pr	spra	4.61	21.96	FALSE
128226	*Rheopelopia*		pr	spra	3.00		FALSE
128234	*Telopelopia*	*okoboji*	pr	burr			FALSE
128236	*Thienemannimyia*		pr	spra	5.91		FALSE
128245	*Thienemannimyia*	*senata*	pr	spra	5.91		FALSE
128249	*Hayesomyia*	*sonata*	pr	spra			FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
128251	*Trissopelopia*		pr	spra	0.19	17.10	FALSE
128252	*Trissopelopia*	*ogemawi*	pr	spra	0.19	17.10	FALSE
128259	*Zavrelimyia*		pr	spra	8.02	18.33	FALSE
128271	*Djalmabatista*		pr	spra	9.00		FALSE
128277	*Procladius*		pr	spra	7.49	20.66	FALSE
128324	*Tanypus*		pr	spra	10.00	23.83	FALSE
128341	Diamesinae		cg	spra	5.00		FALSE
128355	*Diamesa*		cg	spra	5.00		FALSE
128401	*Pagastia*		cg	spra	5.14	14.05	FALSE
128408	*Potthastia*		cg	spra	5.12	20.09	FALSE
128416	*Pseudodiamesa*		cg	spra			FALSE
128440	*Monodiamesa*		cg				FALSE
128446	*Odontomesa*		cg	spra	6.51	17.01	FALSE
128452	*Prodiamesa*		cg	spra	5.76	14.74	FALSE
128457	Orthocladiinae		cg	burr	5.00	20.00	FALSE
128463	*Acricotopus*		cg	spra	4.05	20.16	FALSE
128477	*Brillia*		sh	burr	8.01	18.62	FALSE
128511	*Cardiocladius*		pr	burr	2.69	22.12	FALSE
128520	*Chaetocladius*		cg	spra	6.00		FALSE
128563	*Corynoneura*		cg	spra	6.70	19.42	FALSE
128575	*Cricotopus*		sh	clng	8.52	20.11	FALSE
128583	*Cricotopus*	*bicinctus*	cg	burr	8.52	20.11	FALSE
128670	*Diplocladius*		cg	spra	8.87	22.89	FALSE
128671	*Diplocladius*	*cultriger*	cg	spra	8.87	22.89	FALSE
128680	*Doncricotopus*		cg	spra		17.78	FALSE
128681	*Doncricotopus*	*bicaudatus*	cg	spra		17.78	FALSE
128682	*Epoicocladius*		cg		9.87	24.35	FALSE
128689	*Eukiefferiella*		cg	spra	5.13	16.02	FALSE
128695	*Eukiefferiella*	*devonica*	cg	spra	5.13	16.02	FALSE
128707	*Euryhapsis*						FALSE
128718	*Gymnometriocnemus*		cg	burr			FALSE
128730	*Heleniella*		pr	spra	0.00	17.65	FALSE
128737	*Heterotrissocladius*		cg	spra	5.46	15.28	FALSE
128750	*Hydrobaenus*		sc	spra	8.98	20.69	FALSE
128771	*Krenosmittia*		cg	spra	0.00		FALSE
128776	*Limnophyes*		cg	spra	8.38	18.52	FALSE
128811	*Lopescladius*		cg	burr	0.00	20.12	FALSE
128821	*Metriocnemus*		cg	spra	4.52		FALSE
128844	*Nanocladius*		cg	spra	7.77	20.33	FALSE
128874	*Orthocladius*		cg	spra	7.31	19.13	FALSE
128877	*Symposiocladius*		pr	spra	6.00		FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
128878	*Orthocladius*	*annectens*	cg	spra	7.31	19.13	FALSE
128951	*Parachaetocladius*		cg	spra	7.00		FALSE
128956	*Paracladius*		cg	spra			FALSE
128962	*Paracricotopus*		cg	spra	10.00		FALSE
128968	*Parakiefferiella*		cg	spra	10.00	19.66	FALSE
128978	*Parametriocnemus*		cg	spra	5.15	18.38	FALSE
128989	*Paraphaenocladius*		cg	spra	9.34	18.57	FALSE
129018	*Psectrocladius*		cg	spra	2.60	19.59	FALSE
129052	*Pseudorthocladius*		cg	spra	0.00		FALSE
129071	*Pseudosmittia*		cg	spra	7.48	19.98	FALSE
129083	*Psilometriocnemus*		cg	spra			FALSE
129086	*Rheocricotopus*		cg	spra	6.64	20.35	FALSE
129107	*Rheosmittia*		cg	burr	0.00		FALSE
129110	*Smittia*		cg	burr	2.00		FALSE
129152	*Stilocladius*		cg	spra	4.72	20.55	FALSE
129161	*Synorthocladius*		cg	spra	0.29	20.32	FALSE
129182	*Thienemanniella*		cg	spra	7.95	19.60	FALSE
129197	*Tvetenia*		cg	spra	4.98	17.54	FALSE
129206	*Unniella*		cg	burr	0.66		FALSE
129209	*Xylotopus*	*par*	cg	burr	2.21	19.37	FALSE
129213	*Zalutschia*		sh	spra	7.00		FALSE
129228	Chironominae		cg	burr	7.00		FALSE
