Exponent™

Volume I

Data Report

Macroinvertebrate Communities and Diets of Selected Fish Species in the Upper Hudson River

Prepared for

General Electric Company
Albany, New York

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May 1998

Contract No.: 8600BCH.001 1033

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ACRONYMS AND ABBREVIATIONS

ARC	Aquatic Resources Center
IA	Ichthyological Associates, Inc.
NYSDEC	New York State Department of Environmental Conservation
PCB	polychlorinated biphenyl
QAPP	quality assurance project plan
Study Plan	*Ecological Value and Food Web Structure of Aquatic Vegetation Communities in the Upper Hudson River: Study Plan*

INTRODUCTION

To better understand the aquatic food web structure in the Upper Hudson River, General Electric Company retained the services of Exponent (formerly PTI Environmental Services) to design and implement a study of the structural differences in food webs of open, unvegetated sediments and food webs that characterize submerged aquatic vegetation habitats. The study design, *Ecological Value and Food Web Structure of Aquatic Vegetation Communities in the Upper Hudson River: Study Plan* (Study Plan; PTI 1997d), was previously submitted to the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Environmental Protection Agency.

The specific objective of this study is to compare food web structures in Thompson Island Pool and at Stillwater. The Study Plan identifies specific ecological and management questions that are to be addressed by the study (PTI 1997d). The taxonomic data on macroinvertebrate communities and the diets of selected fish species will be used to answer the following questions:

- What is the relative importance of food webs associated with aquatic vegetation (food sources physically separated from the sediment by plants) and those associated with sediments of the Upper Hudson River?
- How does food web structure differ among habitats (*V. americana*, *T. natans*, and unvegetated) and river reaches (Thompson Island Pool and Stillwater)?
- What are the potential effects of sediment removal or remediation on food webs and the relative importance of different sources of polychlorinated biphenyls (PCBs)?

This report presents only the results of the taxonomic identification and enumeration of macroinvertebrate and fish stomach-content samples and analysis of sediment total organic carbon and grain-size distribution. Analytical results are presented for the following samples:

- Stomach contents of largemouth bass (*Micropterus salmoides*), yellow bullhead (*Ictalurus natalis*), brown bullhead (*Ictalurus nebulosus*), pumpkinseed (*Lepomis gibbosus*), log perch (*Percina caprodes*), yellow perch (*Perca flavescens*), and spottail shiner (*Notropis hudsonius*) caught in vegetated habitats in the Upper Hudson River

- Phytophilous macroinvertebrates collected from *Trapa natans* (water chestnut) and *Vallisneria americana* (water celery)
- Benthic macroinvertebrates collected from vegetated and unvegetated sediments.

Data on species composition of the fish communities is presented in Exponent (1998).

T. natans and *V. americana* habitats were sampled for fish and macroinvertebrates because they are the two most common submerged plant species in Thompson Island Pool and much of the Upper Hudson River (PTI 1997b, Exponent 1998). Largemouth bass, pumpkinseed, and brown bullhead were selected as target species for stomach-content analysis because they are the primary species used by NYSDEC in their long-term monitoring program to characterize trends in PCB concentrations in fish of the Upper Hudson River. Yellow bullhead was used as a surrogate for brown bullhead when sufficient numbers of brown bullhead could not be collected with a reasonable effort. Log perch, yellow perch, and spottail shiner were the dominant forage fish species in the habitats sampled. Forage fish to be sampled for stomach-content analysis were selected in the field based on availability (two species per habitat) and preserved for stomach-content analysis (Table 1). Selection of the forage species was based on the relative abundance of fish in initial boat electroshocker catches.

The following sections present the methods of the fish stomach-content analyses, phytophilous and benthic macroinvertebrate sampling, sediment sampling, and taxonomic analyses. A taxonomic classification of organisms identified in this study is presented in Appendix A. Quality assurance review summaries are provided in Appendices B and C. Data tables referred to in this report are contained in Volume II.

METHODS

An overview of the methods used to collect and analyze samples is provided in this section. Detailed sample collection and analysis procedures are described in the field sampling plan for this investigation (PTI 1997b). All analyses were performed according to specifications outlined in the quality assurance project plan (QAPP) (PTI 1997c).

SAMPLE COLLECTION

Fish and macroinvertebrates were collected at the NYSDEC sampling area at Griffin Island, at an area in northern Thompson Island Pool, and at Stillwater (Figures 1 and 2). The investigation included two distinct areas in Thompson Island Pool. Data from the two sampling areas will be compared to assess potential variations in food web structure within Thompson Island Pool. Sampling was conducted at Stillwater to obtain data for comparison with Thompson Island Pool data.

Samples were collected in relatively shallow waters in each of three habitat types (*T. natans*, *V. americana*, and unvegetated) in each sampling area. At the northern Thompson Island Pool area, *T. natans* was absent; thus, only *V. americana* and unvegetated habitats were sampled. An additional habitat, an unvegetated habitat in deep water, was selected near Griffin Island for benthic macroinvertebrate sampling. The additional benthic macroinvertebrate samples were collected to compare benthic communities in shallow and deep waters.

