QUALITY ASSURANCE PROJECT PLAN

Riffle Bioassessment by Volunteers (RBV)

A Community-Science Water Quality Monitoring Program

EPA RFA#: 21045

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4/6/2021

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REVISIONS PAGE

Date	Review Number	Summary of Changes	Applicable Section
11/27/2015	1	Initial Approval	All
03/31/2021	2	Updated program contacts and responsibilities	Section A.3 Distribution List Section A.4 Project Organization
		Updated program results to-date	Section A.5 Problem Definition/Background
		Added language regarding WQX data entry	Section B.10 Data Management
		Added language to include contracting voucher organism identification out to a third party taxonomist	All Sections
		Updated program website address	All Sections
		All RBV records will be stored at the Windsor Lab in Windsor, CT	All Sections
		Updated appendices with current/revised materials	Appendix B: RBV Field Data Sheet Appendix C: RBV Training Presentation Appendix F: Voucher Review Bench Sheet Appendix I: Equipment List

A.2. Table of Contents

A.3. Distribution List

The following individuals will receive copies of the approved Quality Assurance Project Plan (QAPP) and subsequent revisions:

Name	Title/Organization	E-Mail
Nora Conlan	Quality Assurance Officer, U.S. EPA[1] Region 1	conlon.nora@epa.gov
Corey Conville	QA Reviewer, U.S. EPA Region 1	conville.corey@epa.gov
Stacey Johnson	PPG Project Officer, U.S. EPA Region 1	johnson.stacey@**epa**.gov
TBD	Assistant Director, Planning and Standards Division, CT DEEP WPLR[2]	TBD
Chris Bellucci	Supervising Environmental Analyst, Monitoring Group	Christopher.Bellucci@ct.gov
Meghan Lally	Environmental Analyst, Monitoring Group	Meghan.Lally@ct.gov
Tracy Lizotte	Environmental Analyst, Monitoring Group	Tracy.Lizotte@ct.gov
Various Individuals[3]	Program Coordinator, Local RBV Program	Various[3]
Various Individuals[3]	Certified Trainer, Local RBV Program	Various[3]

[1] United States Environmental Protection Agency

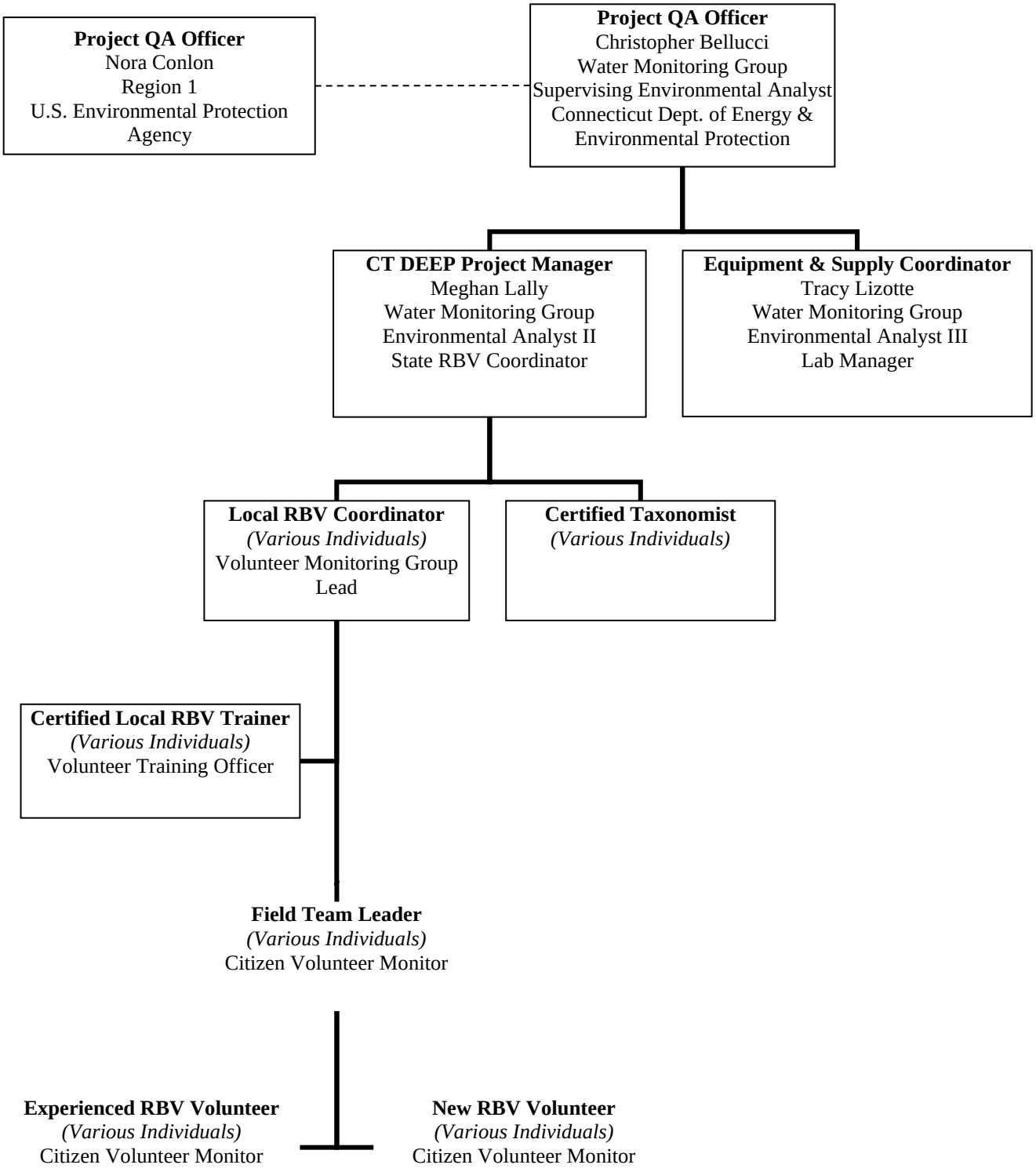
[2] Connecticut Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse

[3] The list of Local RBV Program Coordinators and Certified Local RBV Trainers fluctuates on an annual basis. All current Local RBV Program Coordinators and active/certified Local RBV Trainers will receive via e-mail an electronic copy (.pdf format) of the approved program QAPP and any subsequent revisions.

The most current QAPP will be posted on the RBV Program webpage (https://portal.ct.gov/DEEP/Water/Inland-Water-Monitoring/Riffle-Bioassessment-by-Volunteers-RBV) for viewing and download by program partners and interested members of the public.

A.4. Project/Task Organization

A.4.a Project Organization Chart



A.4.b Project Roles and Responsibilities

CT DEEP Project Quality Assurance Officer

The Project Quality Assurance and Quality Control (QAQC) Lead is the Senior QA Officer and is responsible for development and review of the project QA program. The Project QAQC Lead is responsible for review and approval of project QAPP and associated standard operating protocols (SOPs), and oversees program development, data assessment, and reporting activities.

The Project QAQC Lead supervises the Project Manager and the Equipment & Supply Coordinator.

CT DEEP Project Manager

The Project Manager serves as the State RBV Coordinator. The Project Manager is the project data management officer, senior project training officer, project safety officer, and a project quality control officer. The Project Manager is responsible for the development of the project QAQC program, including maintenance and regular update of the QAPP. The Project Manager is also responsible for development and maintenance of program training materials; retention of program training records; maintenance and loan of project equipment; and data verification (i.e. voucher content review), compilation, quality control review, management, analysis and reporting. The Project Manager obtains any collection permits (i.e. CTDEEP Fisheries Scientific Collector Permit) necessary to execute the program. In addition, the Project Manager is experienced in aquatic macroinvertebrate identification and serves as the Taxonomy QA Officer. The Project Manager conducts an annual blind second review (i.e. taxonomic identification) of at least 10% of vouchers submitted.

The Project Manager supervises the Local RBV Program Coordinators and Certified Local RBV Trainers; the Project Manager reports to the Project QAQC Lead.

Equipment and Supply Coordinator

The WPLR Lab Manager serves as the program Equipment and Supply Coordinator. The Equipment and Supply Coordinator oversees the purchase and maintenance of project-related equipment and supplies. The Equipment and Supply Coordinator works in collaboration with the Project Manager and reports to the Project QAQC Lead.

Local RBV Program Coordinator

The Local RBV Coordinator is the primary CT DEEP contact for each citizen volunteer monitoring group. The Local RBV Coordinator serves as a local volunteer coordinator and event organizer. The Local RBV Coordinator is responsible for volunteer recruitment, coordination, and associated record keeping; ensuring all volunteers have the equipment necessary to conduct RBV monitoring activities; and serving as the lead organizer for local RBV events. The Local RBV Coordinator is responsible for insuring that all volunteers complete annual training prior to monitoring, and compiles and submits corresponding program training records to CT DEEP annually. In addition, the Local RBV Coordinator serves as a local quality assurance agent and is responsible for reviewing new monitoring stations with the Project Manager prior to monitoring and ensuring all data submissions (i.e. vouchers, datasheets, and station documentation photographs) are complete and accurately labeled prior to submission to CT DEEP. The Local RBV Coordinator works in partnership with one or more Certified Local RBV Trainers. The Local RBV Coordinator supervises all individuals serving as volunteers for their local RBV program; the Local RBV Coordinator reports to the Project Manager.

Certified Local RBV Trainer

The Certified Local RBV Trainer serves as a local quality assurance agent and is responsible for executing local RBV volunteer training sessions in accordance with the RBV Program QAPP. The Certified Local RBV Trainer is responsible for documenting all such trainings, and conducting field reviews of volunteer monitoring to ensure volunteers are conducting the program in accordance with program protocols. Local RBV Program Coordinators who complete the required training requirements may concurrently serve as their program's Certified Local RBV Trainer. The Certified Local RBV Trainer works in partnership with one or more Local RBV Coordinators. The Certified Local RBV Trainer supervises RBV volunteers during RBV training activities; the Certified Local RBV Trainer reports to the Local RBV Coordinator and is certified by the Project Manager.

Field Team Leader

The Field Team Leader is an Experienced RBV Volunteer assigned by the Local RBV Coordinator to supervise a volunteer monitoring team of 2 or more volunteers. The Field Team Leader is responsible for overseeing field data collection and documentation. At the conclusion of the monitoring activity, the Field Team Leader is responsible for reviewing all field data and submitting the field data package to the Local RBV Program Coordinator. The Field Team Leader supervises other citizen volunteer monitors; the Field Team Leader reports to the Local RBV Coordinator.

Experienced RBV Volunteer

Experienced RBV Volunteers are adult citizen volunteer water quality monitors who have completed at least one prior RBV monitoring event within the past two years. Experienced RBV Volunteers are responsible for field data collection and documentation. Experienced RBV Volunteers report to the Local RBV Program Coordinator via their Field Team Leader.

New RBV Volunteer

New RBV Volunteers are adult citizen volunteer water quality monitors with no prior RBV training or monitoring experience, or who have not participated in the RBV Program within the past two years. New RBV Volunteers assist with field data collection and documentation. New RBV Volunteers report to the Local RBV Program Coordinator via their Field Team Leader.

Youth RBV Volunteer

All RBV volunteers under age 18 are considered Youth RBV Volunteers, regardless of prior program experience. Youth Volunteers assist with field data collection under the direct supervision of a Field Crew Leader. Youth volunteers must be accompanied by a parent/legal guardian or parent/guardian-approved designee (e.g. school teacher, community group leader). Youth RBV Volunteers report to the Local RBV Program Coordinator via their Field Team Leader.

A.4.c Personnel Qualifications

Table A.4.c1. Project Roles and Personnel Qualifications

Project Role	Name	Qualifications
CT DEEP Project QA Officer	Chris Bellucci	Over 33 years involved with surface water quality and biological monitoring. Supervising Environmental Analyst for the CT DEEP Water Monitoring program.
CT DEEP Project Manager (State RBV Coordinator)	Meghan Lally	Over 11 years involved with surface water quality and biological monitoring, and with volunteer water quality program management. State RBV Coordinator and Environmental Analyst II for the CT DEEP Water Monitoring program.
Equipment & Supply Coordinator	Tracy Lizotte	Over 39 years involved with in water quality monitoring and laboratory analyses. Manager of the CT DEEP ambient water quality monitoring lab and Environmental Analyst III for the CT DEEP Water Monitoring program.
Local RBV Program Coordinator	Various Individuals	Adult volunteer with an active interest in water quality monitoring and/or watershed management. Currently serving as the lead contact of an organized volunteer monitoring group.
Certified Local RBV Trainer	Various Individuals	Adult volunteer with an active interest in water quality monitoring and/or watershed management. Certified by Project Manager to conduct program trainings.
Field Team Leader	Various Individuals	Experienced RBV Volunteer (adult) who has been assigned by the Local RBV Coordinator to serve as the field crew supervisor for a team of 2 or more less experienced or new RBV volunteers.
Experienced RBV Volunteer	Various Individuals	Adult volunteer with an active interest in water quality monitoring. Has previously completed at least one RBV monitoring event within the past two years.
New RBV Volunteer	Various Individuals	Adult volunteer with an active interest in water quality monitoring. No prior RBV experience.
Youth RBV Volunteer	Various Individuals	Any RBV program participant under the age of 18. Active interest in water quality monitoring. May or may not have prior RBV program experience.

A.4.d Communication Pathways

The CT DEEP maintains an RBV Program web page (http://https://portal.ct.gov/DEEP/Water/Inland-Water-Monitoring/Riffle-Bioassessment-by-Volunteers-RBV) which includes program overview information as well as downloadable electronic files of the program training and field materials, annual results summary reports, and the program QAPP.

The Project Manager maintains contact information and certification records for the current Local RBV Program Coordinators and Certified Local RBV Trainers. The Project Manager will electronically notify

Coordinators and Trainers of any changes to program protocols or materials, and/or the release of any new program documents or reports. As necessary, the Project Manager will also communicate directly with Coordinators and/or Trainers to discuss concerns specific to a particular local RBV Program or event. The Project Manager will contact Certified Local RBV Trainers to notify them of certifications that are due to expire and to make subsequent arrangements for recertification. The Project Manager maintains an email listserv for Connecticut volunteer water quality monitors; volunteers will be notified by the Project Manager of any significant programmatic changes or upcoming program events via this listserv.

The Local RBV Coordinator maintains contact information for each adult RBV volunteer associated with his/her local RBV Program. Contact information records are to include the volunteer's full name (e.g. first and last), training date, and mailing address; if available, the volunteer's telephone number and email address will also be recorded. The Local RBV Coordinator is responsible for communicating any program changes or announcements delivered by the Project Manager to the individual volunteers in their program. In the event that the Project Manager has a question or concern regarding an RBV sample, the Local RBV Coordinator is responsible for contacting the individual collectors (i.e. volunteers) for clarification. Contact information for youth volunteers is maintained at the discretion of the Local RBV Coordinator in consultation with the youth volunteer's parent/legal guardian. The Local RBV Program Coordinator will discuss the participation of Youth RBV Volunteers with the Project Manager in advance of monitoring activities to develop a plan to insure that the quality of the monitoring activities is not compromised by the participation of such youth volunteers.

The Local RBV Coordinator is responsible for communicating directly with Field Team Leaders prior to monitoring activities to discuss monitoring location details, review safety, and insure the team has the necessary equipment to conduct monitoring. The Field Team Leader is also responsible for communicating (either verbally or by email) to the Local RBV Coordinator any quality control and/or safety concerns/challenges experienced by the team during monitoring, as soon as possible after the completion of monitoring to allow for prompt resolution. The Local RBV Coordinator is responsible for following up with the Project Manager at the conclusion of monitoring activities to discuss any variations from the RBV protocol and/or safety issues that may have arisen during the season.

The heart of the above communication pathway is between the Project Manager, the Local RBV Program Coordinator, the Certified Local RBV Trainer, and the Field Team Leaders. These individuals are collectively responsible for facilitating, organizing, and reporting all information related to volunteer training, station selection, data collection and submission, and data reporting. Communication flows up through the CT DEEP via the Project Manager and down to individual volunteer monitors via the Local RBV Coordinator, Certified Local RBV Trainer, and Field Team Leader.

A.5. Problem Definition/Background

A.5.a Problem Statement

Connecticut has approximately 5,830 miles of rivers and streams throughout the State. The CT DEEP Bureau of Water Protection and Land Reuse (WPLR) Monitoring & Assessment Group is responsible for monitoring Connecticut's streams and rivers. The Group's Ambient Biological Monitoring (ABM) Program collects chemical, physical and biological data to assess current surface water quality and long term trends. The ABM program characterizes water quality by evaluating the biological integrity of resident communities of aquatic organisms based upon community structure characteristics. Presently the ABM Program monitors three biological community types in freshwater, non-tidal wadeable stream segments: benthic macroinvertebrates, fish, and diatoms.

Despite a robust ambient surface water monitoring program, given the statewide stream mileage, it is not possible for DEEP to directly monitor all of Connecticut's rivers and streams in a given two-year assessment reporting cycle. DEEP therefore also considers external monitoring data, which, when collected with and according to established methods, can greatly increase the number of waterbodies and stream miles assessed by the State biennially.

The RBV protocol was first developed by CT DEEP in 1999. (This QAPP supersedes the CT DEEP program QAPP titled *Rapid Bioassessment in Wadeable Streams and Rivers by Citizen Volunteer*s.) RBV was designed to provide volunteers with a relatively fast, low technology macroinvertebrate collection and identification method that can still concurrently generate data usable by CT DEEP for state and Federal water quality assessment purposes.

Since its introduction, the RBV program has been popular with volunteer water quality monitoring groups in Connecticut. An average of 20 groups, representing several hundred volunteers, participate annually. Collectively these volunteers monitor approximately 100 RBV stations per year.

RBV is particularly well suited to address the shortage of water quality information available for smaller streams in Connecticut. Approximately 74% of all streams and rivers in Connecticut are small, headwater streams (i.e. 1st or 2nd order) (Figure A.5.a1). Evaluation of a recently developed macroinvertebrate-based CTDEEP-developed water quality model, the Connecticut Macroinvertebrate Multimetric Index model or CT MMI model (Bellucci et al 2013; Figure A.5.a2), predicts that the highest water quality in the State (green map area) is likely located in these relatively undeveloped, and, to-date, relatively unmonitored small watersheds.

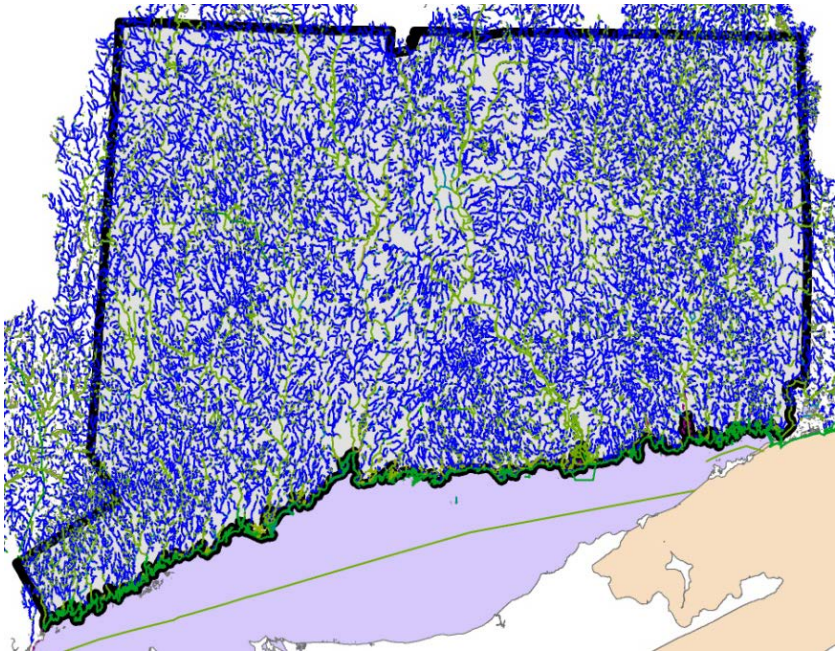


Figure A.5.a1. Connecticut has over 5,800 miles of streams and rivers. In the image above medium to large-sized rivers are shown in green; smaller headwater streams are depicted in blue.

Given the need for additional information on Connecticut's smaller stream segments and the ability of the RBV Program to identify high water quality, in 2012, the program was 're-branded' as CTDEEP's 'Treasure Hunt' for the State's healthiest streams and watersheds. Volunteers are directed to focus their monitoring efforts to small watersheds (i.e. catchment area is less than 15.0 square miles) and which are predicted by the CT MMI model to have high water quality; additional priority is given to waterbodies that have not previously been assessed by the State. Incorporating the mapping tool produced by the

MMI model to identify smaller, high quality streams has lead to an increase in information regarding Connecticut's smaller streams and rivers, and has also improved program efficiency by increasing the overall percent of program submissions that support a CTDEEP water quality assessment.

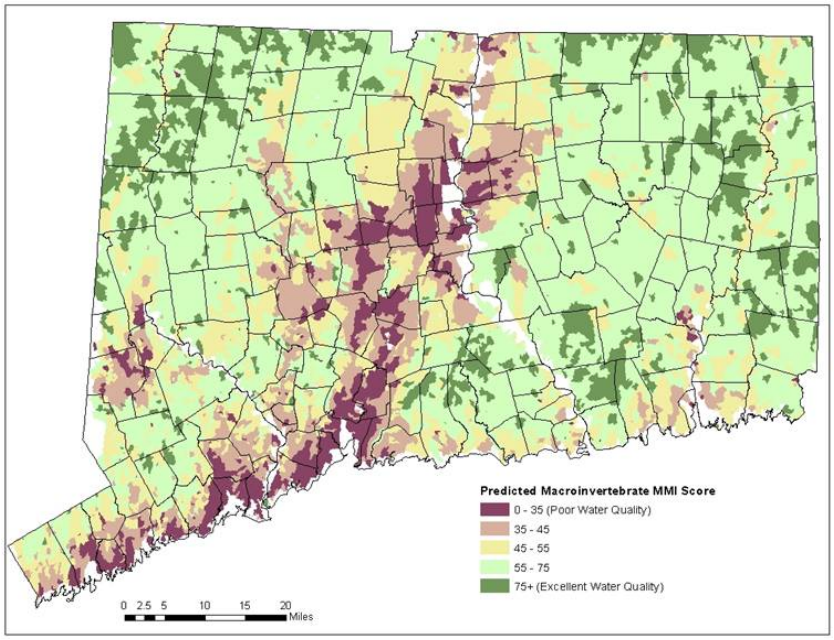


Figure A.5.a2. Predicted surface water quality in Connecticut. The highest water quality predictions (green) are often located in small, relatively undisturbed watersheds.

A.5.b Project Background Information

Benthic macroinvertebrates are macroscopic invertebrate animals that inhabit aquatic habitats. In freshwater, common forms include larval stages of aquatic insects (e.g. mayflies, stoneflies, caddisflies), worms, snails, and crustaceans. Macroinvertebrates are found throughout the state's streams and fulfill an important role in the aquatic food web.

Macroinvertebrates have limited mobility which make them not only easy to collect but excellent indicators of water quality. Benthic aquatic macroinvertebrates spend all or most of their life, which lasts from several months to several years, in the water. However, unlike fish or other more mobile aquatic organisms, macroinvertebrates cannot readily move between locations in a stream system to avoid exposure to pollutants. Therefore, the macroinvertebrate community at a given location is the result of the integrated effects of various water quality (and quantity) stressors at this location over time. As a group, macroinvertebrates exhibit a relatively wide range of response to the effects of water pollutants. However, certain taxa are extremely pollution intolerant and will only be present in those systems with good water quality conditions (Plafkin et al 1989; Barbour et al 1999). By utilizing a screening approach to search for these 'pollution sensitive' taxa in particular, high quality waters in Connecticut can be identified with relatively little cost and effort.

The primary objective of the RBV Program is to train volunteers to collect macroinvertebrate-based water quality information from freshwater, non-tidal wadeable stream segments in Connecticut to support water quality assessments. In particular, RBV seeks to train volunteers to collect macroinvertebrate data to document the presence of these pollution intolerant taxa and therefore support the presence of excellent water quality (i.e. water quality conditions that are fully supporting aquatic life) in previously unassessed, small watersheds (<15.0 square miles). Secondary program objectives include engaging citizen

volunteers in the monitoring of their local water resources and educating the public about water quality issues and CT DEEP's role in monitoring and assessing Connecticut's rivers and streams.

The RBV program was developed in 1999 by CT DEEP (then CT DEP). At that time DEEP assessed river and stream water quality conditions by comparing macroinvertebrate community monitoring results to one of ten high quality reference stations in Connecticut. Evaluation of the reference stations' taxa lists resulted in the identification of 25 target groupings of macroinvertebrates (or RBV 'types'; Table A.5.b1) that could be used to conduct a rapid screening of water quality in high gradient, riffle-based Connecticut streams. These 25 macroinvertebrate 'types' were further divided into the categories 'most wanted,' 'moderately wanted,' and 'least wanted' based upon their relative pollution tolerance.

Table A.5.b1. RBV Program Categories and Corresponding Taxa Groups or 'Types'

Most Wanted (Most Pollution Intolerant)	**Moderately Wanted (Moderately Intolerant)**	**Least Wanted (Least Intolerant)**
Ephemerellidae: *Drunella*	Heptageniidae: *Stenonema**	Amphipoda (All families)
Isonychiidae; *Isonychia*	Philopotamidae; *Chimarra*	Asellidae
Heptageniidae: *Epeorus*	Psephenidae: *Psephenus*	Hirudinea (All families)
Peltoperlidae; *Peltoperla*	Corydalidae; *Nigronia*, *Corydalus*	Chironomidae
Perlidae	Odonata (All families)	Simuliidae
Pteronarcyidae: *Pteronarcys*	Hydropsychidae	Gastropoda (All families)
Misc. Stonefly**		Oligochaeta (All families)
Glossosomatidae: *Glossosoma*		
Apataniidae; *Apatania*		
Rhyacophilidae; *Ryacophila*		
Brachycentridae: *Brachycentrus*		
Lepidostomatidae; *Lepidostoma*		

**The genus Stenonema has been split into Stenonema and Maccaffertium since the program's inception.*
***The miscellaneous stonefly taxa grouping or RBV 'type' includes all other Plecoptera families not otherwise noted that occur in Connecticut, including Capniidae, Leuctridae, Nemouridae, Taeniopterygidae, Chloroperlidae, and Perlodidae.*

RBV macroinvertebrate taxa groups or 'types', each have a distinct and well understood pollution tolerance, are easily recognizable by volunteers due to appearance or behavior and have a statewide distribution. Typically volunteer identification to the family-level is required to place an organism into a taxa group. However, when a family is comprised of several genera of varying pollution sensitivity, the taxa category may be narrowed to represent only one genus, particularly to identify pollution intolerant taxa within the family. For example, the family Heptageniidae is represented under the 'Most Wanted' category by the genus *Epeorus* and under the 'Moderately Wanted' category by genus *Stenonema*. Certain taxa categories are represented at the order level, particularly in the "Least Wanted" category (e.g., Amphipoda), to reduce the RBV identification effort for these categories.

Further evaluation of data from the reference stations indicated that these stations, which were selected based on known excellent water quality conditions, all contained a minimum of four (4) 'most wanted' RBV taxa when sampled for macroinvertebrates (Table A.5.b2). The RBV 'Four or More' rule was therefore established; if volunteers could collect at least four RBV 'most wanted' taxa at a station, then the corresponding stream segment would be flagged for consideration as fully supporting aquatic life use attainment.

In 2008, CT DEEP transitioned to using a macroinvertebrate multi-metric index or MMI score (Gerritsen and Jessup, 2007) to help inform assessments of aquatic life support. To generate an MMI score for a monitoring station, a 200-organism subsample is collected from each station and identified to the lowest taxonomic levels possible. The subsample taxa list and corresponding organism counts are then used to

compute a suite of macroinvertebrate-based water quality metrics. The MMI is a composite 'final score' index of these individual metrics. Stations with an MMI score of 48 or higher are eligible for listing as 'fully supporting' aquatic life use conditions (Gerritsen and Jessup, 2007; CT DEEP, 2014).

Table A.5.b2. Summary statistics for the 10 reference station community data collected from 1995-2000.

Statistic	Most Wanted	Moderately Wanted	Least Wanted
Maximum	9	7	4
75th percentile	8	6	3
Median	7	6	2
Average	7	6	2
25th percentile	5	5	1
Minimum	4	3	1

Analysis of Connecticut macroinvertebrate data collected by CTDEEP between 2000 and 2010 confirmed that the RBV 'Four or More' rule still holds true under the MMI assessment methodology (Figure A.5.b3) As shown in Figure A.5.b3, nearly all Monitoring program benthic macroinvertebrate community samples collected between 2000-2010 that contained four or more 'most wanted' RBV types (99.4%; n=1145), had an MMI score above 48, and therefore would have been assessed as supporting aquatic life use based upon CTDEEP's more extensive MMI assessment methodology.

It should be noted that, as seen in Figure A.5.b3, a small number of samples (n=7, <1%) analyzed from the 2000-2010 data set were likely assessed as not supporting aquatic life use due to an MMI score less than 48, despite containing four most wanted RBV types. These stations were large, urbanized, and/or impaired waterbodies, all of which would fail to meet the required RBV site criteria that RBV Coordinators must consider before selecting monitoring locations. Therefore, if volunteers follow the RBV protocols and attempt monitor only small high quality streams, there is a very minimal likelihood of them finding 4 'most wanted' RBV types at a site that otherwise would not be considered fully supporting aquatic life use.

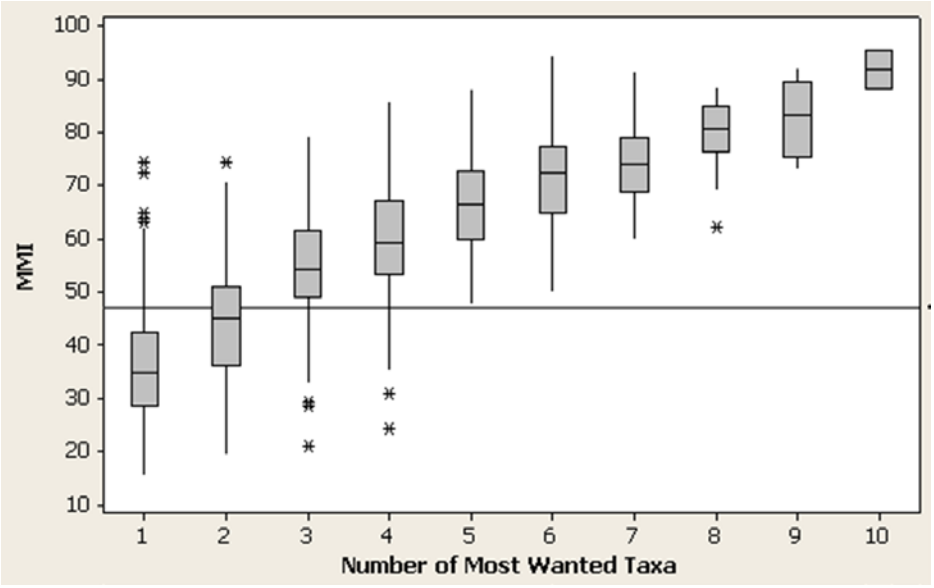


Figure A.5.b3. Comparison of MMI score and count of 'most wanted' RBV taxa present in Connecticut macroinvertebrate samples collected between 2000-2010 (n=1152). The horizontal line indicates an MMI score of 48, or a passing assessment for aquatic life use support.

Over the past fifteen years, RBV has developed into a reliable, easily accessible, volunteer-based water quality screening methodology for identification of Connecticut's healthy waters (i.e. those waters with excellent water quality.) On average, the program helps to confirm aquatic life use support at 35 monitoring locations per IWQR reporting cycle, and this number continues to increase annually (Table A.5.b4). (Final listing in the Integrated Water Quality Report will be dependent upon review and evaluation of other available data for that monitoring station; stations will be listed as 'fully supporting' only when all lines of available evidence are in agreement with this assessment listing.)

Table A.5.b4. RBV data contribution to biennial water quality assessments published in the Connecticut Integrated Water Quality Report (IWQR).

	IWQR Reporting Period									
	2004	**2006**	**2008**	**2010**	**2012**	**2014**	**2016**	**2018**	**2020**	**2022**
Data Collection Period	*2001-2002*	*2003-2004*	*2005-2006*	*2007-2008*	*2009-2010*	*2011-2012*	*2013-2014*	*2015-2016*	*2017-2018*	*2019-2020*
# RBV Samples Submitted*	59	85	183	204	240	257	234	138	133	165
# Fall RBV Samples with 4+ 'Most Wanted' RBV Taxa	26	26	27	28	50	43	71	42	66	TBD
% Samples with 4+ 'Most Wanted' RBV Taxa	44.1%	30.2%	14.8%	13.7%	20.8%	16.7%	30.3%	30.4%	49.6%	TBD

Not shown: During the initial pilot period (1999-2000) volunteers submitted 35 samples, 11 of which (31.4%) included four or more 'most wanted' RBV taxa.

A.6. Project Description

A.6.a Summary of Work to be Performed and Products

The overall goal of the program is to collect volunteer-collected macroinvertebrate data in order to document the location of high quality, or 'healthy', stream segments in Connecticut.

Sampling will take place on high gradient, wadeable streams with an upstream catchment area smaller than 15.0 square miles. Monitoring stations must be characterized by sufficient riffle habitat to complete six kick-stops within a contiguous 100m stretch of stream. Stations are to be free from any obvious or known sources of impairment including but not limited to industrial discharges. Exceptions to these site requirements are made by the Project Manager to support large group training activities and participation of educational groups as needed; the data generated during these activities will discussed with the Project Manager for usability at the conclusion of the season.

RBV sampling occurs each fall between September 1 and November 30, inclusive. Additional program training and reporting activities take place during August and December, respectively. Monitoring is conducted during periods of typical flow; periods of extreme low flow or extreme high flow are avoided due to data quality and safety concerns. Monitoring within 48 hours of heavy precipitation is avoided.

A.6.b Project Schedule

Table A.6.b1 provides a schedule of the project activities for a typical RBV year.

Table A.6.b1. Project Schedule

	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Program Planning												
Training Activities												
Sampling/Monitoring												
Records & Data Submission												
Taxonomist Evaluation												
Data QC												
Reporting												

A.7. Project Quality Objectives and Criteria for Measurement Data

A.7.a Project Quality Objectives

The primary Project Quality Objective for this project is to collect sufficient and accurate macroinvertebrate data to document the locations of high quality stream segments in Connecticut. This information will be used to support biennial water quality assessments for Section 305(b) reporting in the Integrated Water Quality Report.

Following the standard procedures (Appendix A), trained RBV volunteers monitor assigned RBV stations in the fall (September 1-November 30, inclusive). The final product from each station monitored is a set of field/station condition photographs, a completed data sheet (Appendix B), and a representative voucher collection of organisms observed during monitoring. The entire monitoring procedure occurs at the stream station and can be completed by an RBV volunteer field team within 2-4 hours.

A.7.b Measurement Performance Criteria

A.7.b(i) Data Precision, Bias, and Accuracy

Accuracy is insured in the field by adequately training all RBV program participants, and by strict adherence to data and sample collection and documentation protocols.

Standard volunteer training (Appendix C) is conducted prior to each monitoring season to insure volunteer proficiency in and compliance with RBV protocols. Monitoring station requirements, ideal habitat selection, and collection technique are reviewed and practiced to insure collection from an adequate quantity and type of habitat. Individual macroinvertebrate variation is discussed to insure consistency of sorting and identification efforts. Reference collections and identification support materials (Appendix D, Appendix E) are provided to minimize bias towards selection of larger, more active, or more colorful organisms.

If an organism is present in the voucher it is considered evidence that that taxa was present at the RBV monitoring station on the date of monitoring. To account for misidentifications by volunteers, volunteers place 2-3 organisms of each macroinvertebrate type present at the monitoring station into the voucher container; this increases the likelihood of placing at least one correctly identified representative of each type present in the sample into the voucher container. All voucher contents and taxonomic identifications are verified by a trained taxonomist at the conclusion of the monitoring season.

Ten percent of all vouchers submitted annually will also be reviewed by the Project Manager. The results will be compiled by the Project QAQC Lead and remedial action taken as necessary to ensure the quality of program results.

Program collection and sorting equipment is thoroughly rinsed after each station, to prevent cross-contamination between stations. Precautions are also taken to prevent contamination of samples during collection and transport. Between monitoring events, equipment is washed, disinfected, and dried.

A.7.b(ii) Data Representativeness and Comparability

Standardization of sampling across stations is accomplished through pre-season program planning meetings and volunteer training. All data are collected between September 1 and November 30, inclusive. Volunteers avoid monitoring during extreme flows or within 48 hours of heavy precipitation.

RBV monitoring stations are limited to riffle habitat within high gradient, wadeable, small streams (i.e. <15.0 square mile catchment) in Connecticut that are believed to be characterized by high water quality. Local RBV Coordinators are encouraged to discuss new monitoring stations with the Project Manager in advance of monitoring; field visits to review suitability of proposed sites are scheduled as needed. At each station, volunteers collect macroinvertebrates from a standard $1m^2$ area within a 100m reach. Sample collection time is also standardized; rocks are first scrubbed by hand for a maximum of two minutes, and then the substrate is disturbed using the volunteer's foot (i.e. 'kicked') for one minute. The use of brushes, scrapers, or other equipment not otherwise described in the program protocols is prohibited to insure consistent collection methods between stations and participating organizations. Data collected in this fashion provide documentation of organisms present at a station at the date and time of collection and allows for comparability between sites.

At the conclusion of the monitoring season, site photographs are reviewed to ensure collection occurred at suitable locations and under suitable flow conditions. The results of the station are compared to the CT DEEP MMI model predictions, observed station conditions in the photograph and existing water quality information from that station, if available. The results of the review are shared with the Local RBV Coordinator and possible program improvements discussed.

A.7.b(iii) Data Completeness

The goal of the program is to have a vial of voucher organisms submitted for 100% of stations monitored. CT DEEP does not use data associated with any site for which a vial of voucher specimens was not submitted.

The Project Manager will track program progress by evaluating 1) the *total number* of 'four or more' RBV vouchers submitted annually to the State, and 2) the *percentage* of annual RBV vouchers that contain four or more 'most wanted' types. The annual target for samples containing four or more 'Most Wanted' types is 30% or greater.

A.8. Special Training Needs/Certification

A.8.a Training & Certification Requirements

A.8.a(i) Taxonomic Identification Training

The taxonomist conducting organism identification is a professional expert in the field of aquatic macroinvertebrate identification.

To ensure quality control of the 10% blind second review, the Project Manager will complete a pre-review taxonomic identification exam administered by the Project QAQC Lead. The exam shall consist

of the identification of a randomly selected set of macroinvertebrates, which shall include, but will not be limited to, the 'most wanted' RBV taxa. In addition, the Project Manager will attend regional taxonomic identification workshops as such opportunities arise. The Project QAQC Lead will maintain the records for all such trainings.

A.8.a(ii) Certified Local RBV Trainer Training

Individuals interested in becoming a new Certified Local RBV Trainer must successfully complete a DEEP *RBV Train-the-Trainer Workshop* followed by successful completion of a mentorship period.

Workshops are typically held during the summer and led by the Project Manager. During the classroom portion of the workshop, participants are provided with an in-depth overview of the program and its development, a review of the program protocol with emphasis on data collection and documentation quality control, safety review, guidance on how to organize a training event, and training evaluation and documentation requirements. During the field-based portion of the workshop, participants will complete a full monitoring event. Successful completion of the workshop includes 100% participation in all classroom and field based activities. To obtain certification, participants must complete a subsequent probationary training and review period (i.e. mentorship period) during the following monitoring season.

During the mentorship period the participant will successfully organize and lead at least one complete training and monitoring event for volunteers. At the conclusion of the mentorship period, the probationary trainer will have successfully demonstrated proficiency with the RBV protocols, the ability to organize and carry out both the classroom and field-based portions of the RBV volunteer training, and successful participant evaluation and training documentation. The Project Manager will therefore certify the probationary trainer to serve as a Certified Local RBV Trainer, allowing the Trainer to carry out training events for an additional 4-year period. At the conclusion of 4-year period, the Trainer is responsible for completing a recertification review and field audit under the supervision of the Project Manager.