129229	Chironomini		cg	burr	6.00	21.00	FALSE
129236	*Axarus*		cg	spra	2.00		FALSE
129249	*Chernovskiia*		cg	spra	6.00		FALSE
129254	*Chironomus*		cg	burr	8.64	18.97	FALSE
129350	*Cladopelma*		cg	burr	7.08	22.80	FALSE
129368	*Cryptochironomus*		pr	spra	9.13	20.13	FALSE
129394	*Cryptotendipes*		cg	burr	8.01	20.76	FALSE
129421	*Demicryptochironomus*		cg	burr	1.96	19.01	FALSE
129428	*Dicrotendipes*		cg	burr	8.19	20.08	FALSE
129459	*Einfeldia*		cg	burr	9.00		FALSE
129470	*Endochironomus*		sh	clng	8.52	22.08	FALSE
129483	*Glyptotendipes*		sh	burr	9.07	23.13	FALSE
129516	*Kloosia/Harnischia*		cg	burr	8.00		FALSE
129520	*Hyporhygma*		cg	burr	0.00		FALSE
129521	*Hyporhygma*	*quadripunctatus*	cg	burr	0.00		FALSE
129522	*Kiefferulus*		cg	burr	10.00		FALSE
129525	*Lauterborniella*		cg	clng	0.00	20.67	FALSE
129526	*Lauterborniella*	*agrayloides*	cg	clng	0.00	20.67	FALSE
129532	*Microchironomus*		cg	burr	0.00		FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
129535	*Microtendipes*		cf	clng	4.70	19.71	FALSE
129548	*Nilothauma*		cg	burr	0.63	22.05	FALSE
129556	*Omisus*		cg		4.00		FALSE
129561	*Pagastiella*		cg	spra	0.00		FALSE
129564	*Parachironomus*		pr	spra	9.40	21.26	FALSE
129597	*Paracladopelma*		cg	spra	7.29	19.61	FALSE
129616	*Paralauterborniella*		cg	burr	7.62	19.10	FALSE
129619	*Paralauterborniella*	*nigrohalterale*	cg	burr	7.62	19.10	FALSE
129623	*Paratendipes*		cg	burr	8.47	20.02	FALSE
129637	*Phaenopsectra*		sc	clng	6.46	19.74	FALSE
129657	*Polypedilum*		sh	clim	8.57	20.78	FALSE
129730	*Robackia*		cg	burr	6.31		FALSE
129735	*Saetheria*		cg	burr	10.00	20.27	FALSE
129746	*Stenochironomus*		cg	burr	6.49	21.02	FALSE
129785	*Stictochironomus*		cg	burr	10.00	19.41	FALSE
129820	*Tribelos*		cg	burr	2.45	19.88	FALSE
129837	*Xenochironomus*		pr	burr	4.26	20.34	FALSE
129838	*Xenochironomus*	*xenolabis*	pr	burr		20.34	FALSE
129850	Pseudochironomini		cg				FALSE
129851	*Pseudochironomus*		cg	burr	3.10	21.54	FALSE
129872	Tanytarsini		cf	burr	6.00	20.00	FALSE
129873	*Cladotanytarsus*		cg	clim	8.04	20.99	FALSE
129884	*Constempellina*		cg	clim	5.51		FALSE
129890	*Micropsectra*		cg	clim	7.75	17.99	FALSE
129935	*Paratanytarsus*		cg	clng	8.98	20.55	FALSE
129952	*Rheotanytarsus*		cf	clng	6.21	20.22	FALSE
129962	*Stempellina*		cg	clim	0.35	18.90	FALSE
129969	*Stempellinella*		cg	clim	2.24	20.07	FALSE
129975	*Sublettea*		cg	spra	6.98	19.74	FALSE
129976	*Sublettea*	*coffmani*	cg	spra	6.98	19.74	FALSE
129978	*Tanytarsus*		cf	clng	5.04	20.30	FALSE
130038	*Zavrelia*		cg	swim	6.00		FALSE
130040	*Zavreliella*		cg	burr	5.45	25.21	FALSE
130042	*Neozavrelia*						FALSE
130046	*Endotribelos*		cg	burr	2.84	21.24	FALSE
130150	Stratiomyidae		cg	spra	10.00	21.47	FALSE
130160	*Allognosta*		cg	spra			FALSE
130409	*Caloparyphus*		cg	spra	7.00		FALSE
130436	*Euparyphus*		cg	spra	8.00		FALSE
130461	*Oxycera*		sc	spra			FALSE
130573	*Odontomyia*		cg	spra	10.00	21.75	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
130627	*Stratiomys*		cg	spra			FALSE
130694	*Nemotelus*		cg	spra	4.00		FALSE
130929	*Atherix*		pr	spra	3.73	20.33	FALSE
130932	*Atherix*	*variegata*	pr	spra	3.73	20.33	FALSE
130934	Tabanidae		pr	spra	5.91	19.95	FALSE
131078	*Chrysops*		pr	spra	5.15	19.76	FALSE
131321	*Hybomitra*		pr	spra	7.00		FALSE
131527	*Tabanus*		pr	spra	5.00		FALSE
135830	Empididae		pr	spra	5.61	20.25	FALSE