FISH STOMACH CONTENTS

Fish Collection and Stomach-Content Extraction

Fish were collected for taxonomic analysis of stomach contents on September 12–28, 1997. Bass, bullhead, pumpkinseed, and forage fish species were collected primarily using a boat electroshocker because the boat was able to cover large areas within specific habitats. Bass greater than 30.5 cm, bullhead greater than 20 cm total length, and yearling pumpkinseed (75–120 mm) were targeted for collection to be consistent with methods used by NYSDEC in their PCB trends monitoring program. All sizes of forage fish were targeted for collection. A gill net was used beginning on September 25, 1997, to aid in the collection of bass and bullhead species in the Stillwater area. Yellow bullhead was the only species caught by gill net that was analyzed for stomach contents. Non-target fish collected incidentally during electroshocking were kept to provide additional insight into the characteristics of the fish communities of each habitat (PTI 1997a).

The largemouth bass and bullhead collected for stomach-content analysis were also used for analysis of PCBs in edible tissue (PTI 1998). The contents of bass and bullhead stomachs were evacuated and preserved in a buffered 10 percent formalin solution, as described in the field sampling plan (PTI 1997b). Subsequently, the body was frozen for later analysis of PCBs. Because pumpkinseed stomachs could not be evacuated without dissection, pumpkinseed were collected separately for PCB analysis. Forage species were dissected to remove the stomach when their total length exceeded 15 cm. Forage fish other than pumpkinseed shorter than or equal to 15 cm were preserved whole, with their body cavity slit open to allow for formalin penetration. To ensure adequate sample sizes for stomach-content analysis, initial samples of forage fish (n = 5–10 for each target species) were collected and stomach contents were examined. If a substantial percentage of the stomachs examined were empty, sampling was shifted to a different time of day until at least 80 percent of the fish examined had some stomach contents. The empty stomachs encountered in this initial field analysis were not retained in the data record.

All fish species were weighed and measured for total length before removing stomach contents or viscera. Fish collected after September 22, 1997, and preserved whole were measured for length in the field, but because of field equipment failure, they were weighed in the laboratory before stomach removal. As a quality control check, Aquatic Resources Center (ARC) of Franklin, Tennessee, re-weighed fish previously weighed in the field in addition to those that had never been weighed. Linear regression models were developed for two species (log perch and yellow perch) for which both laboratory and field-measured weights were collected. The relationship between laboratory and field measured weights was represented by the equation:

$$W_L = c \times W_F$$

where:

W_L = laboratory measured weight

W_F = field measured weight

c = coefficient.

Results of the regressions showed that the relationship between laboratory and field measured weights is essentially 1:1 (log perch: c=1.048, SE=0.007, R^2>0.99; yellow perch: c=0.935, SE=0.012, R^2=0.99). Therefore, the assumption was made that this relationship is consistent for all species, and laboratory measured weights were accepted and are presented in this report where weights could not be measured in the field.

Taxonomic Analysis

Analytical procedures were conducted in accordance with the requirements specified in the QAPP (PTI 1997c). Taxonomic analysis and enumeration of the stomach contents of nearly all bass, bullhead, and spottail shiner were performed by Ichthyological Associates, Inc. (IA), located in Lansing, New York. To minimize analysis costs and time, ARC

analyzed the stomach contents from 1 largemouth bass, 13 bullhead, and 5 spottail shiner. Except for a few samples of each species that were analyzed by IA, the stomach contents of all log perch, yellow perch, and pumpkinseed were analyzed by ARC. Because of their expertise in chironomid taxonomy, ARC identified and enumerated the chironomids from all fish species. This required IA to isolate the chironomids from the bass, bullhead, and spottail shiner stomach samples and ship them to ARC in Tennessee. IA removed any chironomids from each sample before counting other taxa in the sample. Chain-of-custody procedures were followed during all sample transfers. ARC mounted chironomids and cladocerans on slides and examined them under a microscope (chironomids at 500–800×; cladocerans at 250–400×) to enable accurate identification.

MACROINVERTEBRATE COMMUNITIES

Macroinvertebrate Collection

Phytophilous and benthic macroinvertebrates were collected on September 17–22, 1997. Benthic macroinvertebrate samples and sediments for conventional analyses were collected using a 3-in.-diameter corer according to the specifications in the field sampling plan (PTI 1997b). Replicate stations were located in each habitat that contained representative vegetation density for the area (in vegetated habitats) or was clear of vegetation (in unvegetated habitats). The number of replicate samples in each habitat was increased (from three in vegetated habitats or five in unvegetated habitats [see PTI 1997b]) to nine in each habitat because low densities of macroinvertebrates were observed upon initiation of sampling. To collect the benthic macroinvertebrates, divers from Seaway Diving and Salvage Company, Inc., located in Waterford, New York, sampled sediments to a depth of 8 in. Divers were able to push the corer into the sediments by hand at all stations.