To retain certification, Certified Local RBV Trainers are required to participate in a recertification review and field audit at least once every five years after initial certification. During the review and audit the Project Manager will observe the Trainer lead at least one classroom-based training and one field-based training for volunteers. The Project Manager and the Certified Local RBV Trainer will discuss any quality control concerns that were documented during the review and develop an action plan to remedy any such concerns during future training events. Certified Local RBV Trainers that fail to adhere to multiple aspects of the program protocols during the audit will be required to attend an RBV Trainer refresher workshop at the discretion of the Project Manager.

The Project Manager will retain a list of all former and currently certified Local RBV Trainers, including a record of all previous training dates.

A.8.a(iii) Volunteer Training

All RBV volunteers (i.e. new, returning and youth) are required to attend annual training prior to participating in the current year's monitoring activities. Training is directed by Project Manager or a currently Certified Local RBV Trainer. Training is based upon the methodology outlined in the most current version of CT DEEP RBV training manual (and associated training materials) and the most current program QAPP.

New and youth volunteers must complete both classroom and field-based training activities. During classroom training volunteers are provided with program background and overview information, including a review of the program objectives, field safety, and monitoring protocols via standardized Microsoft PowerPoint presentations (Appendix C). During the field-based training, volunteers travel to a nearby RBV monitoring station to complete the RBV protocol under the supervision of the trainer.

Successful completion of annual training for new and youth RBV volunteers is measured as 100% classroom attendance and demonstration in the field of the ability to implement the RBV protocol (i.e. sample collection, sorting, identification, voucher preparation, and documentation.)

All experienced volunteers must complete, at a minimum, annual field-based training under the supervision of a Certified Local RBV Trainer. Experienced RBV Volunteers may be allowed, at the discretion of the Local RBV Trainer, to review classroom presentation materials remotely (e.g. online/electronically) in lieu of classroom training. Successful completion of annual training for Experienced RBV Volunteers is measured as either 100% classroom attendance or remote review of classroom materials with electronic confirmation, along with field demonstration of the ability to implement the RBV protocol (i.e. sample collection, sorting, identification, voucher preparation, and documentation.)

A.8.b Training Scheduling and Documentation

Trainings described in Section A.8.a are scheduled and documented as described in Table A.8.b1.

All adult volunteers are required to sign-in to training events. The Certified Local RBV Trainer is responsible for maintaining a training record (Appendix G) for each training event. The training record includes the training date, training location, host organization, name of certified trainer conducting the training, and adult attendee/volunteer first and last name. Any experienced volunteers allowed an exception to the classroom portion of training must submit electronic confirmation of program material review to the Local RBV Trainer. The Trainer is responsible for submitting these volunteer training event records to the Local RBV Coordinator at the conclusion of each training event.

At the conclusion of the RBV season, the Local RBV Coordinator is responsible for compiling event training records, reviewing them for completeness and accuracy, and submitting to the Project Manager. The Project Manager will retain a list of all currently certified Local RBV Trainers, including a record of all training and recertification dates.

Table A.8.b1. RBV Program training frequency, function and documentation overview.

Trainee(s)	Course or Description	Trainer	Training Frequency	Training Date	Project Function	Records Maintenance
Project Manager	Macroinvertebrate Identification	Project QAQC Lead	Annually	Prior to Voucher Review	Voucher ID quality assurance	Project Manager
Certified Local RBV Trainers	'Train the Trainer' Workshops and Field Audits	Project Manager	Every 5 years	Fall	Volunteer training quality control	
All RBV Volunteers	RBV Volunteer Training	Certified Local RBV Trainer	Annually	Summer/Fall - Prior to sampling	Station documentation and data collection quality assurance	

A.9. Documentation and Records

A.9.a QAPP Distribution and Maintenance

The Project Manager is responsible for ensuring the distribution of this QAPP to all individuals identified on the distribution list. All distribution list members will receive an electronic version (i.e. PDF format) of the QAPP. In addition to the distribution list, the QAPP will be sent electronically to all Certified Local RBV Trainers and all Local RBV Program Coordinators.

The QAPP will be made publicly available in electronic PDF format on the RBV Program webpage (https://portal.ct.gov/DEEP/Water/Inland-Water-Monitoring/Riffle-Bioassessment-by-Volunteers-RBV). Hard copy versions of the QAPP will be produced and distributed upon request.

The Project Manager is responsible for maintaining and updating the QAPP. QAPP changes can be requested by any participating project member; however any all changes to the QAPP must be approved by the Project QAQC Lead and the Project Manager. The Project Manager will discuss any QAPP deviations, and subsequent data usability concerns, with the Project QAQC Lead.

Decisions regarding real-time changes to volunteer training will be made at the time of training by the Certified Local RBV Trainer. If such changes are necessary they are to be made in such a manner as to not jeopardize the quality or completeness of volunteer training. If a change is made, the change will be documented on the training record by the Certified Local RBV Trainer.

Any decisions regarding real-time changes to sampling effort or location (i.e. monitoring) will be made in the field by the Field Team Leader. If such changes are necessary they are to be made in such a manner as to not jeopardize the validity and comparability of the macroinvertebrate community data. If a change is made, the change will be documented by the Field Team Leader and communicated to the Local RBV Program Coordinator as soon as possible after sampling. Before the conclusion of the RBV season, the Local RBV Program Coordinator will submit documentation of any such deviations from the project QAPP, including the date of the deviation, the nature of the deviation, and any follow-up or corrective action(s) taken to the Project Manager.

A.9.b Field Data Report Package

Each Local RBV Program Coordinator will submit a field data report package to the Project Manager at the conclusion of the RBV season and no later than December 15th. The field data report package will include sampling collection records (e.g. RBV field data sheets, digital site condition photographs) and a preserved macroinvertebrate voucher for each site monitored by the local RBV Program.

Original hard copy datasheets are to be relinquished with vouchers. Photographs are to be labelled with date and monitoring location information and submitted in digital format either by e-mail or on a portable drive.

In addition, the package will include original hard copies of volunteer training records and documentation of any QAPP deviation(s) as described in Section A.8 and Section A.9.a.

A.9.c Laboratory Data Package

RBV vouchers submitted by volunteers are reviewed by a certified taxonomist at a third-party laboratory. All associated laboratory SOPs and QAPPs will be followed. A signed chain of custody will remain with the vouchers at all times.

Upon completion of review, voucher contents are placed into a glass vial, preserved with 70% ethyl alcohol, labelled with the sample ID, date of collection, assigned station ID, and waterbody name. Vouchers are sealed with a rubber stopper. Original volunteer voucher labels are affixed to the volunteer field datasheets and stored indefinitely at the Windsor Lab. Results will be reported electronically to the Project Manager as a list of samples and associated taxa identified to the lowest taxonomic level possible, with the exception of oligochaetes and chironomids which will be identified to the family level or higher.

Upon return of the vouchers and identifications, the Project Manager will complete a blind review of 10% of the vouchers. The results of the review will be reported to the Project QAQC Lead and compared to the taxonomist identification. Remedial action will be taken as appropriate in the event that substantial differences exist between the initial and QC identifications.

A.9.d Annual Report

Program results (i.e. stations and corresponding taxa lists) and a participation summary are compiled by the Project Manager into an annual program report. The annual program report is finalized and distributed electronically to all Local RBV Program Coordinators, Certified Local RBV Trainers, and CT DEEP WPLR Water Planning & Management Division staff by March 31 annually. The report is posted online (https://portal.ct.gov/DEEP/Water/Inland-Water-Monitoring/Riffle-Bioassessment-by-Volunteers-RBV) for public viewing and download as soon as possible thereafter.

If a station is characterized by four or more 'most wanted' RBV taxa, the corresponding stream segment will be flagged for consideration for a 'fully supporting' aquatic life use water quality assessment during the next Integrated Water Quality Reporting (IWQR) cycle. Assessment decisions made using RBV program data are reported in the IWQR to Congress, according to the following schedule:

RBV Data Collection Year:	IWQR Reporting Year
2021	2024
2022	2024
2023	2026
2024	2026
2025	2028

Upon approval by U.S. EPA, IWQRs are made publicly available online (www.ct.gov/deep/iwqr).

A.9.e Document and Record Storage and Retention

Training records are stored by the Project Manager at the DEEP Water Lab in Windsor, CT.

Original hard copy volunteer field datasheets, along with any corresponding documentation of QAPP deviations, are stapled to the corresponding voucher review bench sheet and stored, organized by monitoring year, by the Project Manager at the DEEP Water Lab in Windsor, CT for a period of at least 7 years.

Digital site condition photographs are renamed to include the collection date, collecting organization, and the unique CT DEEP database station identification number to which the RBV monitoring station was assigned. These digital files are stored indefinitely in electronic .jpg format in the 'RBV Program' folder on the CT DEEP Monitoring Group network drive (e.g. "M: Drive").

Preserved and officially labelled RBV vouchers are maintained by the Project Manager and stored at the DEEP Water Lab in Windsor, CT or other appropriate long-term laboratory collection facility (e.g. Yale Peabody Museum).

Electronic copies of annual program reports are stored indefinitely in the 'RBV Program' folder on the CT DEEP Water Monitoring Group network drive (e.g. "M: Drive").

GROUP B. DATA GENERATION AND ACQUISITION

B.1. Sampling Process Design

The RBV Program is intended to serve as a volunteer-based screening protocol to identify high quality or 'healthy' stream segments in Connecticut. The sample collection design is such that a representative macroinvertebrate voucher will be collected by trained volunteers at suitable stream and river locations and submitted to the CTDEEP for evaluation, in order to confirm the location of stream/river segments that are fully supporting the aquatic life use criteria as determined by the State's listing methodology. The RBV program is used only to confirm the presence of high quality waters; RBV data is not used to establish evidence of impairment, to compare water quality between monitoring locations, nor to track incremental changes in water quality over time. Samples will not be collected from stream segments listed on the 303(d) list of impaired waters or from any water body otherwise known or believed to be characterized by insufficient habitat or poor water quality conditions. The exact location of the sample will be determined in the field by the Field Team Leader.

Samples will be collected during the fall monitoring period to coincide with the index period for CT DEEP's ambient water quality monitoring program. To minimize the impacts of extreme flow events, volunteers will sample during periods of 'normal' flow (i.e. 25-75th percentile), avoid sampling within 48 hours of heavy precipitation, and collect samples from locations in the stream that are most likely to have remained wetted throughout the year (i.e. avoid edges, sand/gravel bars, etc.).

B.2. Sampling Methods

B.2.a Sample/Data Collection Procedures

Samples will be collected according to RBV field protocols (Appendix A).

Preliminary data collection activities involve documentation of the monitoring station, acquiring GPS coordinates, taking station condition photographs, and completing the station description information on the RBV Field Datasheet (Appendix B). Datasheets should be complete and contain the following information: stream name, station location description and town, station latitude and longitude, collection date, full name (i.e. first and last) of all adult volunteers/collectors, and the organization responsible for the volunteers. Station photographs should be clear and include as much of the stream reach sampled and surrounding riparian conditions as possible. (Photographs document field conditions at the time of monitoring, provide evidence that monitoring occurred in suitable habitat conditions, and document the exact location of the monitoring station.)

In-stream sampling activities involve the use of a rectangular frame kick net to collect aquatic macroinvertebrates from six kick-stop riffle locations, totaling approximately 1 square meter of substrate from the monitoring reach. All kick nets must have an 18" x 9" net opening/frame, and an attached 10" deep net with 500 micron mesh size.

The start of the sampling reach is determined by the Field Team Leader based upon best available habitat and flow conditions within the intended monitoring station (i.e. stream reach). Working upstream, volunteers conduct a series of six kick stops. At each kick stop, the net is placed firmly against the substrate with the opening facing upstream and perpendicular to the current. Volunteers first identify all cobble size substrate (approximately tennis ball sized or larger) located within the 18 in x 14 in. 'sampling zone' in front of the net. This cobble sized substrate is placed inside the net and hand scrubbed to dislodge any attached organisms; once scrubbed cobble sized rocks are placed to the side outside of the sampling zone. Next, the volunteer stands adjacent to the net, so as not to block stream flow into the net, and uses the heel of their foot to vigorously 'kick' the sampling zone for 1 minute. Upon completion of the 'kick', the net is carefully removed from the stream so as not to lose any portion of the sample, and then the process is repeated at a second kick stop location. The contents of the two kick stops are carried to the stream bank and emptied into a sorting tray. This entire process is repeated two more times, with the contents of kicks three and four emptied into a second sorting tray, and the contents of kicks five and six emptied into a third sorting tray.

Each tray is sorted streamside by volunteers using forceps and plastic spoons. Sorting entails volunteers reviewing each tray, and removing any organisms observed. Removed organisms are grouped by similar appearance into an ice cube tray. Sorting is continued until volunteers are unable to identify any additional 'types' of organisms in the sub-sample. Once sorting is complete, volunteers use the RBV Sorting Guide (Appendix D), RBV Field Identification Cards (Appendix E), and the RBV reference collection to identify the organisms. (The identification level required varies from genus to order level. Accurate volunteer identifications are not required however, as official taxa identifications are made by CT DEEP staff (or certified taxonomist) based upon the content of the voucher vial; see below.). Each macroinvertebrate 'type' found is marked off by the volunteer on the RBV datasheet (Appendix B).

After sorting and identification are complete, the Field Team Leader oversees the preservation of representative specimens of each macroinvertebrate type identified in the sample (i.e. a 'voucher') for taxonomic verification. (The preserved voucher serves as evidence of the presence of a given RBV organism at the monitoring station at the time of volunteer monitoring.) Vouchers contain 2-3 representative organisms of each type of macroinvertebrate observed in the sample. Suitable voucher containers include smooth-sided, clear, plastic or glass containers with sealable lid. A label (Appendix H) containing the station identification number, stream name and location description, date, and last name of sampler, is completed in pencil and placed inside the voucher container. The container is then preserved by filling with isopropyl or ethyl alcohol, and sealed for storage and eventual transport (along with station photographs and field datasheet) to CTDEEP. (Volunteers are required to complete field data package materials, including the datasheet and voucher label, in pencil as the voucher preservative will dissolve the ink of most standard pens and markers.) Remaining organisms in the sample are returned to the stream. (If present, crayfish and freshwater mussels are not preserved but rather are photographed, noted on the field datasheet, and then released.)

B.2.b Sample/Data Collection Equipment

The equipment required to monitor one station using the RBV method is listed in Appendix I.

B.3. Sample Handling & Custody

At the conclusion of the monitoring event, the Field Team Leader is responsible for compiling and submitting the field data package to the Local RBV Coordinator. It is the responsibility of the Local RBV Coordinator to review these materials for completeness and accuracy, and to follow up with the Field Team Leader to resolve any inconsistencies or omissions prior to submitting these materials to the Project Manager as outlined in Section A.9.b.

The Project Manager logs each sample into the RBV Program Microsoft Access database upon receipt. During voucher logging, the monitoring station is assigned to an official station in the CT DEEP Ambient Water Quality database. Any station information discrepancies identified during voucher log entry are immediately discussed with the Local RBV Program Coordinator. Once assigned, the CT DEEP station ID number is recorded on the voucher container and the field datasheet. Station photographs are labeled with the CTDEEP station ID, stream name, and collection date, and stored electronically within an RBV Program folder on the CT DEEP network.

All vouchers and corresponding datasheets are stored at the CT DEEP Windsor laboratory until reviewed by CT DEEP staff. Upon review vouchers are preserved for indefinite long-term storage at the CT DEEP Windsor laboratory or other appropriate facility (e.g. Yale Peabody Museum). Datasheets and corresponding field bench sheets are stored at least 7 years at the DEEP Water Lab in Windsor, CT.

B.4. Analytical Methods

There are no field analytical tests performed, other than sample collection as described in Section B.2.

Laboratory analytical methods are limited to identification of voucher collection contents. A certified taxonomist reviews and identifies the contents of the RBV voucher collections submitted by Local RBV Programs. Voucher contents are identified to the lowest taxonomic level possible. (An exception to this is chironomids and oligochaetes which are identified only to family or order, respectively.) Upon receipt of the voucher review results, data are entered into the RBV database along with the corresponding station and collection information.

A blind review is conducted by the Project Manager on 10% of voucher specimens submitted annually. A macroinvertebrate reference collection is maintained at the Water Lab in Windsor, CT and utilized as needed to confirm identifications. Additional taxonomic identification support is provided by the Project QAQC Lead as needed/requested by the Project Manager. All identified organisms (e.g. vouchers) are preserved for long-term storage to allow for later re-identification as needed or requested.

B.5. Quality Control

The RBV Program is intended to serve as a screening program for high quality waters in Connecticut. Statistical analysis of CT DEEP ambient monitoring data has demonstrated that the presence of four or more pollution intolerant taxa (e.g. ‘Most Wanted’ RBV taxa) is reliable evidence that that stream segment support the aquatic life use criteria of Connecticut’s water quality standards based upon the health of the macroinvertebrate community at that location (Section A.5).

The possibility of a ‘false positive’ result, or a stream incorrectly being assessed as supporting aquatic life use based on RBV data, is minimal. False positive results are likely to occur only in the event of human error, in particularly if a volunteer were to incorrectly label a sample as being from a stream segment other than the one from which it was collected. Digital photographs help to verify site location within a

stream. It is assumed that RBV volunteers have no incentive to intentionally mislabel or otherwise tamper with samples, therefore the quality assurance program is focused on protecting against accidental mislabeling of samples through volunteer training and oversight and quality controls are focused on the identification of any such mislabeling after samples have been submitted.

Misidentification of the voucher contents could also result in a false positive result. Effort is made to minimize such error by utilizing a professional taxonomist to conduct organism identifications. The Project Manager is required to participate in annual training and implementation of an internal identification exam prior to conducting any QC reviews.

Given the significant potential for volunteer taxa identification error that could result in collection of a fewer number of taxa from a monitoring location than actually were present at the station at the time of sampling, low numbers of 'Most Wanted' taxa in a voucher are not considered reliable evidence of water quality degradation or impairment. If a voucher contains fewer than four 'Most Wanted' taxa, no assessment is made regarding the water quality at the monitoring station; the potential for a 'false negative' result is therefore eliminated.

B.5.a Field Activity Quality Control

Quality assurance programs are directed towards protecting against accidental mislabeling of samples through volunteer training and field oversight of new volunteers. New volunteers are required to participate during their first monitoring season under the supervision of an experienced volunteer and/or Local RBV Program Coordinator. In addition, the most experienced member of the field crew, the Field Crew Lead, and is responsible for the completion of the field data sheet and voucher container, thereby maximizing the likelihood of complete and accurate documentation. Upon receipt of volunteer sample materials, quality controls focus on the identification of potential mislabeling of samples by comparing volunteer's written station descriptions to station photographs and locational information provided. Any discrepancies in these three pieces of information (i.e. volunteer written location description, site photographs, GPS coordinates) are discussed and resolved with the assistance of the Local RBV Coordinator and Field Crew Lead prior to processing the voucher.

As noted above, volunteers are not expected to have the training or expertise of a trained, experienced professional, particularly with regard to macroinvertebrate taxonomy; volunteer error, particularly during sorting and identification, is expected and for this reason RBV data is used only as 'proof positive' of high water quality.

B.5.b Laboratory Activity Quality Control

Taxonomists from an accredited laboratory are contracted to conduct voucher organism identification. Any such contractor is considered to be a professional expert in the field of taxonomy and as such additional training or testing prior to identifications is not warranted.

At the conclusion of the RBV season's voucher collection review, ten percent (10%) of the voucher collections will be randomly selected by the Project Manager for a blind second review. The Project Manager will conduct a second review of the contents of each voucher without knowledge of the initial identification results. The result of this second review is compared to the initial identifications. Any discrepancies identified will be with the taxonomist and corrective action taken as needed. The results of this internal voucher identification QC check are compiled by the Project QAQC Lead and stored with the RBV Field Data Sheets at CT DEEP's Water Lab in Windsor, CT.

B.6. Instrument/Equipment Testing, Inspection & Maintenance

The Project Manager is responsible for inspection, maintenance, cleaning and storage of all CTDEEP loan equipment. Local RBV Coordinators are responsible for the inspection, maintenance, cleaning and storage of equipment owned by their programs.

The only field equipment requiring testing, inspection, and maintenance are the GPS unit and the digital camera used to record station location and condition at the time of sampling. This equipment should be tested, inspected and maintained according to their individual manufacturer's specifications. Battery level should be checked in each prior to monitoring.

To avoid material loss during collection, the kick net must free of holes, rips, and tears. Voucher containers must be free of cracks, ill-fitting lids, and other obvious defects before use and will be discarded if defects are found to be present. Additional macroinvertebrate sampling equipment (e.g., sieve, sorting trays, forceps, spoons, identification materials) are checked for completeness and cleanliness prior to sampling by the equipment owner (CT DEEP or the Local RBV Program). All defective equipment must be repaired or replaced prior to monitoring.

All equipment is inspected and thoroughly rinsed with stream water following sampling. To avoid transfer of aquatic invasive organisms and pathogens, volunteers are instructed to return sample material to and rinse equipment in only the stream segment from which the sample was collected. Thorough equipment cleaning occurs with a scrub brush and hot soapy water between sampling events and prior to storing the gear.

Table B.6.1. Maintenance of Sampling Equipment

Equipment	Maintenance Activity	Maintenance Frequency	Person Responsible
Kick Nets	Repair holes/tears; replace irreparable net heads and handles	At the conclusion of each monitoring season; recheck prior to each monitoring season	State RBV Program Coordinator w/ assistance from Equipment and Supply Coordinator* (*If equipment is owned by volunteer group, Local RBV Program Coordinator is responsible)
Digital Camera	Remove and replace batteries	Battery removal at conclusion of monitoring season; Battery replacement prior to start of monitoring season	
GPS Unit	Remove and replace batteries	Battery removal at conclusion of monitoring season; Battery replacement prior to start of monitoring season	
Stop Watch	Check battery level and operation	Prior to each monitoring event	
RBV Reference Collections	Refill preservative; replace missing/damaged specimens	At the conclusion of each monitoring season; recheck prior to each monitoring season	
Sorting Trays	Clean and decontaminate for storage; replace missing/broken units	At the conclusion of each monitoring season; recheck prior to each monitoring season	State RBV Program Coordinator w/ assistance from Equipment and Supply Coordinator* (*If equipment is owned by volunteer group, Local RBV Program Coordinator is responsible)
Ice Cube Trays	Clean and decontaminate for storage; replace missing/broken units	At the conclusion of each monitoring season; recheck prior to each monitoring season	
Sorting Tools (forceps, spoons)	Clean and decontaminate for storage; replace missing/broken units	At the conclusion of each monitoring season; recheck prior to each monitoring season	
Hand Lens	Clean and decontaminate for storage; replace missing/broken units	At the conclusion of each monitoring season; recheck prior to each monitoring season	

Sieve - Size #30	Clean and decontaminate for storage; replace missing/broken units	At the conclusion of each monitoring season; recheck prior to each monitoring season	
RBV Kit Bag	Repair tears; wash and dry for storage	At the conclusion of each monitoring season; recheck prior to each monitoring season	
Laminated Field ID Cards	Replace damaged/missing materials	Prior to start of monitoring season	
Laminated Sorting Guide	Replace damaged/missing materials	Prior to start of monitoring season	
Laminated Field Instructions	Update with SOP changes; Replace damaged/missing materials	Upon announcement of SOP change; Prior to start of monitoring season	

B.7. Instrument/Equipment Calibration & Frequency

There is no equipment in need of calibration for macroinvertebrate collection.

B.8. Inspection/Acceptance of Supplies and Consumables

Program supplies and consumables include pencils, field datasheets, voucher containers, voucher labels, and voucher preservative. It is the responsibility of the Local RBV Program Coordinator to obtain all program supplies and consumables prior to monitoring activities. At least one pencil, datasheet, voucher container and voucher label must be present and in usable condition prior to the start of the sampling event. Voucher containers must be clean and undamaged; lids must be able to be securely attached at the conclusion of the monitoring event. Adequate preservation material (isopropyl or ethyl alcohol) to completely fill the voucher container must be present at the monitoring station.

The Local RBV Program Coordinator will inspect all supplies and consumables prior to distribution to monitoring field teams; any missing or damaged supplies and consumables will be replaced by the Local RBV Coordinator. Field Team Leaders will inspect all supplies and consumables prior to monitoring; any missing or damaged supplies and consumables will be reported to the Local RBV Program Coordinator and monitoring ceased until a replacement or approved substitute can be obtained.

B.9. Non-direct Measurements

No data are obtained from existing data sources for this project. This project does not involve non-direct measurements.

B.10. Data Management

Upon receipt of the voucher review report from the taxonomist, the Project Manager enters the data (e.g. the identified voucher contents) into the RBV Database along with the corresponding station and collection information. The CT DEEP RBV Program Database is an Access database stored on the CT DEEP computer network. These data are neither transformed nor reduced. Raw data can be retrieved upon request by the Project Manager. In addition, a taxa list for each station is uploaded to the U.S. EPA Water Quality Exchange (WQX). The final 'most wanted' taxa count for each sample is also uploaded as an annual metric to the WQX. These data are retrievable by the public using the Water Quality Portal (WQP).

Program data are compiled into an annual program report, which is posted electronically to the RBV webpage (https://portal.ct.gov/DEEP/Water/Inland-Water-Monitoring/Riffle-Bioassessment-by-Volunteers-RBV) for a period of three years. Electronic copies of the reports are stored indefinitely in the 'RBV Program' folder on the CT DEEP Water Monitoring Group network drive (i.e. "M Drive") and can be retrieved upon request by the Project Manager.

Preserved RBV vouchers are maintained by the Project Manager and stored indefinitely at the DEEP Water Lab in Windsor, CT until they can be transferred to an approved long-term storage facility (e.g. Yale Peabody Museum); these RBV vouchers can be retrieved and reevaluated as necessary if there are concerns or questions relating to the data in the RBV Database.

Digital site condition photographs are renamed by the Project Manager to include the collection date, collecting organization, and the Ambient Water Quality Exchange (AWQ) database station identification number to which the RBV monitoring station was assigned. These digital files are stored indefinitely in electronic .jpg format in the 'RBV Program' folder on the CT DEEP Water Monitoring Group network drive (e.g. "M: Drive").

RBV Database and the CT DEEP Water Monitoring Group network drive are located on the CT DEEP computer network. The CT DEEP Information and Technology Department maintain this network. The network is backed up regularly in order to allow for restoration following catastrophic loss or the corruption.

GROUP C. ASSESSMENT AND OVERSIGHT

C.1. Assessment and Response Actions

During Train-the-Trainer workshops and Trainer recertification audits, trainers will be required to successfully demonstrate proper field collection, data documentation, and data submission protocols as well as proper volunteer training, review and documentation protocols to the Certified Local RBV Trainer. During annual volunteer training, all volunteers will be required to successfully demonstrate proper collection and data documentation protocols to the Certified Local RBV Trainer in the field setting. Whenever possible, QAPP nonconformance issues encountered during training and/or field monitoring are handled in a timely manner so as not to jeopardize the sample results. Any deficiencies or unusual conditions/circumstances are documented and communicated as described in Section A.4.d *Communication Pathways* and Section C.2. *Reports to Management*. Issues that cannot be immediately resolved are reported by the Project Manager to the Project QAQC Lead.

C.2. Reports to Management

General project communication pathways are outlined in Section A.4.d, *Communication Pathways*. The Certified Local RBV Trainer is responsible for communicating any training challenges or deviations from approved protocol to the Project Manager. The Field Team Leader is responsible for communicating (either verbally or by email) to the Local RBV Coordinator any quality control and/or safety concerns/challenges experienced by the team during monitoring, as soon as possible, and no more than one week, after the completion of monitoring to allow for prompt resolution. The Local RBV Coordinator is responsible for following up with the Project Manager at the conclusion of monitoring activities to discuss any variations from the RBV protocol and/or safety issues that arose during the season.

Training reports will be compiled and submitted at the conclusion of the RBV monitoring season. The Local RBV Program Coordinator, with support from the Certified Local RBV Trainer, is responsible for submitting proof of volunteer training as well as a report of any QA issues or concerns that arose over the monitoring season to the Project Manager by December 15 of that monitoring year. The Project Manager will compile all QA issues or concerns reported by Local RBV Coordinators and submit a summary report to the Project QAQC Lead for review and follow-up action by March 1 of the following year. Every five years Certified Local RBV Trainers are responsible for completing a recertification review to be administered by the Project Manager. The results of the review will be communicated to the Trainer as soon as it is practical thereafter. Current trainer certification status and recertification due dates will be summarized by the Project Manager and reported to project staff, including Certified Local RBV Trainers and Local RBV Program Coordinators, by March 1 of the following year.

The Project Manager is will compile an annual summary report containing the list of sites monitored and the corresponding results by March 1 of the following year. The report will be distributed immediately thereafter by the Project Manager to all project participants and posted online (http://https://portal.ct.gov/DEEP/Water/Inland-Water-Monitoring/Riffle-Bioassessment-by-Volunteers-RBV) for viewing by individual project volunteers, project partners and the general public. The Project Manager will e-mail a program-specific report to each Local RBV Coordinator to document and discuss recommended remedial action(s) related to any reported or observed deviations from the project QAPP during the prior monitoring season.

Upon completion of initial voucher review by the taxonomist, the Project Manager will randomly select ten percent (10%) of the vouchers for a second review. The Project QAQC Lead will summarize the results of the initial and second QA review in a memo as soon as it is practical thereafter and distribute to the project staff for discussion and identification of corrective or remedial follow-up actions as necessary.

Special project QAQC reports, such as assessments comparing RBV data to DEEP macroinvertebrate data collected at the same sites during the same monitoring season, will be prepared as such opportunities arise by the Project Manager and submitted to the Project QAQC Lead.

GROUP D. DATA VALIDATION AND USABILITY

D.1. Data Review, Verification and Validation

The Project Manager will document the receipt of all program materials (e.g. training records, site photographs, datasheets, and vouchers) in an annual electronic voucher log as they are received. The voucher log is stored on the WPLR network drive.

The station location information (i.e. stream name, location description and town, latitude and longitude, and station photographs) provided on the datasheet is evaluated and compared to determine the exact location of the monitoring station. The information on the voucher label is compared to that on the datasheet to insure consistency. Any apparent discrepancies will be resolved with the Local RBV Coordinator responsible for that monitoring station. Data from flagged stations will discussed with the Project Manager to determine suitability for consideration during the next IWQR reporting cycle. If a location conflict is unable to be resolved and/or the station cannot be determined with complete confidence, the voucher will be discarded and the Local RBV Coordinator instructed to follow up with the collector(s) to provide remedial training.

Once the station location has been determined, the station is assigned to the nearest monitoring station that resides on the same stream segment in the CTDEEP WPLR Ambient Water Quality (AWQ) database; new stations will be created in the database at the discretion of the Project Manager.

Station photographs are labeled with the AWQ station number assigned to that RBV monitoring location along with the name of the responsible organization and photograph date. Photographs are reviewed to insure volunteers sampled appropriate habitat (i.e. riffle habitat) and under appropriate flow conditions (i.e. normal flow conditions). Any apparent discrepancies from the RBV protocol will be flagged discussed with the Local RBV Coordinator responsible for the volunteers that collected the sample. Data from flagged stations will discussed with the Project Manager to determine suitability for consideration during the next IWQR reporting cycle.

After assignment to an AWQ station and resolution of any documentation discrepancies, volunteer field data (i.e. organisms observed at the monitoring site as noted on the Field Data Sheet) are verified and validated by evaluating the contents of the voucher collection. RBV voucher contents are evaluated by the Project Manager or certified third-party taxonomist. The voucher contents are emptied into a Petri dish and the label is cross-referenced against the datasheet. Organisms are then individually examined using a dissecting microscope, light source, and taxonomic key to the taxonomic level necessary to confirm the presence of one of the twenty-six RBV organisms.

The reviewer checks off each organism present on the original volunteer data sheet, including those not initially noted by the volunteer as present. "NIV", which stands for 'not in voucher,' is recorded beneath any organism that was marked present by the volunteer but not found by the reviewer in the voucher.' At the conclusion of the review, the reviewer tallies and records the final number of 'Most Wanted' types in the upper corner of the data sheet, and then dates and initials the sheet.

Voucher information including the station location information (i.e. AWQ station), collector information (i.e. organization, volunteer names, collection date), and the list of taxa present in the voucher are then entered into an electronic RBV Access database.

D.2. Verification and Validation Methods

During sampling, volunteers check off all organism types that they believe they have identified in their sample on the RBV Field Data Sheet. At least one of each of the organism checked off on the RBV Field Data Sheet are placed in the voucher collection container at the conclusion of the sampling event. In addition, at least one of each type of organism either not on the datasheet or that was not able to be definitively identified by volunteers in the field are placed in the voucher collection. If more than one representative organism of a given organism type is present in the sample, volunteers are instructed to place 2-3 representative organisms into the voucher container; this is intended to decrease the likelihood of not placing a representative organism of a present type into the voucher due to misidentification as another type already represented in the voucher.

At the conclusion of the monitoring season, after ensuring the accuracy and completeness of the station and collection information, the Project Manager reviews each organism in the voucher collection. Organisms are identified using a dissecting microscope and taxonomic key, and confirmed against a reference specimen. Because the RBV methodology does not provide volunteers with a comprehensive list of all potential riffle-dwelling benthic macroinvertebrates found in Connecticut streams, it is expected that organisms not listed as part of the protocol will be present in the voucher vial. All organisms in the vial are identified by the Project Manager to the family level and recorded on the corresponding voucher review bench sheet. (Organisms on the RBV organism list are identified to the genus or species level if necessary to confirm the presence of the target RBV type.) Identifications of rare or unusual organisms are confirmed with a Taxonomy QA Officer.

As described in Section B.5.b *Laboratory Activity Quality Control*, at least 10% of the vouchers submitted during each RBV monitoring season are randomly selected by the Project Manager for a second taxonomic review by one of the Taxonomy QA Officers.

D.3. Reconciliation with User Requirements

If correct sampling methods were used, the data packages are complete and the data meet DQO's for precision, accuracy/bias, completeness, representativeness, and comparability as described in Section A.7 *Quality Objectives and Criteria for Measurement Data*, the data are considered usable for the stated purpose of this project. If DQO's are not met, the Project Manager will work with the Local RBV Coordinator and Certified Local RBV Trainer (if applicable) to determine the source of errors or discrepancies. The Project Manager, in consultation with the Project Manager, will make a decision whether to qualify or discard data, or resample if possible.

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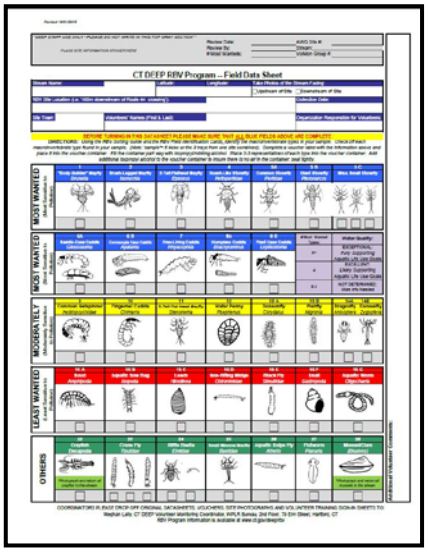
Appendix A: RBV Field Instructions

Revised 08/16/2016

CT DEEP RBV Program
Volunteer Field Quick Reference Guide



Step 1: **Identify the riffle areas within your stream reach; identify 6 'kick-stop' locations** within the study riffle where you will collect your samples.

Step 2: Fill out the top of your datasheet completely. **Use a GPS unit (or Smartphone) to **determine the latitude/longitude** of your site. **

Step 3: Stand in the middle of the stream and **take a photo facing upstream**. Try to capture as much of the stream and both stream banks as possible in your photograph. Turn 180 degrees and **take a second photo facing downstream**.

Step 4: Place your net, opening facing upstream, at the first kick-stop. Envision an 18 in. (width of the net) by 14 in. rectangle in front of the net (see photo). Pick up any rocks (tennis ball to basket-ball size) located in your imaginary rectangle. One at a time, hold each rock inside the net, under water, and **using your hands, rub the rocks briskly to dislodge attached organism.** (Imagine you are washing off a dirty softball inside your net.) Set rocks off to the side after washing; take no longer than 2 minutes.

Step 5: Stand next to the net (have your partner hold it), and **use your heel to vigorously 'kick' the stream bottom in front of the net for 1 minute** using a back and forth or 'Z' motion to dig up the sediment.

Step 6: Carefully pick up the net out of the water being careful to not lose any material inside, and move upstream to your second kick-stop. **Repeat the process,** scrubbing rocks in the net and then kicking the area in front of the net for 1 minute. **Empty the net contents from kick 1 and kick 2 into a white sample tray**.

Step 7: **Repeat Step 4 and 5 at your next two kick-stop locations.** Empty the contents of the net into a second white sample tray.

Step 8: **Repeat Step 4 and 5 at your last two kick-stop locations.** Empty the contents of the net into your third white sample tray.

Step 9: **Using tweezers or spoons, pick out as many organisms as possible from each tray; use an ice cube try to sort your organisms into groups of similar looking critters**. (There should be one ice cube tray for each sample tray.)

Step 10: Use the RBV Sorting Guide and the Field Identification Cards to try to **identify each of the types of organisms** in the ice cube trays. **As you identify each macroinvertebrate, check the corresponding type as present ("X") on your datasheet.**

Step 11: **Using your completed datasheet as a guide, place 2-3 of each macroinvertebrate type** checked off **into a glass or clear plastic voucher container.** Complete an RBV label using pencil and **place the label *inside*** the vial. (You may tape a second label on the outside if you desire.) **Fill the container completely with rubbing alcohol and tightly secure the lid in place.**

Step 12: **Submit the photographs, completed datasheet, and labeled voucher to your Local RBV Coordinator** for submission to CT DEEP.