135844	Clinocerinae		pr	clng			FALSE
135849	*Clinocera*		pr	clng	2.99		FALSE
135871	*Dolichocephala*		pr	clng			FALSE
135893	*Roederiodes*		pr	clng			FALSE
135903	*Trichoclinocera*		pr	clng			FALSE
135920	*Wiedemannia*		pr	clng			FALSE
136290	Hemerodromiinae		pr	spra			FALSE
136305	*Chelifera*		cg	spra	6.67	17.75	FALSE
136327	*Hemerodromia*		pr	spra	5.38	20.53	FALSE
136352	*Neoplasta*		pr	spra	7.11	18.95	FALSE
136377	*Oreogeton*		pr	spra			FALSE
136824	Dolichopodidae		pr	burr	1.04	21.30	FALSE
138921	Phoridae		cg	burr	6.00		FALSE
139621	Syrphidae		cg	burr	10.00		FALSE
140904	*Eristalis*		cg	burr	10.00		FALSE
144653	Sciomyzidae		pr	burr	9.85	19.66	FALSE
144898	*Sepedon*		pr	burr			FALSE
146893	Ephydridae		cg	burr	9.46	19.84	FALSE
147117	*Hydrellia*		cg	burr			FALSE
150025	Muscidae		pr	spra	7.72	22.13	FALSE
150730	*Limnophora*		pr	burr	6.00		FALSE
152741	Hymenoptera		pr		8.00		FALSE
185976	*Serratella*	*serrata*	cg	clng	0.56	18.97	FALSE
185979	*Aeshna*	*interrupta*	pr	clim	7.99	19.17	TRUE
185987	*Epitheca*	*spinigera*	pr	clim			TRUE
186372	*Deronectes*	*griseostriatus*	pr				FALSE
189328	*Zavreliella*	*marmorata*	cg	burr		25.21	FALSE
193637	*Gymnochthebius*				2.98	21.34	FALSE
204785	*Fridericia*		cg	burr	6.00		FALSE
206620	*Acerpenna*	*pygmaea*	cg	swim	2.68	20.86	FALSE
206622	*Procloeon*		cg	swim	3.80	21.09	FALSE
206655	*Apedilum*		cg		6.00		FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
563956	*Nemata*						FALSE
568515	*Cricotopus (Isocladius)*		sh	clng	7.00		FALSE
568523	*Orthocladius (Symposiocladius)*		cg	spra			FALSE
568545	Leptohyphidae		cg				FALSE
568546	*Acerpenna*		cg	swim	2.68	20.86	FALSE
568550	*Diphetor*		cg	clim			FALSE
568551	*Fallceon*		sh	swim	10.00	22.54	FALSE
568552	*Labiobaetis*		cg	swim	6.00		FALSE
568553	*Plauditus*			swim	4.67	21.50	FALSE
568554	*Pseudocentroptiloides*		cg	clng			FALSE
568556	*Cercobrachys*		cg	spra			FALSE
568559	*Anthopotamus*		cg	burr	8.95	22.27	FALSE
568560	*Barbaetis*		cg	clng	7.47		FALSE
568574	*Acentrella*	*turbida*	cg	swim		20.96	FALSE
568598	*Diphetor*	*hageni*	cg	clim			FALSE
568601	*Fallceon*	*quilleri*	sh	swim		22.54	FALSE
568604	*Labiobaetis*	*dardanus*	cg	swim	6.00		FALSE
568605	*Labiobaetis*	*propinquus*	cg	swim	6.00		FALSE
568623	*Amercaenis*	*ridens*	cg	spra			FALSE
568627	*Caenis*	*youngi*	cg	spra		21.47	FALSE
568668	*Labiobaetis*	*frondalis*	cg	swim	6.00		FALSE
568671	*Acerpenna*	*macdunnoughi*	sh	swim	2.68	20.86	FALSE
568680	*Pseudocloeon*	*dardanum*	sc	swim		20.55	FALSE
568681	*Pseudocloeon*	*propinquum*	sc	swim		20.55	FALSE
568685	*Leptophlebia*	*bradleyi*	cg	swim		20.40	FALSE
568757	Uenoidae		sc	clng	0.00		FALSE
568817	*Ceratopsyche*	*ventura*	cf	clng	6.61	19.32	FALSE
568826	*Stictotarsus*		pr				FALSE
568954	*Desserobdella*	*picta*	pr	clim			FALSE
591727	Macromiinae		pr	spra			TRUE
592856	*Gomphus*	*fraternus*	pr	burr	6.00	21.09	TRUE
598162	Limnephiloidea						FALSE
598372	*Ylodes*		sh	swim			FALSE
603100	*Oecetis*	*furva*	pr		4.31	20.78	FALSE
603269	*Oecetis*	*testacea*	pr		4.31	20.78	FALSE
609530	*Acentrella*	*parvula*	cg	swim		20.96	FALSE
609583	*Pseudocentroptiloides*	*usa*	cg	clng			FALSE
609591	*Cercobrachys*	*etowah*	cg	spra			FALSE
609660	*Anthopotamus*	*myops*	cf	burr	8.95	22.27	FALSE
609662	*Anthopotamus*	*verticis*	cf	burr	8.95	22.27	FALSE