Phytophilous macroinvertebrates were collected using a Plexiglas® box sampler (6-L volume) as described in the field sampling plan (PTI 1997b). At the same vegetated stations where benthic macroinvertebrates were sampled, divers used the box samplers to collect macroinvertebrates associated with vegetation. For *T. natans*, a plant that has proportionately unbalanced biomass distribution, the floating rosette was not sampled. Only the stems beneath the rosette were enclosed in the box sampler for removal. A minimum of one sample was collected at each station in each vegetated habitat. Duplicate samples were collected in *V. americana* and *T. natans* habitat at the Stillwater sampling area to allow additional statistical analyses (i.e., species-volume relationships).

Upon initiation of sampling, *T. natans* habitats were visually estimated to contain fewer organisms than the *V. americana* habitats. Thus, the sample volume in *T. natans* habitats was doubled to obtain a larger sampling of invertebrates. Two 6-L samples of phytophilous macroinvertebrates in *T. natans* habitat were combined to obtain each sample for taxonomy and enumeration. At Stillwater, duplicate composite samples were collected at each of the three stations in *T. natans* habitat. In accordance with the field sampling plan

(PTI 1997b), the vegetation and associated macroinvertebrates were preserved and shipped together for analysis.

In addition to the vegetation sampled with the phytophilous macroinvertebrates, vegetation was sampled using 0.1-m^2 quadrats. Vegetation was collected from inside quadrats to enable the comparison of phytophilous macroinvertebrate taxonomic results with the benthic macroinvertebrate results on a surface area basis. All aboveground plant parts of *V. americana* were collected from inside the quadrat; however, stems only, without floating rosettes, were collected in the quadrats in *T. natans* habitat. Duplicate quadrat samples were collected at each station sampled for phytophilous macroinvertebrates.

Measurements of water depth at the macroinvertebrate and vegetation sampling stations were standardized to the annual mean depth using hydrologic data generated and maintained by the U.S. Geological Survey. There is a water stage recorder at Fort Edward that records the river's stage height every 15 minutes of every day. These data are posted on the Internet (http//water.usgs.gov/public/realtime.html), and summary statistics are published each year. The data providing the stage height at Fort Edward at all time intervals during the vegetation survey, September 17 through September 25, 1997, were downloaded from the Internet. The annual mean discharge for Fort Edward for the period from 1978 to 1995 was reported by USGS (1995) to be 5,095 ft^3/sec. The annual mean stage height of 21.88 ft for Fort Edward was calculated from this value using a model of the relationship between stage height and discharge derived by USGS (1992). For each data point on each transect, the adjusted depth was calculated as:

$$AD = (G_{AM} - G_T) + D_T$$

where:

AD	=	adjusted depth (ft)
G_{AM}	=	annual mean stage height (ft)
G_T	=	stage height at time T (ft)
D_T	=	depth at time T (ft).

Taxonomic Analysis

Analytical procedures were conducted in accordance with the requirements specified in the QAPP (PTI 1997c). Barry A. Vittor and Associates, Inc., of Mobile, Alabama, conducted taxonomic analysis of all benthic and phytophilous macroinvertebrate samples and determined the biomass (dry weight) of the vegetation from each phytophilous macroinvertebrate sample and from quadrat samples. Procedures for taxonomic analysis were followed as described in the field sampling plan (PTI 1997b). Taxonomists identified organisms to the lowest level possible. Chironomids and oligochaetes were mounted on slides and examined under a microscope (10–100×) to enable accurate identification.

RESULTS

Results of the taxonomic analyses, fish characteristics, and biomass measurements are presented in the following sections. All data tables are contained in Volume II of this report. Summaries of the quality assurance reviews are also included; complete quality assurance reports are provided in Appendices A and B.

FISH STOMACH-CONTENT ANALYSES

Table 1 lists, by sample area, the total number of fish collected and archived and the data presented in this report. The results of the stomach-content analyses are presented in Tables 2–5.

The catch-per-unit-effort for largemouth bass, yellow and brown bullhead, and pumpkinseed was lower than for the smaller forage species. Fish collection in unvegetated areas was not successful. A total shock time of 135 minutes in unvegetated habitat resulted in collection of less than 10 individuals of any target species.

Stomach-content analyses were completed in the laboratory on 37 largemouth bass, 21 brown bullhead, 14 yellow bullhead, 98 pumpkinseed, 159 yellow perch, 149 log perch, 7 redbreast sunfish, 7 spotfin shiner, and 250 spottail shiner (Table 1). Stomachs of 28 fish were empty, and the stomach contents of 2 fish were found to be too dehydrated for identification. Also, three eastern silvery minnows were inadvertently collected because they were incorrectly identified as spottail shiners in the field. Thus, data for these 32 fish are not presented. Rock bass, golden shiner, and smallmouth bass stomachs were not analyzed but were archived because these samples were not needed to meet the goals of this phase of the study.

BENTHIC AND PHYTOPHILOUS MACROINVERTEBRATE ANALYSES

The water depth at each station sampled for phytophilous and benthic macroinvertebrates is presented in Table 6. Because the water fluctuated irregularly, measurements of depth recorded during the macroinvertebrate and fish sampling event were relative, not absolute, depth measurements (see *Methods*).