To learn more about the CT DEEP RBV Program visit www.ct.gov/deep/rbv

Appendix B: RBV Field Data Sheet

Riffle Bioassessment by Volunteers (RBV)
Field Datasheet

For DEEP Staff Use:

Sample ID: _____

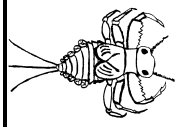
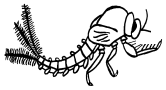
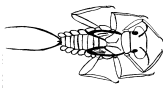
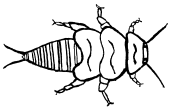
AWQ: _____ Group ID: _____

PLEASE MAKE SURE ALL SECTIONS BELOW ARE COMPLETE BEFORE RETURNING TO YOUR LOCAL RBV COORDINATOR

Stream Name:	Latitude:	Longitude:	Stand In the Stream and Take a Photo: ☐ Facing Upstream ☐ Facing Downstream
Description of Sample Location (i.e. '100m downstream of Route 44 crossing'):			Collection Date:
Town:	Collectors' Names (First Initial and Last Name):		Organization Responsible for Volunteers:

DIRECTIONS: RBV is a treasure hunt for healthy waters in Connecticut. Your goal is to use the RBV method to evaluate the water quality of an assigned stream segment. Check off each type of macroinvertebrate you find in your sample and then place 2-3 of each into the provided voucher container. Make sure to complete the top of this data sheet and include a matching label inside your voucher! (Drawings are NOT to scale!**)**

MOST WANTED (Most Sensitive to Pollution)

1	2	3	4	5A	5 B	5C-1 and 5C-2
"Body-Builder" Mayfly Ephemerellidae *(*Drunella spp.)*	**Brush-Legged Mayfly** Isonychiidae	**2-Tail Flathead Mayfly** Heptageniidae *(* Epeorus spp.)*	**Roach-Like Stonefly** Peltoperlidae	**Common Stonefly** Perlidae	**Giant Stonefly** Pteronarcyidae	**Small Stoneflies** Perlodidae / Chloroperlidae
						
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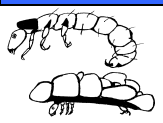
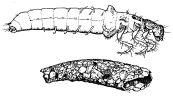
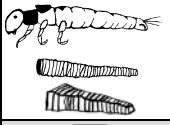
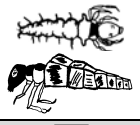
MOST WANTED (Most Sensitive to Pollution)

5C-3 and 5C-4	5C-5 and 5C-6	6A	6 B	7	8A	8 B
Small Stoneflies Capniidae / Leuctridae	**Small Stoneflies** Taeniopterygidae/ Nemouridae	**Saddle-Case Caddis** Glossosomatidae	**Cornucopia Case Caddis** Apataniidae	**Free-Living Caddis** Rhyacophilidae	**Humpless Caddis** Brachycentridae	**Plant Case Caddis** Lepidostomatidae
						
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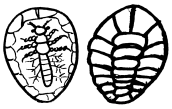
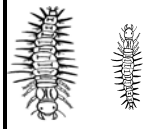
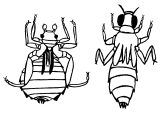
MODERATELY (Moderately Sensitive to Pollution)

9	10	11	12	13	14A	14B
Common Netspinner Hydropsychidae	**Fingernet Caddis** Philopotamidae	**3-Tail Flat Head Mayfly** Heptageniidae	**Water Penny** Psephenidae	**Dobsonfly/Fishfly** Corydalidae	**Dragonfly** Anisoptera	**Damselfly** Zygoptera
						
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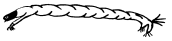
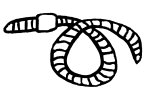
LEAST WANTED (Least Sensitive to Pollution)

15	16	17	18	19	20	21
Scud Amphipoda	**Aquatic Sow Bug** Isopoda	**Leech** Hirudinea	**Non-Biting Midge** Chironimidae	**Black Fly** Simuliidae	**Snail / Limpet** Gastropoda	**Aquatic Worm** Oligochaeta
						
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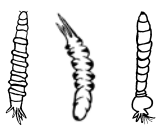
OTHERS

22	23	24	25	26	27	28
Crayfish Decapoda	**Crane Fly** Tipulidae	**Riffle Beetle** Elmidae	**Small Minnow Mayfly** Baetidae	**Aquatic Snipe Fly** Athericidae	**Flatworm** Planariidae	**Mussel/Clam** Bivalvia
 *Photograph and return all crayfish to the stream						 *Submit only EMPTY shells; do not disturb LIVE mussels
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Additional Volunteer Comments:

 # MOST Wanted Taxa: _____ # MODERATELY Wanted Taxa: _____ # LEAST Wanted Taxa: _____ # OTHER Taxa: _____

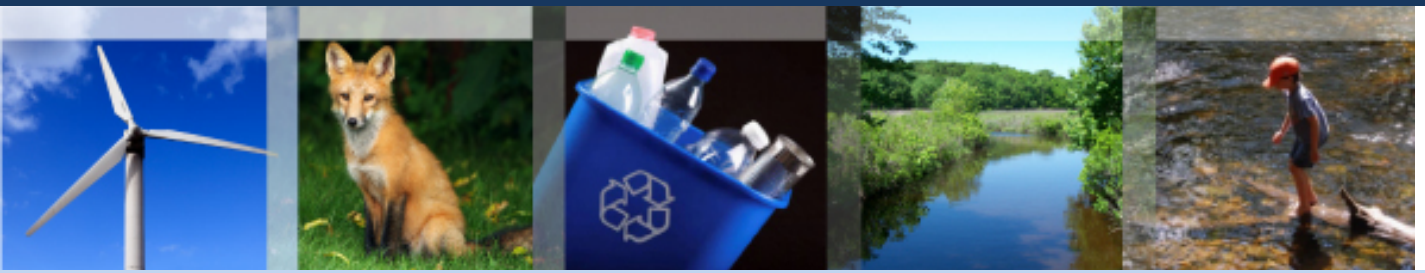
How Healthy is Your Site? The more 'Most Wanted' types you can find, the healthier the stream is likely to be. If you can find 4 or more 'Most Wanted' types, you have found the treasure: this site is a Healthy Water! **NOTE: Not all streams will have 4 'most wanted' types, that's ok!

LEARN MORE AT WWW.CT.GOV/DEEP/RBV

Datasheet Version: 2019

Appendix C: RBV Training Presentation

Connecticut Department of Energy and Environmental Protection



Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

RBV

CONNECTICUT ENERGY ENVIRONMENT

CTDEEP Riffle Bioassessment by Volunteers Program

Riffle Bioassessment by Volunteers (RBV)

Volunteer Training

A CT DEEP Tier 2
Volunteer Water Quality Monitoring Network
www.ct.gov/deep/rbv

Last revised 10/09/2015

Connecticut Department of Energy and Environmental Protection

Training Topics

Part 1: Program Background & Overview

Part 2: RBV Methods & Procedures

Part 3: Field Safety

Part 4: The RBV Organisms








Riffle Bioassessment by Volunteers (RBV)

Volunteer Training Presentation:

Part 1 - Program Background& Overview



A CT DEEP Tier 2

Volunteer Water Quality Monitoring Network

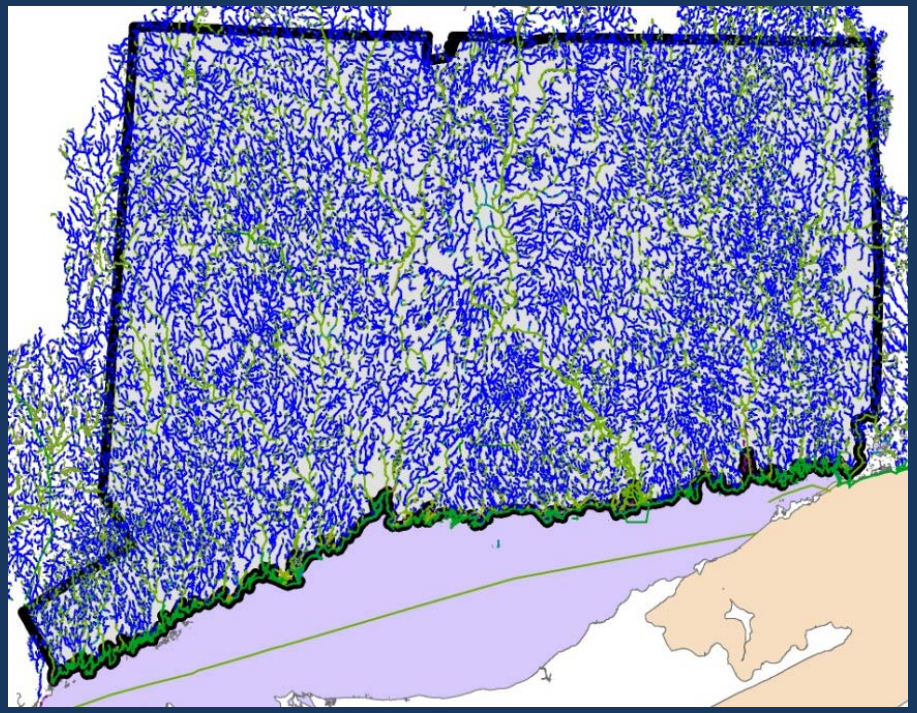
www.ct.gov/deep/rbv

Last revised 10/09/2015

Connecticut Department of Energy and Environmental Protection

The Need for RBV: So Many Stream Miles!

- CT has ~5,830 miles of rivers and streams
  - That's about the length of the US-Canada and US-Mexico borders combined!
- CT DEEP conducts annual monitoring of CT's waters
  - Able to directly monitor and assess on average only about 20% of all streams and rivers.



The Need for RBV: So Many Stream Miles!

- RBV was developed by CT DEEP in 1999
  - Provides volunteers with a relatively fast, low technology macroinvertebrate collection and identification method
  - Allows volunteers to generate data usable by CT DEEP for state and Federal water quality assessment purposes
  - Increases the number of stream miles assessed by CT DEEP during each two-year reporting cycle

- Between 1999-2014, RBV volunteers have collected more than 3,100 samples!
  - Over 280 'Four or More' samples submitted
  - On average 20 active local programs per year – monitor over 100 stations per year together

What the RBV Program IS…

- A relatively quick, easy to learn ‘citizen science’ volunteer program coordinated by the State of Connecticut.
- A simple screening tool that uses macroinvertebrates to find and document good water quality in your local streams.
- A way to help your community and the State collect meaningful data.
- An opportunity to explore some beautiful locations in your community with other like-minded individuals!

Why Use Macroinvertebrates to Study Water Quality?

- They are in almost every stream in CT
- They have limited mobility and therefore ‘absorb’ water quality conditions around them
- Their response to water quality is very well known and documented
- They are easy to capture
- They recover rapidly from sampling



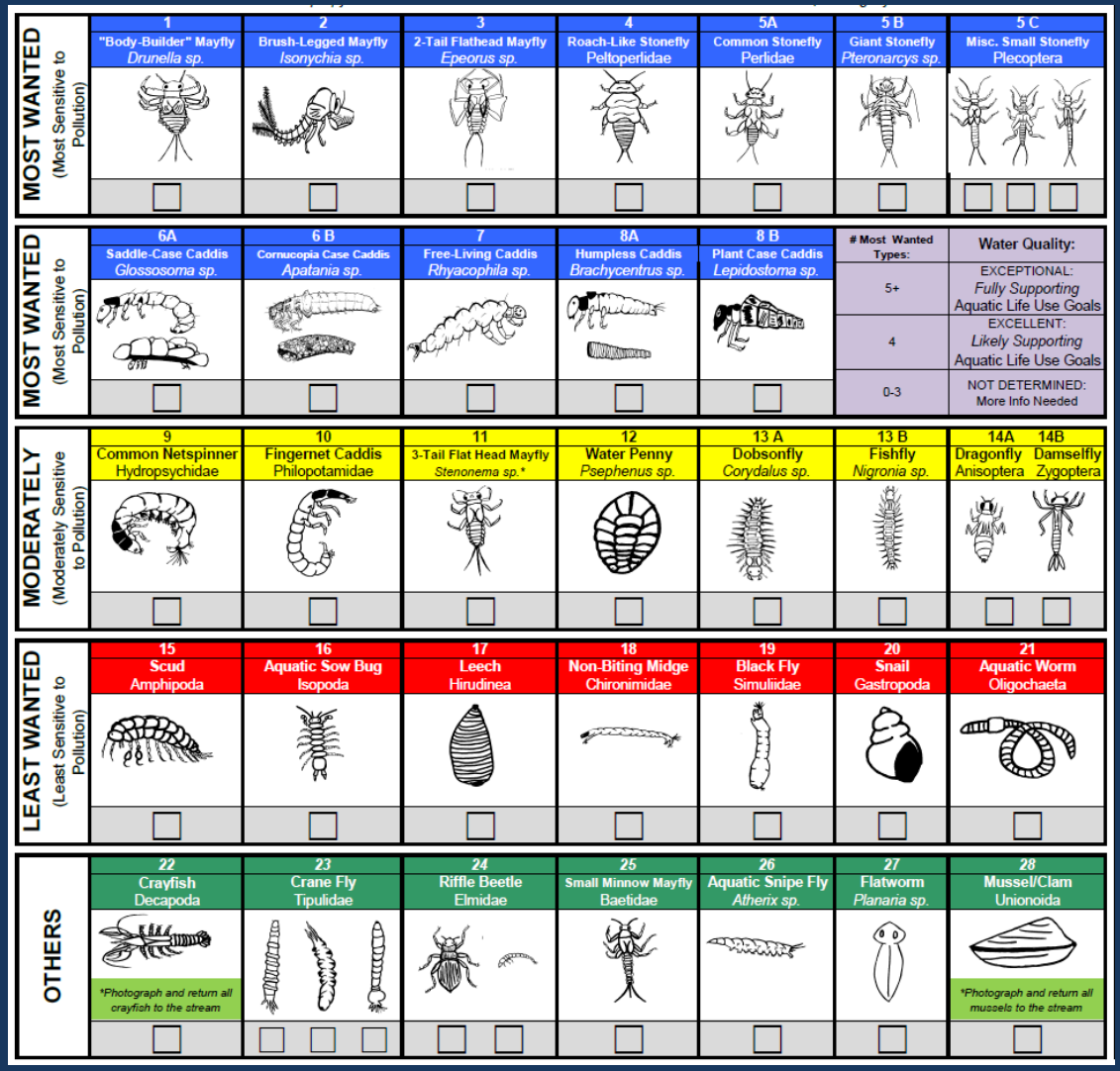




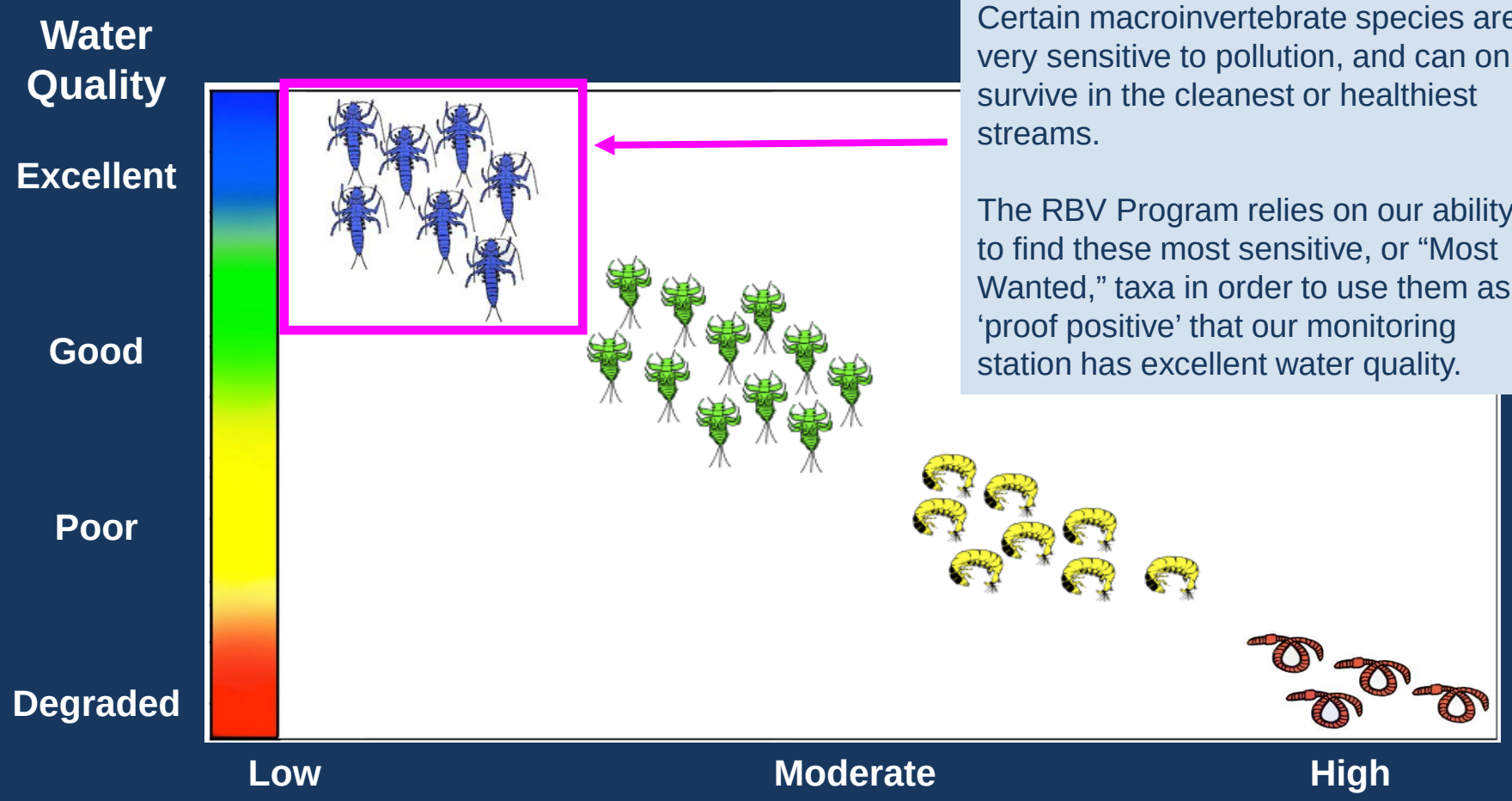

The RBV Organisms

28 RBV organism ‘types’ selected for inclusion in the program based upon:

- Known pollution sensitivities
- Easily identified
- Relatively common with statewide distribution
- Unique identifying features such as color, shape or behavior



Why Use Macroinvertebrates to Study Water Quality?



Certain macroinvertebrate species are very sensitive to pollution, and can only survive in the cleanest or healthiest streams.

The RBV Program relies on our ability to find these most sensitive, or "Most Wanted," taxa in order to use them as 'proof positive' that our monitoring station has excellent water quality.

CT's Healthy Stream Treasure Hunt

The "Four or More Rule": RBV is a 'treasure hunt' for the State's healthiest streams. We are looking for those streams that have 4 or more "Most Wanted" macroinvertebrate types at them. These macroinvertebrates are very sensitive to pollution, so if we find them it is strong evidence that the stream is very clean!

MOST WANTED (Most Sensitive to Pollution)

1	2	3	4	5A	5 B	5 C
"Body-Builder" Mayfly *Drunella sp.*	Brush-Legged Mayfly *Isonychia sp.*	2-Tail Flathead Mayfly *Epeorus sp.*	Roach-Like Stonefly Peltoperlidae	Common Stonefly Perlidae	Giant Stonefly *Pteronarcys sp.*	Misc. Small Stonefly Plecoptera
☐	☐	☐	☐	☐	☐	☐ ☐ ☐

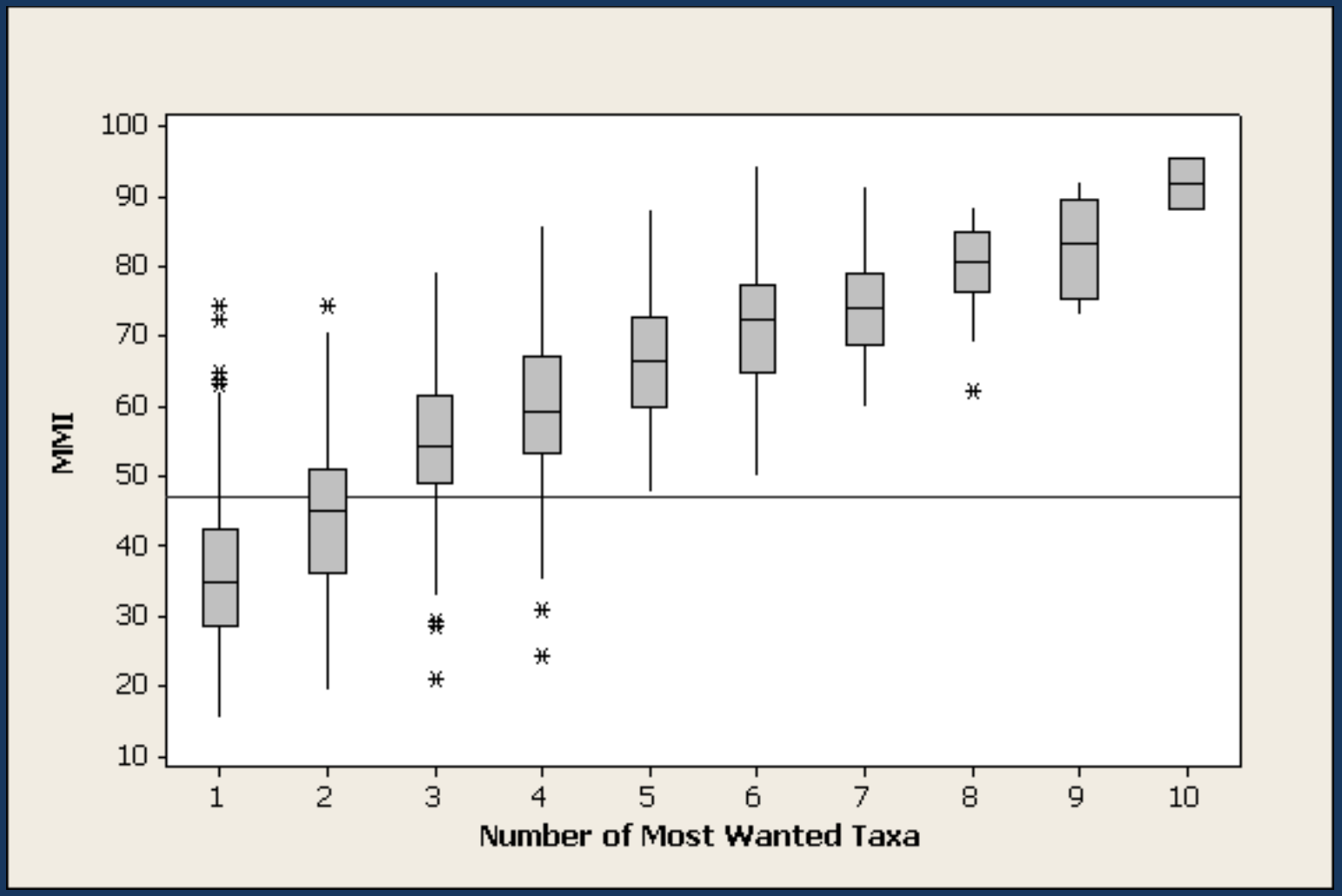
MOST WANTED (Most Sensitive to Pollution)

6A	6 B	7	8A	8 B
Saddle-Case Caddis *Glossosoma sp.*	Cornucopia Case Caddis *Apatania sp.*	Free-Living Caddis *Rhyacophila sp.*	Humpless Caddis *Brachycentrus sp.*	Plant Case Caddis *Lepidostoma sp.*
☐	☐	☐	☐	☐

# Most Wanted Types:	Water Quality:
5+	EXCEPTIONAL: *Fully Supporting* Aquatic Life Use Goals
4	EXCELLENT: *Likely Supporting* Aquatic Life Use Goals
0-3	NOT DETERMINED: More Info Needed

How Does the ‘4 or More’ Rule Work?

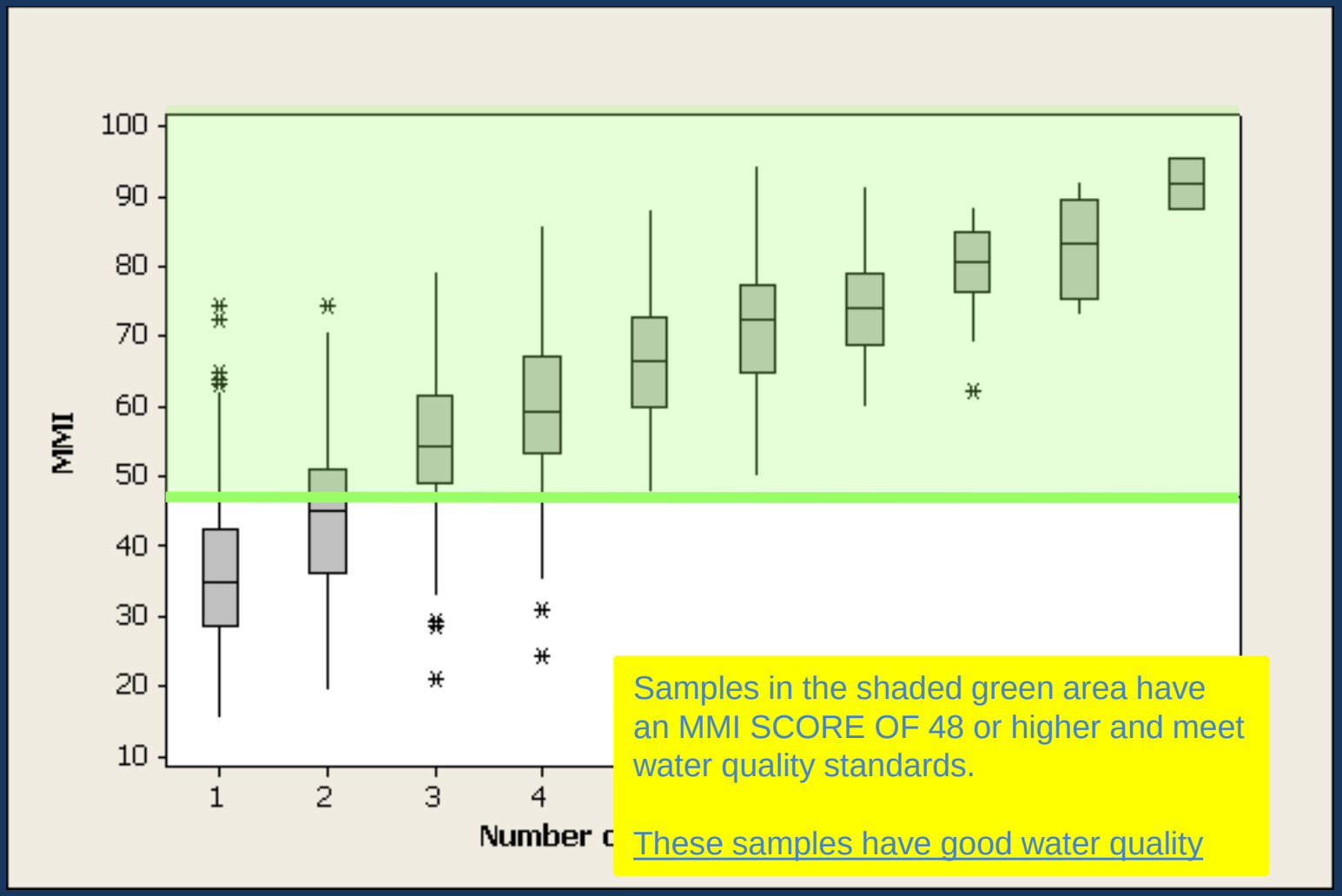
Shown at right are over 1,000 macro-invertebrate samples collected by DEEP between 1999-2011 as part of the general statewide monitoring program (e.g. not RBV samples).



How Does the ‘4 or More’ Rule Work?

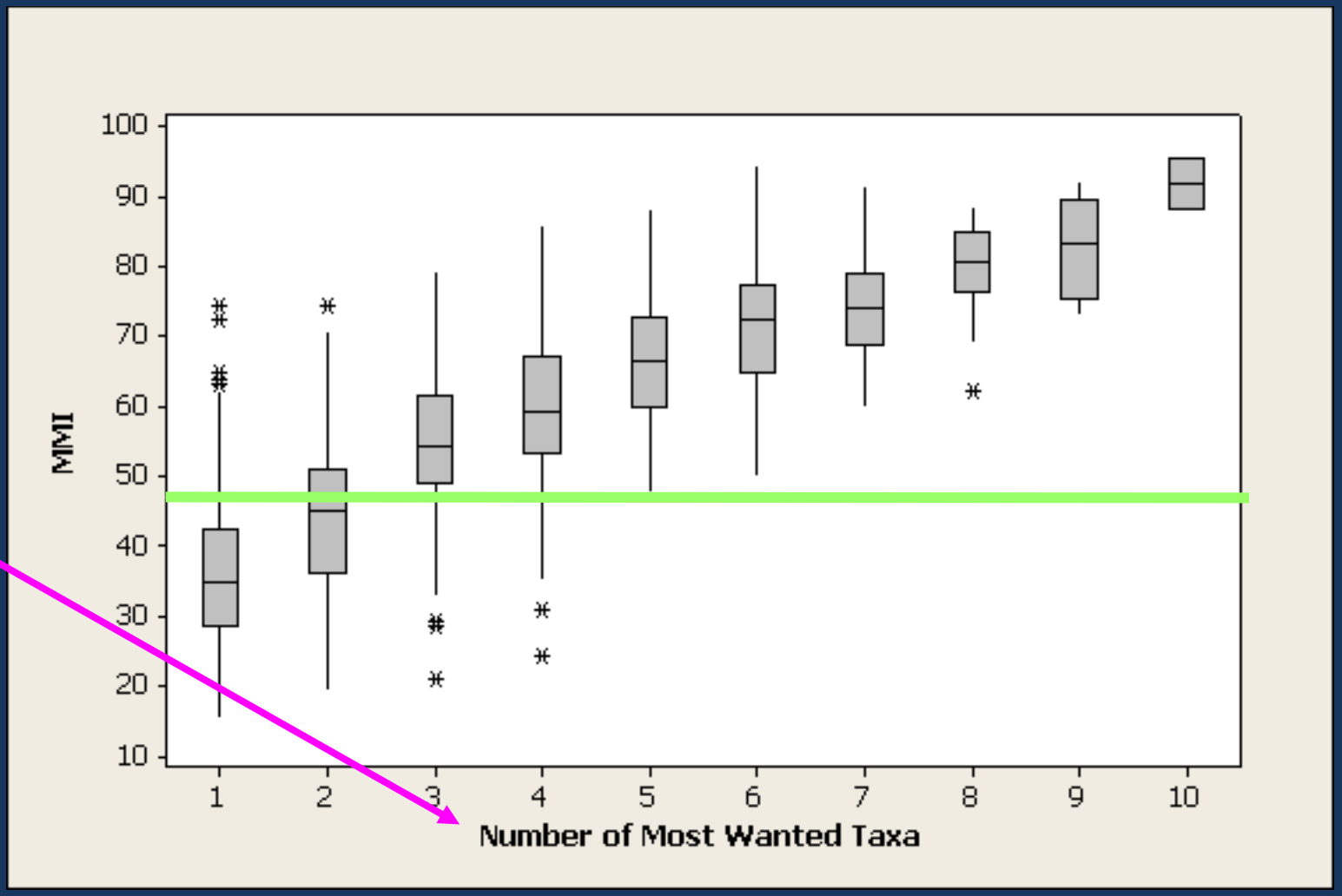
For each sample CT DEEP calculates a **multi-metric index (MMI) score** to determine if the water quality is good enough to meet state standards.

A MMI score of 48 or higher is needed to pass State water quality requirements.



How Does the ‘4 or More’ Rule Work?

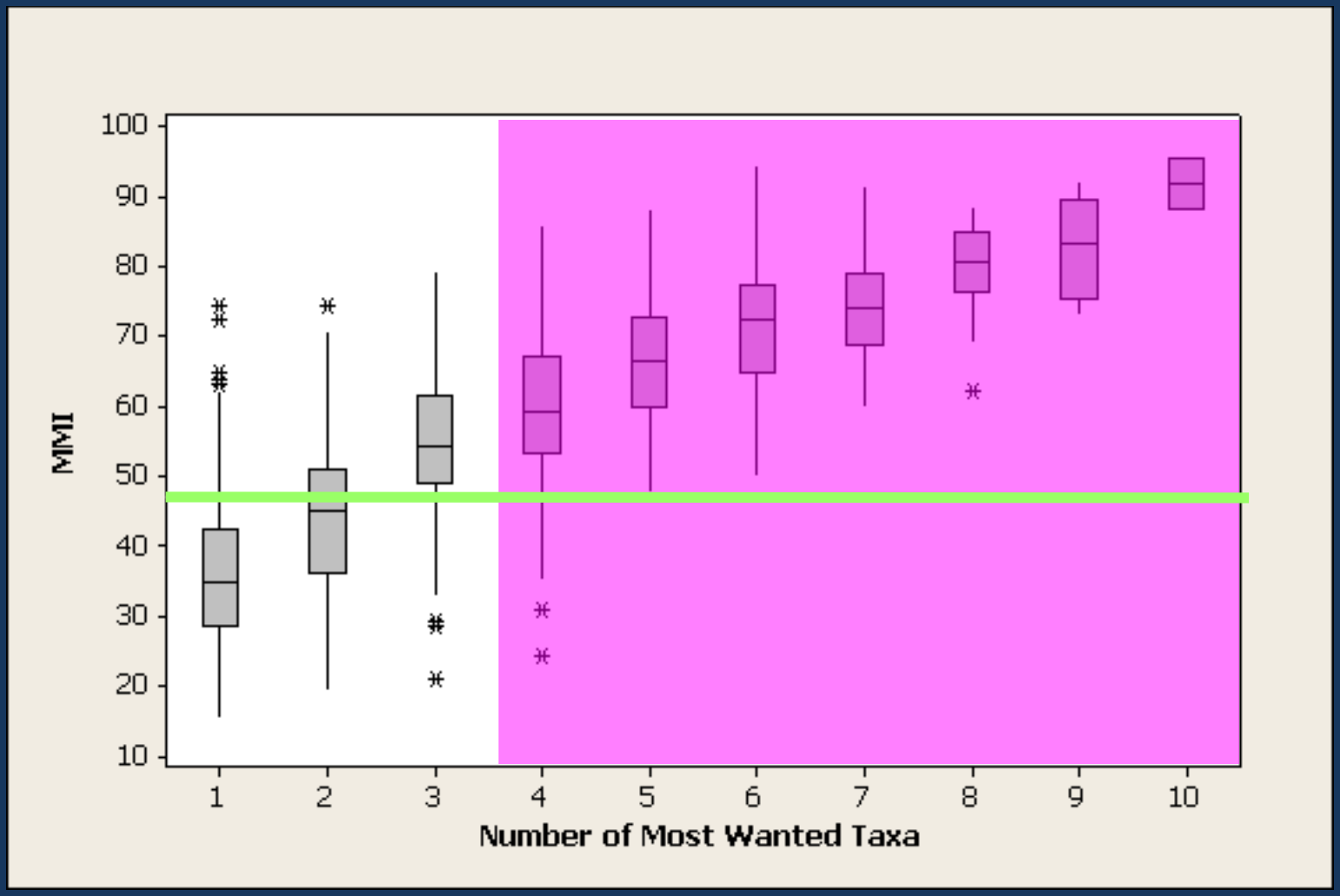
The samples in the chart are grouped by the number of RBV most wanted types they contained (bottom axis).



How Does the ‘4 or More’ Rule Work?

The pink box highlights samples with 4 or more Most Wanted RBV types.

>99%* of these ‘4 or More’ samples also had an MMI score greater than 48, indicating they were collected from sites with excellent water quality.

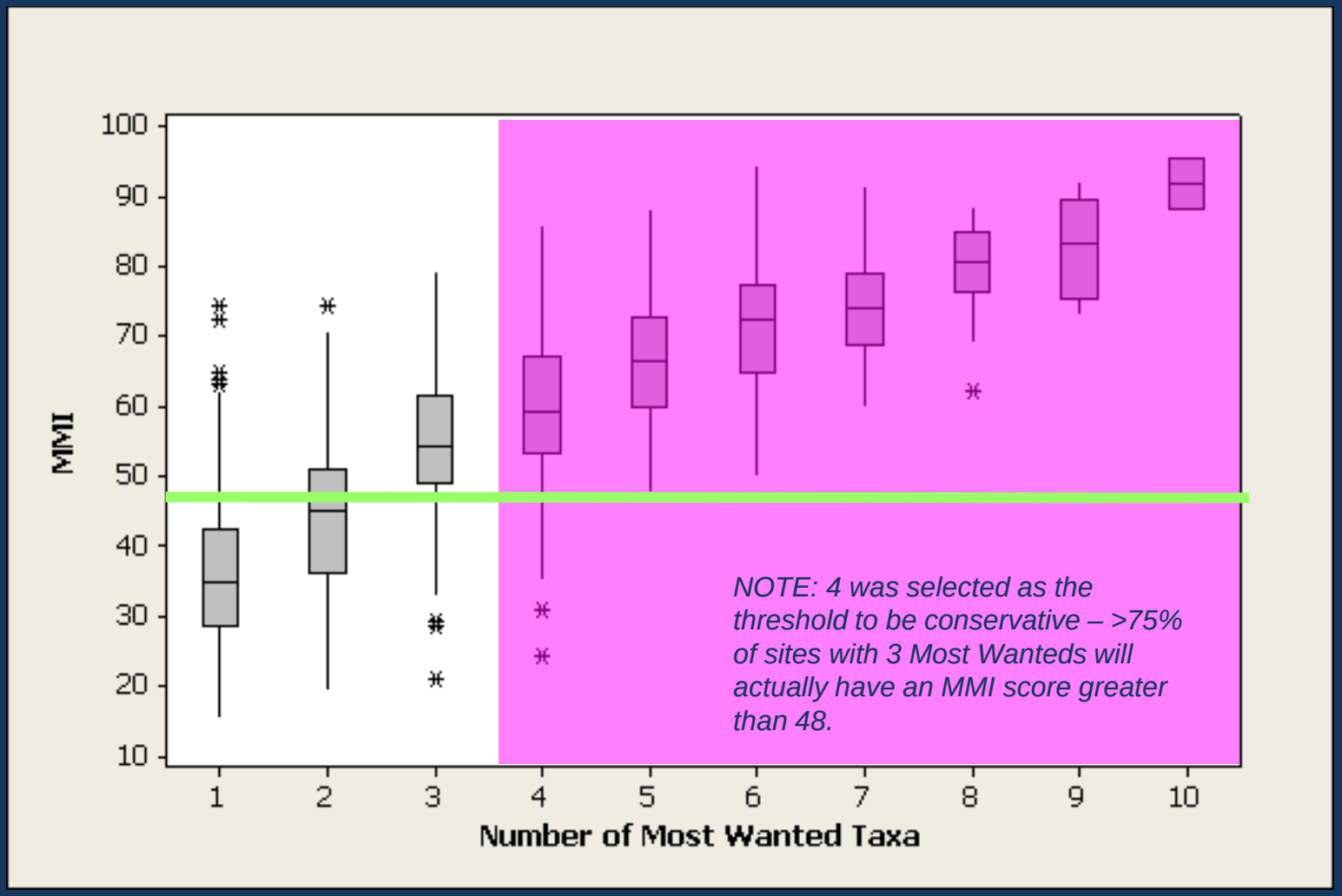


*7 out of 1152 samples had 4 Most Wanteds but an MMI score less than 48; all were sites that we would not use RBV on (e.g. large rivers)

How Does the ‘4 or More’ Rule Work?

RBV Program Basis:

If we find 4 or More Most Wanted Types in an RBV sample, it can be used as evidence of excellent water quality.

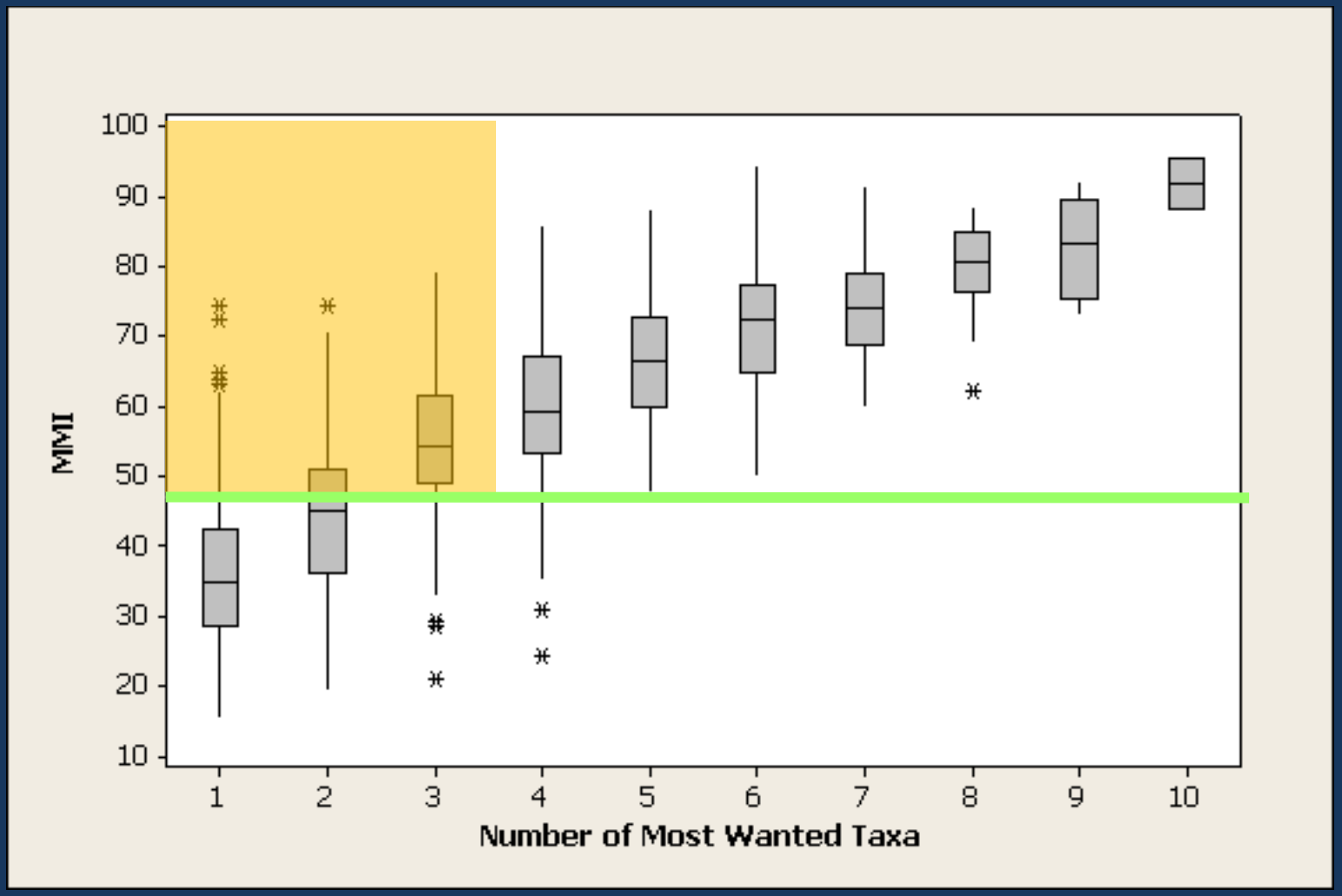


**The 7 samples that had 4 Most Wanteds but an MMI score less than 48 were very large rivers that we would not use RBV on.*

Does <4 Most Wanteds Indicate Bad Water Quality?