TSN	Name1	Name2	FFG	Habit	MN Tolerance	Coldwater Tolerance	LongLived
678385	Sphaeriusidae		hb				FALSE
678801	Donaciinae		sh	clng	6.00		FALSE
678851	Dytiscinae		pr	swim			FALSE
693963	Crambidae		sh		6.87	23.47	FALSE
697957	*Maccaffertium*		sc	clng	6.77	21.48	FALSE
698057	*Labiobaetis*	*longipalpus*	cg	swim	6.00		FALSE
698216	*Maccaffertium*	*exiguum*	sc	clng	6.77	21.48	FALSE
698222	*Maccaffertium*	*luteum*	sc	clng	6.77	21.48	FALSE
698232	*Maccaffertium*	*modestum*	sc	clng	6.77	21.48	FALSE
698241	*Maccaffertium*	*pulchellum*	sc	clng	6.77	21.48	FALSE
698255	*Maccaffertium*	*vicarium*	sc	clng	6.77	21.48	FALSE
698469	*Maccaffertium*	*mediopunctatum*	sc	clng	6.77	21.48	FALSE
698470	*Maccaffertium*	*mexicanum*	sc	clng	6.77	21.48	FALSE
698471	*Maccaffertium*	*terminatum*	sc	clng	6.77	21.48	FALSE
698515	*Maccaffertium*	*integrum*	sc	clng	6.77	21.48	FALSE
717547	*Aquarius*		pr	skat			FALSE
722295	*Sperchopsis*	*tessellata*					FALSE
728212	Agabinae		pr	swim			FALSE
728241	*Platambus*		pr	swim			FALSE
728249	*Heterosternuta*		pr	swim	7.82	20.13	FALSE
728251	*Nebrioporus*		pr	swim			FALSE
728252	*Neoporus*		pr	swim	10.00	20.50	FALSE
728253	*Sanfilippodytes*		pr	swim			FALSE
733321	Acari		pr	clng	7.00		FALSE
776922	*Sparbarus*		cg	spra			FALSE
776928	*Iswaeon*					21.29	FALSE
776935	*Acentrella*	*nadineae*	cg	swim		20.96	FALSE
776969	*Sparbarus*	*maculatus*	cg	spra			FALSE
776981	*Teloganopsis*	*deficiens*	cg	clng	3.00		FALSE
914204	Trepaxonemata						FALSE
974284	Naidinae		cg	burr	6.00		FALSE
974289	Tubificinae		cg	burr			FALSE