Benthic Macroinvertebrate Identifications

Eighty-six benthic macroinvertebrate samples were sieved, sorted, and processed for taxonomic identification and enumeration in accordance with the field sampling plan (PTI

1997b) and QAPP (PTI 1997c). All organisms were identified to the lowest possible taxonomic level (species level if possible). Table 6 shows the number of organisms identified in each sample by taxonomic group. Appendix A provides a key to the taxonomic codes used in Table 7.

Phytophilous Macroinvertebrate Identifications and Vegetation Biomass

Twenty-one phytophilous macroinvertebrate samples were sorted and processed for taxonomic identification and enumeration (Table 8) in accordance with the field sampling plan (PTI 1997b) and QAPP (PTI 1997c). Data for sample numbers PM0001, PM0002, PM0003, PM0010, PM0011, PM0012, PM0013, PM0014, and PM0015 from *T. natans* habitat at Griffin Island and Stillwater represent identifications from the composite samples. The dry weight biomass of vegetation from each sample of phytophilous macroinvertebrates is shown in Table 8. Vegetation biomass, as dry weight, from the 0.1-m^2 quadrat sampling is shown in Table 9.

Sediment Chemistry

The total organic carbon and grain-size distribution of sediments collected at each station are reported in Table 10.

SUMMARY OF QUALITY ASSURANCE REVIEW

The quality assurance review was conducted to verify that the laboratory quality assurance and quality control procedures were documented and that the quality of data is sufficient to meet the project's data quality objectives and support the use of the data for its intended purposes. All of the final fish stomach contents data and the phytophilous and benthic macroinvertebrate data are acceptable relative to the data quality objectives for this study (Appendices B and C).

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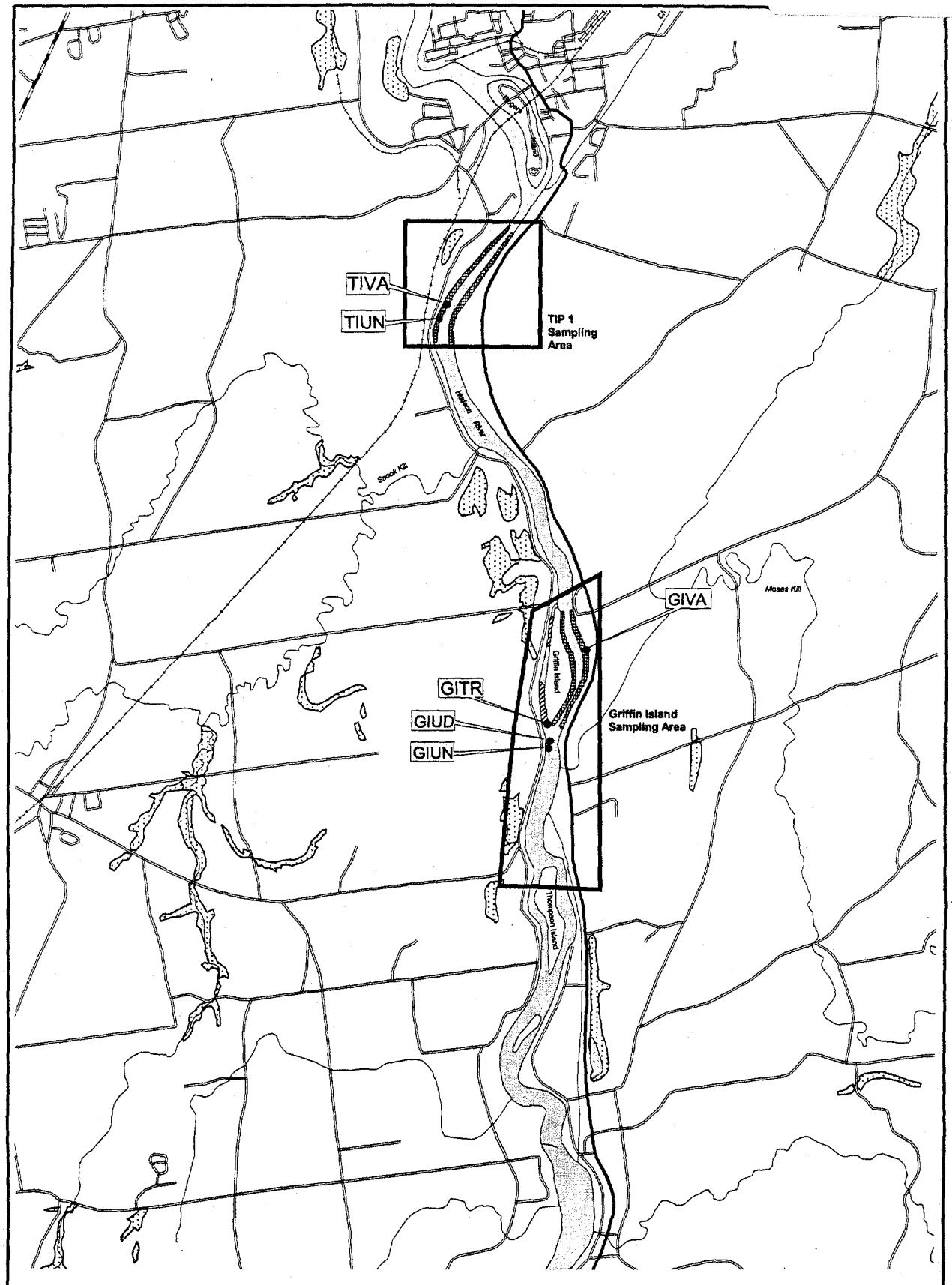
Figures