NO!!!

Low numbers of most wanted types is not a reliable indicator of reduced water quality.

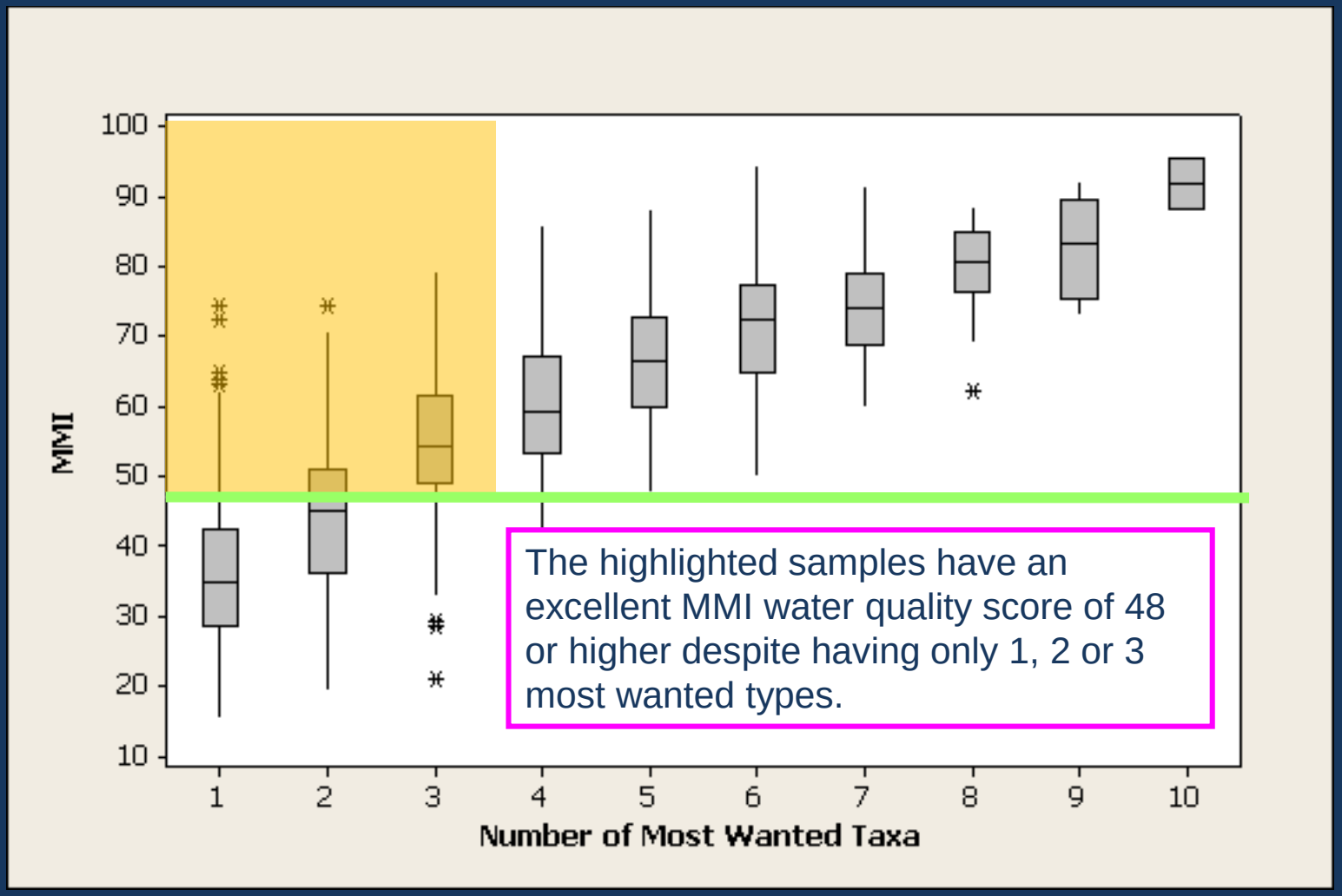


**The 7 samples that had 4 Most Wanteds but an MMI score less than 48 were very large rivers that we would not use RBV on.*

Does <4 Most Wanteds Indicate Bad Water Quality?

NO!!!

Because CT has so many species of macroinvertebrates and the 26 RBV types represent only a tiny fraction of these, not all sites with good water quality will have 4 or More RBV Most Wanted taxa present.



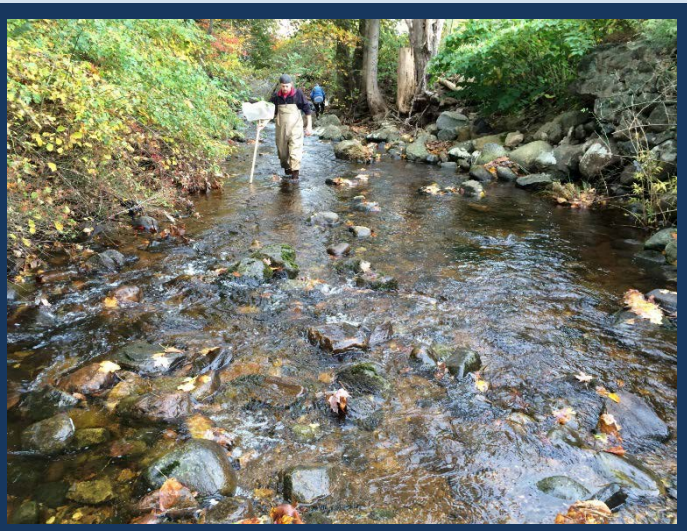
Where Do We Use RBV?

Not all waterbodies can be successfully monitored with RBV – we are primarily looking to document high quality headwater streams.

RBV monitoring locations must be:

- Smaller streams and rivers, approximately 1st-3rd order in size (<15 mi2 watershed)
- Characterized by plenty of riffle habitat
- Free of discharges, dams, or other obvious factors that would reduce water quality.
- Flow year-round under normal conditions

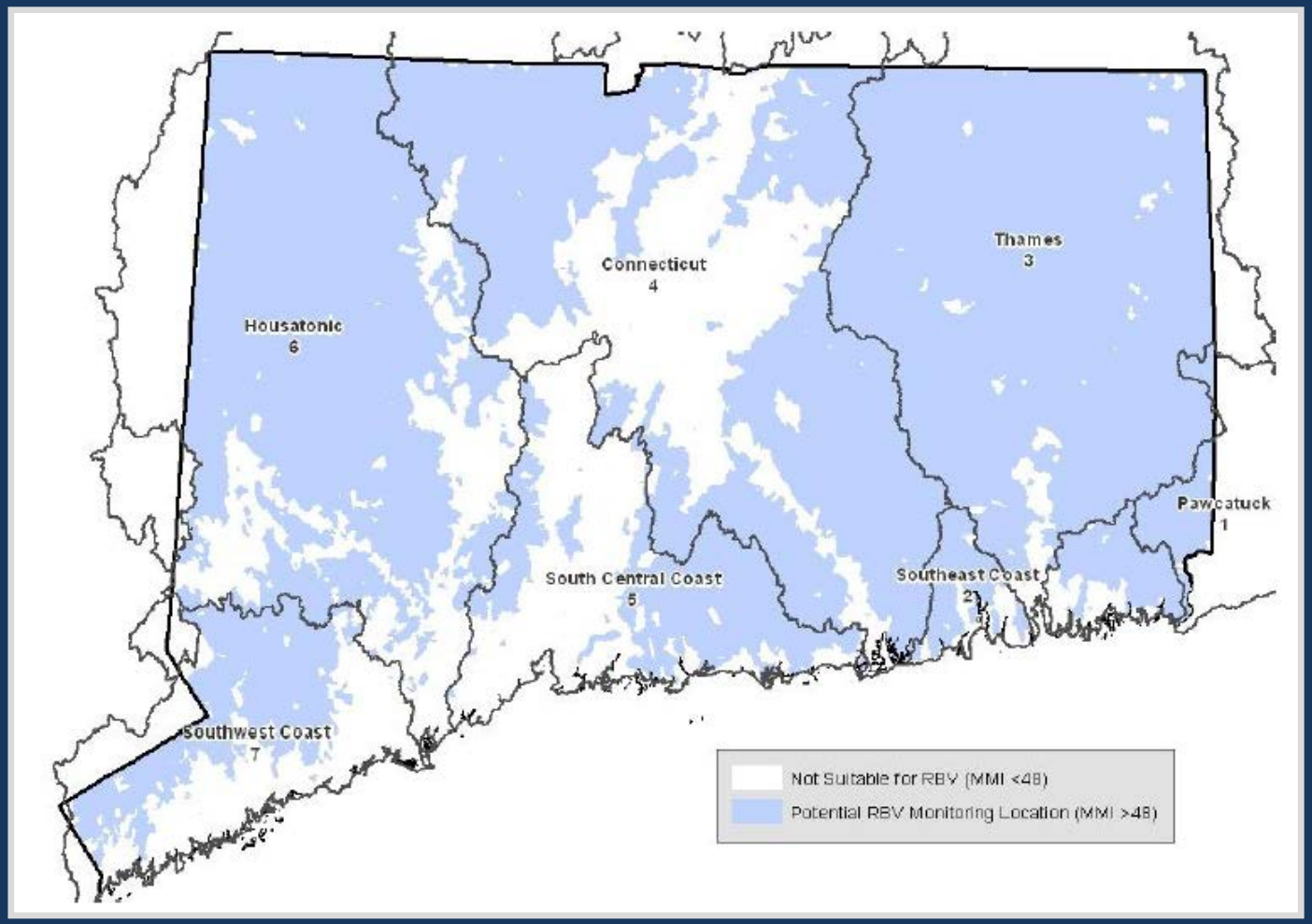
Don't forget - we are on a treasure hunt for Connecticut's healthiest streams!



Recommended RBV Monitoring Regions

RBV is a 'treasure hunt' for CT's healthiest streams!

Volunteers will be targeting streams predicted to have an MMI score of 48 or greater (i.e. predicted to have excellent water quality.)



Want to Learn More? Go to the Website!

RBV Webpage:
www.ct.gov/deep/rbv

- Additional Overview Information
- Annual Summary Reports
- State Coordinator Information
- Copies of Training Presentations
- Downloadable field materials

Riffle Bioassessment by Volunteers (RBV)

Volunteer Training Presentation:

Part 2 – RBV Methods & Procedures



A CT DEEP Tier 2

Volunteer Water Quality Monitoring Network

www.ct.gov/deep/rbv

Last revised 10/09/2015

Connecticut Department of Energy and Environmental Protection

The Field Team

RBV volunteers sample in groups referred to as "Field Teams."

- Groups consist of at least 2 volunteers ('team members') typically no more than 5
- Each field team is supervised by a **Field Team Leader**
    - Experienced volunteer (at least 1 year of prior experience)
    - Assigned to team by Local RBV Coordinator; reports to the Local RBV Coordinator
    - Responsible for reviewing and submitting field data package (photos, datasheet, voucher) at end of sample

Experienced Volunteer – 1 or more years of training and experience within past two years.

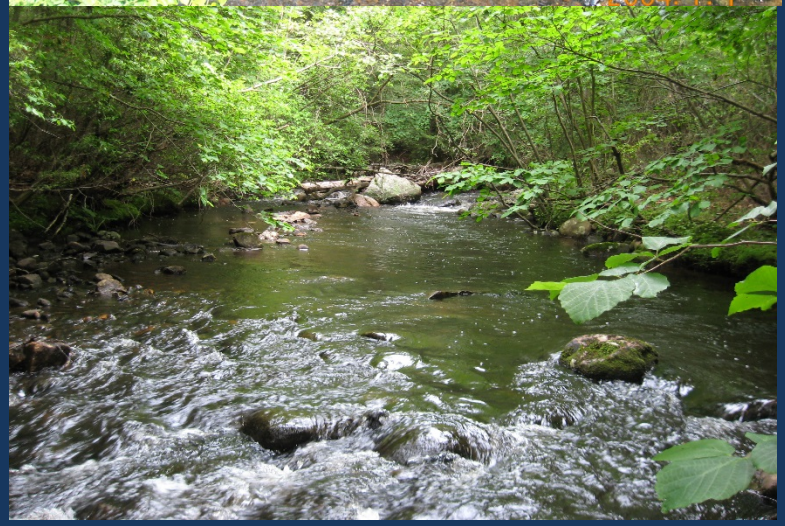
New Volunteer – no prior RBV experience OR has not participated in more than 2 years

Youth Volunteer – anyone under 18 regardless of past experience; refer to local program rules regarding participation limitations

Overview of the RBV Protocol

- Site selection (set up)
- Site photographs and GPS
- Collect (scrub & kick)
- Process (observe & Sort)
- Identify
- Voucher
- Submit
- Congratulations!

Monitoring Station Selection



Sites are selected in advance by the Local RBV Coordinator

- RBV Site Requirements:
  - Safely accessible by volunteers
  - Characterized by riffle habitat
  - Small, perennial 1st-3rd order streams (no large rivers!!)
  - Not listed as impaired or immediately downstream of a discharge or dam

*Ideal Sites are headwater streams thought to be high quality but which have not been monitored or assessed by DEEP within the past two years.


RIFFLES!!
2004. 6. 29

Step 1: Site Set Up

Establish the Sampling Station:

– Select an appropriate riffle area

NOTE:

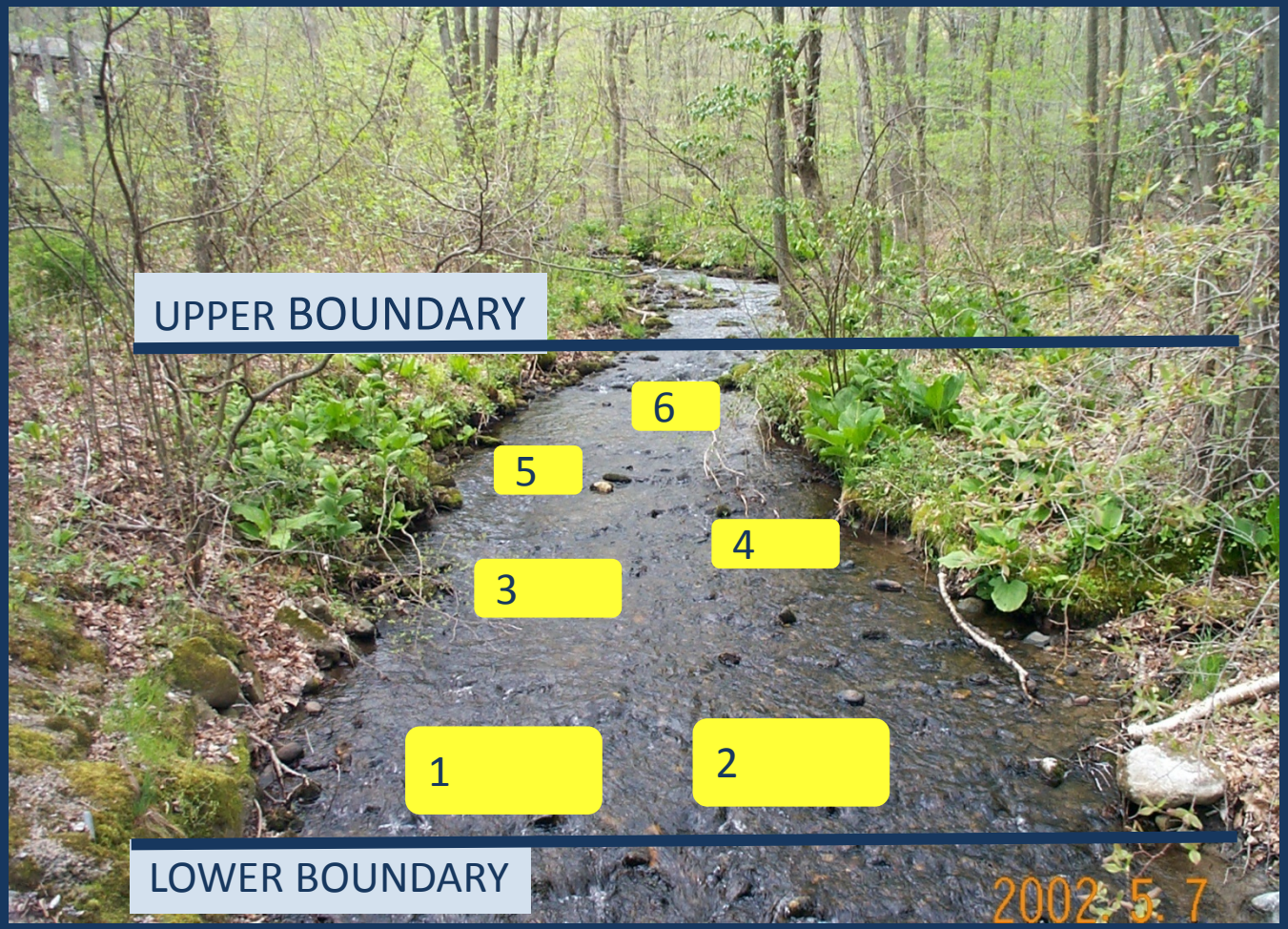
If sampling at a road crossing – sample UPSTREAM of the crossing whenever possible

Step 1: Site Set Up

Establish the Sampling Station:

- Select an appropriate riffle area
- Define the upper and lower boundaries of the riffle

Step 1: Site Set Up



Establish the Sampling Station:

- Select an appropriate riffle area
- Define the upper and lower boundaries of the riffle
- Visualize where you can put the net into the water 6 times

Note: One Site may require several riffles

Note: One Site may require several riffles

Step 2: Site Photographs & GPS Location

- For each site take two photographs:
  - Stand in the middle of your riffle and face **upstream** → take photo #1
  - Turn 180 degrees so that you are now facing **downstream** → take photo #2

Example upstream site photograph

Remember: The goal is to take a photograph to document the area from which you will collect the sample!

Photo #1: DOWNSTREAM of the Site

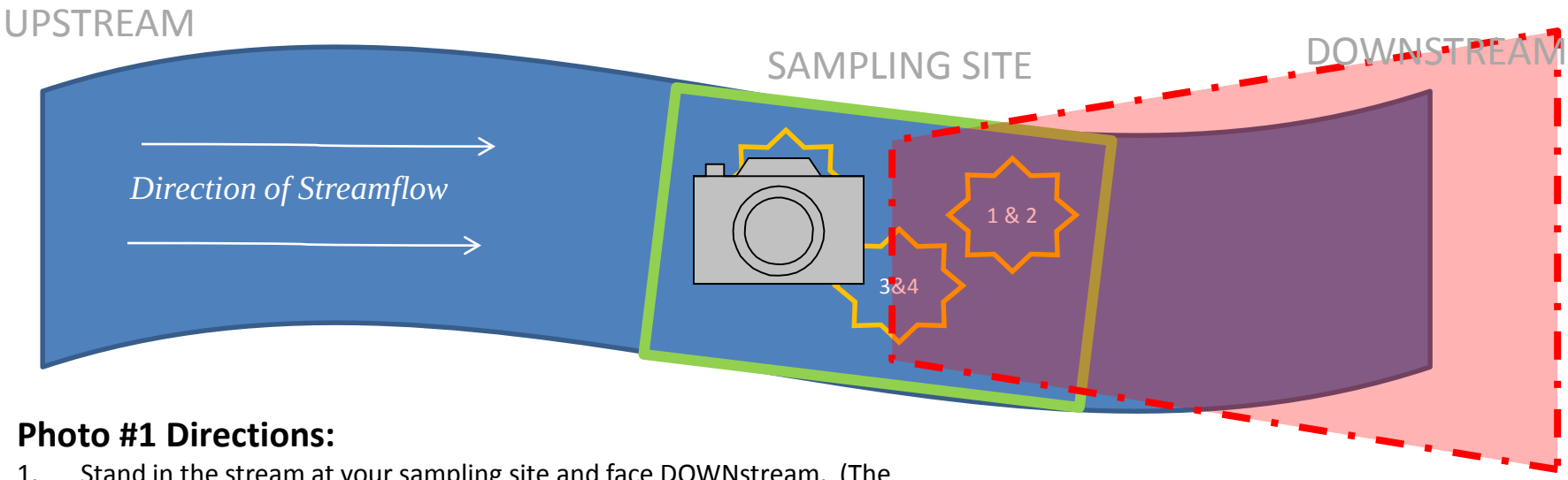


Photo #1 Directions:

1. Stand in the stream at your sampling site and face DOWNstream. (The water should be flowing so that it is coming from behind you, flowing past, and travelling away in front of you.)
2. If the setting is available set your camera to the 'Landscape' setting. Make sure it is zoomed out as much as possible.
3. Take your photo, trying to capture the stream in the distance ahead of you as well both banks as much as possible.
4. Check the photo to make sure it is clear.
5. If using a digital camera, record the photo number on your data sheet in the comments section.

LEGEND

- Area to capture in photo
- Location of camera
- Stream
- Sampling site (6 kicks total)
- # Kicks within sampling site

Photo #2: UPSTREAM of the Site

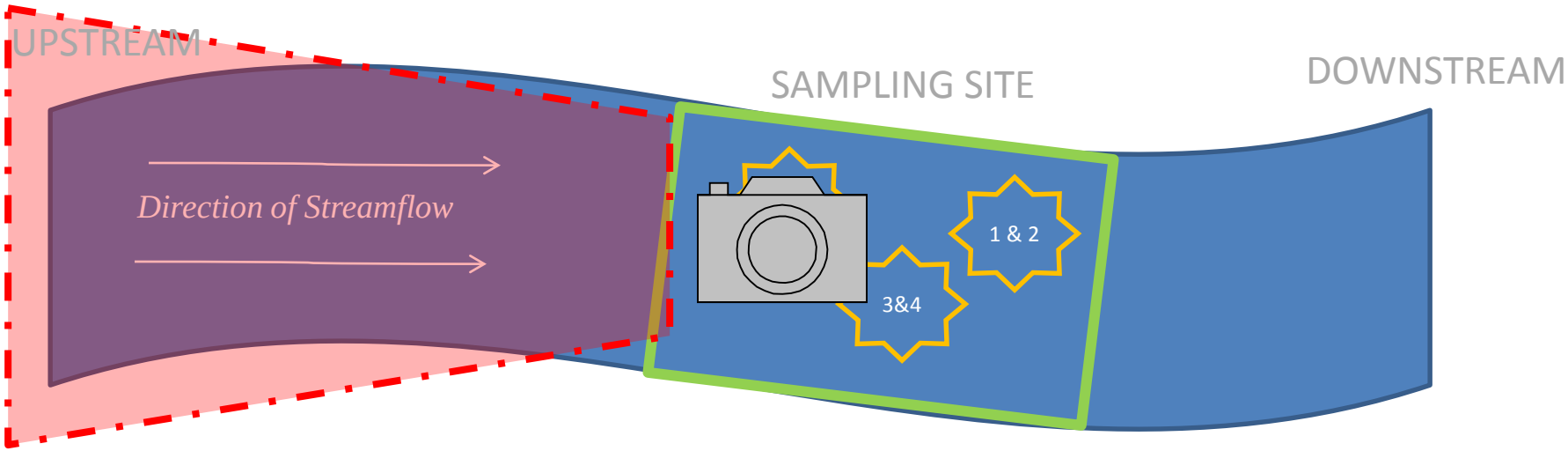


Photo #2 Directions:

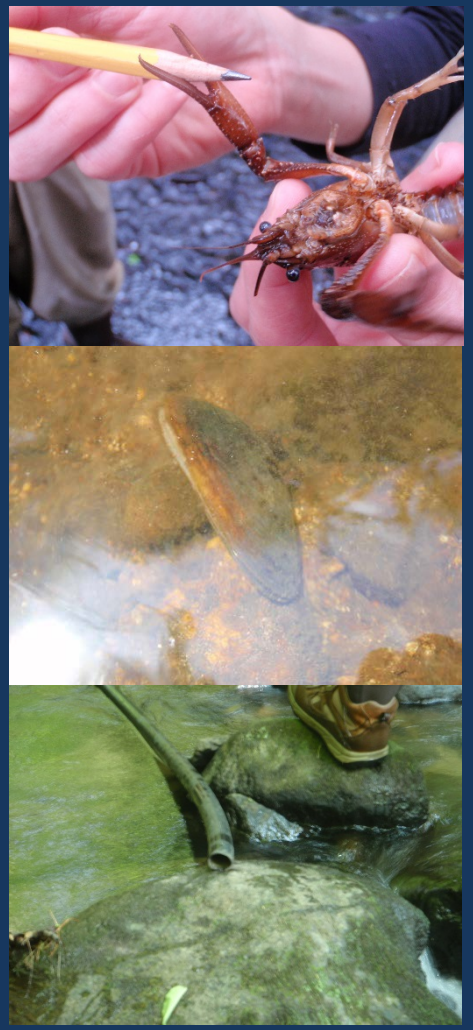
1. Stand in the stream at your sampling site and face UPtream. (The water should be flowing so that it is coming from in front of you, flowing past, and travelling away behind you.)
2. If the setting is available set your camera to the 'Landscape' setting. Make sure it is zoomed out as much as possible.
3. Take your photo, trying to capture the stream in the distance ahead of you as well both banks as much as possible.
4. Check the photo to make sure it is clear.
5. If using a digital camera, record the photo number on your data sheet in the comments section.

LEGEND

- Area to capture in photo
- Location of camera
- Stream
- Sampling site (6 kicks total)
- # Kicks within sampling site

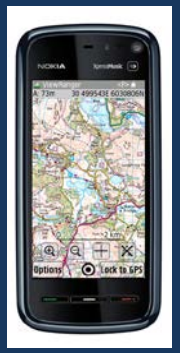
Step 2: Site Photographs & GPS Location

- Take photographs the same day as conducting the RBV event
- Try to capture the field conditions at the time of sampling - Include as much of the riparian vegetation and upstream/downstream area as possible
- Take additional photographs of unusual or unique features as needed



Step 2: Site Photographs & GPS Location

- Use a GPS unit or cell-phone with GPS feature to collect the latitude and longitude of the site. <u>Record the lat/long on your datasheet!!</u>



Step 2: Site Photographs & GPS Location

- Record the site latitude/longitude information on your datasheet.

Revised 10/01/2015

DEEP STAFF USE ONLY - PLEASE DO NOT WRITE IN THIS TOP GRAY SECTION

PLACE SITE INFORMATION STICKER HERE

Review Date: _____ AWQ Site #: _____
Review By: _____ Stream: _____
Most Wanteds: _____ VolMon Group #: _____

CT DEEP RBV Program -- Field Data Sheet

Stream Name:	Latitude:	Longitude:	Take Photos of the Stream Facing: ☐Upstream of Site ☐Downstream of Site
RBV Site Location (i.e. '100m downstream of Route 44 crossing'):			Collection Date:
Site Town:	Volunteers' Names (First & Last):		Organization Responsible for Volunteers:

BEFORE TURNING IN THIS DATASHEET PLEASE MAKE SURE THAT ALL BLUE FIELDS ABOVE ARE COMPLETE

DIRECTIONS: Using the RBV Sorting Guide and the RBV Field Identification Cards, identify the macroinvertebrate types in your sample. Check off each macroinvertebrate type found in your sample. (Note: 'sample'= 6 kicks or the 3 types from one site combined). Complete a voucher label with the information above and place it into the voucher container. Fill the container part way with isopropyl rubbing alcohol. Place 2-3 representatives of each type into the voucher container. Add additional isopropyl alcohol to the voucher container to insure there is no air in the container; seal tightly.

WANTED (sensitive to pollution)	1 "Body-Builder" Mayfly *Drunella sp.*	2 Brush-Legged Mayfly *Isonychia sp.*	3 2-Tail Flathead Mayfly *Heptagenia sp.*	4 Roach-Like Stonefly Peltoperlidae	5A Common Stonefly Perlidae	5 B Giant Stonefly *Pteronarcys sp.*	5 C Misc. Small Stonefly Plecoptera
							

- Check off the boxes on the datasheet to confirm you have taken each of the required site photographs.

Step 3: Collect (Scrub & Kick!!)

Collect aquatic macroinvertebrates from each of the six locations within your site. Scrub any rocks within the net first before kicking the area in front of the net vigorously (max 2 minutes per kick). Kick in a "Z" pattern for 1 minute. Empty the contents of each pair of kicks into a white tray.

Step 3: Collect

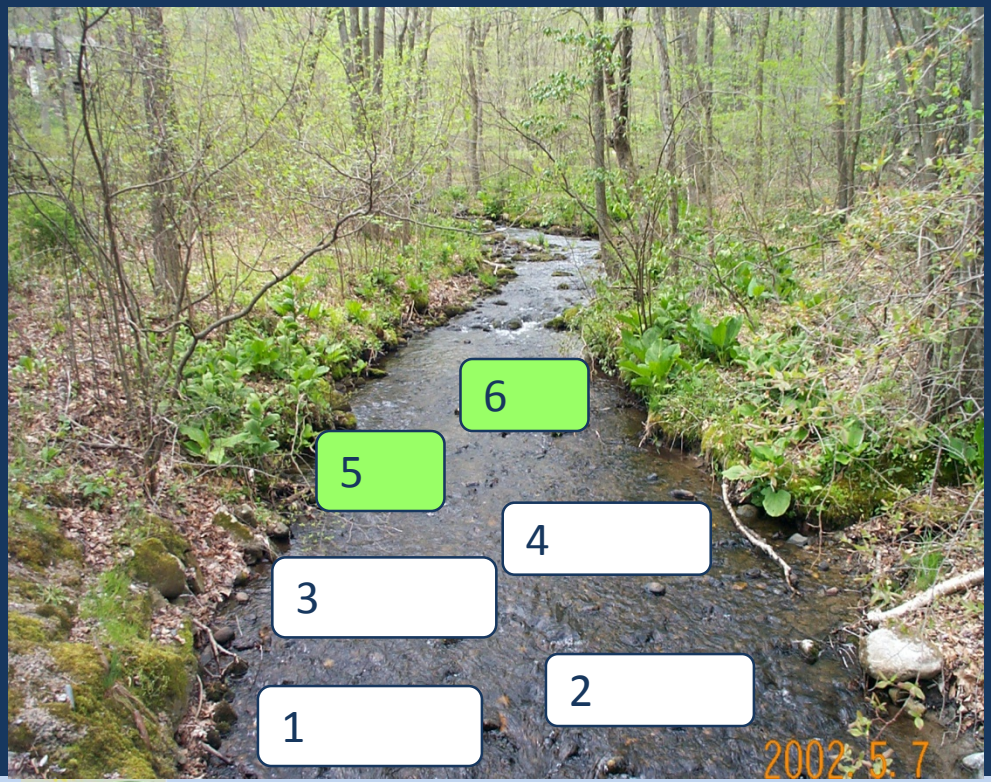
- Collect Samples from Locations 1 & 2
- EMPTY CONTENTS OF KICKS 1&2 INTO TRAY A

Step 3: Collect

- Collect Samples from Locations 3 & 4
- EMPTY CONTENTS OF KICKS 3&4 INTO TRAY B

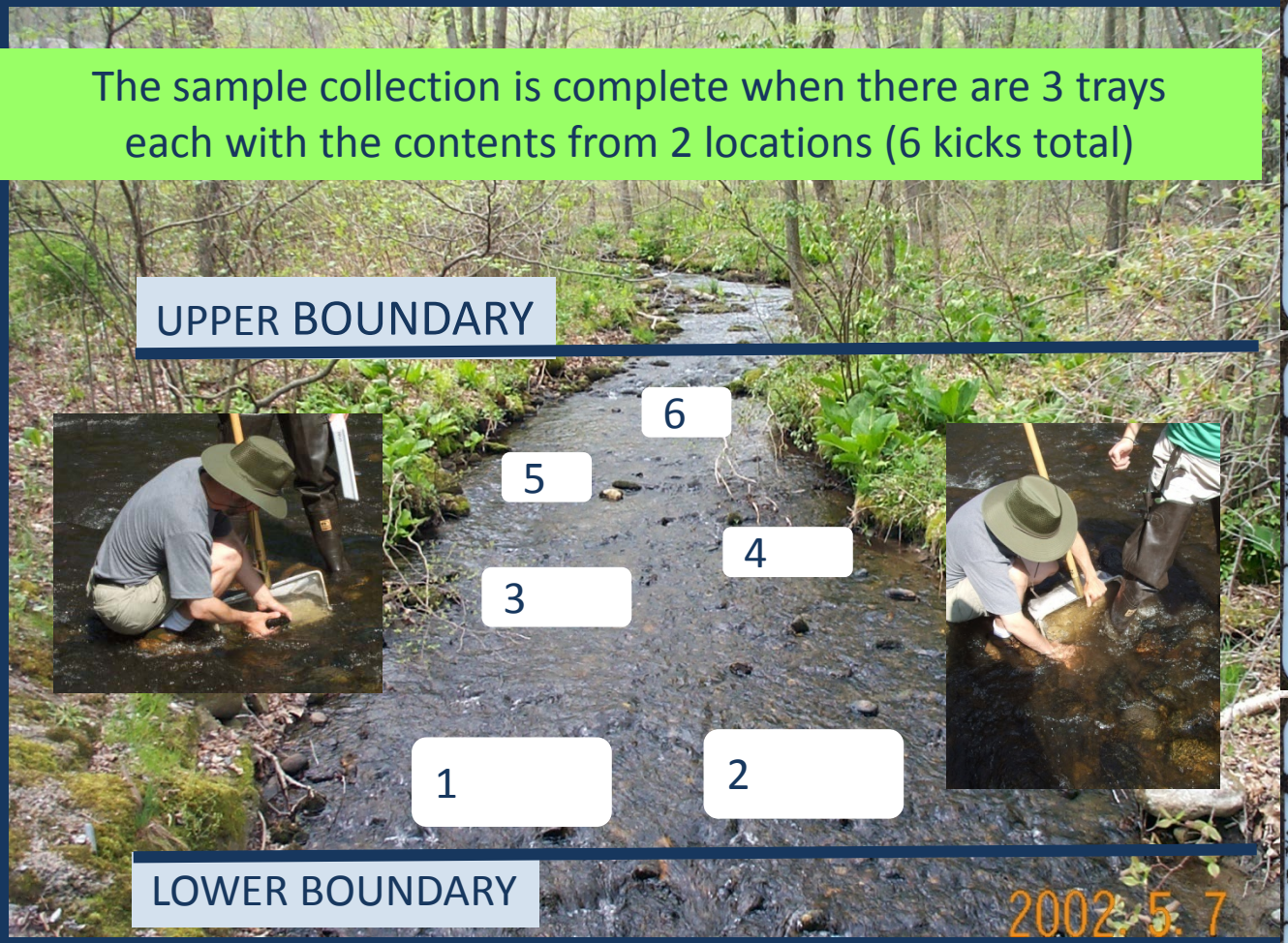
Step 3: Collect

- Collect Samples from Locations 5 & 6
- EMPTY CONTENTS OF KICKS 5&6 INTO TRAY C

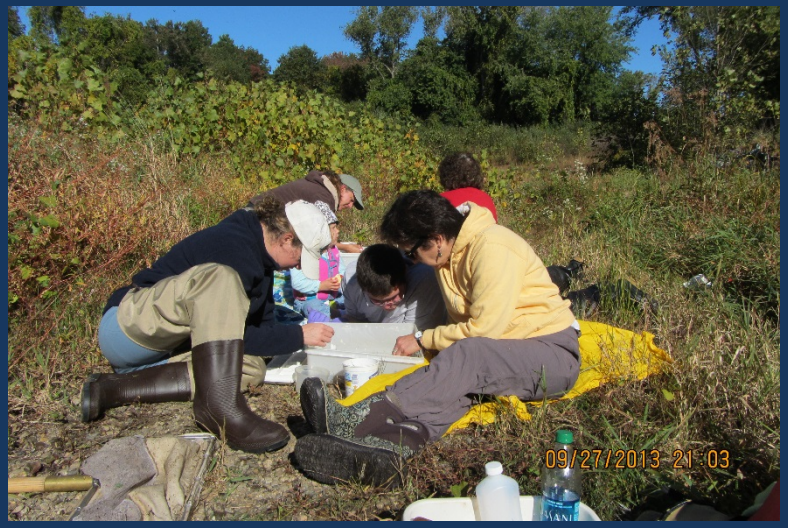


Step 3: Collect

The sample collection is complete when there are 3 trays each with the contents from 2 locations (6 kicks total)



Step 4: Process the Sample (Sorting)



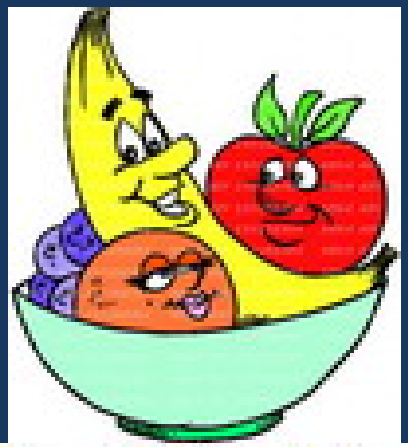
- Use tweezers and spoons
- Pick out organisms and place in ice cube tray
- Sort similar looking organisms into the same cube
- <u>Look carefully – some are very small and/or camouflaged</u>
- Experienced team leaders oversee the process

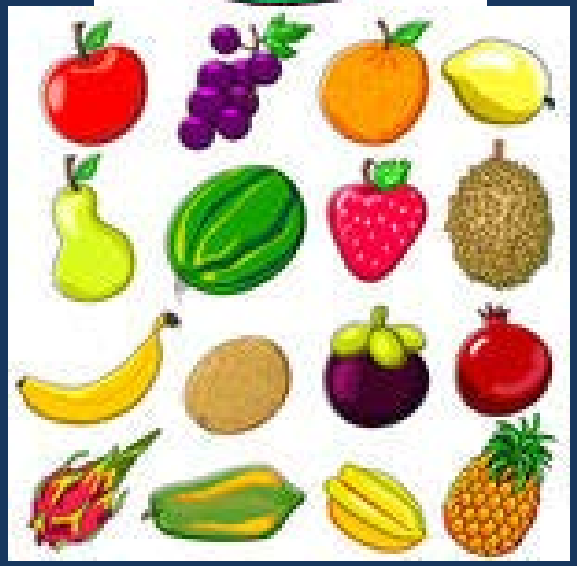
Step 4: Sorting

Processing is complete when you have found as many of the different TYPES as possible and put representatives of each type into the ice cube trays

Step 5: Identify the Macroinvertebrates

Step 5: Identify the Macroinvertebrates





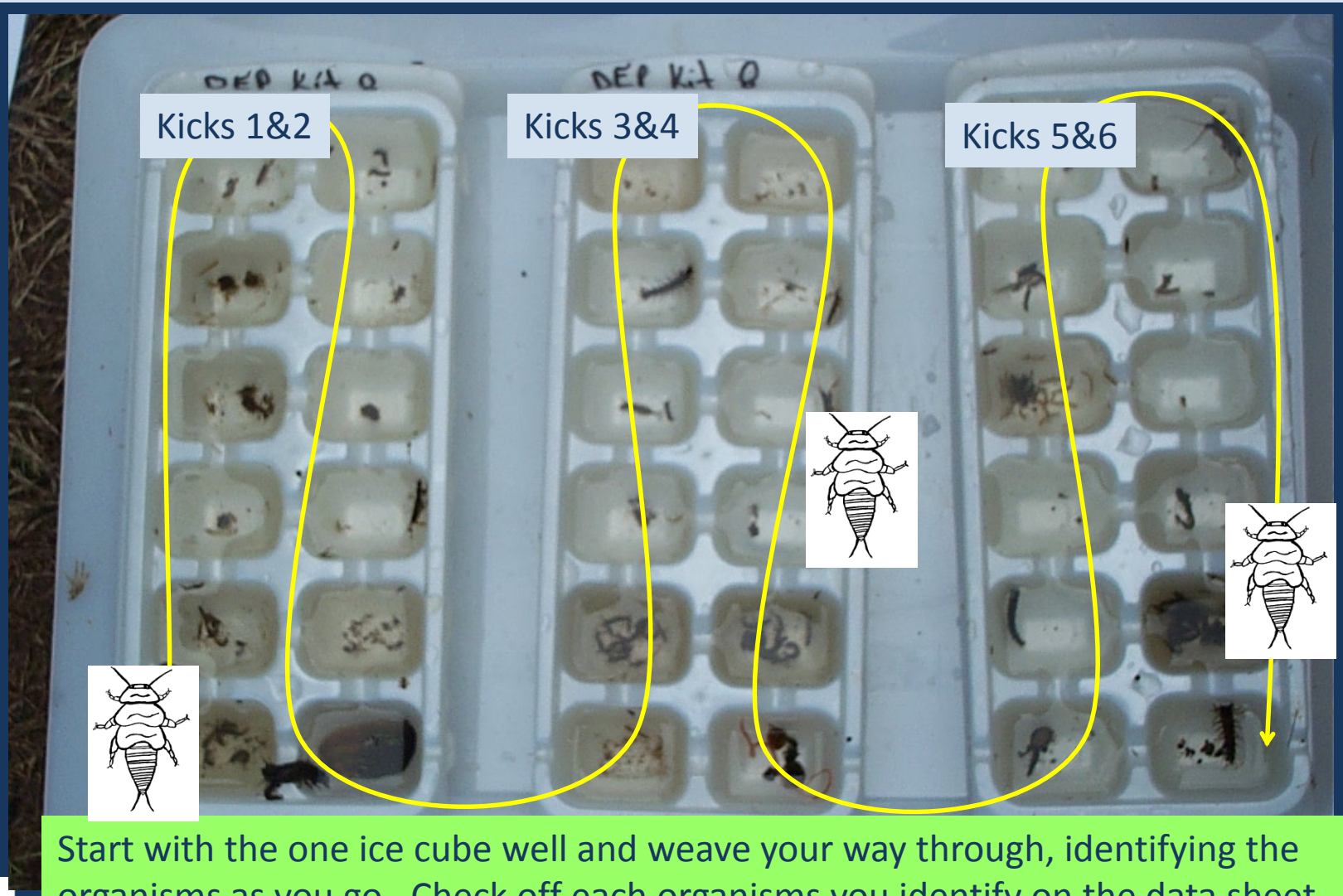
<u>Do not stress over identifications!!</u>
<u>RBV volunteers are not expected to identify 100% of all organisms correctly!</u>

Sorting your sample into different types and then adding 2-3 of each type to your voucher - *even if you don't know what they actually are* - is what is most important.