Appendix E: Taxonomic targets

The taxonomic targets vary by group depending on the feasibility and need for finer taxonomic resolution. There are two target levels currently used by the MPCA. The “IBI Taxonomic Target” is the taxonomic resolution needed for calculating the IBIs described in this document. The second is the “Current Taxonomic Target” and the taxonomic resolution currently used by the MPCA. Although not required for the IBIs in this document, subsequent revisions to the IBI models may require this finer taxonomic resolution. In addition, the finer resolution of the “Current Taxonomic Target” can be useful for other efforts such as stressor identification and thermal condition reviews.

Classification Group	Order	IBI Taxonomic Target	Current Taxonomic Target
Bivalvia		Genus	Genus
Gastropoda		Genus	Genus
Hydrozoa		Class	Class
Oligochaeta		Class	Family
Crustacea	Amphipoda	Genus	Genus
Branchiobdellida	Branchiobdellida	Order	Order
Coleoptera	Coleoptera	Genus	Genus
Crustacea	Decapoda	Genus	Genus
Insecta	Diptera	Genus	Genus
Insecta	Ephemeroptera	Genus	Species
Insecta	Hemiptera	Genus	Genus
Insecta	Hymenoptera	Genus	Genus
Isopoda	Isopoda	Genus	Genus
Insecta	Lepidoptera	Genus	Genus
Insecta	Neuroptera	Genus	Genus
Insecta	Odonata	Genus	Species
Insecta	Plecoptera	Genus	Species
Insecta	Trichoptera	Genus	Species
Nematoda		Phylum	Phylum
Nematomorpha		Phylum	Phylum
Acari		Subclass	Subclass
Hirudinea		Genus	Genus
Trepaxonemata		Class	Class

Appendix F: Macroinvertebrate IBI metric information

Table E1 – Metric information for Large River MIBI, stream types 1 and 2.

Metric Name	Metric Type	Target Group	Metric Calculation Description	Response	Transformation	Drainage Correction	Ceiling	Floor
Percent (%) Dominant Five Taxa	Relative Adundance	5 most abundant taxa	Relative abundance (%) of dominant five taxa in subsample (Chironomid genera treated individually)	increase	none	none	41.7	82.3
Hilsenhoff Biotic Index, MN TVs	Biotic Index	MN Tolerance, All Taxa	Abundance weighted average of each taxon using MN derived tolerance values.	increase	none	none	5.5	8.3
Intolerant Taxa	Richness	MN Tolerance <=4	Taxa richness of countable macroinvertebrates with tolerance values less than or equal to 4, using MN derived tolerance values	decrease	none	none	18.2	0
Odonata Taxa	Richness	Odonata Taxa	Taxa richness of countable Odonata taxa	decrease	none	none	5	0
Predator Taxa	Richness	FFG = Predator	Taxa richness of countable predator taxa	decrease	none	none	18.3	3.5
Total Taxa	Richness	All Taxa	Total taxa richness of all countable macroinvertebrates	decrease	none	none	57.6	24
Percent (%) Trichoptera-Hydropsychidae	Relative Adundance	Trichoptera, excluding Hydropsychidae	Relative abundance (%) of non-Hydropsychidae Trichoptera individuals in subsample	decrease	log10(x+1)	none	22.8	0
Percent (%) VeryTolerant	Relative Adundance	MN Tolerance >=8	Relative abundance (%) of macroinvertebrate individuals in subsample with tolerance values equal to or greater than 8, using MN derived tolerance values	increase	none	none	12.8	78.7

Table E2 – Metric Information for High Gradient Stream MIBI, stream types 3 and 5.