LEGEND

- Sampling station
- Local road
- Primary road
- Railroad
- Wetland
- Open water

Area of electroshocking
- *Trapa natans* habitats
- *Vallisneria americana* habitats

Note: Station IDs are coded as follows:
The first two letters designate the area
GI-Griffin Island
TI-northern Thompson Island Pool
The second two letters designate habitat type
TR-*Trapa natans*
VA-*Vallisneria americana*
UN-unvegetated
UD-unvegetated deepwater

Source: U.S. Geological Survey

0 2000 4000 8000 Feet

Figure 1. Sampling stations and electroshock and gill net transects at Griffin Island and northern Thompson Island Pool.

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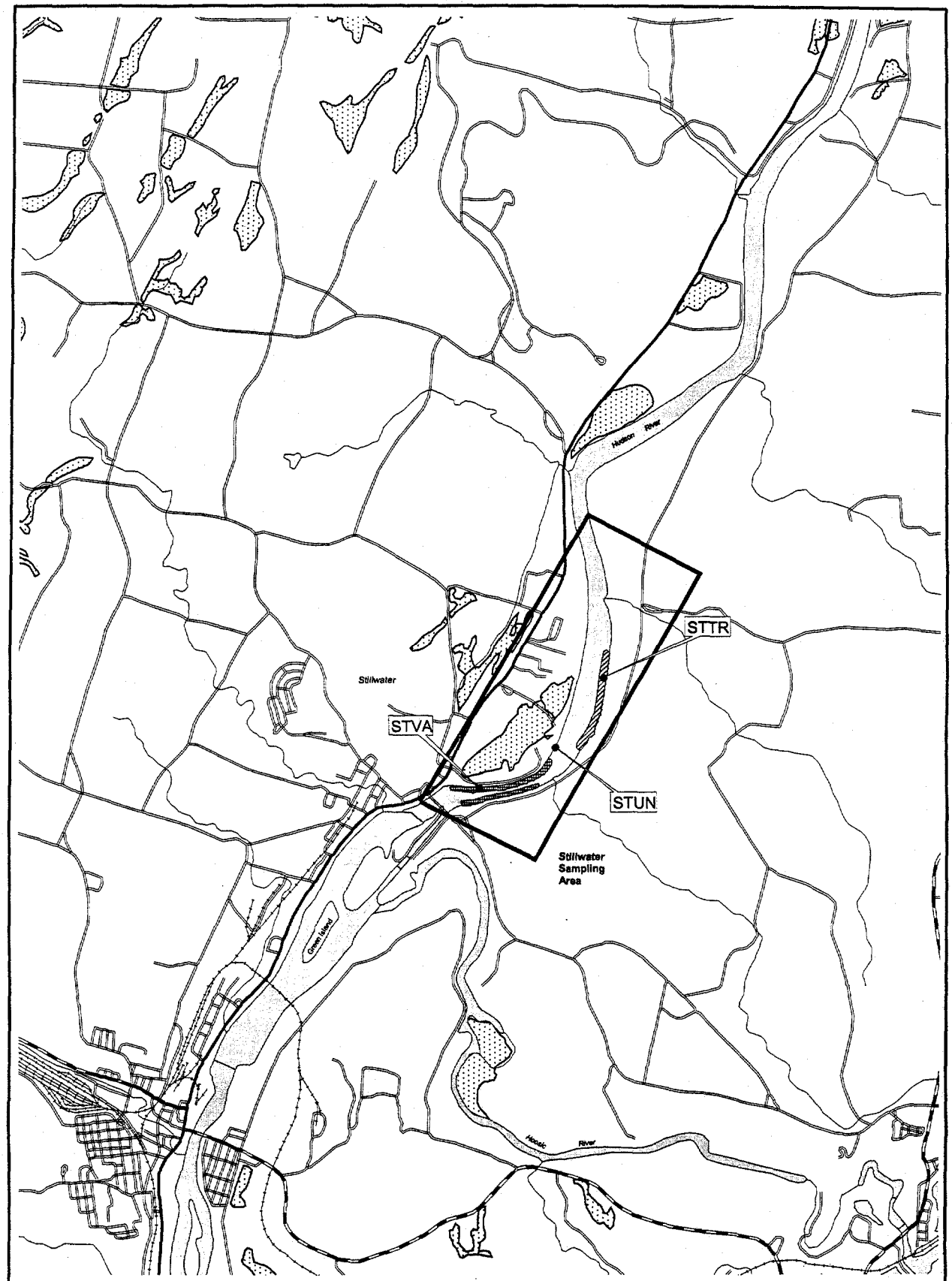

Figure 2. Sampling stations and electroshock and gill net transects at Stillwater.