RBV is like making a fruit bowl from a big pile of random produce…

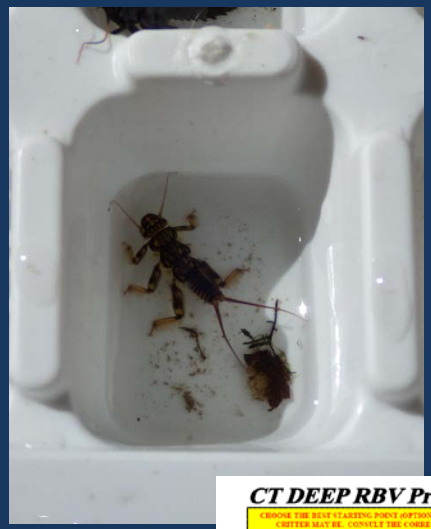
You probably know many of the fruit shown at left but there are also probably a few you aren't sure about, right? So imagine you were given a big pile of these different fruits and someone needs your help making a fruit bowl for display. The display needs to contain at least one of each type of fruit - would you be able to sort the pile into similar looking fruits and then place 2-3 of each type of fruit into a bowl? Sure you could! ☺

Step 5: Identify



Start with the one ice cube well and weave your way through, identifying the organisms as you go. Check off each organisms you identify on the data sheet.

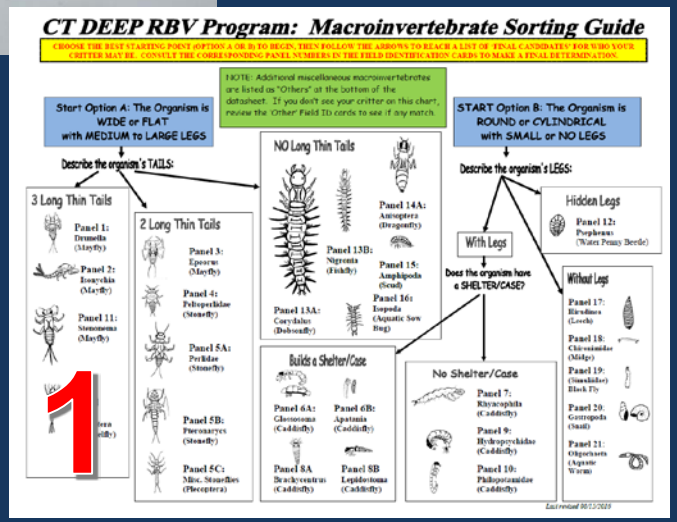
3-Part Identification Process

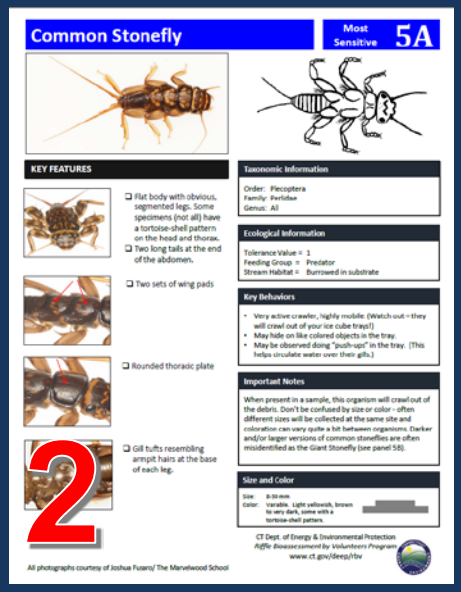


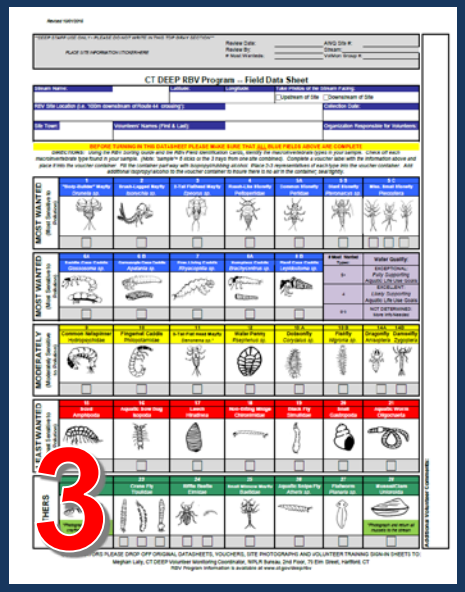
Step 1 –MACROINVERTEBRATE SORTING GUIDE

Step 2 –FIELD IDENTICATION CARDS

Step 3 – Check off **DATASHEET**

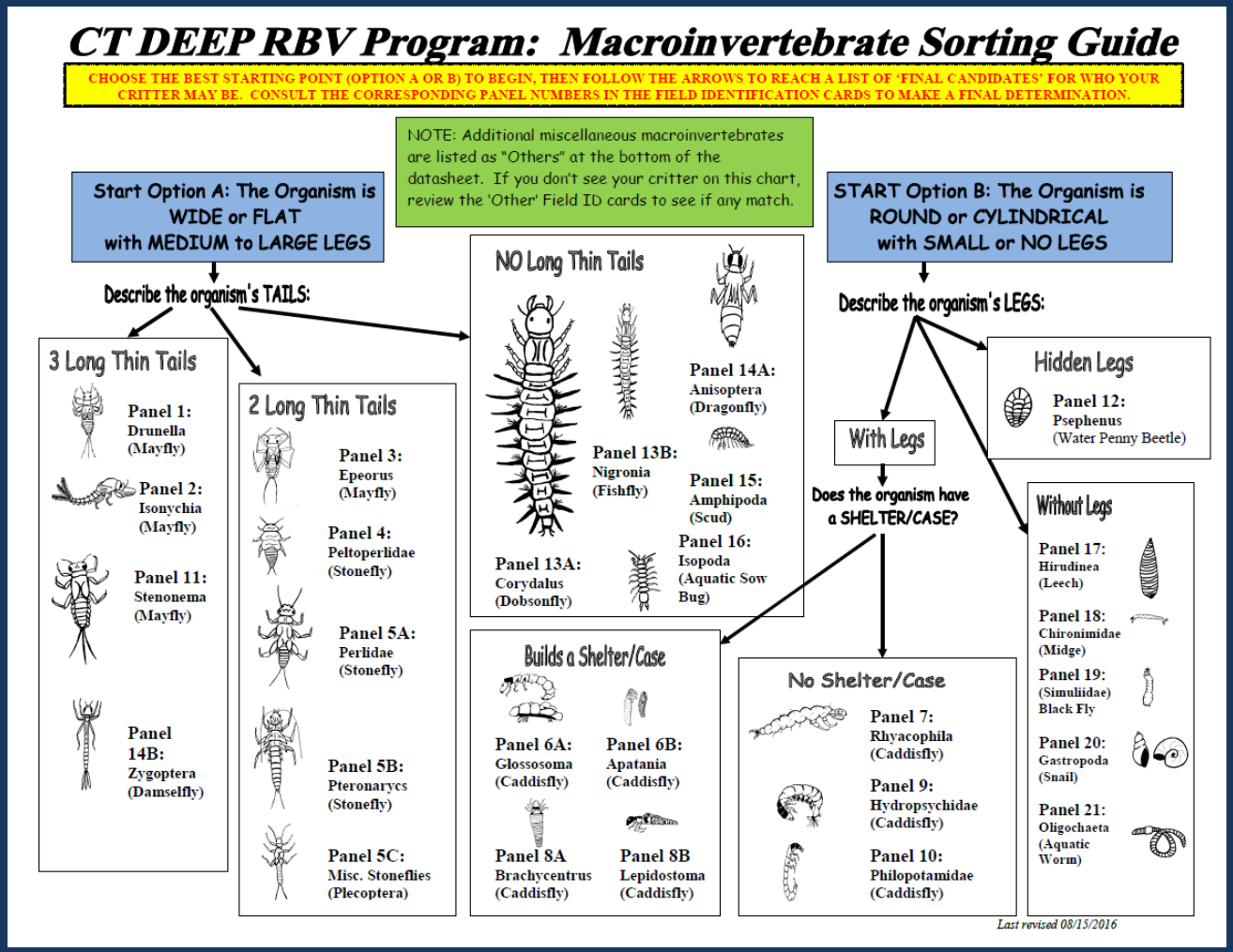






Connecticut Department of Energy and Environmental Protection

Start with the Sorting Guide



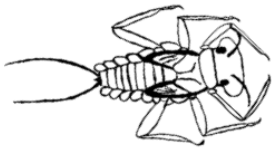
STEP 1:
Use the sorting guide and field ID cards to identify each type of macroinvertebrate present in your sample.

Note the numbers on the ID cards correspond to those on the sorting guide and datasheet.

Review Field Identification Cards

Two-Tailed Flathead Mayfly

Most Sensitive 3



KEY FEATURES

- ❑ Extremely flat, almost translucent body, long thin legs.

- ❑ Small round gills on the sides of the abdomen.
- ❑ Two Long thin tails at the end of the abdomen (easily broken)

- ❑ Single set of wing pads.
- ❑ Wide flat head, obvious eyes.

Taxonomic Information

Order: Ephemeroptera
Family: Heptageniidae
Genus: *Epeorus*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = Cobble and organic substrates

Key Behaviors

- This mayfly nymph crawls very fast on the surface of stones.
- Will move quickly in the tray and try to hide under any leaves or sticks present.
- *Epeorus* may try to swim by wiggling side to side.

Important Notes

The best way to find *Epeorus* is to carefully 'wash off' cobbles in the net before kicking. When present, these mayflies will scurry along the surface of the rock. Because of the body color and shape, they can be very difficult to spot. *Epeorus* can be extremely abundant when conditions are appropriate.

Size and Color

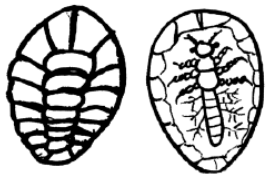
Size: 2-10 mm
Color: Tan to dark brown, sometimes with lighter gills and markings on the legs and head.

Photographs courtesy of (top to bottom): Kelsey Quartuccio / CT DEEP; DEEP files, author unknown; NY DEC Biomonitoring Unit; DEEP files, author unknown

CT Dept. of Energy & Environmental Protection
Riffle Bioassessment by Volunteers Program
www.ct.gov/deep/rbv

Water Penny Beetle

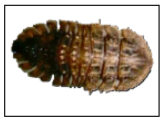
Moderately Sensitive 12



KEY FEATURES

- ❑ Small, flat, disc-shaped organism.
- ❑ Uniform in color
- ❑ Head and legs only visible from ventral view (i.e. from underneath)

Don't be Fooled by This Imposter!



- ❑ Often confused with the False Water Penny (*Eubriidae*). *Eubriidae* is more ovoid in shape and has a serrated or more jagged outer edge.

Taxonomic Information

Order: Coleoptera
Family: Psephenidae
Genus: *Psephenus*

Ecological Information

Tolerance Value = 4
Feeding Group = Scraper
Stream Habitat = Attached to rocks in fast flows

Key Behaviors

- Cling very well to rocks and smooth surfaces such as the sorting tray (see image at left)
- May glide along the bottom of the tray
- May curl up when disturbed

Important Notes

Water penny beetle larvae are common in RBV samples, but can be very hard to locate in the field due to their cryptic nature. Look very closely at any cobbles in your sample area; water penny beetle larva will adhere strongly to rock surfaces. They are very distinctive due to their penny like shape and coloration. These organisms can be locally abundant when conditions are appropriate.

Size and Color

Size: 3-10 mm
Color: Uniform in color. Ranges from golden to dark brown.

Photographs courtesy of (top to bottom): Jake Renkert / The Marvelwood School (top three); Meghan Lally/CT DEEP; The Marvelwood School/Kent Conservation Commission RBV program; The

CT Dept. of Energy & Environmental Protection
Riffle Bioassessment by Volunteers Program
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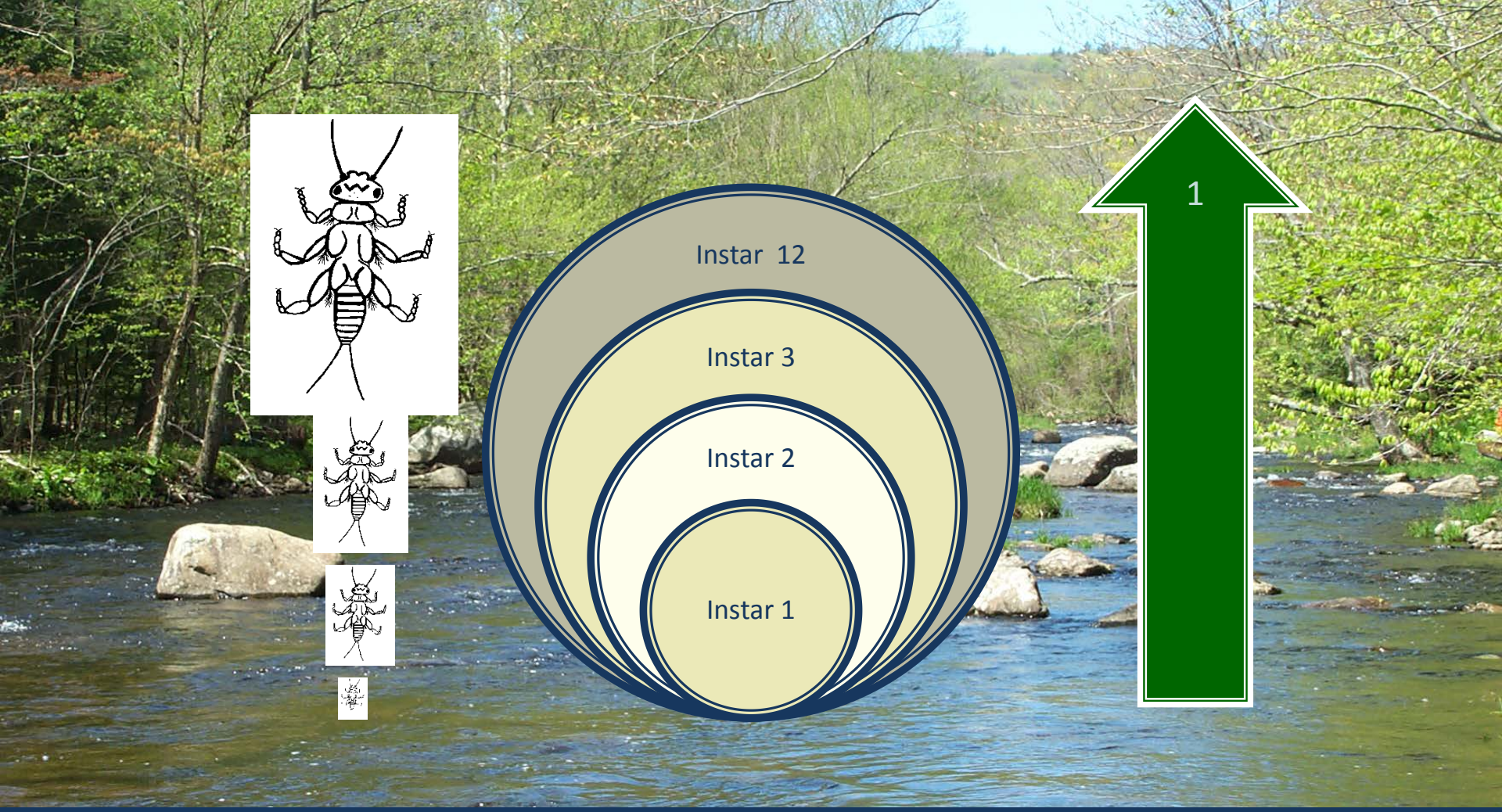


Don’t be fooled by size!

Check off ID on Datasheet

Complete the top of your datasheet!!!

Check to make sure the top of your datasheet is complete.

Check off all of the macroinvertebrate types that were present in your sample (all 6 kicks combined).

Revised 10/01/2015

"DEEP STAFF USE ONLY - PLEASE DO NOT WRITE IN THIS TOP GRAY SECTION"

PLACE SITE INFORMATION STICKER HERE

Review Date: _____ AWQ Site #: _____
Review By: _____ Stream: _____
Most Wanteds: _____ VolMon Group #: _____

CT DEEP RBV Program -- Field Data Sheet

Stream Name:	Latitude:	Longitude:	Take Photos of the Stream Facing: ☐Upstream of Site ☐Downstream of Site
RBV Site Location (i.e. '100m downstream of Route 44 crossing'):			Collection Date:
Site Town:	Volunteers' Names (First & Last):		Organization Responsible for Volunteers:

BEFORE TURNING IN THIS DATASHEET PLEASE MAKE SURE THAT ALL BLUE FIELDS ABOVE ARE COMPLETE

DIRECTIONS: Using the RBV Sorting Guide and the RBV Field Identification Cards, identify the macroinvertebrate types in your sample. Check off each macroinvertebrate type found in your sample. (Note: 'sample'= 6 kicks or the 3 trays from one site combined). Complete a voucher label with the information above and place it into the voucher container. Fill the container part way with isopropyl/rubbing alcohol. Place 2-3 representatives of each type into the voucher container. Add additional isopropyl alcohol to the voucher container to insure there is no air in the container; seal tightly.

MOST WANTED (Most Sensitive to Pollution)

1 "Body-Builder" Mayfly *Drunella sp.*	2 Brush-Legged Mayfly *Isonychia sp.*	3 2-Tail Flathead Mayfly *Epeorus sp.*	4 Roach-Like Stonefly Peltoperlidae	5A Common Stonefly Perlidae	5 B Giant Stonefly *Pteronarcys sp.*	5 C Misc. Small Stonefly Plecoptera
☐	☐	☐	☐	☐	☐	☐ ☐ ☐

MOST WANTED (Most Sensitive to Pollution)

6A Saddle-Case Caddis *Glossosoma sp.*	6 B Cornucopia Case Caddis *Apatania sp.*	7 Free-Living Caddis *Rhyacophila sp.*	8A Humpless Caddis *Brachycentrus sp.*	8 B Plant Case Caddis *Lepidostoma sp.*	# Most Wanted Types:	Water Quality:
☐	☐	☐	☐	☐	5+	EXCEPTIONAL: *Fully Supporting* Aquatic Life Use Goals
					4	EXCELLENT: *Likely Supporting* Aquatic Life Use Goals
					0-3	NOT DETERMINED: More Info Needed

MODERATELY (Moderately Sensitive to Pollution)

9 Common Netspinner Hydropsychidae	10 Fingernet Caddis Philopotamidae	11 3-Tail Flat Head Mayfly *Stenonema sp.*	12 Water Penny *Psephenus sp.*	13 A Dobsonfly *Corydalus sp.*	13 B Fishfly *Nigronia sp.*	14A Dragonfly Anisoptera	14B Damselfly Zygoptera
☐	☐	☐	☐	☐	☐	☐	☐

LEAST WANTED (Least Sensitive to Pollution)

15 Scud Amphipoda	16 Aquatic Sow Bug Isopoda	17 Leech Hirudinea	18 Non-Biting Midge Chironimidae	19 Black Fly Simulidae	20 Snail Gastropoda	21 Aquatic Worm Oligochaeta
☐	☐	☐	☐	☐	☐	☐

OTHERS

22 Crayfish Decapoda	23 Crane Fly Tipulidae	24 Riffle Beetle Elmidae	25 Small Minnow Mayfly Baetidae	26 Aquatic Snipe Fly *Atherix sp.*	27 Flatworm *Planaria sp.*	28 Mussel/Clam Unionoida
*Photograph and return all crayfish to the stream	☐ ☐ ☐	☐ ☐	☐	☐	☐	*Photograph and return all mussels to the stream

Additional Volunteer Comments:

COORDINATORS PLEASE DROP OFF ORIGINAL DATASHEETS, VOUCHERS, SITE PHOTOGRAPHS AND VOLUNTEER TRAINING SIGN-IN SHEETS TO:
Meghan Lally, CT DEEP Volunteer Monitoring Coordinator, WPLR Bureau, 2nd Floor, 79 Elm Street, Hartford, CT
RBV Program information is available at www.ct.gov/deep/rbv

Step 6: Prepare a Voucher

RBV VOUCHER
Stream: Burnap Brook
Location: 50 m upstream Rt 6
Town: Andover
Date: 10/15/15
Organization: Andover Stream Club
Collectors: M. Lally & P. Lally

CRITICAL STEP!!

- Steps To Create and Preserve a Voucher Collection of RBV Organisms:
  1. Complete your label and insert it into your container.
  2. Fill the container half way with preservative (alcohol).
  3. Put 2-3 of each RBV organism type found into the container (no mussels or crayfish).
  4. Add any unknown organisms to the container.
  5. Fill the container the remaining way with preservative.
  6. Optional: complete and tape a second label to the outside of the voucher container.
  7. Seal tightly for transport and give to your Field Team Leader.

Step 6: Prepare a Voucher

RBV VOUCHER
Stream: Burnap Brook
Location: 50 m upstream RT 6
Town: Andover
Date: 10/15/15
Organization: Andover Stream Club
Collectors: M. Lally & P. Lally

****THE VOUCHER IS YOUR DATA – THE VOUCHER IS THE PROOF THAT AN ORGANISM TYPE WAS PRESENT IN YOUR SAMPLE****

IMPORTANT:

- Use only pencil to write!! The preservative will dissolve ink.
- Site information on the voucher label and the datasheet MUST be the same.
- Be sure to fill your container COMPLETELY with preservative before sealing.
- Do not use baby jars or containers with ribbed sides (e.g. water or sports drink bottles).

Step 7: Crayfish & Mussels

- Crayfish and mussels should not be placed in the voucher!!
- Photograph any live crayfish found and return to the stream.
- Live mussels should be left in place if observed – photograph if possible.

- **If empty mussel shells are found (dead mussels), place them in a plastic bag with a completed RBV voucher label and submit with your RBV materials to your Local RBV Coordinator.

Step 8: Submit Data, Voucher, Photos

- For each site monitored, **the Field Team Leader is responsible for submitting** the following to their Local RBV Coordinator:
  - **Two digital photographs** for each site monitored: one facing upstream and one facing downstream from the center of your sampling area.
  - **One preserved and labelled RBV voucher** per site. Remember to place a COMPLETE label inside the container and fill completely with preservative. A second label can be taped to the outside if desired.
  - **One datasheet** per site. Make sure to complete ALL fields, and write legibly!
  - Optional: labelled mussel specimens, additional site/critter photographs

Questions?

Riffle Bioassessment by Volunteers (RBV)

Volunteer Training Presentation:

Part 3 – Field Safety



A CT DEEP Tier 2
Volunteer Water Quality Monitoring Network
www.ct.gov/deep/rbv

Connecticut Department of Energy and Environmental Protection

Safety Considerations

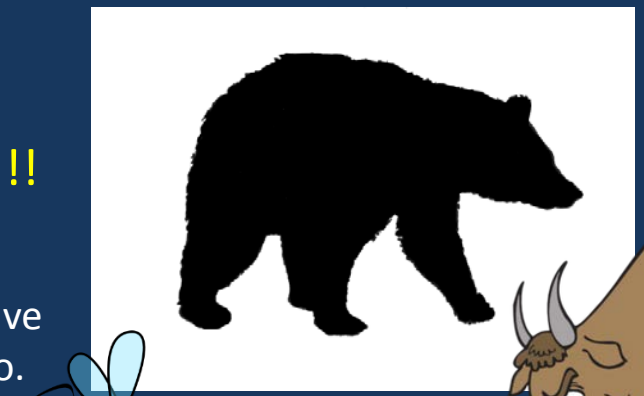
SAMPLE SAFELY:

Your personal safety and that of your teammates is more important than the data!!!

If you do not feel safe, DO NOT continue.

- Confirm with your Local RBV Coordinator that you have permission to access private property before doing so.
- Do not interact with any pets, wildlife (other than your RBV organisms!), or livestock you encounter.
- Know what poison ivy looks like and how to avoid it.
- Don't sample during dangerous flows or bad weather. If it starts to thunder or lightening while sampling, stop sampling and leave to safety.

Report any safety concerns immediately to your Field Team Leader. The Field Team Leader will relay any concerns or incidents to the Local RBV Coordinator within 24 hours of sampling.



Safety Considerations

WADING IN THE STREAM:

- Slippery, unstable rocks
- Unexpected deep spots
- Cold water
- Fast water

→ Walk slowly and carefully. Bring a towel and a change of clothes (just in case!). Don't sample under high flow conditions.

COLLECTING THE ORGANISMS:

- Hidden sharp debris – glass, metal, other objects
- Unhappy critters (crayfish, large dobsonflies, snakes)

→ Protect your fingers and toes! Wear waders and rubber gloves while sampling.

Tips to Minimize Issues in the Field

- RBV volunteers will NEVER sample alone. NO EXCEPTIONS.
- The Field Team Leader serves as site supervisor while in the field.
- Travel in the field in pairs – don't walk in the woods alone
- Bring a cell phone and store emergency numbers and the number of your coordinator in your phone before you leave
- Use common sense and trust your 'gut' – <u>if something does not feel right, leave the site!</u>
- Bring plenty of snacks and fluids with you

Tips to Minimize Issues in the Field

- Have hard copy site maps – don't assume your GPS will work in the field!
- Check with your coordinator before heading out in the field. Your coordinator may tell you to postpone due to high flows or weather concerns.
- Assign someone to check on you and/or notify help if you have not contacted them by an agreed upon time
- Talk to your Local RBV Coordinator regarding any health concerns. If you have physical limitations, severe allergies, asthma, etc. RBV may not be a safe activity for you.

Questions?

Riffle Bioassessment by Volunteers (RBV)

Volunteer Training Presentation:

Part 4 – The RBV Organisms



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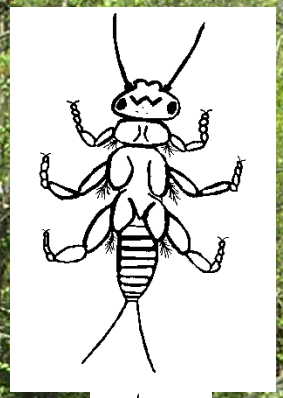
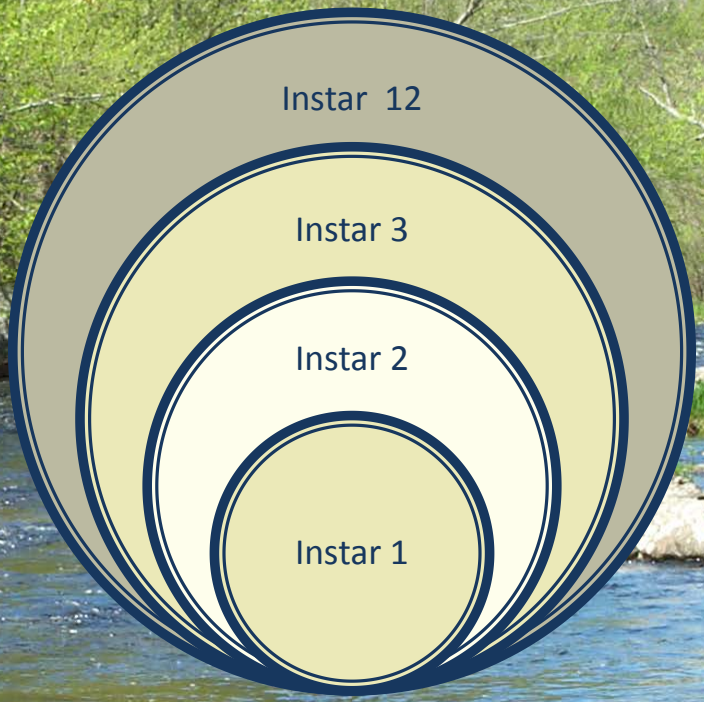
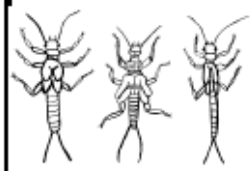
Insect Anatomy Overview





Don’t be fooled by size!

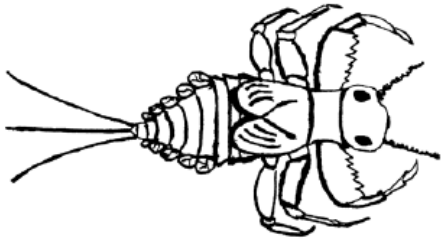
“Most Wanted” Macroinvertebrates

MOST WANTED (Most Sensitive to Pollution)	1	2	3	4	5A	5 B	5 C
	"Body-Builder" Mayfly *Drunella sp.*	Brush-Legged Mayfly *Isonychia sp.*	2-Tail Flathead Mayfly *Epeorus sp.*	Roach-Like Stonefly Peltoperlidae	Common Stonefly Perlidae	Giant Stonefly *Pteronarcys sp.*	Misc. Small Stonefly Plecoptera
							
	☐	☐	☐	☐	☐	☐	☐ ☐ ☐

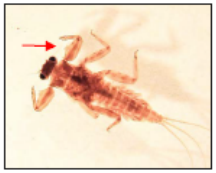
MOST WANTED (Most Sensitive to Pollution)	6A	6 B	7	8A	8 B	# Most Wanted Types:	Water Quality:
	Saddle-Case Caddis *Glossosoma sp.*	Cornucopia Case Caddis *Apatania sp.*	Free-Living Caddis *Rhyacophila sp.*	Humpless Caddis *Brachycentrus sp.*	Plant Case Caddis *Lepidostoma sp.*	5+	EXCEPTIONAL: *Fully Supporting* Aquatic Life Use Goals
						4	EXCELLENT: *Likely Supporting* Aquatic Life Use Goals
	☐	☐	☐	☐	☐	0-3	NOT DETERMINED: More Info Needed

Body-Builder Mayfly

Most Sensitive **1**



KEY FEATURES



- ❑ The first section of the front legs look like muscular biceps being flexed.
- ❑ Front legs have a serrated edge.

- ❑ Flat body with obvious legs.
- ❑ Single set of wing pads.
- ❑ Three hair-like tails at the end of the abdomen.
- ❑ Small, round gills on the side of the abdomen

Photographs courtesy of (top to bottom): Kelsey Quartuccio/CT DEEP; Kelsey Quartuccio/CT DEEP; Jake Renkert/The Marvelwood School

Taxonomic Information

Order: Ephemeroptera
Family: Ephemerellidae
Genus: *Drunella*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = On rocks or coarse organic substrates

Key Behaviors

- This mayfly nymph will crawl among leaves, stones, and other debris in the tray.
- Occasionally *Drunella* may swim by slowly undulating back and forth.

Important Notes

This organism can be confused with other members of the Ephemerellidae family. The distinguishing characteristic of *Drunella* is the enlarged front legs, each with a serrated margin along the front edge. These mayfly can be very abundant under appropriate conditions, however they typically emerge in the spring and are therefore uncommon in RBV samples.

Size and Color

Size: 6-15 mm
Color: Tan to dark brown, legs may have orange or yellow bands

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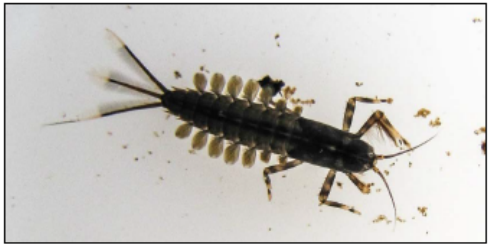
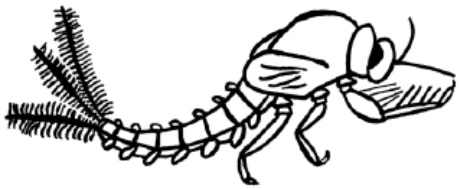
1
"Body-Builder" Mayfly
Drunella sp.

Brush-Legged Mayfly

Most Sensitive 2

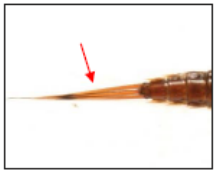




KEY FEATURES

- ❑ Streamlined body, taller than wide.
- ❑ Often with a "humped back" or "S-shaped" appearance when swimming.

- ❑ Front legs have a double row of long hairs on the inside edge.
- ❑ Single set of wing pads.
- ❑ Small, round gills on the side of the abdomen.



- ❑ Three feather-like tails at the end of the abdomen.

Taxonomic Information

Order: Ephemeroptera
Family: Isonychidae (Oligoneuriidae)
Genus: *Isonychia*

Ecological Information

Tolerance Value = 2
Feeding Group = Collector-Filterer
Stream Habitat = Moderate to fast flows, rock surfaces

Key Behaviors

- This mayfly nymph is an extremely strong swimmer. It swims by undulating back and forth very rapidly.
- This mayfly will often stand on rocks, leaves and sticks.

Identification Notes

There is only one genera (*Isonychia*) of Isonychidae in Connecticut. *Isonychia*, often called "Minnow Mayflies" by experienced volunteers, are very strong swimmers. The three tails are made up of a series of fine hairs that act like an oar on a boat, propelling the mayfly through the water. No other mayfly has a double row of fine hairs on the front legs.

Size and Color

Size: 8-17 mm
Color: Light brown to dark brown body, sometimes with yellow or white markings

Photographs courtesy of (top to bottom): Kelsey Quartuccio/CT DEEP; Jake Renkert/The Marvelwood School; NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School

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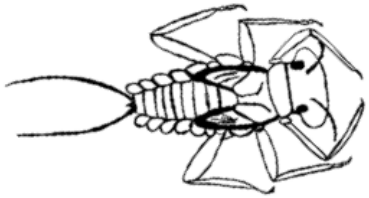
2

Brush-Legged Mayfly
Isonychia sp.

Two-Tailed Flathead Mayfly

Most Sensitive 3



KEY FEATURES

- ❑ Extremely flat, almost translucent body, long thin legs.

- ❑ Small round gills on the sides of the abdomen.
- ❑ Two Long thin tails at the end of the abdomen (easily broken)

- ❑ Single set of wing pads.
- ❑ Wide flat head, obvious eyes.

Taxonomic Information

Order: Ephemeroptera
Family: Heptageniidae
Genus: *Epeorus*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = Cobble and organic substrates

Key Behaviors

- This mayfly nymph crawls very fast on the surface of stones.
- Will move quickly in the tray and try to hide under any leaves or sticks present.
- *Epeorus* may try to swim by wiggling side to side.

Important Notes

The best way to find *Epeorus* is to carefully 'wash off' cobbles in the net before kicking. When present, these mayflies will scurry along the surface of the rock. Because of the body color and shape, they can be very difficult to spot. *Epeorus* can be extremely abundant when conditions are appropriate.

Size and Color

Size: 2-10 mm
Color: Tan to dark brown, sometimes with lighter gills and markings on the legs and head.

Photographs courtesy of (top to bottom): Kelsey Quartuccio / CT DEEP; DEEP files, author unknown; NY DEC Biomonitoring Unit; DEEP files, author unknown

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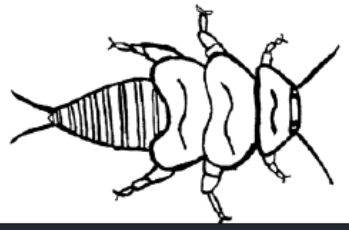
3

2-Tail Flathead Mayfly
Epeorus sp.

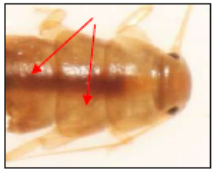
Roach-Like Stonefly

Most Sensitive **4**



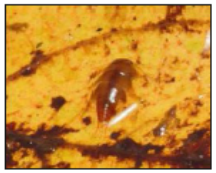
KEY FEATURES

- ❑ Tear-drop shaped body with a uniformly shiny brown exoskeleton.
- ❑ Two short tails at the end of the abdomen.



- ❑ Two sets of wing pads.

- ❑ No gills on the sides of the abdomen.



- ❑ Commonly found on leaves

Taxonomic Information

Order: Plecoptera
Family: Peltoperlidae
Genus: All

Ecological Information

Tolerance Value = 0
Feeding Group = Shredder
Stream Habitat = In and on coarse organic substrates

Key Behaviors

- This stonefly nymph is commonly found crawling in and amongst leaf packs in riffle areas. To locate, peel apart leaves in any packs present!
- Typically not observed swimming in the tray.

Important Notes

Peltoperlids are very intolerant of environmental stresses. Its characteristic inverted tear drop shape, short tails, and head which is broadly joined to the thorax, differentiate the Roach-Like Stonefly from other stoneflies.

Size and Color

Size: 6-11 mm
Color: Light to dark brown, uniform

All photographs courtesy of Jake Renkert / The Marvelwood School

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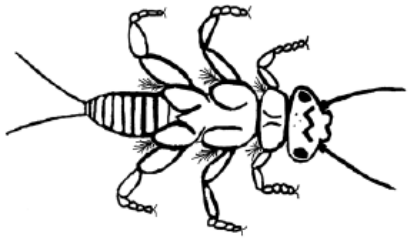
Riffle Bioassessment by Volunteers Program
www.ct.gov/deep/rbv

4

Roach-Like Stonefly
Peltoperlidae

Common Stonefly

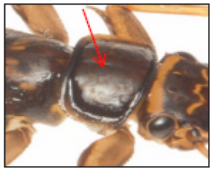
Most Sensitive **5A**



KEY FEATURES

- ❑ Flat body with obvious, segmented legs. Some specimens (not all) have a tortoise-shell pattern on the head and thorax.
- ❑ Two long tails at the end of the abdomen.

- ❑ Two sets of wing pads



- ❑ Rounded thoracic plate

- ❑ Gill tufts resembling armpit hairs at the base of each leg.

Taxonomic Information

Order: Plecoptera
Family: Perlidae
Genus: All

Ecological Information

Tolerance Value = 1
Feeding Group = Predator
Stream Habitat = Burrowed in substrate

Key Behaviors

- Very active crawler, highly mobile. (Watch out – they will crawl out of your ice cube trays!)
- May hide on like colored objects in the tray.
- May be observed doing "push-ups" in the tray. (This helps circulate water over their gills.)

Important Notes

When present in a sample, this organism will crawl out of the debris. Don't be confused by size or color - often different sizes will be collected at the same site and coloration can vary quite a bit between organisms. Darker and/or larger versions of common stoneflies are often misidentified as the Giant Stonefly (see panel 5B).

Size and Color

Size: 8-30 mm
Color: Variable. Light yellowish, brown to very dark, some with a tortoise-shell pattern.