Metric Name	Metric Type	Target Group	Metric Calculation Desctiption	Response	Transformation	Drainage Correction	Ceiling	Floor
Climber Taxa	Richness	Habitat = Climber	Taxa richness of countable climber taxa	decrease	none	none	12.0	2.7
Clinger Taxa %	Relative Richnes	Habitat = Clinger	Relative percentage of countable taxa adapted to cling to substrates in swift flowing water	decrease	none	none	46.0	20.0
Percent (%) Dominant Five Taxa	Relative Adundance	5 most abundant taxa	Relative abundance (%) of dominant five taxa in subsample (chironomid genera treated individually)	Increase	none	none	38.2	78.2
Hilsenhoff Biotic Index, MN TVs	Biotic Index	MN Tolerant, All Taxa	Abundance weighted average of each taxon using MN derived tolerance values. Only count taxa with a TV.	Increase	none	none	4.9	8.3
Insect Taxa %	Relative Richnes	Insect Taxa	Relative percentage of insect taxa	decrease	arcsin(sqrt(x))*	none	93.6	72.5
Odonata Taxa	Richness	Odonata Taxa	Taxa richness of countable Odonata taxa	decrease	log10(x+1)	none	5.0	0.0
Plecopotera Taxa	Richness	Plecoptera Taxa	Taxa richness of countable Plecoptera taxa	decrease	log10(x+1)	none	3.0	0.0
Predator Taxa Richness (excludes genus level Chironomidae)	Richness	FFG = Predator	Taxa richness of countable predator taxa (excluding Chironomidae predator taxa at the genus level)	decrease	none	none	16.0	3.0
Tolerant %	Relative Richnes	MN Tolerance >=6	Relative richness of macroinvertebrate indivduals in subsample with tolerance values equal to or greater than 6, using MN derived tolerance values.	Increase	none	none	93.7	47.1
Trichoptera Taxa	Richness	Trichoptera Taxa	Taxa richness of countable Trichoptera taxa	decrease	none	none	12.0	2.0

*Value of x must range from 0 to 1

Table E3 – Metric information for Low Gradient Stream MIBI, stream types 4, 6, and 7.

Metric Name	Metric Type	Target Group	Metric Description	Response	Transformation	Drainage Correction	Ceiling	Floor
Clinger Taxa	Richness	Habitat = Clinger	Taxa richness of countable clinger taxa	Decrease	none	none	17.0	2.0
Percent (%) Collector-filterers	Relative Abudance	FFG = Filterer	Relative abundance (%) of collector-filterer individuals	Decrease	none	none	37.9	0.3
Percent (%) Dominant Five Taxa	Relative Abudance	5 most abundant taxa	Relative abundance (%) of dominant five taxa in subsample (chironomid genera treated individually)	Increase	none	none	43.2	90.8
Hilsenhoff Biotic Index, MN Tvs	Biotic Index	MN Tolerant, All Taxa	Abundance weighted average of each taxon using MN derived tolerance values	Increase	none	none	5.8	8.9
Very Intolerant Taxa Richness	Richness	MN Tolerance <=2	Taxa richness of countable macroinvertebrates with tolerance values less than or equal to 2, using MN TVs	Decrease	log10(x+1)	none	3.0	0.0
POET Taxa	Richness	Plecoptera, Odonata, Ephemeroptera, Trichoptera Taxa	Combined richness of countable taxa within the orders Plecoptera, Odonata, Ephemeroptera, & Trichoptera, with all Baetid taxa treated as the family level	Decrease	none	none	16.0	2.0
Predator Taxa	Richness	FFG = Predator	Taxa richness of countable predator taxa	Decrease	none	none	18.0	4.0
Taxa Taxa	Richness	All Taxa	Total taxa richness of all countable macroinvertebrates	Decrease	none	none	53.0	19.0
Trichoptera %	Relative Richness	Trichoptera Taxa	Relative richness of countable Trichoptera taxa	Decrease	none	none	16.4	0.0
Percent (%) Trichoptera-Hydropsychidae	Relative Abundanc	Trichoptera, excluding Hydropsychidae	Relative abundance (%) of non-hydropsychid Trichoptera individuals in subsample	Decrease	log10(x+1)*	none	10.8	0.0