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Tables

Presented in Volume II

Appendix A

Taxonomic Classification of Taxa Identified in All Samples

TABLE A-1. TAXONOMIC CLASSIFICATION OF TAXA IDENTIFIED IN ALL SAMPLES

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
BL	Chordata	Osteichthyes	Siluriformes		Ictaluridae		Ameirus	nebulosus	brown bullhead
BS	Chordata	Osteichthyes	Perciformes		Centrarchidae		Micropterus	salmoides	largemouth bass
Centrarc	Chordata	Osteichthyes	Perciformes		Centrarchidae				sunfishes; basses
Cyprinid	Chordata	Osteichthyes	Cypriniformes		Cyprinidae				minnows
Etheosto	Chordata	Osteichthyes	Perciformes		Percidae		Etheostoma		darters
HybRegiu	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Hybognathus	regius	eastern silvery minnow
Lepomis	Chordata	Osteichthyes	Perciformes		Centrarchidae		Lepomis		sunfishes
NC	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Notemigonus	crysoleucas	golden shiner
NotHudso	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Notropis	hudsonius	spottail shiner
Notropis	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Notropis		shiners
NS	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Notropis	spilopterus	spotfin shiner
PerCapro	Chordata	Osteichthyes	Perciformes		Percidae		Percina	caprodes	logperch
Percidae	Chordata	Osteichthyes	Perciformes		Percidae				perch; darters
PU	Chordata	Osteichthyes	Perciformes		Centrarchidae		Lepomis	gibbosus	pumpkinseed
RB	Chordata	Osteichthyes	Perciformes		Centrarchidae		Lepomis	auritus	red breast sunfish
SPSH	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Notropis	hudsonius	spottail shiner
YB	Chordata	Osteichthyes	Siluriformes		Ictaluridae		Ameirus	natalis	yellow bullhead
YP	Chordata	Osteichthyes	Perciformes		Percidae		Perca	flavescens	yellow perch
Ablabesm	Arthropoda	Insecta	Diptera		Chironomidae		Ablabesmyia		true flies
AblAnnul	Arthropoda	Insecta	Diptera		Chironomidae		Ablabesmyia	annulata	true flies
Abllidei	Arthropoda	Insecta	Diptera		Chironomidae		Ablabesmyia	idei	true flies
AblMallo	Arthropoda	Insecta	Diptera		Chironomidae		Ablabesmyia	mallochi	true flies
AblSimps	Arthropoda	Insecta	Diptera		Chironomidae		Ablabesmyia	simpsoni	true flies
Acarina	Arthropoda	Insecta	Acarina						mites
Acentria	Arthropoda	Insecta	Lepidoptera		Pyralidae		Acentria		butterflies; moths
Acroperu	Arthropoda	Crustacea	Cladocera		Chydoridae		Acroperus		water fleas
Agralea	Arthropoda	Insecta	Trichoptera		Hydroptilidae		Agralea		caddisflies
Agrypnia	Arthropoda	Insecta	Trichoptera		Phyrganeidae		Agrypnia		caddisflies
AlbHeter	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Alboglossiphonia	heteroclita	leeches
Algae									algae
AloAffin	Arthropoda	Crustacea	Cladocera		Chydoridae	Chydorinae	Alona	affinis	water fleas
AloExcis	Arthropoda	Crustacea	Cladocera		Chydoridae		Alonella	excisa	water fleas
AloGutta	Arthropoda	Crustacea	Cladocera		Chydoridae	Chydorinae	Alona	guttata	water fleas
Alona	Arthropoda	Crustacea	Cladocera		Chydoridae	Chydorinae	Alona		water fleas
AloQuadr	Arthropoda	Crustacea	Cladocera		Chydoridae	Chydorinae	Alona	quadrangularis	water fleas
AloRecta	Arthropoda	Crustacea	Cladocera		Chydoridae	Chydorinae	Alona	rectangula	water fleas
Amnicola	Mollusca	Gastropoda	Mesogastropoda		Hydrobiidae		Amnicola		snails; limpets
AmnLimn	Mollusca	Gastropoda	Mesogastropoda		Hydrobiidae		Amnicola	limnosa	snails; limpets
Amphipod	Arthropoda	Crustacea	Amphipoda						scuds
Ancylida	Mollusca	Gastropoda	Basommatophora		Ancylidae				snails; limpets
Ancyrony	Arthropoda	Insecta	Coleoptera		Elmidae		Ancyronyx		beetles
Anisopte	Arthropoda	Insecta	Odonata	Anisoptera					dragonflies; damselflies
Arachnid	Arthropoda	Arachnida							spiders