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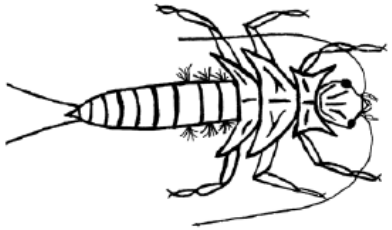
All photographs courtesy of Joshua Fusaro/ The Marvelwood School

5A
Common Stonefly
Perlidae

Giant Stonefly

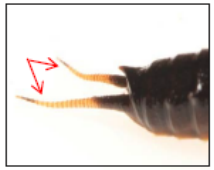
Most Sensitive **5B**



KEY FEATURES

❑ Robust body, typically dark but occasionally with white or yellow markings.

❑ Pointed edges along the sides of the abdomen.



❑ Two, short tails at the end of the abdomen.

❑ First thoracic plate is rectangular with flared edges
❑ Two sets of wing pads, very angular in shape.

❑ Gill tufts on the thorax and the sides of the first three sections of the abdomen.

Photographs courtesy of Joshua Fusaro/ The Marvelwood School

Taxonomic Information

Order: Plecoptera
Family: Pteronarcyidae
Genus: *Pteronarcys*

Ecological Information

Tolerance Value = 0
Feeding Group = Shredder
Stream Habitat = Fast flowing, high-gradient riffles

Key Behaviors

- This stonefly nymph is not very active. If it moves at all, it will crawl very slowly around the tray.
- May curl into a C-shape and pretend to be dead when disturbed.

Important Notes

Pteronarcys is often confused with the Common Stonefly (Panel 5A) as both can grow to be quite big. The Giant Stonefly is distinguished easily by its relatively sluggish activity level and more armored appearance. Don't be fooled by size – all giant stoneflies must start out small! Typically, only a few Pteronarcyidae are collected at any site when conditions are appropriate.

Size and Color

Size: 35-50 mm
Color: Brown to black, sometimes with white or yellow tail tips

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5 B
Giant Stonefly
Pteronarcys sp.

Miscellaneous Small Stoneflies

Most Sensitive **5C**

SMALL STONELY FAMILES

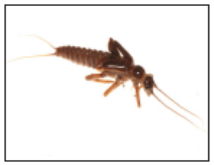
❑ **Small Winter Stoneflies**[1] (*Capniidae*)
- Often dark
- Legs short
- Abdomen slightly wider at middle

❑ **Green Stoneflies**[1] (*Chloroperlidae*)
- No distinctive color patterns
- Tails shorter than the abdomen is long

❑ **Rolled-winged Stoneflies** (*Leuctridae*)[2]
- Long, slender body
- Short legs
- Abdomen same width along length

❑ **Nemourid Stoneflies**[1] (*Nemouridae*)
- Long legs (tips extend to the tip of the abdomen or beyond)

❑ **Perlodid Stoneflies**[3] (*Perlodidae*)
- Very similar to the Common Stonefly but without gill tufts near the base of the legs

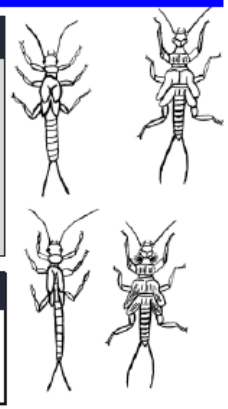


❑ **Winter Stoneflies** (*Taeniopterygidae*)[4]
- Wing pads form a distinct triangle
- Typically only present in late November RBV samples

Photographs courtesy of: [1]Donald S. Chandler – www.discoverlife.org; [2]Author unknown; [3]Unknown - http://aquaticinsectsofcentralvirginia.blogspot.com; [4]Jake Renkert – The Marvelwood School

General Identification

The following characteristics are universally true of the stonefly families at left:
- Two tails
- Two tarsal claws ('toes') at the end of each leg
- Dorsally flattened
- Small in size



Taxonomic Information

Order: Plecoptera
Family: See families at left
Genus: All within families at left

Ecological Information

Tolerance Value = See below
Feeding Group = See below
Stream Habitat = Fast moving water, under rocks/debris

	Tolerance Value	Feeding Group
Capniidae	1	Shredder
Chloroperlidae	1	Predator
Leuctridae	0	Shredder
Nemouridae	2	Shredder
Perlodidae	2	Predator
Taeniopterygidae	2	Shredder

Important Notes

All stoneflies are intolerant of organic pollutants and therefore indicate high water quality.

Size and Color

Size: 4-10 mm average (*Taeniopterygidae* can reach up to 15 mm))
Color: Variable. Many light brown or cream colored

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Photo courtesy of NY DEC

5 C

Misc. Small Stonefly
Plecoptera

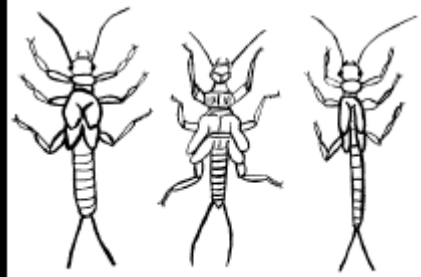
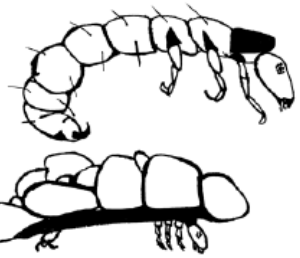


Photo courtesy of NY DEC

Photo courtesy of NY DEC

Saddlecase Maker Caddisfly

Most Sensitive **6A**



KEY FEATURES

- ❑ Small oval stone case made of sand grains and/or tiny pebbles, resembles a saddle or a turtle shell. (Case is NOT tube-shaped.)
- ❑ Underside of case has two round openings.

- ❑ Larva body is maggot-like and slightly C-shaped.
- ❑ Larva has a light (white to light brown) body with a dark head and legs.
- ❑ End of the abdomen has an attached 'butt plate' (red arrow)

Taxonomic Information

Order: Trichoptera
Family: Glossosomatidae
Genus: *Glossosoma*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = Exposed upper surfaces of rocks

Key Behaviors

- This caddisfly larva is often attached to the surface of rocks in fast current.
- *Glossosoma* may not move at all while in the tray. If it does, it will crawl very slowly along the bottom of the tray.

Important Notes

Glossosoma is often confused with other small stone case building caddisflies. Unlike other caddisfly cases, the *Glossosoma* case is not tube shaped but rather resembles a turtle shell with only a thin 'strap' of pebbles holding the case around the organism. Keep an eye out for both the case and the organism in your tray as the two are easily separated.

Size and Color

Size: 3-10 mm
Color: White to light brown, with dark head, legs and butt plate

Photographs courtesy of (top to bottom): NY DEC Biomonitoring Unit; Kelsey Quartuccio/CT DEEP; Jake Renkert/The Marvelwood School

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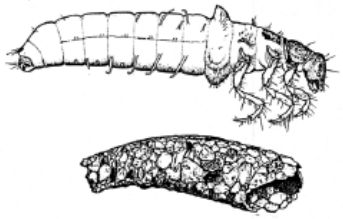
6A

Saddle-Case Caddis
Glossosoma sp.

Cornucopia-Case Caddisfly

Most Sensitive 6B



KEY FEATURES

- ❑ *Tiny* light-bodied organism
- ❑ Hunched appearance when in case.
- ❑ Triangular head with dark legs.
- ❑ Very small, delicate case made of sand grains
- ❑ Case is cone-shaped like a Thanksgiving cornucopia.

Don't be Fooled by This Imposter!

- ❑ The Strong Case-Maker Caddisfly (Odontoceridae) also makes a case of small grains of sand. To tell the two apart, inspect the case closely. Odontoceridae cases are very difficult to break apart and are the same width at both ends. In comparison, the Apatania case is quite small (see above), more easily broken apart, and noticeably wider at the opening than at the other end.

Taxonomic Information

Order: Trichoptera
Family: Apataniidae
Genus: *Apatania*

Ecological Information

Tolerance Value = 3
Feeding Group = Scraper
Stream Habitat = Fast flowing, shallow riffles

Key Behaviors

- This caddisfly larva is tiny and therefore easily overlooked, however if you watch your tray closely you may see a tiny sand horn walking around the bottom!
- Resembles a tiny hermit crab in that it drags its case along as it walks.

Important Notes

This organism is commonly confused with other stone case building caddisflies including *Glossosoma*. The easiest distinguishing characteristic is that that *Apatania* is VERY tiny, typically smaller than the width of your pinky nail. This caddisfly can be abundant under appropriate conditions. Look very carefully in your trays for these tiny caddisfly larvae!

Size and Color

Size: 2-6 mm
Color: Light colored body with dark head

Photographs courtesy of (top to bottom): NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School; DEEP file photo, author unknown

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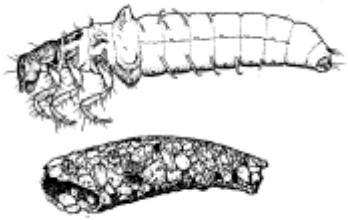
6 B

Cornucopia Case Caddis
Apatania sp.



Courtesy of NY DEC

Free-Living Caddisfly

Most Sensitive **7**

KEY FEATURES

- ❑ Nicknamed "Michelin Man" caddisfly due to its smooth, lumpy abdomen
- ❑ Six short legs near the head

- ❑ Hard tan or yellow and brown patterned head with a single thoracic plate.

- ❑ Armored plate and two hooks at the end of the abdomen, somewhat loosely attached

Taxonomic Information

Order: Trichoptera
Family: Rhyacophilidae
Genus: *Rhyacophila*

Ecological Information

Tolerance Value = 0
Feeding Group = Predator
Stream Habitat = Fast flowing, high-gradient riffles

Key Behaviors

- Clings very well to the net.
- Moderately active organism; will crawl or wiggle in the tray.
- Will try to hide under objects.

Important Notes

Rhyacophila is called the 'free-living' caddisfly because larvae of this genus do not build a case until they are about to pupate. (At which point they will build a loosely constructed stone shelter.) This organism is often found among aquatic mosses. A key field characteristic is the bright green or lavender abdominal coloring.

Size and Color

Size: 10-30 mm
Color: Variable. White, green, purple

Photographs courtesy of (top to bottom): Jake Renkert/The Marvelwood School;): Jake Renkert/The Marvelwood School; NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School; Jake Renkert/The Marvelwood School

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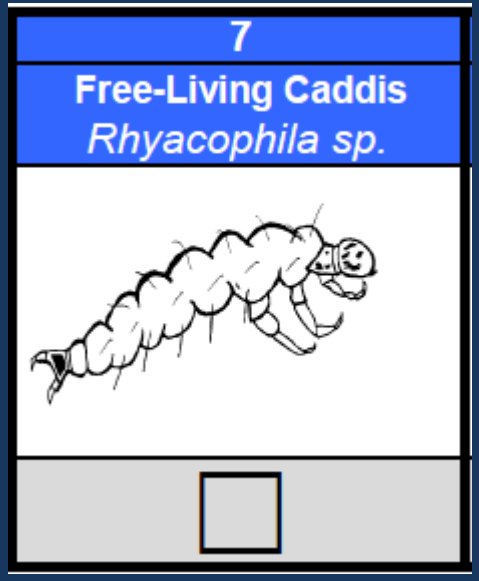
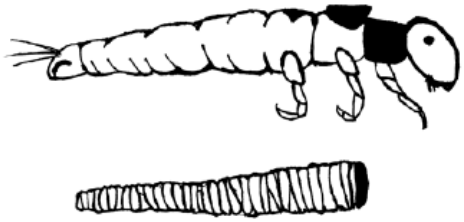


Humpless Case Maker Caddisfly

Most Sensitive **8A**



KEY FEATURES

Case Construction:

- ❑ Case constructed of thin strips of plant material assembled with a square opening.
- ❑ Wider at head opening than at tail end.

Macroinvertebrate Features:

- ❑ Light colored body with dark head and legs.
- ❑ Very long legs
- ❑ No abdominal humps.

All photographs courtesy of Jake Renkert/The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Brachycentridae
Genus: *Brachycentrus*

Ecological Information

Tolerance Value = 1
Feeding Group = Shredder
Stream Habitat = Upper surfaces of rocks

Key Behaviors

- Typically *Brachycentrus* does not move in the tray. If it does move, it will carry its case with it as it slowly crawls along.

Important Notes

This caddisfly can be very abundant under the appropriate conditions. Look carefully for *Brachycentrus* when the sample contains old leaves, sticks or bark. The cases may be attached to sticks, leaves or larger rocks.

Size and Color

Size: 10-17 mm
Color: Light body with dark head and legs

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8A

Humpless Caddis
Brachycentrus sp.

Courtesy NY DEC

Plant Case Maker Caddisfly

Most Sensitive 8B

KEY FEATURES

Case Construction:

- ❑ Builds a case out of small, rectangular or square pieces of bark or wood (no sand grains).
- ❑ Case is typically slightly wider at the head end.

Macroinvertebrate Features:

- ❑ Light colored body with dark head and legs.
- ❑ Lateral humps present on the first section of the abdomen.

Photographs courtesy of (top to bottom): Jake Renkert/The Marvelwood School; NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Lepidostomatidae
Genus: *Lepidostoma*

Ecological Information

Tolerance Value = 1
Feeding Group = Shredder
Stream Habitat = Accumulated plant debris on bottom

Key Behaviors

- Typically does not move in the tray. If it does move, will carry its case with it as it slowly crawls.

Important Notes

This caddisfly can be very abundant under the appropriate conditions, particularly in forested areas. Look carefully for *Lepidostoma* when the sample contains old leaves, sticks or bark. The cases may be attached to sticks, leaves or larger rocks.

Size and Color

Size: 7-15 mm
Color: Light body with dark head and legs

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8 B

Plant Case Caddis
Lepidostoma sp.

“Moderately Wanted” Macroinvertebrates

MODERATELY (Moderately Sensitive to Pollution)	9	10	11	12	13 A	13 B	14A	14B
	Common Netspinner Hydropsychidae	**Fingernet Caddis** Philopotamidae	**3-Tail Flat Head Mayfly** *Stenonema sp.**	**Water Penny** *Psephenus sp.*	**Dobsonfly** *Corydalus sp.*	**Fishfly** *Nigronia sp.*	**Dragonfly** Anisoptera	**Damselfly** Zygoptera
								
	☐	☐	☐	☐	☐	☐	☐	☐

Common Netspinner Caddisfly

Moderately Sensitive **9**

KEY FEATURES

❑ Series of three dark plates on the dorsal side of the thorax below the head.

❑ Fluffy gills on the underside (ventral sections) of the abdomen.

❑ Two paintbrush-like tails with hooks at the end of the abdomen.
❑ May have a 'dirty' or hairy appearance

Photographs courtesy of (top to bottom): NY DEC Biomonitoring unit; The Marvelwood School & Kent Conservation Commission RBV Program; Jake Renkert / The Marvelwood School; Becky Martorelli / Quinnipiac River Watershed Association; Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Hydropsychidae
Genus: All

Ecological Information

Tolerance Value = 4
Feeding Group = Collector-filterer
Stream Habitat = Rock surfaces, woody debris, plants

Key Behaviors

- Extremely active, wiggles violently back and forth
- Gregarious, will form clumps of 2-4 in the tray
- May cling strongly to the net!

Important Notes

Hydropsychidae is probably one of the most common organisms encountered during benthic sampling. These can be extremely abundant under appropriate conditions. Because some are greenish in color they may be confused as *Rhyacophila* (Panel 7). Hydropsychidae have a dark plate above each pair of legs & fluffy gills on the underside of the abdomen, *Rhyacophila* does not.

Size and Color

Size: 13-18 mm
Color: Light brown to black, sometimes with green tint

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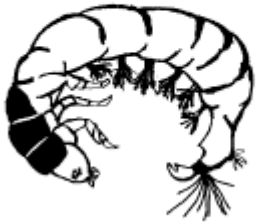
9
Common Netspinner
Hydropsychidae



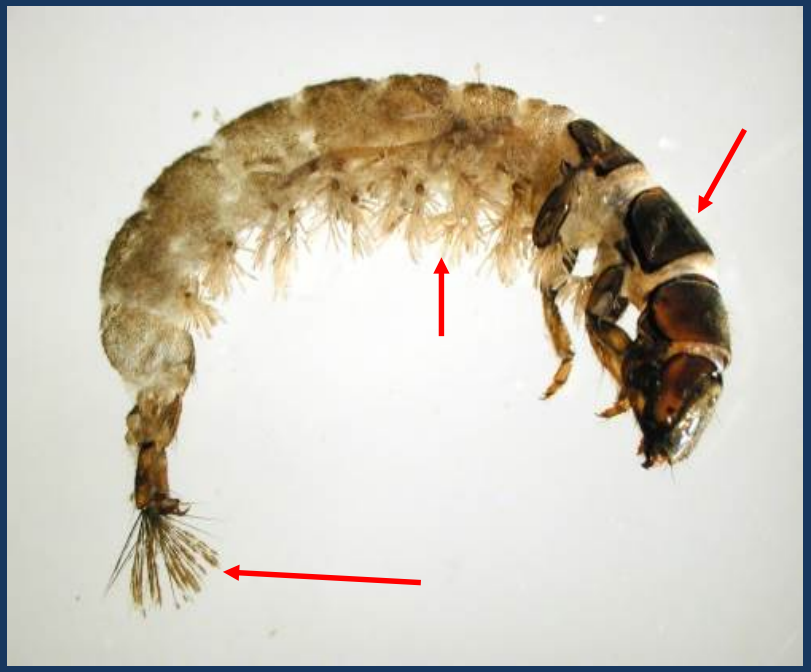
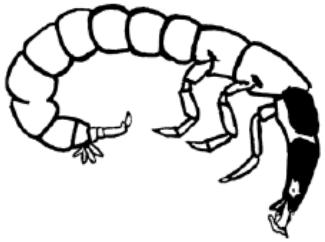


Photo courtesy NY DEC

Fingernet Caddisfly

Moderately Sensitive **10**



KEY FEATURES

- ❑ Elongate, slender worm-like body.
- ❑ No gills on or along the abdomen.
- ❑ Two hooks at the end of the abdomen.

- ❑ Bright orange head with a transparent, t-shaped upper lip.

- ❑ Black border along the back edge of pronotum (the plate located behind the head capsule.)

Photographs courtesy of (top to bottom): NY DEC Biomonitoring unit; The Marvelwood School/Kent Conservation Commission RBV program; The Marvelwood School/Kent Conservation Commission RBV program; The Marvelwood School/Kent Conservation Commission RBV program; Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Philopotamidae
Genus: *All*

Ecological Information

Tolerance Value = 3
Feeding Group = Collector-filterer
Stream Habitat = Undersides of rocks in high gradient

Key Behaviors

- Extremely active, wiggles violently back and forth.
- Gregarious, will form clumps of 2-4 in the tray.
- Very active, will crawl around the bottom of the tray.

Important Notes

Philopotamidae is a very common organism encountered during RBV sampling, and can be extremely abundant under appropriate conditions.

Size and Color

Size: 13-17 mm
Color: Yellow-orange, bright yellow, beige, white, or transparent

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10
Fingernet Caddis
Philopotamidae

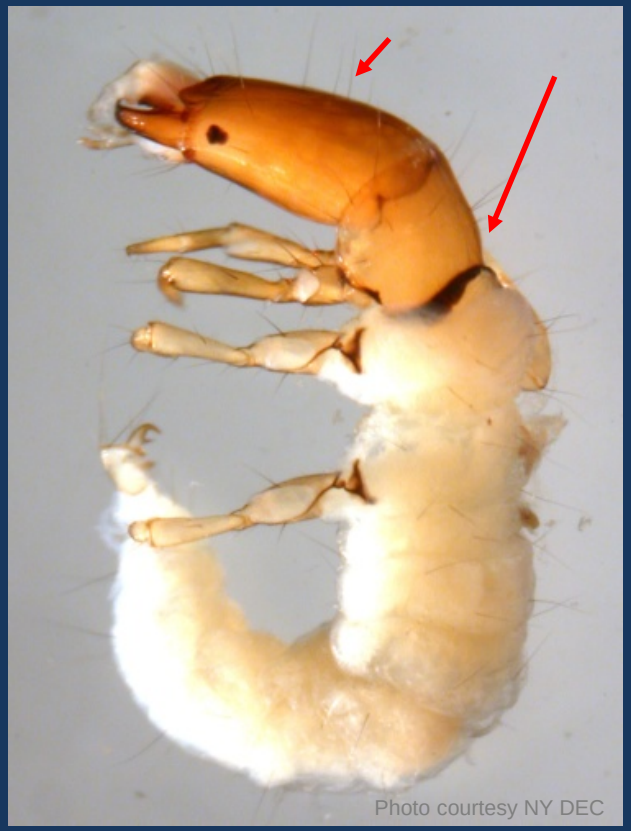
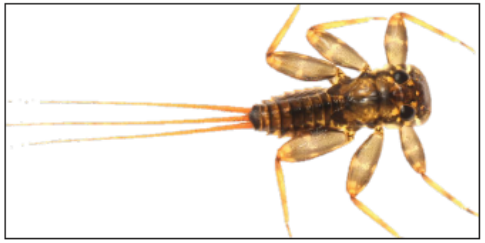
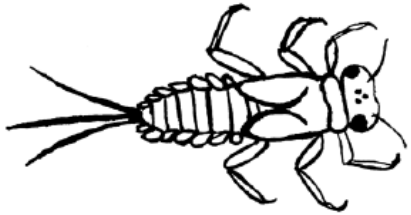


Photo courtesy NY DEC

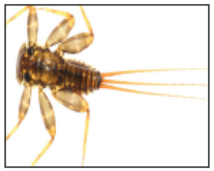
Three-Tailed Flat Headed Mayfly

Moderately Sensitive **11**

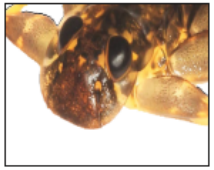




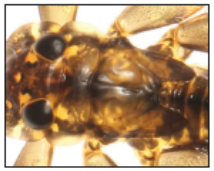
KEY FEATURES



- ❑ Extremely flattened body.
- ❑ Small, oval or square-shaped gills along the sides of the abdomen.
- ❑ Three very long tails at the end of the abdomen. (Tails are fragile and can break off giving the appearance of only one or two.)



- ❑ Head is flat with large eyes on top.
- ❑ Resembles 'Jack Skellington' from Nightmare Before Christmas.



- ❑ Single set of wing pads.

Photographs courtesy of Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Ephemeroptera
Family: Heptageniidae
Genus: *Stenonema* and *Maccaffertium*

Ecological Information

Tolerance Value = 4
Feeding Group = Scraper
Stream Habitat = On/underneath cobbles and organics

Key Behaviors

- Very mobile; can move and swim fast when in water.
- Doesn't move well in the net
- It will try to hide on any flat dark colored object like stones, leaves, and other invertebrates

Important Notes

Very common across Connecticut. Flat headed mayflies can be found by slowly lifting the cobbles out of the water. They may run to the other side of the rock. Be careful not to confuse this organism with the two-tailed version (*Epeorus*/Panel 3); the legs, gills, and tails of the flat headed mayfly tend to break off during the collection process.

Size and Color

Size: 5-20 mm
Color: Light golden brown to dark brown, often with spots or stripes on the legs and body

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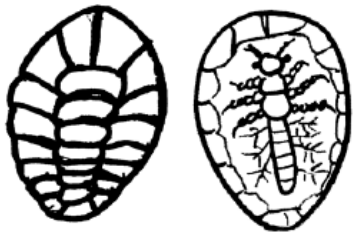
11

3-Tail Flat Head Mayfly

*Stenonema sp.**

Water Penny Beetle

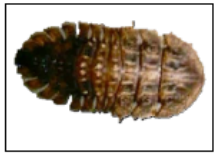
Moderately Sensitive **12**



KEY FEATURES

- ❑ Small, flat, disc-shaped organism.
- ❑ Uniform in color
- ❑ Head and legs only visible from ventral view (i.e. from underneath)

Don't be Fooled by This Imposter!



- ❑ Often confused with the False Water Penny (*Eubriidae*). *Eubriidae* is more ovoid in shape and has a serrated or more jagged outer edge.

Photographs courtesy of (top to bottom): Jake Renkert / The Marvelwood School (top three); Meghan Lally/CT DEEP; The Marvelwood School/Kent Conservation Commission RBV program; The

Taxonomic Information

Order: Coleoptera
Family: Psephenidae
Genus: *Psephenus*

Ecological Information

Tolerance Value = 4
Feeding Group = Scraper
Stream Habitat = Attached to rocks in fast flows

Key Behaviors

- Cling very well to rocks and smooth surfaces such as the sorting tray (see image at left)
- May glide along the bottom of the tray
- May curl up when disturbed

Important Notes

Water penny beetle larvae are common in RBV samples, but can be very hard to locate in the field due to their cryptic nature. Look very closely at any cobbles in your sample area; water penny beetle larva will adhere strongly to rock surfaces. They are very distinctive due to their penny like shape and coloration. These organisms can be locally abundant when conditions are appropriate.

Size and Color

Size: 3-10 mm
Color: Uniform in color. Ranges from golden to dark brown.

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12

Water Penny

Psephenus sp.

Dobsonfly

Moderately Sensitive **13A**

KEY FEATURES

- ❑ Elongate body with a pair of long soft spine-like appendages on each section of the abdomen.
- ❑ Can be extremely large (up to 4 inches)

- ❑ Large pinching mouth parts.
- ❑ Will bite sampling spoons and your fingers so watch out!

- ❑ Two prolegs at the end of the abdomen, each with two hooks.

- ❑ Tufts of fluffy gills at the base of each abdominal projection.

Taxonomic Information

Order: Megaloptera
Family: Corydalidae
Genus: *Corydalus*

Ecological Information

Tolerance Value = 6
Feeding Group = Predator
Stream Habitat = Under loosely embedded stones

Key Behaviors

- Very mobile, will be very active crawling or wiggling in the tray
- Will curl their abdomen around your finger if picked up
- May cling to the net
- May pinch! Use caution when handling!

Important Notes

Dobsonflies are very common in RBV samples. These macroinvertebrates are sometimes called "Hellgrammites" by fishermen and are a trout favorite! *Corydalus* is often confused with *Nigronia* (Panel 13B). The Dobsonfly can be distinguished by its larger size, darker brown color, and the presence of fluffy gill tufts on the underside of the abdomen.

Size and Color

Size: 25-90 mm
Color: Variable. Brown to nearly black

Photographs courtesy of Jake Renkert / The Marvelwood School

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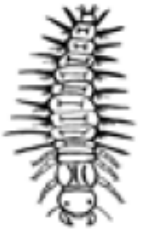
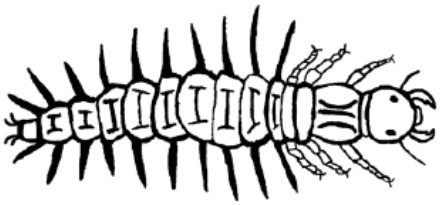
13 A
Dobsonfly
Corydalus sp.



Fishfly

Moderately Sensitive **13B**



KEY FEATURES

❑ Elongate body with a pair of long soft spine-like appendages on each section of the abdomen.

❑ Large pinching mouth parts.

❑ Two prolegs at the end of the abdomen, each with two hooks.

❑ No gills at the base of the abdominal projection.

Taxonomic Information

Order: Megaloptera
Family: Corydalidae
Genus: *Nigronia*

Ecological Information

Tolerance Value = 4
Feeding Group = Predator
Stream Habitat = Under loosely embedded stones

Key Behaviors

- Very mobile, will be very active crawling or wiggling in the tray
- Will curl their abdomen around your finger if picked up
- May cling to the net
- May pinch! Use caution when handling!

Important Notes

Very common in RBV samples. *Nigronia* is often confused with *Corydalus* (Panel 13A). The fishfly can be distinguished by its smaller size, more reddish color, and absence of fluffy gill tufts on the underside of the abdomen.

Size and Color

Size: 25-50 mm
Color: Variable. Light brown to reddish orange.

All photographs courtesy of Jake Renkert / The Marvelwood School

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13 B
Fishfly
Nigronia sp.

Dragonfly

Moderately Sensitive **14A**

General Identification

The following characteristics are universally true of the dragonfly families below:

- Robust body
- Three short spike-lie tails
- Two sets of wing pads
- Very large eyes
- Extendable lower jaw

DRAGONFLY FAMILES

❑ **Darner Dragonfly** (*Aeshnidae*)

- Very common
- Usually very dark and almost black
- Elongate body with small thin legs

❑ **Biddie Dragonfly** (Cordulergastridae)

- Somewhat common
- Light brown; robust, hairy appearance
- Deeply rounded labium extends out almost half the length of the body

❑ **Club Tail Dragonfly** (*Gomphidae*)

- Very common
- Short antennae similar in shape to a Q-tip
- Adapted for burrowing into the substrate to wait for prey

❑ **Common Skimmer Dragonfly** (*Libellulidae*)

- Rare – prefers ponds and wetlands

All photographs courtesy of Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Odonata (Suborder Anisoptera)
Family: All families at left
Genus: All genera within families at left

Ecological Information

Tolerance Value = See below
Feeding Group = See below
Stream Habitat = Typically among rocks and vegetation, or burrowed in soft substrate

	Tolerance Value	Feeding Group
Aeshnidae	3	Predator
Cordulergastridae	3	Predator
Gomphidae	1	Predator
Libellulidae	9	Predator

Important Notes

Dragonfly nymphs can be very common when conditions are appropriate. They are very mobile and move with jet propulsion or by walking. There are several types of dragonflies found in riffle areas, however the majority of species live in slow moving or standing water.

Size and Color

Size: 8-42mm
Color: Variable. Light brown to nearly black

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14A
Dragonfly
Anisoptera

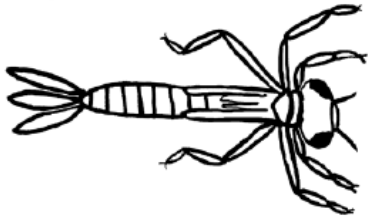
Damselfly

Moderately Sensitive **14B**

General Identification

The following characteristics are universally true of the damselfly families below:

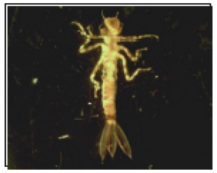
- Slender, delicate body with long legs.
- Three long feather-like caudal gills at the end of the abdomen that resemble tails.
- Two sets of wing pads.
- Very large eyes and extendable lower jaw.



DAMSELFLY FAMILES

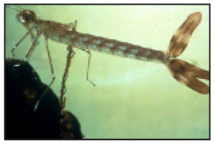
❑ **Broad Winged Damselfly** (*Calopterygidae*)

- First antennae segment is very long, almost half the length of the antenna
- Uncommon in RBV samples; prefers low gradient habitat



❑ **Narrow Winged Damselfly** (*Coengrionidae*)

- Two-toned gills at end of abdomen
- Occasionally in RBV samples; prefers rocks and vegetation in moderate to slow flowing waters



❑ **Spread Winged Damselfly** (*Lestidae*)

- Lower lip (labium) is long and slender
- Gills at end of abdomen are very dark and thick
- Rare in RBV samples; prefers thick vegetation in very slow flows

Photographs courtesy of Jake Renkert (top); NY DEC (middle); DEEP files, author unknown (bottom)

Taxonomic Information

Order: Odonata (Suborder Zygoptera)
Family: All families at left
Genus: All genera within families at left

Ecological Information

Tolerance Value = See below
Feeding Group = See below
Stream Habitat = Slow or standing water, on vegetation

	Tolerance Value	Feeding Group
Calopterygidae	5	Predator
Coengrionidae	9	Predator
Lestidae	9	Predator

Important Notes

These larvae are very active and will move by wiggling side to side.

Damselflies are rare in riffle areas; the majority of species live in slow moving or standing water. If you find a lot of damselflies in your sample check that you are in the right habitat for the RBV program.

Size and Color

Size: 13-50mm
Color: Variable. Yellow to dark brown. Sometimes with patterns.

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14B
Damselfly
Zygoptera

Photo courtesy NY DEC

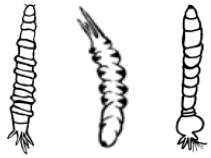
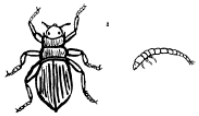
“Least Wanted” Macroinvertebrates

Photo courtesy NY DEC

LEAST WANTED (Least Sensitive to Pollution)	15	16	17	18	19	20	21
	Scud Amphipoda	**Aquatic Sow Bug** Isopoda	**Leech** Hirudinea	**Non-Biting Midge** Chironimidae	**Black Fly** Simuliidae	**Snail** Gastropoda	**Aquatic Worm** Oligochaeta
	☐	☐	☐	☐	☐	☐	☐

Photo courtesy NY DEC

“Others” Commonly Collected During RBV

OTHERS	22	23	24	25	26	27	28
	Crayfish Decapoda	**Crane Fly** Tipulidae	**Riffle Beetle** Elmidae	**Small Minnow Mayfly** Baetidae	**Aquatic Snipe Fly** *Atherix sp.*	**Flatworm** *Planaria sp.*	**Mussel/Clam** Unionoida
							
	*Photograph and return all crayfish to the stream						*Photograph and return all mussels to the stream
	☐	☐ ☐ ☐	☐ ☐	☐	☐	☐	☐

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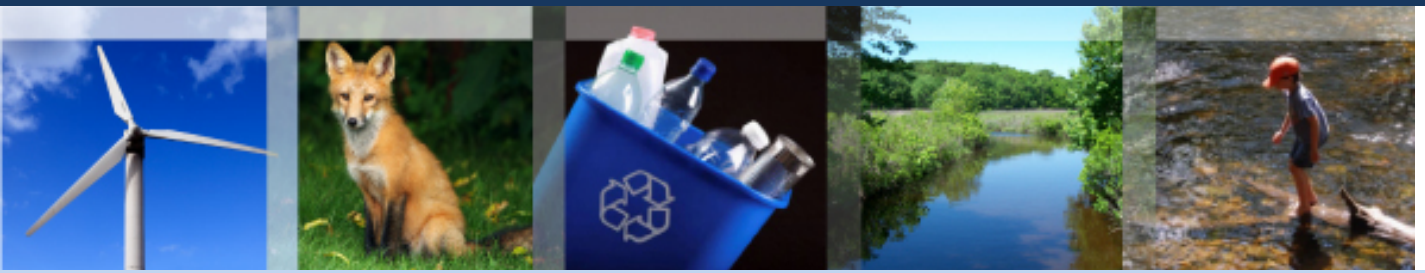

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Appendix D: Field Macroinvertebrate Sorting Guide

CT DEEP RBV Program: Macroinvertebrate Sorting Guide

CHOOSE THE BEST STARTING POINT (OPTION A OR B) TO BEGIN, THEN FOLLOW THE ARROWS TO REACH A LIST OF 'FINAL CANDIDATES' FOR WHO YOUR CRITTER MAY BE. CONSULT THE CORRESPONDING PANEL NUMBERS IN THE FIELD IDENTIFICATION CARDS TO MAKE A FINAL DETERMINATION.

NOTE: Additional miscellaneous macroinvertebrates are listed as "Others" at the bottom of the datasheet. If you don't see your critter on this chart, review the 'Other' Field ID cards to see if any match.

Start Option A: The Organism is WIDE or FLAT with MEDIUM to LARGE LEGS

Describe the organism's TAILS:

3 Long Thin Tails

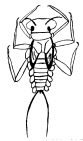
Panel 1: Drunella (Mayfly)

Panel 2: Isonychia (Mayfly)

Panel 11: Stenonema (Mayfly)

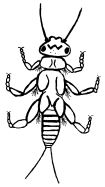
Panel 14B: Zygoptera (Damselfly)

2 Long Thin Tails



Panel 3: Epeorus (Mayfly)

Panel 4: Peltoperlidae (Stonefly)

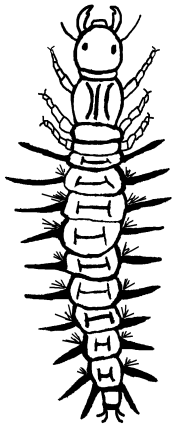


Panel 5A: Perlidae (Stonefly)

Panel 5B: Pteronarycs (Stonefly)

Panel 5C: Misc. Stoneflies (Plecoptera)

NO Long Thin Tails



Panel 14A: Anisoptera (Dragonfly)

Panel 13B: Nigronia (Fishfly)

Panel 15: Amphipoda (Scud)

Panel 13A: Corydalus (Dobsonfly)

Panel 16: Isopoda (Aquatic Sow Bug)

Builds a Shelter/Case

Panel 6A: Glossosoma (Caddisfly)

Panel 6B: Apatania (Caddisfly)

Panel 8A Brachycentrus (Caddisfly)

Panel 8B Lepidostoma (Caddisfly)

START Option B: The Organism is ROUND or CYLINDRICAL with SMALL or NO LEGS

Describe the organism's LEGS:

Hidden Legs

Panel 12: Psephenus (Water Penny Beetle)

With Legs

Does the organism have a SHELTER/CASE?