Table E4 – Metric Information for Northern Coldwater Stream MIBI, stream type 8.

Metric Name	Metric Type	Target Group	Metric Description	Response	Transformation	Drainage Correction	Ceiling	Floor
Collector-Gatherer Taxa %	Relative Richness	FFG = Gatherer	Relative richness of countable collector-gatherer taxa	Increase	none	none	22.1	41.90
Hilsenhoff Biotic Index, MN TVs	Biotic Index	MN Tolerance, all taxa	Abundance weighted average of each taxon using MN derived tolerance values.	Increase	none	none	4.22	7.03
Very Intolerant Taxa Richness	Richness	MN Tolerance <=2	Taxa richness of countable macroinvertebrates with tolerance values less than or equal to 2, Using MN TVs	Decrease	none	none	12	0.00
Long-lived Taxa %	Relative Richness	LongLived = True	Relative richness of countable long-lived taxa	Decrease	none	none	26	6.00
Non-insect Taxa %	Relative Richness	Non-insect taxa	Relative richness of countable non-insect taxa	Increase	none	none	2.47	20.79
Odonata Taxa %	Relative Richness	Odonata Taxa	Relative richness of countable odonata taxa	Decrease	none	none	9.5	0.00
POET Taxa	Richness	Plecoptera, Odonata, Ephemeroptera, and Trichoptera	Combined richness of countable taxa within the orders Plecoptera, Odonata, Ephemeroptera, & Trichoptera, with all Baetidae taxa treated at the family level	Decrease	none	none	29	8.00
Predator Taxa Richness (excludes genus level Chironomidae)	Richness	FFG = Predator	Taxa richness of countable predator taxa (excluding Chironomidae predator taxa at the genus level)	Decrease	none	none	16	5.00
Very Tolerant Taxa %	Relative Richness	MN Tolerance >=8	Relative richness of countable taxa with tolerance values equal to or greater than 8, using MN TVs.	Increase	none	none	9.2	32.50

Table E5 – Metric Information for Southern Coldwater Stream MIBI, stream type 9.

Metric Name	Metric Type	Target Group	Metric Description	Response	Transformation	Drainage Correction	Ceiling	Floor
Coldwater Biotic Index	Biotic Index	CW Tolerance	Coldwater Biotic Index score based on coldwater tolerance values derived from Minnesota taxa/temperature data.	increase	none	slope = 0.579 constant = 17.923	-0.69	1.41
Chiro:Diptera	Ratio	Diptera taxa	Ratio of Chironomidae abundance to total Dipteran abundance.	increase	none	slope = 9.428 constant = 45.12	-40.33	37.59
Percent (%) Collector – Filterers	Relative Abundance	FFG = filterers	Relative abundance (%) of collector-filterer individuals in a subsample	decrease	none	none	53.41	7.36
Hilsenhoff Biotic Index, MN TVs	Biotic Index	MN Tolerance, all taxa	Abundance weighted average of each taxon using MN derived tolerance values.	increase	none	slope = 0.375 constant = 6.046	-0.58	1.04
Very intolerant Taxa Richness	Richness	MN Tolerance <=2	Taxa richness of macroinvertebrates with tolerance values less than or equal to 2, using MN TVs	decrease	none	none	3	0.00
Trichoptera Taxa %	Relative Richness	Trichoptera Taxa	Relative richness of countable trichoptera taxa	Decrease	none	none	23.74	6.27
Percent (%) Very Tolerant	Relative Abundance	MN Tolerance >=8	Relative abundance (%) of macroinvertebrate individuals in subsample with tolerance values equal to or greater than 8, using MN TVs.	increase	none	slope = 4.239 constant = 7.249	-10.28	35.77