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
Argia	Arthropoda	Insecta	Odonata		Coenargrionidae		Argia		dragonflies; damselflies
Arrenuru	Arthropoda	Arachnida	Hydracarina		Arreburidae		Arrenurus		water mites
AulPigue	Annelida	Oligochaeta	Tubificida		Tubificidae		Aulodrilus	pigueti	aquatic worms
Axonopsi	Arthropoda	Arachnida	Hydracarina		Axonopsidae		Axonopsis		water mites
Baetidae	Arthropoda	Insecta	Ephemeroptera		Baetidae				mayflies
Baetis	Arthropoda	Insecta	Ephemeroptera		Baetidae		Baetis		mayflies
BatPhale	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Batracobdella	phalera	leeches
Batracob	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Batracobdella		leeches
Berosus	Arthropoda	Insecta	Coleoptera		Hydrophilidae		Berosus		beetles
BezPalpo	Arthropoda	Insecta	Diptera		Ceratopoginidae		Bezzia/Palpomyia		true flies
Bosmina	Arthropoda	Crustacea	Cladocera		Bosminidae		Bosmina		water fleas
Bosminid	Arthropoda	Crustacea	Cladocera		Bosminidae				water fleas
Bryozoa	Bryozoa	Bryozoa							moss animals
Caecidot	Arthropoda	Crustacea	Isopoda		Asellidae		Caecidotea		aquatic sow bugs
Caenis	Arthropoda	Insecta	Ephemeroptera		Caenidae		Caenis		mayflies
Callibae	Arthropoda	Insecta	Ephemeroptera		Baetidae		Callibaetis		mayflies
Cambarid	Arthropoda	Crustacea	Decapoda		Cambaridae				crayfish; freshwater shrimps
Camptoce	Arthropoda	Crustacea	Cladocera		Chydoridae		Camptocercus		water fleas
CamRecti	Arthropoda	Crustacea	Cladocera		Chydoridae		Camptocercus	rectirostris	water fleas
Candona	Arthropoda	Crustacea	Ostracoda		Candonidae		Candona		seed shrimps
Capitell	Annelida	Polychaeta			Capitellidae				marine worms
Ceraclea	Arthropoda	Insecta	Trichoptera		Leptoceridae		Ceraclea		caddisflies
Ceratopo	Arthropoda	Insecta	Diptera		Ceratopogonidae				true flies
Ceriodap	Arthropoda	Crustacea	Cladocera		Daphnidae		Ceriodaphnia		water fleas
CerRetic	Arthropoda	Crustacea	Cladocera		Daphnidae		Ceriodaphnia	reticulata	water fleas
Chaoboru	Arthropoda	Insecta	Diptera		Chaoboridae		Chaoborus		true flies
CheSerpe	Chordata	Reptilia	Testudines		Chelydridae		Chelydra	serpentina	snapping turtle
Chiromin	Arthropoda	Insecta	Diptera		Chironomidae	Chironominae	Chironomini-tribe		true flies
Chiromus	Arthropoda	Insecta	Diptera		Chironomidae		Chironomus		true flies
Chironom	Arthropoda	Insecta	Diptera		Chironomidae				true flies
Chrysops	Arthropoda	Insecta	Diptera		Tabanidae		Chrysops		true flies
Chydorid	Arthropoda	Crustacea	Cladocera		Chydoridae				water fleas
Chydorin	Arthropoda	Crustacea	Cladocera		Chydoridae	Chydorinae			water fleas
Chydorus	Arthropoda	Crustacea	Cladocera		Chydoridae		Chydorus		water fleas
ChySphae	Arthropoda	Crustacea	Cladocera		Chydoridae		Chydorus	sphaericus	water fleas
Cladocer	Arthropoda	Crustacea	Cladocera						water fleas
Cladopel	Arthropoda	Insecta	Diptera		Chironomidae		Cladopelma		true flies
Cladotan	Arthropoda	Insecta	Diptera		Chironomidae		Cladotanytarsus		true flies
Clinotan	Arthropoda	Insecta	Diptera		Chironomidae		Clinotanypus		true flies
Coelotan	Arthropoda	Insecta	Diptera		Chironomidae		Coelotanypus		true flies
Coenagri	Arthropoda	Insecta	Odonata		Coenargionidae		Coenagrion		dragonflies; damselflies
Coenargi	Arthropoda	Insecta	Odonata		Coenargionidae				dragonflies; damselflies
Coleopte	Arthropoda	Insecta	Coleoptera						beetles