No Shelter/Case

Panel 7: Rhyacophila (Caddisfly)

Panel 9: Hydropsychidae (Caddisfly)

Panel 10: Philopotamidae (Caddisfly)

Without Legs

Panel 17: Hirudinea (Leech)

Panel 18: Chironimidae (Midge)

Panel 19: (Simuliidae) Black Fly

Panel 20: Gastropoda (Snail)

Panel 21: Oligochaeta (Aquatic Worm)

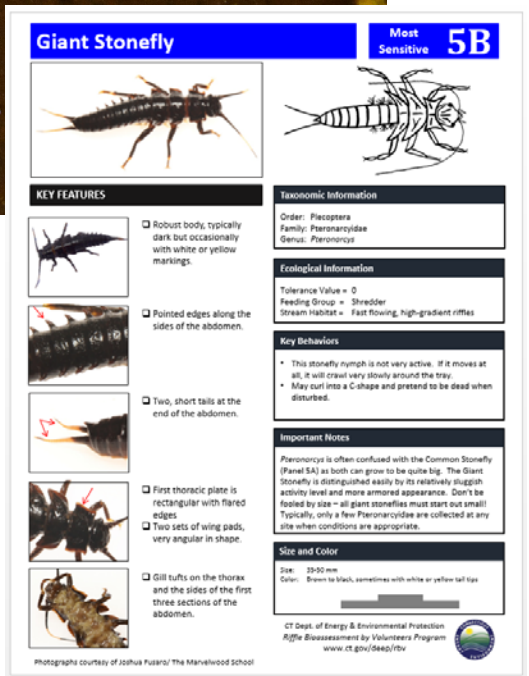
Last revised 08/15/2016

Appendix E: Field Macroinvertebrate Identification Cards

CT DEEP Riffle Bioassessment by Volunteers (RBV) Program

A CT DEEP Tier 2 Volunteer Water Quality Monitoring Network

MACROINVERTEBRATE FIELD IDENTIFICATION CARDS



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Published August 15, 2016

RBV Field Identification Card Overview

Common name

Panel number and RBV category

Full-body photograph of organism

Line drawing – highlights key identification features

Key Features section - bullet points of primary identification features along with supporting photographs

Scientific name

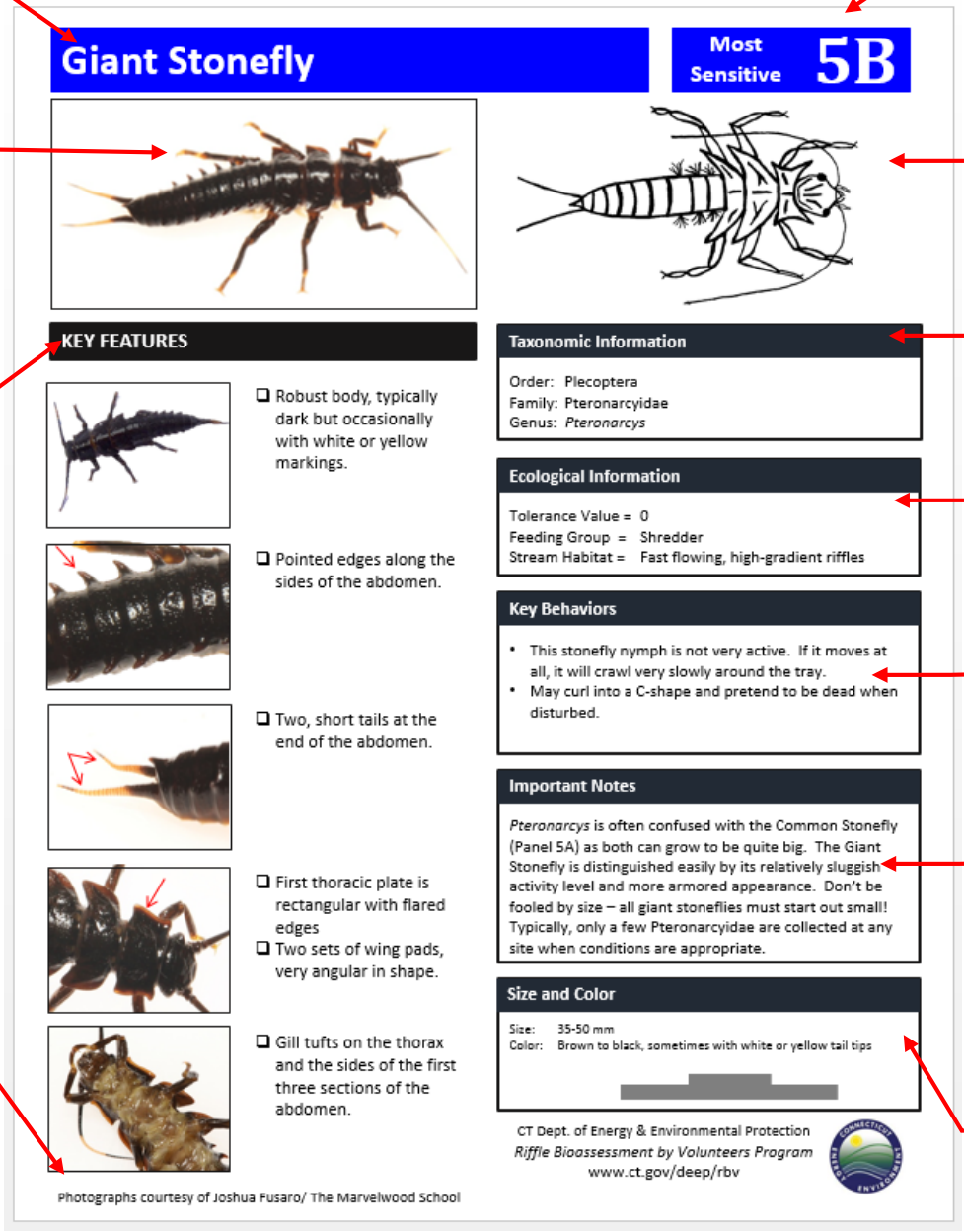
Pollution sensitivity and habitat information

Unique behaviors to help with ID

Photography credits for photos shown on the card

Important miscellaneous notes and facts

Size and color – includes a scale bar representing the minimum and maximum size

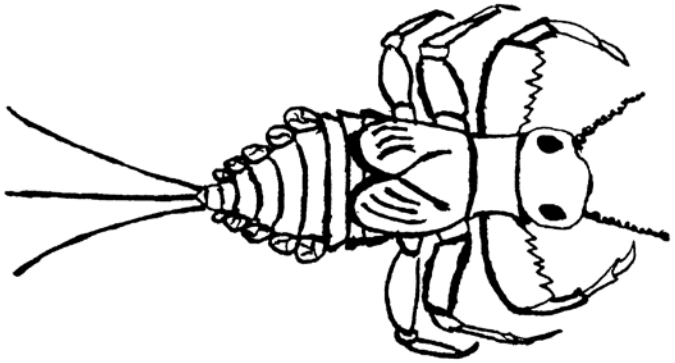


Acknowledgements

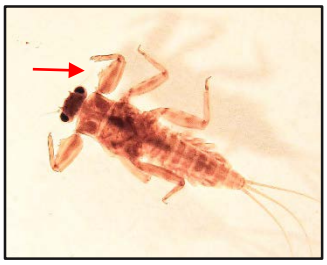
The 2016 RBV Field Identification Cards are the second version of these cards; the original RBV Field Identification Cards were developed and authored by **Mike Beauchene**, former CT DEEP State RBV Program Coordinator. All line drawings are courtesy of Mike Beauchene/CT DEEP. Photography credits are noted on the bottom of each card. Special thanks to former **Marvelwood School (Kent, CT)** students **Jake Renkert and Joshua Fusaro**, along with their advisor, **Laurie Doss**, for the amazing macrophotography images included throughout the cards. Jake Renkert is also credited with the redesign of the card template into the standardized format shown above. Jake, Josh and Laurie's involvement in this project would not have been possible without the support of the **Kent Conservation Commission** and the **Uconn Natural Resources Conservation Academy**. Additional photography credit is owed to **Kelsey Quarticco**, 2014 CT DEEP intern. The 2016 RBV Field Identification Card revision project was managed by **Meghan Lally**, CT DEEP State RBV Program Coordinator. For more information about the RBV Program please visit www.ct.gov/deep/rbv

Body-Builder Mayfly

Most Sensitive 1



KEY FEATURES



- ❑ The first section of the front legs look like muscular biceps being flexed.
- ❑ Front legs have a serrated edge.

- ❑ Flat body with obvious legs.
- ❑ Single set of wing pads.
- ❑ Three hair-like tails at the end of the abdomen.
- ❑ Small, round gills on the side of the abdomen

Photographs courtesy of (top to bottom): Kelsey Quartuccio/CT DEEP; Kelsey Quartuccio/CT DEEP; Jake Renkert/The Marvelwood School

Taxonomic Information

Order: Ephemeroptera
Family: Ephemerellidae
Genus: *Drunella*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = On rocks or coarse organic substrates

Key Behaviors

- This mayfly nymph will crawl among leaves, stones, and other debris in the tray.
- Occasionally *Drunella* may swim by slowly undulating back and forth.

Important Notes

This organism can be confused with other members of the Ephemerellidae family. The distinguishing characteristic of *Drunella* is the enlarged front legs, each with a serrated margin along the front edge. These mayfly can be very abundant under appropriate conditions, however they typically emerge in the spring and are therefore uncommon in RBV samples.

Size and Color

Size: 6-15 mm
Color: Tan to dark brown, legs may have orange or yellow bands

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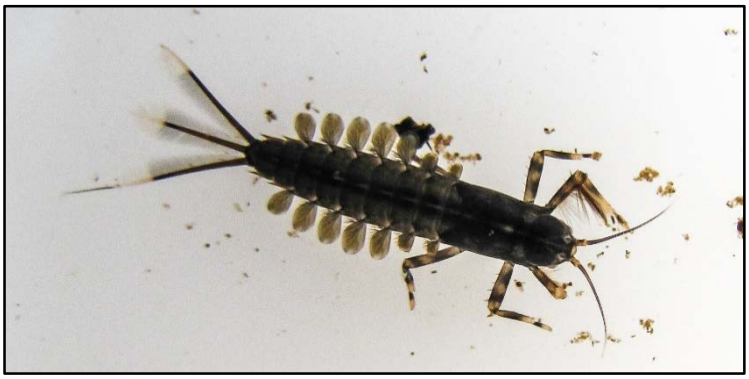
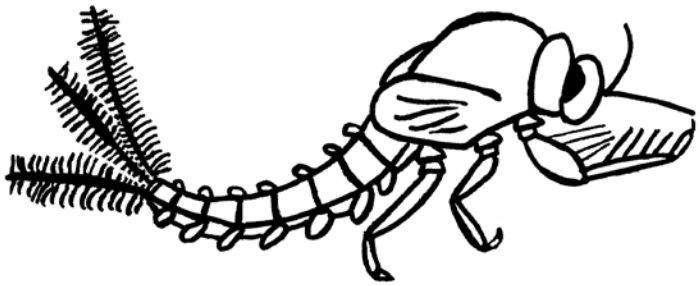
Brush-Legged Mayfly

Most Sensitive 2

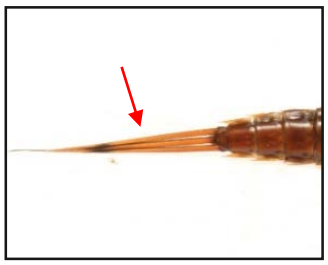




KEY FEATURES

- ❑ Streamlined body, taller than wide.
- ❑ Often with a "humped back" or "S-shaped" appearance when swimming.

- ❑ Front legs have a double row of long hairs on the inside edge.
- ❑ Single set of wing pads.
- ❑ Small, round gills on the side of the abdomen.



- ❑ Three feather-like tails at the end of the abdomen.

Taxonomic Information

Order: Ephemeroptera
Family: Isonychidae (Oligoneuriidae)
Genus: *Isonychia*

Ecological Information

Tolerance Value = 2
Feeding Group = Collector-Filterer
Stream Habitat = Moderate to fast flows, rock surfaces

Key Behaviors

- This mayfly nymph is an extremely strong swimmer. It swims by undulating back and forth very rapidly.
- This mayfly will often stand on rocks, leaves and sticks.

Identification Notes

There is only one genera (*Isonychia*) of Isonychidae in Connecticut. *Isonychia*, often called "Minnow Mayflies" by experienced volunteers, are very strong swimmers. The three tails are made up of a series of fine hairs that act like an oar on a boat, propelling the mayfly through the water. No other mayfly has a double row of fine hairs on the front legs.

Size and Color

Size: 8-17 mm
Color: Light brown to dark brown body, sometimes with yellow or white markings

Photographs courtesy of (top to bottom): Kelsey Quartuccio/CT DEEP; Jake Renkert/The Marvelwood School; NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School

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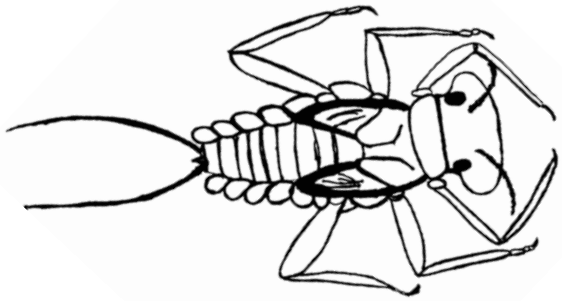
Two-Tailed Flathead Mayfly

Most Sensitive 3



KEY FEATURES

- ❑ Extremely flat, almost translucent body, long thin legs.

- ❑ Small round gills on the sides of the abdomen.
- ❑ Two Long thin tails at the end of the abdomen (easily broken)

- ❑ Single set of wing pads.
- ❑ Wide flat head, obvious eyes.

Taxonomic Information

Order: Ephemeroptera
Family: Heptageniidae
Genus: *Epeorus*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = Cobble and organic substrates

Key Behaviors

- This mayfly nymph crawls very fast on the surface of stones.
- Will move quickly in the tray and try to hide under any leaves or sticks present.
- *Epeorus* may try to swim by wiggling side to side.

Important Notes

The best way to find *Epeorus* is to carefully 'wash off' cobbles in the net before kicking. When present, these mayflies will scurry along the surface of the rock. Because of the body color and shape, they can be very difficult to spot. *Epeorus* can be extremely abundant when conditions are appropriate.

Size and Color

Size: 2-10 mm
Color: Tan to dark brown, sometimes with lighter gills and markings on the legs and head.

Photographs courtesy of (top to bottom): Kelsey Quartuccio / CT DEEP; DEEP files, author unknown; NY DEC Biomonitoring Unit; DEEP files, author unknown

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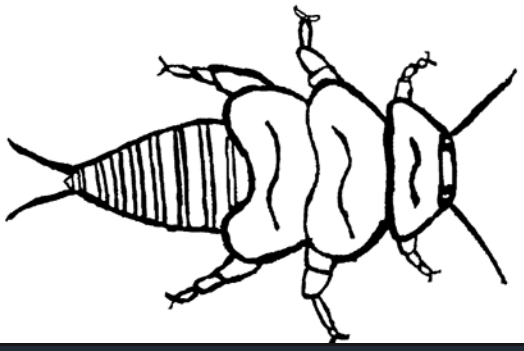
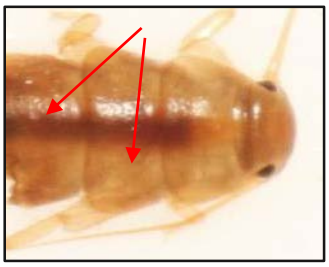
Roach-Like Stonefly

Most Sensitive **4**



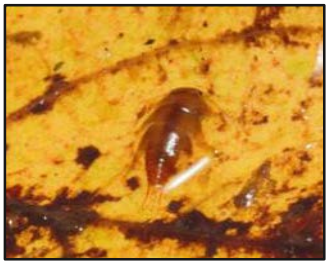
KEY FEATURES

- ❑ Tear-drop shaped body with a uniformly shiny brown exoskeleton.
- ❑ Two short tails at the end of the abdomen.



- ❑ Two sets of wing pads.

- ❑ No gills on the sides of the abdomen.



- ❑ Commonly found on leaves

Taxonomic Information

Order: Plecoptera
Family: Peltoperlidae
Genus: All

Ecological Information

Tolerance Value = 0
Feeding Group = Shredder
Stream Habitat = In and on coarse organic substrates

Key Behaviors

- This stonefly nymph is commonly found crawling in and amongst leaf packs in riffle areas. To locate, peel apart leaves in any packs present!
- Typically not observed swimming in the tray.

Important Notes

Peltoperlids are very intolerant of environmental stresses. Its characteristic inverted tear drop shape, short tails, and head which is broadly joined to the thorax, differentiate the Roach-Like Stonefly from other stoneflies.

Size and Color

Size: 6-11 mm
Color: Light to dark brown, uniform

All photographs courtesy of Jake Renkert / The Marvelwood School

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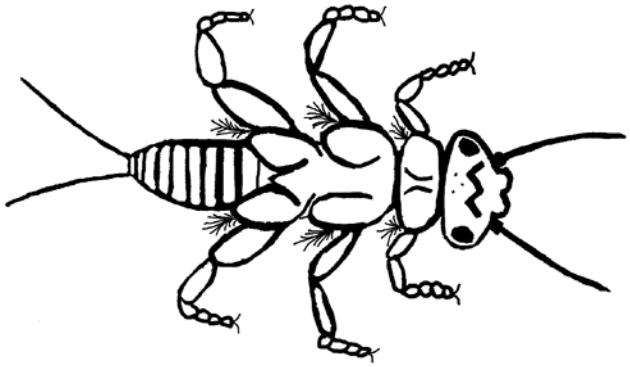
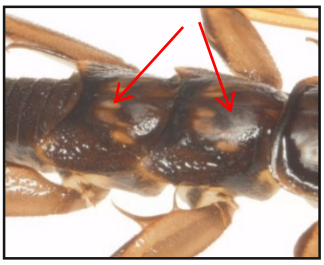
Common Stonefly

Most Sensitive **5A**

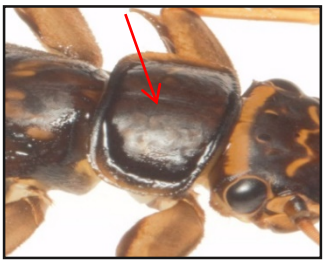


KEY FEATURES

- ❑ Flat body with obvious, segmented legs. Some specimens (not all) have a tortoise-shell pattern on the head and thorax.
- ❑ Two long tails at the end of the abdomen.



- ❑ Two sets of wing pads



- ❑ Rounded thoracic plate

- ❑ Gill tufts resembling armpit hairs at the base of each leg.

Taxonomic Information

Order: Plecoptera
Family: Perlidae
Genus: All

Ecological Information

Tolerance Value = 1
Feeding Group = Predator
Stream Habitat = Burrowed in substrate

Key Behaviors

- Very active crawler, highly mobile. (Watch out – they will crawl out of your ice cube trays!)
- May hide on like colored objects in the tray.
- May be observed doing "push-ups" in the tray. (This helps circulate water over their gills.)

Important Notes

When present in a sample, this organism will crawl out of the debris. Don't be confused by size or color - often different sizes will be collected at the same site and coloration can vary quite a bit between organisms. Darker and/or larger versions of common stoneflies are often misidentified as the Giant Stonefly (see panel 5B).

Size and Color

Size: 8-30 mm
Color: Variable. Light yellowish, brown to very dark, some with a tortoise-shell pattern.

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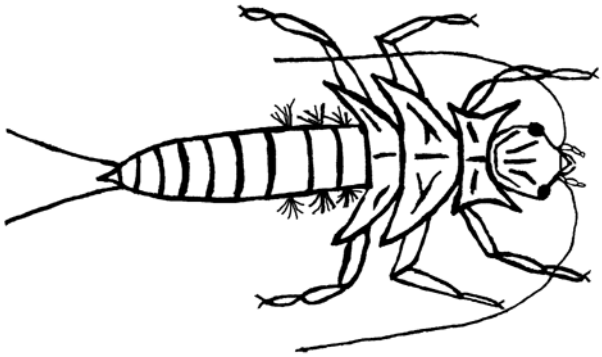
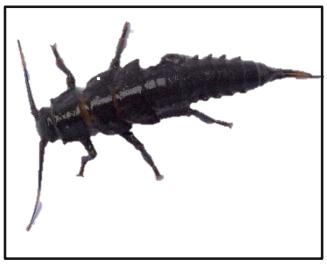
All photographs courtesy of Joshua Fusaro/ The Marvelwood School

Giant Stonefly

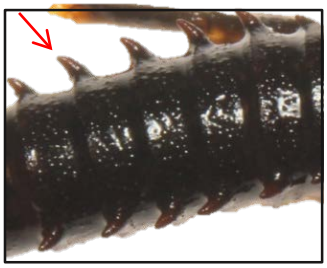
Most Sensitive **5B**



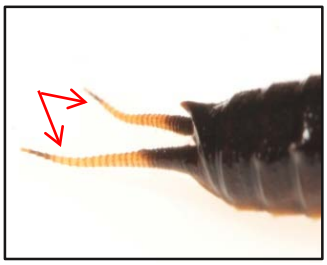
KEY FEATURES



❑ Robust body, typically dark but occasionally with white or yellow markings.



❑ Pointed edges along the sides of the abdomen.



❑ Two, short tails at the end of the abdomen.

❑ First thoracic plate is rectangular with flared edges

❑ Two sets of wing pads, very angular in shape.

❑ Gill tufts on the thorax and the sides of the first three sections of the abdomen.

Photographs courtesy of Joshua Fusaro/ The Marvelwood School

Taxonomic Information

Order: Plecoptera
Family: Pteronarcyidae
Genus: *Pteronarcys*

Ecological Information

Tolerance Value = 0
Feeding Group = Shredder
Stream Habitat = Fast flowing, high-gradient riffles

Key Behaviors

- This stonefly nymph is not very active. If it moves at all, it will crawl very slowly around the tray.
- May curl into a C-shape and pretend to be dead when disturbed.

Important Notes

Pteronarcys is often confused with the Common Stonefly (Panel 5A) as both can grow to be quite big. The Giant Stonefly is distinguished easily by its relatively sluggish activity level and more armored appearance. Don't be fooled by size – all giant stoneflies must start out small! Typically, only a few Pteronarcyidae are collected at any site when conditions are appropriate.

Size and Color

Size: 35-50 mm
Color: Brown to black, sometimes with white or yellow tail tips

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Miscellaneous Small Stoneflies

Most Sensitive **5C**

SMALL STONELY FAMILES

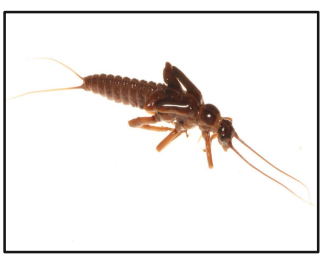
❑ **Small Winter Stoneflies**[1] (*Capniidae*)
- Often dark
- Legs short
- Abdomen slightly wider at middle

❑ **Green Stoneflies**[1] (*Chloroperlidae*)
- No distinctive color patterns
- Tails shorter than the abdomen is long

❑ **Rolled-winged Stoneflies** (*Leuctridae*)[2]
- Long, slender body
- Short legs
- Abdomen same width along length

❑ **Nemourid Stoneflies**[1] (*Nemouridae*)
- Long legs (tips extend to the tip of the abdomen or beyond)

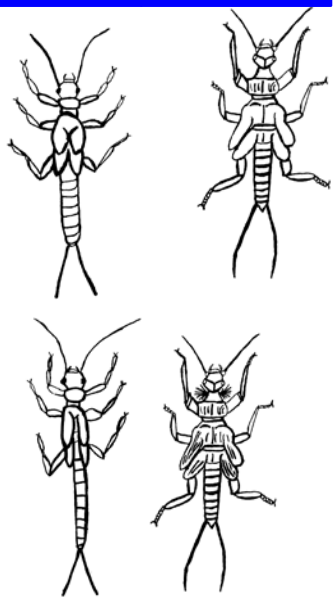
❑ **Perlodid Stoneflies**[3] (*Perlodidae*)
- Very similar to the Common Stonefly but without gill tufts near the base of the legs



❑ **Winter Stoneflies** (*Taeniopterygidae*)[4]
- Wing pads form a distinct triangle
- Typically only present in late November RBV samples

General Identification

The following characteristics are universally true of the stonefly families at left:
- Two tails
- Two tarsal claws ('toes') at the end of each leg
- Dorsally flattened
- Small in size



Taxonomic Information

Order: Plecoptera
Family: See families at left
Genus: All within families at left

Ecological Information

Tolerance Value = See below
Feeding Group = See below
Stream Habitat = Fast moving water, under rocks/debris

	Tolerance Value	Feeding Group
Capniidae	1	Shredder
Chloroperlidae	1	Predator
Leuctridae	0	Shredder
Nemouridae	2	Shredder
Perlodidae	2	Predator
Taeniopterygidae	2	Shredder

Important Notes

All stoneflies are intolerant of organic pollutants and therefore indicate high water quality.

Size and Color

Size: 4-10 mm average (*Taeniopterygidae* can reach up to 15 mm))
Color: Variable. Many light brown or cream colored

Photographs courtesy of: [1]Donald S. Chandler – www.discoverlife.org; [2]Author unknown; [3]Unknown - http://aquaticinsectsofcentralvirginia.blogspot.com; [4]Jake Renkert – The Marvelwood School

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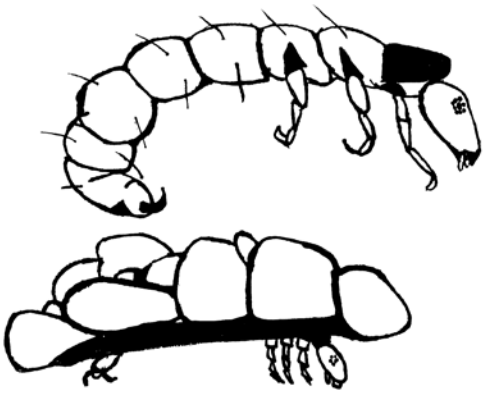
Saddlecase Maker Caddisfly

Most Sensitive 6A



KEY FEATURES

- ❑ Small oval stone case made of sand grains and/or tiny pebbles, resembles a saddle or a turtle shell. (Case is NOT tube-shaped.)
- ❑ Underside of case has two round openings.

- ❑ Larva body is maggot-like and slightly C-shaped.
- ❑ Larva has a light (white to light brown) body with a dark head and legs.
- ❑ End of the abdomen has an attached 'butt plate' (red arrow)

Taxonomic Information

Order: Trichoptera
Family: Glossosomatidae
Genus: *Glossosoma*

Ecological Information

Tolerance Value = 0
Feeding Group = Scraper
Stream Habitat = Exposed upper surfaces of rocks

Key Behaviors

- This caddisfly larva is often attached to the surface of rocks in fast current.
- *Glossosoma* may not move at all while in the tray. If it does, it will crawl very slowly along the bottom of the tray.

Important Notes

Glossosoma is often confused with other small stone case building caddisflies. Unlike other caddisfly cases, the *Glossosoma* case is not tube shaped but rather resembles a turtle shell with only a thin 'strap' of pebbles holding the case around the organism. Keep an eye out for both the case and the organism in your tray as the two are easily separated.

Size and Color

Size: 3-10 mm
Color: White to light brown, with dark head, legs and butt plate

Photographs courtesy of (top to bottom): NY DEC Biomonitoring Unit; Kelsey Quartuccio/CT DEEP; Jake Renkert/The Marvelwood School

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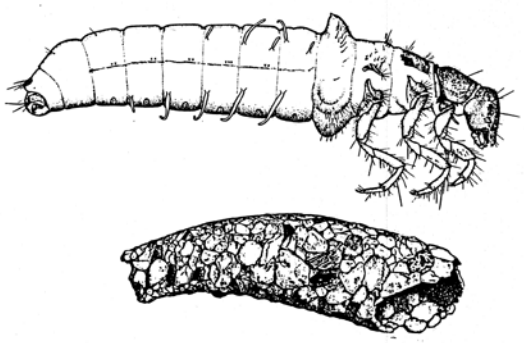
Cornucopia-Case Caddisfly

Most Sensitive **6B**



KEY FEATURES

- ❑ *Tiny* light-bodied organism
- ❑ Hunched appearance when in case.
- ❑ Triangular head with dark legs.

- ❑ Very small, delicate case made of sand grains
- ❑ Case is cone-shaped like a Thanksgiving cornucopia.

Don't be Fooled by This Imposter!

- ❑ The Strong Case-Maker Caddisfly (Odontoceridae) also makes a case of small grains of sand. To tell the two apart, inspect the case closely. Odontoceridae cases are very difficult to break apart and are the same width at both ends. In comparison, the Apatania case is quite small (see above), more easily broken apart, and noticeably wider at the opening than at the other end.

Taxonomic Information

Order: Trichoptera
Family: Apataniidae
Genus: *Apatania*

Ecological Information

Tolerance Value = 3
Feeding Group = Scraper
Stream Habitat = Fast flowing, shallow riffles

Key Behaviors

- This caddisfly larva is tiny and therefore easily overlooked, however if you watch your tray closely you may see a tiny sand horn walking around the bottom!
- Resembles a tiny hermit crab in that it drags its case along as it walks.

Important Notes

This organism is commonly confused with other stone case building caddisflies including *Glossosoma.* The easiest distinguishing characteristic is that that *Apatania* is VERY tiny, typically smaller than the width of your pinky nail. This caddisfly can be abundant under appropriate conditions. Look very carefully in your trays for these tiny caddisfly larvae!

Size and Color

Size: 2-6 mm
Color: Light colored body with dark head

Photographs courtesy of (top to bottom): NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School; DEEP file photo, author unknown

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Free-Living Caddisfly

Most Sensitive 7

KEY FEATURES

- ❑ Nicknamed "Michelin Man" caddisfly due to its smooth, lumpy abdomen
- ❑ Six short legs near the head

- ❑ Hard tan or yellow and brown patterned head with a single thoracic plate.

- ❑ Armored plate and two hooks at the end of the abdomen, somewhat loosely attached

Taxonomic Information

Order: Trichoptera
Family: Rhyacophilidae
Genus: *Rhyacophila*

Ecological Information

Tolerance Value = 0
Feeding Group = Predator
Stream Habitat = Fast flowing, high-gradient riffles

Key Behaviors

- Clings very well to the net.
- Moderately active organism; will crawl or wiggle in the tray.
- Will try to hide under objects.

Important Notes

Rhyacophila is called the 'free-living' caddisfly because larvae of this genus do not build a case until they are about to pupate. (At which point they will build a loosely constructed stone shelter.) This organism is often found among aquatic mosses. A key field characteristic is the bright green or lavender abdominal coloring.

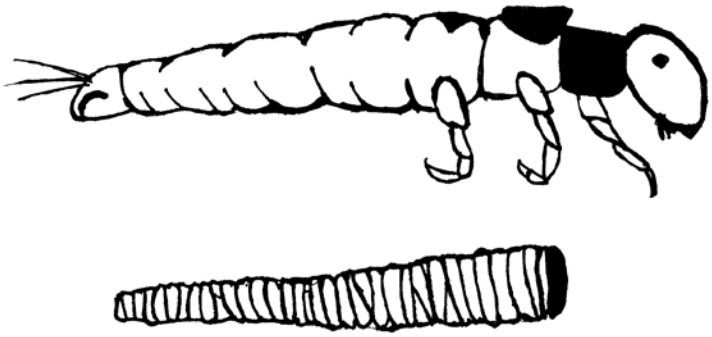
Size and Color

Size: 10-30 mm
Color: Variable. White, green, purple

Photographs courtesy of (top to bottom): Jake Renkert/The Marvelwood School;): Jake Renkert/The Marvelwood School; NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School; Jake Renkert/The Marvelwood School

Humpless Case Maker Caddisfly

Most Sensitive **8A**



KEY FEATURES

Case Construction:

- ❑ Case constructed of thin strips of plant material assembled with a square opening.
- ❑ Wider at head opening than at tail end.

Macroinvertebrate Features:

- ❑ Light colored body with dark head and legs.
- ❑ Very long legs
- ❑ No abdominal humps.

All photographs courtesy of Jake Renkert/The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Brachycentridae
Genus: *Brachycentrus*

Ecological Information

Tolerance Value = 1
Feeding Group = Shredder
Stream Habitat = Upper surfaces of rocks

Key Behaviors

- Typically *Brachycentrus* does not move in the tray. If it does move, it will carry its case with it as it slowly crawls along.

Important Notes

This caddisfly can be very abundant under the appropriate conditions. Look carefully for *Brachycentrus* when the sample contains old leaves, sticks or bark. The cases may be attached to sticks, leaves or larger rocks.

Size and Color

Size: 10-17 mm
Color: Light body with dark head and legs

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Plant Case Maker Caddisfly

Most Sensitive 8B

KEY FEATURES

Case Construction:

- ❑ Builds a case out of small, rectangular or square pieces of bark or wood (no sand grains).
- ❑ Case is typically slightly wider at the head end.

Macroinvertebrate Features:

- ❑ Light colored body with dark head and legs.
- ❑ Lateral humps present on the first section of the abdomen.

Photographs courtesy of (top to bottom): Jake Renkert/The Marvelwood School; NY DEC Biomonitoring Unit; Jake Renkert/The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Lepidostomatidae
Genus: *Lepidostoma*

Ecological Information

Tolerance Value = 1
Feeding Group = Shredder
Stream Habitat = Accumulated plant debris on bottom

Key Behaviors

- Typically does not move in the tray. If it does move, will carry its case with it as it slowly crawls.

Important Notes

This caddisfly can be very abundant under the appropriate conditions, particularly in forested areas. Look carefully for *Lepidostoma* when the sample contains old leaves, sticks or bark. The cases may be attached to sticks, leaves or larger rocks.

Size and Color

Size: 7-15 mm
Color: Light body with dark head and legs

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Common Netspinner Caddisfly

Moderately Sensitive **9**

KEY FEATURES

❑ Series of three dark plates on the dorsal side of the thorax below the head.

❑ Fluffy gills on the underside (ventral sections) of the abdomen.

❑ Two paintbrush-like tails with hooks at the end of the abdomen.
❑ May have a 'dirty' or hairy appearance

Photographs courtesy of (top to bottom): NY DEC Biomonitoring unit; The Marvelwood School & Kent Conservation Commission RBV Program; Jake Renkert / The Marvelwood School; Becky Martorelli / Quinnipiac River Watershed Association; Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Hydropsychidae
Genus: All

Ecological Information

Tolerance Value = 4
Feeding Group = Collector-filterer
Stream Habitat = Rock surfaces, woody debris, plants

Key Behaviors

- Extremely active, wiggles violently back and forth
- Gregarious, will form clumps of 2-4 in the tray
- May cling strongly to the net!

Important Notes

Hydropsychidae is probably one of the most common organisms encountered during benthic sampling. These can be extremely abundant under appropriate conditions. Because some are greenish in color they may be confused as *Rhyacophila* (Panel 7). Hydropsychidae have a dark plate above each pair of legs & fluffy gills on the underside of the abdomen, *Rhyacophila* does not.

Size and Color

Size: 13-18 mm
Color: Light brown to black, sometimes with green tint

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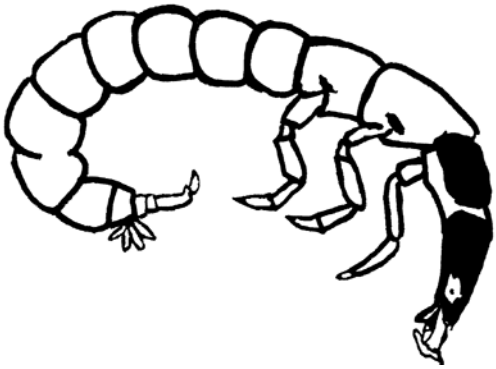
Fingernet Caddisfly

Moderately Sensitive **10**



KEY FEATURES

- ❑ Elongate, slender worm-like body.
- ❑ No gills on or along the abdomen.
- ❑ Two hooks at the end of the abdomen.

- ❑ Bright orange head with a transparent, t-shaped upper lip.

- ❑ Black border along the back edge of pronotum (the plate located behind the head capsule.)

Photographs courtesy of (top to bottom): NY DEC Biomonitoring unit; The Marvelwood School/Kent Conservation Commission RBV program; The Marvelwood School/Kent Conservation Commission RBV program; The Marvelwood School/Kent Conservation Commission RBV program; Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Trichoptera
Family: Philopotamidae
Genus: *All*

Ecological Information

Tolerance Value = 3
Feeding Group = Collector-filterer
Stream Habitat = Undersides of rocks in high gradient

Key Behaviors

- Extremely active, wiggles violently back and forth.
- Gregarious, will form clumps of 2-4 in the tray.
- Very active, will crawl around the bottom of the tray.

Important Notes

Philopotamidae is a very common organism encountered during RBV sampling, and can be extremely abundant under appropriate conditions.

Size and Color

Size: 13-17 mm
Color: Yellow-orange, bright yellow, beige, white, or transparent

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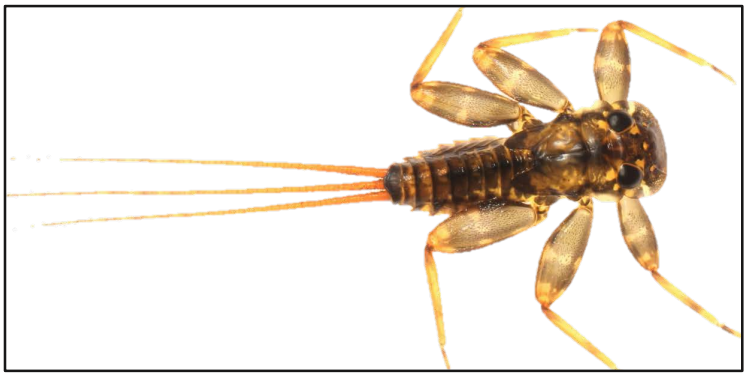
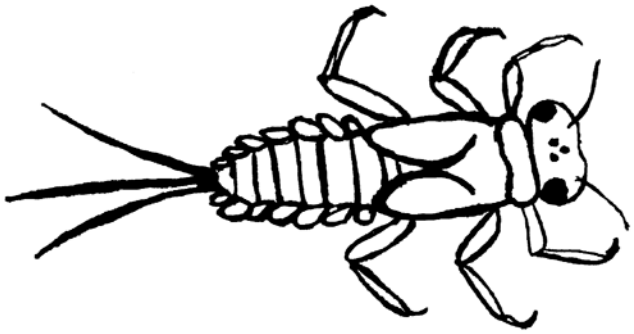
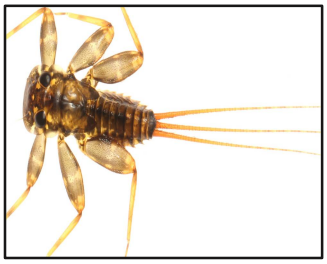
Three-Tailed Flat Headed Mayfly

Moderately Sensitive **11**





KEY FEATURES



- ❑ Extremely flattened body.
- ❑ Small, oval or square-shaped gills along the sides of the abdomen.
- ❑ Three very long tails at the end of the abdomen. (Tails are fragile and can break off giving the appearance of only one or two.)

- ❑ Head is flat with large eyes on top.
- ❑ Resembles 'Jack Skellington' from Nightmare Before Christmas.

- ❑ Single set of wing pads.

Photographs courtesy of Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Ephemeroptera
Family: Heptageniidae
Genus: *Stenonema* and *Maccaffertium*

Ecological Information

Tolerance Value = 4
Feeding Group = Scraper
Stream Habitat = On/underneath cobbles and organics

Key Behaviors

- Very mobile; can move and swim fast when in water.
- Doesn't move well in the net
- It will try to hide on any flat dark colored object like stones, leaves, and other invertebrates

Important Notes

Very common across Connecticut. Flat headed mayflies can be found by slowly lifting the cobbles out of the water. They may run to the other side of the rock. Be careful not to confuse this organism with the two-tailed version (*Epeorus*/Panel 3); the legs, gills, and tails of the flat headed mayfly tend to break off during the collection process.

Size and Color

Size: 5-20 mm
Color: Light golden brown to dark brown, often with spots or stripes on the legs and body

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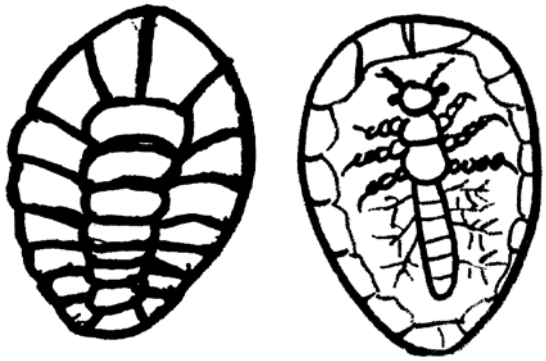
Water Penny Beetle

Moderately Sensitive **12**



KEY FEATURES

- ❑ Small, flat, disc-shaped organism.
- ❑ Uniform in color
- ❑ Head and legs only visible from ventral view (i.e. from underneath)

Don't be Fooled by This Imposter!

- ❑ Often confused with the False Water Penny (*Eubriidae*). *Eubriidae* is more ovoid in shape and has a serrated or more jagged outer edge.

Taxonomic Information

Order: Coleoptera
Family: Psephenidae
Genus: *Psephenus*

Ecological Information

Tolerance Value = 4
Feeding Group = Scraper
Stream Habitat = Attached to rocks in fast flows

Key Behaviors

- Cling very well to rocks and smooth surfaces such as the sorting tray (see image at left)
- May glide along the bottom of the tray
- May curl up when disturbed

Important Notes

Water penny beetle larvae are common in RBV samples, but can be very hard to locate in the field due to their cryptic nature. Look very closely at any cobbles in your sample area; water penny beetle larva will adhere strongly to rock surfaces. They are very distinctive due to their penny like shape and coloration. These organisms can be locally abundant when conditions are appropriate.

Size and Color

Size: 3-10 mm
Color: Uniform in color. Ranges from golden to dark brown.

Photographs courtesy of (top to bottom): Jake Renkert / The Marvelwood School (top three); Meghan Lally/CT DEEP; The Marvelwood School/Kent Conservation Commission RBV program; The

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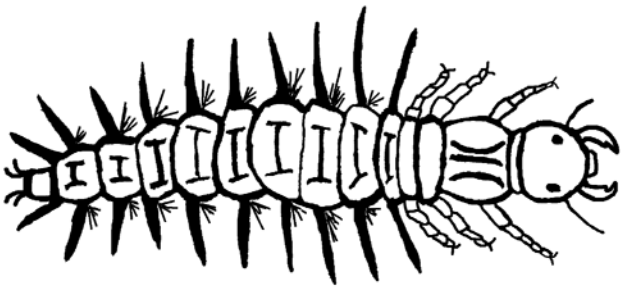
Dobsonfly

Moderately Sensitive **13A**



KEY FEATURES

- ❑ Elongate body with a pair of long soft spine-like appendages on each section of the abdomen.
- ❑ *C*an be extremely large (up to 4 inches)

- ❑ Large pinching mouth parts.
- ❑ Will bite sampling spoons and your fingers so watch out!

- ❑ Two prolegs at the end of the abdomen, each with two hooks.

- ❑ Tufts of fluffy gills at the base of each abdominal projection.

Taxonomic Information

Order: Megaloptera
Family: Corydalidae
Genus: *Corydalus*

Ecological Information

Tolerance Value = 6
Feeding Group = Predator
Stream Habitat = Under loosely embedded stones

Key Behaviors

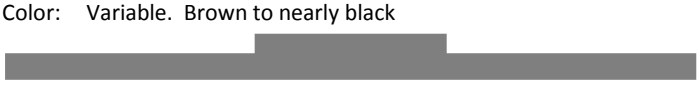
- Very mobile, will be very active crawling or wiggling in the tray
- Will curl their abdomen around your finger if picked up
- May cling to the net
- May pinch! Use caution when handling!

Important Notes

Dobsonflies are very common in RBV samples. These macroinvertebrates are sometimes called "Hellgrammites" by fishermen and are a trout favorite! *Corydalus* is often confused with *Nigronia* (Panel 13B). The Dobsonfly can be distinguished by its larger size, darker brown color, and the presence of fluffy gill tufts on the underside of the abdomen.

Size and Color

Size: 25-90 mm
Color: Variable. Brown to nearly black



Photographs courtesy of Jake Renkert / The Marvelwood School

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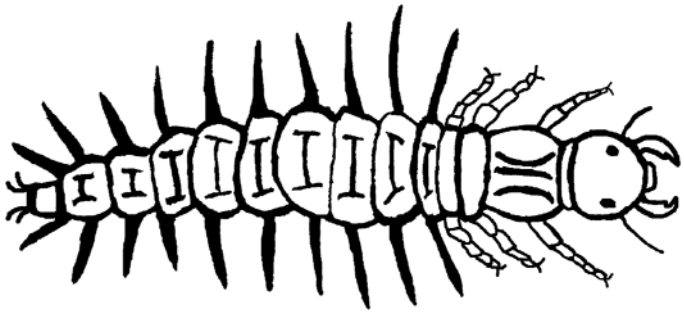
Fishfly

Moderately Sensitive **13B**



KEY FEATURES

❑ Elongate body with a pair of long soft spine-like appendages on each section of the abdomen.

❑ Large pinching mouth parts.

❑ Two prolegs at the end of the abdomen, each with two hooks.

❑ No gills at the base of the abdominal projection.

Taxonomic Information

Order: Megaloptera
Family: Corydalidae
Genus: *Nigronia*

Ecological Information

Tolerance Value = 4
Feeding Group = Predator
Stream Habitat = Under loosely embedded stones

Key Behaviors

- Very mobile, will be very active crawling or wiggling in the tray
- Will curl their abdomen around your finger if picked up
- May cling to the net
- **May pinch! Use caution when handling!**

Important Notes

Very common in RBV samples. *Nigronia* is often confused with *Corydalus* (Panel 13A). The fishfly can be distinguished by its smaller size, more reddish color, and absence of fluffy gill tufts on the underside of the abdomen.

Size and Color

Size: 25-50 mm
Color: Variable. Light brown to reddish orange.

All photographs courtesy of Jake Renkert / The Marvelwood School

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Dragonfly

Moderately Sensitive **14A**

General Identification

The following characteristics are universally true of the dragonfly families below:

- Robust body
- Three short spike-lie tails
- Two sets of wing pads
- Very large eyes
- Extendable lower jaw

DRAGONFLY FAMILES

❑ **Darner Dragonfly** (*Aeshnidae*)

- Very common
- Usually very dark and almost black
- Elongate body with small thin legs

❑ **Biddie Dragonfly** (Cordulergastridae)

- Somewhat common
- Light brown; robust, hairy appearance
- Deeply rounded labium extends out almost half the length of the body

❑ **Club Tail Dragonfly** (*Gomphidae*)

- Very common
- Short antennae similar in shape to a Q-tip
- Adapted for burrowing into the substrate to wait for prey

❑ **Common Skimmer Dragonfly** (*Libellulidae*)

- Rare – prefers ponds and wetlands

All photographs courtesy of Jake Renkert / The Marvelwood School

Taxonomic Information

Order: Odonata (Suborder Anisoptera)
Family: All families at left
Genus: All genera within families at left

Ecological Information

Tolerance Value = See below
Feeding Group = See below
Stream Habitat = Typically among rocks and vegetation, or burrowed in soft substrate

	Tolerance Value	Feeding Group
Aeshnidae	3	Predator
Cordulergastridae	3	Predator
Gomphidae	1	Predator
Libellulidae	9	Predator

Important Notes

Dragonfly nymphs can be very common when conditions are appropriate. They are very mobile and move with jet propulsion or by walking. There are several types of dragonflies found in riffle areas, however the majority of species live in slow moving or standing water.

Size and Color

Size: 8-42mm
Color: Variable. Light brown to nearly black

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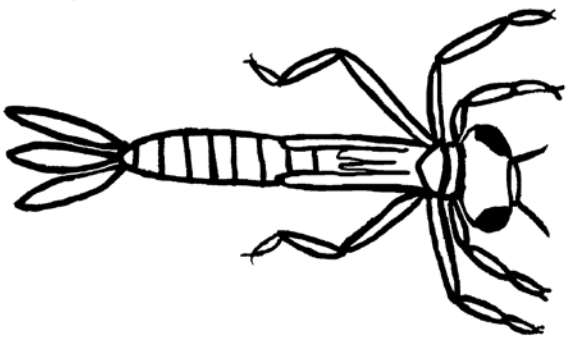
Damselfly

Moderately Sensitive **14B**

General Identification

The following characteristics are universally true of the damselfly families below:

- Slender, delicate body with long legs.
- Three long feather-like caudal gills at the end of the abdomen that resemble tails.
- Two sets of wing pads.
- Very large eyes and extendable lower jaw.



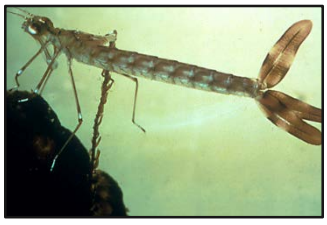
DAMSELFLY FAMILES

❑ **Broad Winged Damselfly** (*Calopterygidae*)

- First antennae segment is very long, almost half the length of the antenna
- Uncommon in RBV samples; prefers low gradient habitat

❑ **Narrow Winged Damselfly** (*Coengrionidae*)

- Two-toned gills at end of abdomen
- Occasionally in RBV samples; prefers rocks and vegetation in moderate to slow flowing waters



❑ **Spread Winged Damselfly** (*Lestidae*)

- Lower lip (labium) is long and slender
- Gills at end of abdomen are very dark and thick
- Rare in RBV samples; prefers thick vegetation in very slow flows

Photographs courtesy of Jake Renkert (top); NY DEC (middle); DEEP files, author unknown (bottom)

Taxonomic Information

Order: Odonata (Suborder Zygoptera)
Family: All families at left
Genus: All genera within families at left

Ecological Information

Tolerance Value = See below
Feeding Group = See below
Stream Habitat = Slow or standing water, on vegetation

	Tolerance Value	Feeding Group
Calopterygidae	5	Predator
Coengrionidae	9	Predator
Lestidae	9	Predator

Important Notes

These larvae are very active and will move by wiggling side to side.

Damselflies are rare in riffle areas; the majority of species live in slow moving or standing water. If you find a lot of damselflies in your sample check that you are in the right habitat for the RBV program.

Size and Color

Size: 13-50mm
Color: Variable. Yellow to dark brown. Sometimes with patterns.

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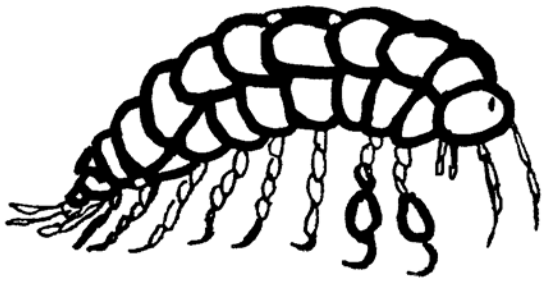
Scud

Least Sensitive **15**



KEY FEATURES

- ❑ Body strongly flattened from side to side.
- ❑ Two pairs of antennae are about the same length.

- ❑ Seven pairs of walking legs.
- ❑ The first two pairs of legs have hinged claws.

Taxonomic Information

Order: Amphipoda
Family: All
Genus: All

Ecological Information

Tolerance Value = 6
Feeding Group = Collector-gatherer
Stream Habitat = In and on organic substrate, slow flows

Key Behaviors

- Can swim very rapidly on their sides when disturbed; also called “side swimmers”
- Turn bleach white when preserved

Important Notes

Common in CT streams, but less likely in RBV samples due to their preference for slower flows and lower gradients. They are typically found in areas of loose substrate and prefer cool, shallow streams and the backwaters of larger rivers. Most are omnivorous and feed in organic debris that accumulate in the stream margins. Scuds are an important food source for fish.

Size and Color

Size: 5-20 mm
Color: White to gray

Photographs courtesy of (top to bottom): Jake Renkert / The Marvelwood School (top); Becky Martorelli / Quinnipiac River Watershed Coalition; Kelsey Quartuccio / CT DEEP

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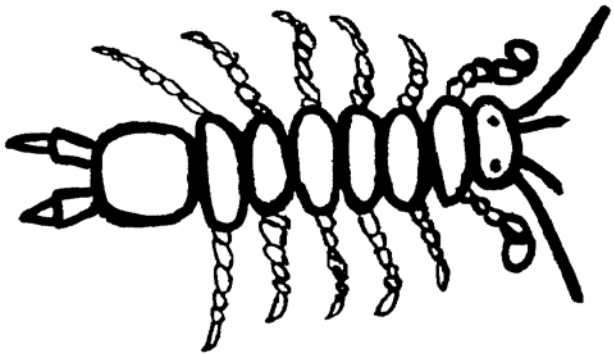
Aquatic Sow Bug

Least Sensitive **16**

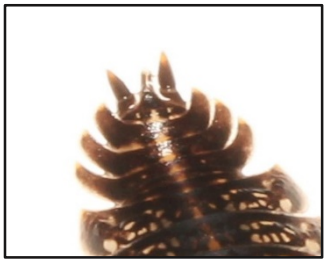


KEY FEATURES

❑ Body is strongly flattened from top to bottom.

❑ Two pairs of antennae, of which one pair is significantly longer than the other pair.

❑ Seven pairs of legs.
❑ First pair of walking legs has enlarged ends with hinged claws.



❑ Six pairs of short appendages on the underside of the abdomen. The sixth pair extends behind like a pair of flat tails.

Taxonomic Information

Order: Isopoda
Family: Asellidae
Genus: All

Ecological Information

Tolerance Value = 8
Feeding Group = Collector-gatherer
Stream Habitat = In and on substrate, slow flows

Key Behaviors

- Crawl slowly amongst the debris.
- Sow bugs will avoid light by hiding under leaves or other debris.
- Turn gray when preserved

Important Notes

Aquatic sow bugs prefer darker, slower, shallow habitats; they are not typically found in high quality riffles and therefore are rare in RBV samples. Sow bugs are an important food source for fish in low gradient CT streams.

Size and Color

Size: 5-20 mm
Color: Medium to dark gray is most common but can also be blackish or brownish

Photographs courtesy of: Jake Renkert / The Marvelwood School

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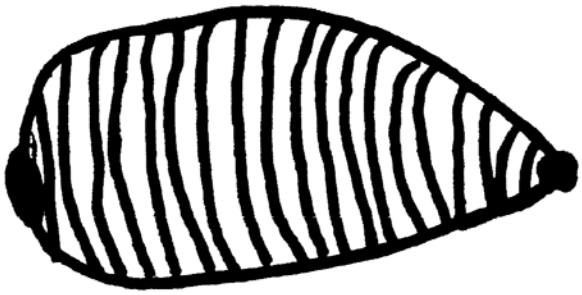
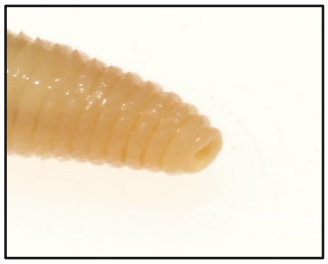
Leech

Least Sensitive **17**



KEY FEATURES



- ❑ Somewhat soft but muscular, flattened body with many segments and no legs.
- ❑ Two distinct suction discs on the bottom of the body, one on each end.
- ❑ Several small eyespots on top of first segments.

Taxonomic Information

Phylum: Annelida
Class: Clitellata
Sub-Class: Hirudinea

Ecological Information

Tolerance Value = 10
Feeding Group = Predator
Stream Habitat = Slow or standing water, among debris

Key Behaviors

- Leeches will stick to the bottom of the tray and move like inch worms
- Tend to curl up when preserved

Important Notes

Leeches are rare in RBV samples due to their preference for slow flows. They feed on the blood of a host organism by using a drill-like rasping tongue to penetrate the skin. The leech injects hirudin, a chemical which prevents the blood from clotting. Some leeches are used in medical practice to remove the build-up of blood and body fluids in bruised or surgically reattached appendages or tissues.

Size and Color

Size: 4-450 mm
Color: Tan, brown, gray or black sometimes with colored patterns

Photographs courtesy of Jake Renkert / The Marvelwood School (top two); and NY DEC Biomonitoring Unit (bottom)

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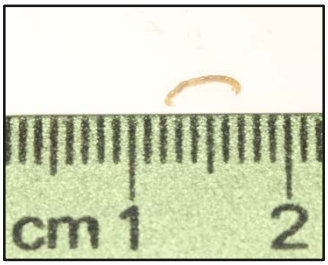
Non-Biting Midge

Least Sensitive **18**

KEY FEATURES



- ❑ Small, very thin, wormlike body
- ❑ Red or white in color

- ❑ Distinct head capsule, though very tiny

- ❑ May be found hiding in very finely constructed cases

Taxonomic Information

Order: Diptera
Family: Chironimidae
Genus: All

Ecological Information

Tolerance Value = 6 (White) or 8 (Red)
Feeding Group = Collector-gatherer
Stream Habitat = On substrate in all flow types

Key Behaviors

- Midges swim by violent side to side wiggling
- Red midges turn white when preserved.

Important Notes

Look carefully for midge larvae, they are common but extremely small! There are approximately 100 different genera of midges in Connecticut. These can be divided into two main groups: the white and red midges. The color in the red midges comes from a hemoglobin-like compound which allows the midge to survive in very low oxygen levels.

Size and Color

Size: 5-25 mm
Color: White (clear to cream) or red

Photographs courtesy of: Jake Renkert / The Marvelwood School (top three); and NY DEC (bottom)

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Black Fly

Least Sensitive **19**

KEY FEATURES

- ❑ Bowling pin shaped body with a capsule-like head that is distinct from the thorax.
- ❑ Enlarged rear one-third of the body. Resembles the shape of a vase.
- ❑ There is a proleg on the bottom of the first thorax segment..

Taxonomic Information

Order: Diptera
Family: Simuliidae
Genus: All

Ecological Information

Tolerance Value = 6
Feeding Group = Collector-filterer
Stream Habitat = Attached to rocks in riffle areas

Key Behaviors

- Black flies will attach to the bottom of the tray
- Move like inch-worms

Important Notes

Black fly larvae are common in RBV samples, but are relatively small so may be easily overlooked.

Black fly larvae have a ring of small hooks at the back end of the abdomen that enables them to adhere to a rock and not be swept away by the current. They use a brush-like structure to filter fine organic matter from the water column.

Size and Color

Size: 5-10 mm
Color: Whitish-gray

Photographs courtesy of (top to bottom): Jake Renkert / The Marvelwood School; The Marvelwood School/Kent Conservation Commission Local RBV program;): Jake Renkert / The Marvelwood School

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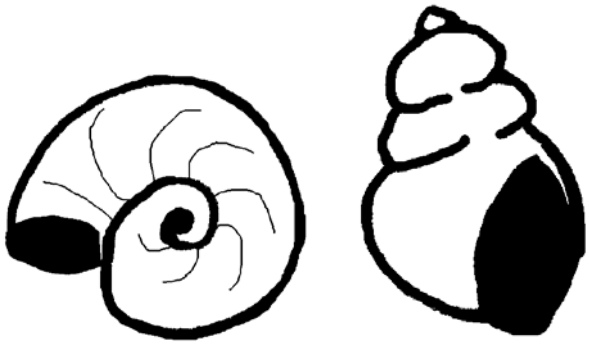
Snail

Least Sensitive **20**



KEY FEATURES

❑ **Gilled Snails**
Subclass: Prosobranchia
- Breathe by absorbing dissolved oxygen from the water through gills
- Sensitive to pollution; indicative of high water quality

❑ **Lunged Snails**
Subclass: Pulmonata
- Take in oxygen from the air into an internal lung-like structure
- Can tolerate low dissolved oxygen levels

❑ **Chinese Mystery Snail** (*Bellamya chinensis)*
❑ **Invasive!**
❑ Relatively large, globose shells with concentrically marked opercula

Taxonomic Information

Phylum: Mollusca
Class: Gastropoda

Ecological Information

Tolerance Value = Variable
Feeding Group = Scraper
Stream Habitat = On rock surfaces and finer sediments

Key Behaviors

- May glide along the bottom of the tray or cling to tray walls

Important Notes

Freshwater snails in CT are most commonly located below ponds and in wetlands areas and are therefore relatively uncommon in RBV samples.
There are two major groups of snails in CT – 'right handed' and 'left handed'; they can be differentiated by facing the snail toward you and determining the direction to which the snail opens at the bottom.

Size and Color

Size: 3-60 mm
Color: Variable. Light tan to dark brown.

Photographs courtesy of: Jake Renkert / The Marvelwood School (top); USGS / Wikipedia.org (bottom)

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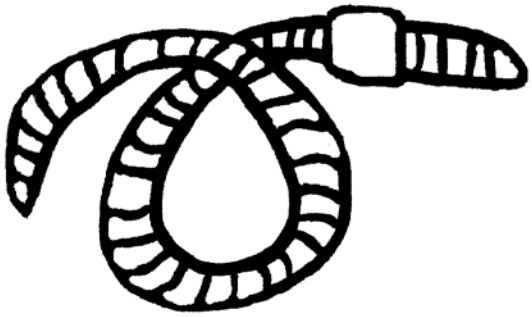
Aquatic Worm

Least Sensitive **21**



KEY FEATURES

- ❑ Soft, long, cylindrical bodies consisting of many ring-like segments
- ❑ No suckers or eyespots

Taxonomic Information

Phylum: Annelida
Class: Oligochaeta

Ecological Information

Tolerance Value = 8
Feeding Group = Collector-gatherer
Stream Habitat = In and on fine substrate

Key Behaviors

- May wiggle or curl up in a 'knot' while in the tray

Important Notes

Aquatic earthworms can be found in any flows, but prefer slower flows and are therefore not common in RBV samples. Aquatic earthworms, especially tubifex worms, can live in extremely polluted water with very low dissolved oxygen levels. Often, severely impacted streams will have large populations of these worms.

Size and Color

Size: 1-30 mm avg. (up to 150 mm)
Color: Variable, but typically white or reddish.

Above photographs courtesy of Jake Renkert / The Marvelwood School

Crayfish

Misc. Other **22A**

CAMBARUS SPECIES IN CT

❑ **Common Crayfish**
(*Cambarus bartonii*)
- Native, rare (western CT)
- No depression on large claw
- 1 row of tubercles
- Lower part of gonopod 'pipe' longer than the top part

❑ **Robust Crayfish**
(*Cambarus robustus*)
- Introduced, common (Statewide)
- Deep depression on outer margin of large claw
- Pipe-wrench shaped gonopods of equal length
- 2 rows of tubercles

PROCAMBARUS SPECIES IN CT

❑ **White River Crayfish**
(*Procambarus acutus*)
- Introduced, common (eastern CT)
- No spikes on inside margin of claws
- Brown mottled color
- Areola open

General Identification

Cambarus crayfish species:
- Rostrum is not "J" shaped
- Gonopods are pipe-wrench shaped

Procambarus crayfish species:
- Long, slender, curved claws
- Rostrum is "J" shaped w/ spines
- Gonopods not pipe-wrench; males with 4 hooks

Taxonomic Information

Order: Decapoda
Family: Cambaridae
Genus: Cambarus, Procambarus

Ecological Information

Tolerance Value = 6
Feeding Group = Gatherer, collector
Stream Habitat = All flows, shallows (1-2m) burrowed in substrate or under rocks

Important Notes

Crayfish resemble small lobsters. They have a hard exoskeleton, long "nose"; large eyes; 5 pairs of walking legs; flipper at end of tail; and large claws. When disturbed in the water, crayfish use their "flipper" to quickly scoot backwards through the water.

DO NOT INCLUDE CRAYFISH IN YOUR VOUCHER COLLECTION; photograph any crayfish found and return them alive to the stream from which you collected them.

Size and Color

Size: 10-150mm
Color: Usually brownish green but ranges from blackish to red/orange, often speckled

Above photographs courtesy of Robert Jacobs / CT DEEP Inland Fisheries Division

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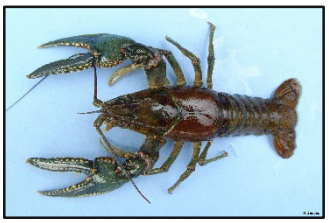
Crayfish

Misc. Other **22B**

ORCONECTES SPECIES IN CT

❑ **Spiny Cheek Crayfish** (*Orconectes limosus*)
- Native, common (Statewide)
- Spiny cheeks! (Can feel if rub finger along side of head)
- Claw tips are orange with a black band

❑ **Rusty Crayfish** (*Orconectes rusticus*)
- **Invasive!** Common in western CT
- Rusty colored patch near tail above legs
- Claw tips orange with black band
- No spines on cheeks



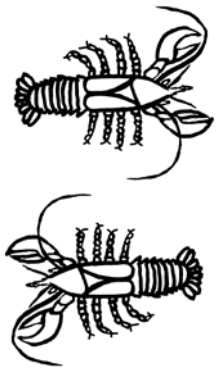
❑ **Virile or Northern Crayfish** (*Orconectes virilis*)
- Occasional, statewide
- Blue claws with prominent white bumps
- Pair of dark tail spots
- Scissor-like gonopods
- No spines on cheeks

❑ **Ringed Crayfish** (*Orconectes neglectus*)
- Introduced, Rare (Hudson drainage)
- Heavy black banding
- Claw tips orange with black "racing stripe"
- No spines on cheeks

Above photographs courtesy of Robert Jacobs / CT DEEP Inland Fisheries Division

General Identification

The following characteristics are universally true of the Orconectes crayfish species in CT:
- Rostrum is "J" shaped and spines present
- Gonopods are not pipe-wrench like in shape



Taxonomic Information

Order: Decapoda
Family: Cambaridae
Genus: Orconectes

Ecological Information

Tolerance Value = 6
Feeding Group = Gatherer, collector
Stream Habitat = All flows, shallows (1-2m) burrowed in substrate or under rocks

Important Notes

Crayfish are the largest stream invertebrates and can be extremely numerous under appropriate conditions. Crayfish are tolerant of most pollution and environmental stress (temperature, pH, alkalinity). Although, they bioaccumulate some metals (mercury); crayfish tissue samples can be used to detect contamination.

DO NOT INCLUDE CRAYFISH IN YOUR VOUCHER COLLECTION; photograph any crayfish found and return them alive to the stream from which you collected them.

Size and Color

Size: 10-150mm
Color: Usually brownish green but ranges from blackish to red/orange, often speckled

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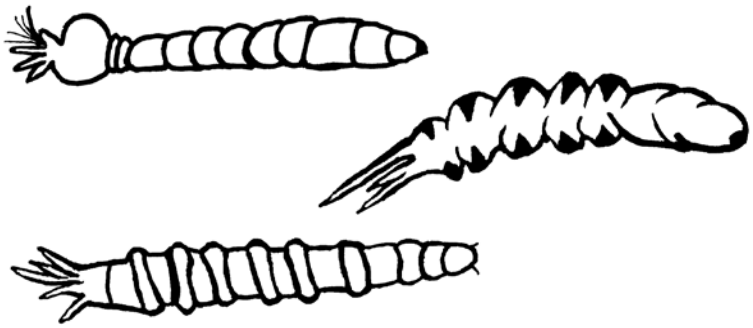
Cranefly

Misc. Other 23

Hexatoma sp.

Antocha sp.

Tipula sp.



KEY FEATURES

The following characteristics are universally true of cranefly:

- ❑ Body is cylindrical and usually stout.
- ❑ Typically very soft bodied.
- ❑ Head is withdrawn and not visible.
- ❑ Two spiracles at the end of the abdomen surrounded by several pairs of short, fleshy lobes.
- ❑ One to seven pairs of lobes that often have a fringe of hair.

Taxonomic Information

Order: Diptera
Family: Tipulidae
Genera: Hexatoma, Antocha, Tipula

Ecological Information

Tolerance Value = 3
Feeding Group = Shredder
Stream Habitat = Burrowed in substrate and leaf packs

Key Behaviors

- Often found in leaf packs within sample

Important Notes

Craneflies are common in RBV samples. All crane flies have what appear to be tails, however they are respiratory organs. Most crane fly larvae are very large at around 2 inches long. Some species have a bulb-like structure near the tails, while others have dark areas on the top and bottom of the abdomen.

Size and Color

Size: 5-25 mm average (up to 100 mm)
Color: Tan to White.

Above photographs courtesy Jake Renkert / The Marvelwood School

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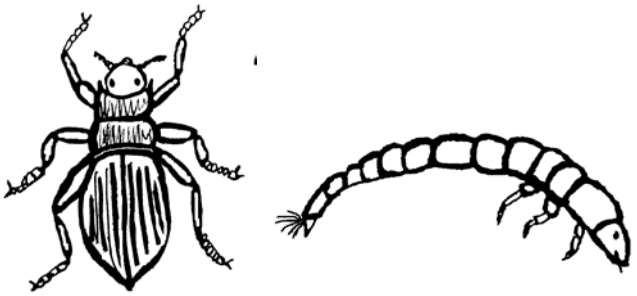
Riffle Beetle

Misc. Other **24**



KEY FEATURES (Larva)

❑ Small, hard-bodied, cylindrical and slightly "C" shaped

❑ Long legs in relation to body size.

❑ Two prominent claws on the ends of the legs.

KEY FEATURES (Adult)

❑ Small, dark brown or black beetles.

Above photographs courtesy of (top to bottom): Jake Renkert / The Marvelwood School); NY DEC Biomonitoring Unit; Jake Renkert / The Marvelwood School); Jake Renkert / The Marvelwood School); NY DEC Biomonitoring Unit

Taxonomic Information

Order: Coleoptera
Family: Elmidae
Genus: All

Ecological Information

Tolerance Value = 4
Feeding Group = Scraper
Stream Habitat = On organic substrate in riffles

Key Behaviors

- Larval form is relatively inactive, but adult riffle beetles will crawl around the sorting tray.

Important Notes

Riffle Beetles are common in RBV samples. *Elmidae* is one of the very few benthic macroinvertebrates who remain aquatic in both its larval and adult stages.

Size and Color

Size: 5-15 mm (Larva)
Color: Brown

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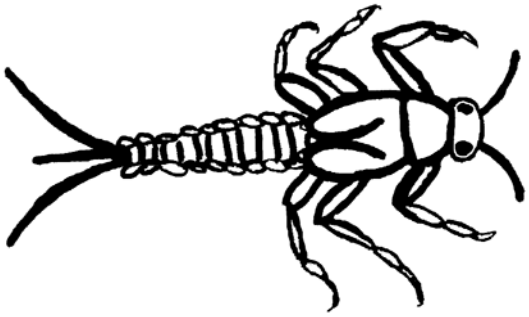
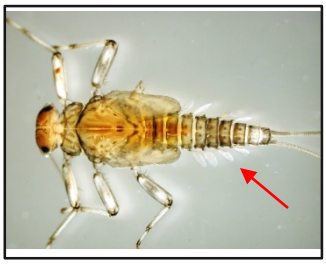
Small Minnow Mayfly

Misc. Other **25**



KEY FEATURES

- ❑ Small in overall size.
- ❑ Three pairs of legs; legs do not have a feathery fringe of hairs
- ❑ 2-3 hair-like tails, sometimes with a shorter middle tail



- ❑ Small, round gills along the sides of the abdomen – may be difficult to see without magnification
- ❑ Elongated wing pads

Taxonomic Information

Order: Ephemeroptera
Family: Baetidae
Genus: All

Ecological Information

Tolerance Value = 4
Feeding Group = Collector-gatherer
Stream Habitat = On and in rocky substrates

Key Behaviors

- Swim very well and will quickly swim in short bursts from one hiding spot to another in the tray

Important Notes

Baetidae are common in RBV samples, however due to their small size they are often easily missed when sampling. Baetidae is commonly confused with Isonychidae (Panel 2). Baetidae can be differentiated by its smaller size and lack of fine hairs along the inside edge of the front legs. (Some genera of Baetidae may also appear to only have two tails.)

Size and Color

Size: 3-12 mm
Color: Light brown

Above photographs courtesy of (top to bottom): NY DEC Biomonitoring Unit; Kelsey Quartuccio / CT DEEP; NY DEC Biomonitoring Unit; CT DEEP files, author unknown

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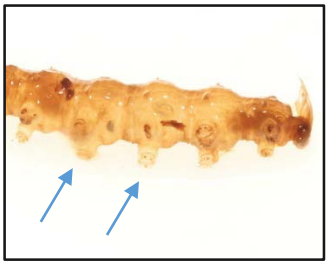
Aquatic Snipe Fly

Misc. Other 26

KEY FEATURES

- ❑ Body is elongate with a pointed head end and tail-like structures at the end of the abdomen.



- ❑ Series of small, paired prolegs along abdomen
- ❑ Rough appearance to the exoskeleton.

- ❑ Two stout, pointed tails with a fringe of hairs at the end of the abdomen

Taxonomic Information

Order: Diptera
Family: Athericidae
Genus: *Atherix*

Ecological Information

Tolerance Value = 2
Feeding Group = Predator
Stream Habitat = Buried in the substrate in fast flows

Key Behaviors

- No unique behaviors; may be observed crawling in tray

Important Notes

Atherix is relatively rare in RBV samples. They are piercer-predators that prey on midge and mayfly larvae.

Size and Color

Size: 10-20 mm
Color: Golden brown to dark brown

Above photographs courtesy of (top to bottom) Kelsey Quartuccio / CT DEEP; Becky Martorelli / Quinnipiac River Watershed Association; Jake Renkert / The Marvelwood School; and Kelsey Quartuccio / CT DEEP

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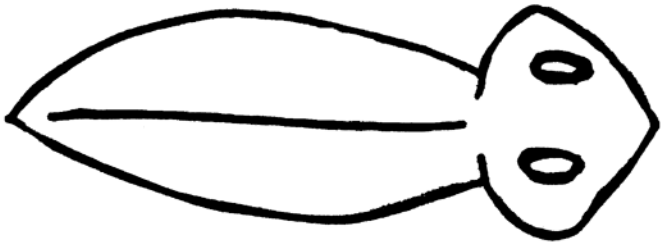
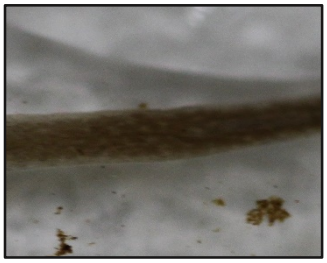
Flatworm

Misc. Other 27



KEY FEATURES



❑ Soft, elongate, flattened body without segmentation or legs

❑ Slightly triangular head with two eyespots on top. (Resemble a cross-eyed, unsegmented leech)

Taxonomic Information

Order: Tricladida
Family: Planariidae
Genus: *Planaria*

Ecological Information

Tolerance Value = 4
Feeding Group = Predator
Stream Habitat = On rocky substrate

Key Behaviors

- Planaria are able to 'glide' by beating microscopic cilia along a film of mucus.
- Tend to curl up when preserved

Important Notes

Although flatworms occur in a wide variety of habitats, they are rarely collected in RBV samples. When a large number of planarians are present in a collection, the site is most likely affected by organic pollution.
Flatworms are heavily studied due to their regenerative capacity; when split lengthwise or crosswise they will regenerate into two genetically identical, individuals!

Size and Color

Size: 5-20 mm
Color: Gray, brown or black on top, sometimes with spots or pattern; light on bottom

Above photographs courtesy of Meghan Lally / CT DEEP (top); Becky Martorelli / Quinnipiac River Watershed Association (bottom two)

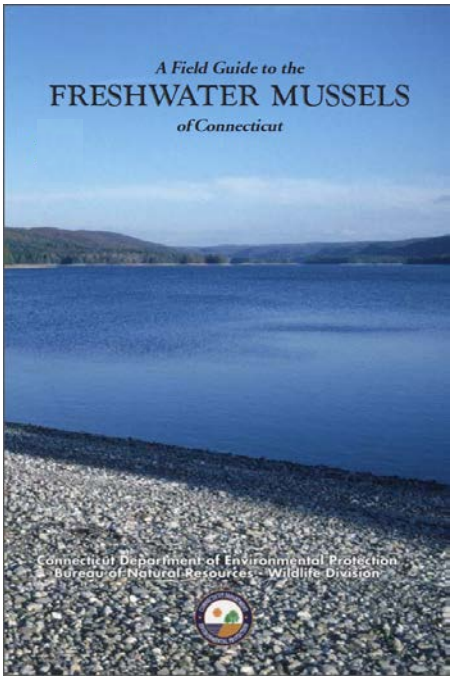
CT Dept. of Energy & Environmental Protection
Riffle Bioassessment by Volunteers Program
www.ct.gov/deep/rbv

Freshwater Mussel/Clam

Misc. Other **28**

FRESHWATER MUSSELS IN CONNECTICUT

Refer to the CT DEEP publication "A Field Guide to the Freshwater Mussels of Connecticut" for identification details.



To download a PDF version visit:
www.ct.gov/deep/lib/deep/wildlife/pdf_files/nongame/fwmusl.pdf

INTRODUCED MUSSELS IN CONNECTICUT

❑ **Zebra Mussel**
(*Dreissena polymorpha)*
- Small (< 1inch)
- Triangular shaped
- Distinct black or gray stripes
- Strongly adheres to surfaces

❑ **Asian Clam**
(*Corbicula fluminea)*
- Small (0.5-.75 inches wide)
- Triangular shaped
- Yellowish, light brown or black

Photographs courtesy of Dave Brenner, Michigan Sea Grant (top) and USGS, author unknown (bottom)

General Identification

The following characteristics are universally true of the freshwater mussels in CT:
- Two shells connected by a strong hinge
- No distinct head

Taxonomic Information

Order: Unionoida
Family: Margaritiferidae, Unionidae
Genus: See Field Guide

Ecological Information

Tolerance Value = 7
Feeding Group = Collector-filterer
Stream Habitat = Buried in substrate, slower flows

Key Behaviors

- Live on stream bottom, typically partially buried

Important Notes

Almost all kinds of mussels are sensitive to pollution and environmental stress. In Connecticut, 6 of the 12 native freshwater mussel species are listed as special concern, threatened, or endangered.

To avoid accidentally injuring a listed species, please **DO NOT DISTURB OR HANDLE LIVE MUSSELS** observed at your RBV monitoring location. **Photograph live mussels only; if empty shells are found, turn these in to your coordinator with your voucher.**

Size and Color

Size: Variable (refer to guide)
Color: Variable (refer to guide)

CT Dept. of Energy & Environmental Protection
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www.ct.gov/deep/rbv

Appendix F: Voucher Review Bench Sheet

RBV Voucher Review Bench Sheet

Database Sample ID# _____

SAMPLE INFORMATION:

AWQ#: _____ **Date:** _____
Waterbody: _____ **Town:** _____ *Affix voucher label here*

Group: _____ **ID#:** _____
Collector(s): _____

REVIEW SUMMARY:

Reviewer: **M. Lally**
Review Date: _____
'Most Wanted' Taxa: _____

Lab Accession #: ___**RBV-2019-**_____
Comments: _____

Panel #	Taxa Identification	Present	QC Issue	Comments
1	Drunella spp. (Ephemerellidae)			
2	Isonychia spp. (Isonychiidae)			
3	Epeorus spp. (Heptageniidae)			
4	Peltoperlidae			
5A	Perlidae			
5B	Pteronarcyidae			
5C	Capniidae			
	Perlodidae			
	Leuctridae			
	Chloroperlidae			
	Nemouridae			
	Taeniopterygidae			
6A	Glossosoma spp. (Glossosomatidae)			
6B	Apatania spp. (Apataniidae)			
7	Rhyacophila spp. (Rhyacophilidae)			
8A	Brachycentrus spp. (Brachycentridae)			
8B	Lepidostoma spp. (Lepidostomatidae)			
9	Hydropsychidae			
10	Philopotamidae			
11	Heptageniidae, not Epeorus spp.			
12	Psephenidae			
13	Corydalidae			
14A	Gomphidae			
	Cordulegasteridae			
	Aeshnidae			
	Macromiidae			
	Corduliidae			
	Libellulidae			
14B	Calopterygidae			
	Lestidae			
	Coenagrionidae			
15A	Amphipoda *(*All families = 1 taxa)*			
15B	Isopoda *(*All families = 1 taxa)*			
15C	Hirudinea *(*All families = 1 taxa)*			
15D	Chironimidae			
15E	Simuliidae			
15F	Gastropoda *(*All families = 1 taxa)*			
15G	Oligochaeta *(*All families = 1 taxa)*			
Other				
Other				
Other				
Other				
Other				
Other				

Appendix G: Event Training Record

RBV Program - Annual Volunteer Training
Training Sign-In Sheet

Training Date:_____

Training Location: _____

Host Organization(s):_____

Name of Trainer(s): _____

_____

PLEASE WRITE LEGIBLY. This is an official record that will be submitted to CT DEEP to prove you completed training today; volunteer first and last name are required fields.

FIRST NAME	LAST NAME	Email*	Phone*	Mailing Address*	"yes" or "no" Under 18 years old?*	New RBV Vol?

***Contact information will be used in the event that we need to contact you with questions regarding your monitoring location and/or results. Contact information is not required for volunteers under 18 years old.**

Appendix H: Voucher Labels

CT DEEP RBV Program
Voucher Labels

REMEMBER: WRITE IN PENCIL ONLY!! (Alcohol will dissolve most inks)

RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:
RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:
RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:
RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:
RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:
RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:
RBV VOUCHER Stream: Location: Town: Date: Organization: Collectors:	**RBV VOUCHER** Stream: Location: Town: Date: Organization: Collectors:

Appendix I: Equipment List

Last updated 8/16/16

RBV EQUIPMENT KIT CONTENTS

Present?	Equipment	Quantity	Notes
	RECTANGULAR FRAME KICK NET	**1**	Used to collect organisms from 6 riffle locations at your sampling station.
	CANVAS BAG	1	To contain the various other equipment during transport.
	WHITE RECTANGULAR SAMPLE TRAYS	3	The tray is used to view and sort the contents collected during each set of kicks.
	ICE CUBE TRAYS	3	Provides a convenient tool to sort the organisms by type. Each well can hold all of one type of organism.
	US # 30 SEIVE	1	Can be used to "rinse" the sample if there is a lot of fine material causing the water in the sample tray to be very cloudy.
	LAMINATED SORTING GUIDE	3	Use to identify the organisms observed in your sorting tray. Numbers on the guide correspond with the field ID cards and datasheet panels.
	LAMINATED FIELD ID CARDS	3 sets	Use to identify the organisms observed in your sorting tray. Panel numbers on the ID cards correspond with the organism numbers on the sorting guide and datasheet.
	LAMINATED DATASHEETS	3	Complete one laminated datasheet for each sorting tray. Use a wax pencil to mark off RBV organisms observed in your sorting tray. Organism numbers on the datasheet correspond with the numbers on the sorting guide and the panel numbers on the field ID cards.
	WAX PENCILS	4	Use with the laminated datasheet to temporarily record macroinvertebrates observed in your sorting tray. Use w/ equipment list to verify presence of all equipment.
	Bag w/ DATASHEETS	1	Each kit contains a plastic bag with multiple copies of the official paper datasheet. At the end of your sampling event you will compile the list of organisms noted on your laminated datasheets onto one datasheet for submission to DEEP.
	CLIP BOARD	1	Use to assist with completing the official paper datasheet
	PLASTIC SPOONS	6	Use to remove organisms from the sample tray and place them into the ice cube tray for sorting and identification.
	FORCEPS (TWEEZERS)	6	Use to remove organisms from the sample tray and place them into the ice cube tray for sorting and identification.
	HANDS LENSES	3	Use to magnify the organisms for identification.
	PETRI DISH – LID & BASE	1	Use to contain individual organisms during identification. Particularly helpful when trying to look at organisms with the hand lenses.
	VOUCHER CONTAINERS/VIALS	1	Each kit contains a plastic jar with several glass voucher containers/vials. The vial is used to preserve a voucher collection of organisms from your site. Return any unused vials to the plastic jar and put inside the equipment bag.
	VOUCHER LABELS	1	Each kit contains a plastic jar with several printed labels. Fill out one label and place it inside your voucher. Return unused labels to the plastic jar and put inside the equipment bag.
	PENCILS	4	Use to complete the final datasheet and voucher label for your sample.

IMPORTANT: You will also need **isopropyl alcohol, a camera*, stop watch*, and GPS unit*** to complete monitoring. Please check with your Coordinator if you do not have these supplies.
*(*Can be replaced with a smartphone with this capability.)*

To learn more about the CT DEEP RBV Program visit www.ct.gov/deep/rbv