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
Copepoda	Arthropoda	Crustacea	Copepoda						copepods
Cordulii	Arthropoda	Insecta	Odonata		Corduliidae				dragonflies; damselflies
Corixida	Arthropoda	Insecta	Hemiptera		Corixidae				true bugs
CorLibel	Arthropoda	Insecta	Odonata		Corduliidae/Libellulidae				dragonflies; damselflies
Corynone	Arthropoda	Insecta	Diptera		Chironomidae		Corynoneura		true flies
Crangony	Arthropoda	Crustacea	Amphipoda		Crangonyctidae		Crangonyx		scuds
CriBicin	Arthropoda	Insecta	Diptera		Chironomidae		Cricotopus	bicinctus	true flies
Cricetid	Chordata	Mammalia	Rodentia		Cricetidae				mice, rats, voles
Cricotop	Arthropoda	Insecta	Diptera		Chironomidae		Cricotopus		true flies
CriInter	Arthropoda	Insecta	Diptera		Chironomidae		Cricotopus	intersectus	true flies
CriOrtho	Arthropoda	Insecta	Diptera		Chironomidae		Cricotopus/Orthocladius		true flies
CriSylve	Arthropoda	Insecta	Diptera		Chironomidae		Cricotopus	sylvestris	true flies
Crustacea	Arthropoda	Crustacea							crustaceans
Cryptoch	Arthropoda	Insecta	Diptera		Chironomidae		Cryptochironomus		true flies
Cryptote	Arthropoda	Insecta	Diptera		Chironomidae		Crytotendipes		true flies
Culicoid	Arthropoda	Insecta	Diptera		Chironomidae		Culicoides		true flies
Cyclopid	Arthropoda	Crustacea	Copepoda	Cyclopoida	Cyclopidae				copepods
CycNaupl	Arthropoda	Crustacea	Copepoda	Cyclopoida	Cyclopidae				nauplii
CypB	Arthropoda	Crustacea	Ostracoda		Cypridopsidae		Cypridopsis	b	seed shrimps
Cypretta	Arthropoda	Crustacea	Ostracoda		Cypridopsidae		Cypretta		seed shrimps
Cypridop	Arthropoda	Crustacea	Ostracoda		Cypridopsidae		Cypridopsis		seed shrimps
Daphnida	Arthropoda	Crustacea	Cladocera		Daphnidae				water fleas
Dasyhele	Arthropoda	Insecta	Diptera		Ceratopogonidae		Dasyhelea		true flies
Demicryp	Arthropoda	Insecta	Diptera		Chironomidae		Demicryptochironomus		true flies
DerDigit	Annelida	Oligochaeta	Tubificida		Naididae		Dero	digitata	aquatic worms
DerTrifi	Annelida	Oligochaeta	Tubificida		Naididae		Dero	trifida	aquatic worms
DicModes	Arthropoda	Insecta	Diptera		Chironomidae		Dicrotendipes	modestus	true flies
DicNeomo	Arthropoda	Insecta	Diptera		Chironomidae		Dicrotendipes	neomodestus	true flies
DicNervo	Arthropoda	Insecta	Diptera		Chironomidae		Dicrotendipes	nervosus	true flies
Dicroten	Arthropoda	Insecta	Diptera		Chironomidae		Dicrotendipes		true flies
Didymops	Arthropoda	Insecta	Odonata		Corduliidae	Macromiinae	Didymops		dragonflies; damselflies
Diptera	Arthropoda	Insecta	Diptera						true flies
Dubiraph	Arthropoda	Insecta	Coleoptera		Elmidae		Dubiraphia		beetles
Dytiscid	Arthropoda	Insecta	Coleoptera		Dytiscidae				beetles
Ectopria	Arthropoda	Insecta	Coleoptera		Psephenidae		Ectopria		beetles
EinA	Arthropoda	Insecta	Diptera		Chironomidae		Einfeldia	a	true flies
Einfeldi	Arthropoda	Insecta	Diptera		Chironomidae		Einfeldia		true flies
EinNatci	Arthropoda	Insecta	Diptera		Chironomidae		Einfeldia	natcitochae	true flies
EllCompl	Mollusca	Bivalvia	Eulamellibranchia		Unionidae		Elliptio	complanata	clams; mussels
Elmidae	Arthropoda	Insecta	Coleoptera		Elmidae				beetles
Empidida	Arthropoda	Insecta	Diptera		Empididae				true flies
Enallagm	Arthropoda	Insecta	Odonata		Coenagrionidae		Enallagma		dragonflies; damselflies
Enchytra	Annelida	Oligochaeta	Tubificida		Enchytraeidae				aquatic worms

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
Endotrib	Arthropoda	Insecta	Diptera		Chironomidae		Endotribelos		true flies
Ephemeri	Arthropoda	Insecta	Ephemeroptera		Ephemeridae				mayflies
EpiPrinc	Arthropoda	Insecta	Odonata		Libellulidae		Epitheca	princeps	dragonflies; damselflies
EpiTetra	Arthropoda	Insecta	Odonata		Libellulidae		Epitheca/Tetragoneuria		dragonflies; damselflies
EpoFlave	Arthropoda	Insecta	Diptera		Chironomidae		Epoicocladius	flavens	true flies
Epoicocl	Arthropoda	Insecta	Diptera		Chironomidae		Epoicocladius		true flies
EubTubic	Arthropoda	Crustacea	Cladocera		Bosminidae		Eubosmina	tubicen	water fleas
Eurycerc	Arthropoda	Crustacea	Cladocera		Chydoridae		Eurycercus		water fleas
FerParal	Mollusca	Gastropoda	Basommatophora		Ancylidae		Ferrissia	parallela	snails; limpets
Ferrissi	Mollusca	Gastropoda	Basommatophora		Ancylidae		Ferrissia		snails; limpets
Formicid	Arthropoda	Insecta	Hymenoptera		Formicidae				ants; bees; wasps
GamFacia	Arthropoda	Crustacea	Amphipoda		Gammaridae		Gammarus	fasciatus	scuds
GamLacus	Arthropoda	Crustacea	Amphipoda		Gammaridae		Gammarus	lacustris	scuds
Gammarid	Arthropoda	Crustacea	Amphipoda		Gammaridae				scuds
Gammaru	Arthropoda	Crustacea	Amphipoda		Gammaridae		Gammarus		scuds
Gastropo	Mollusca	Gastropoda							snails; limpets
Glyptote	Arthropoda	Insecta	Diptera		Chironomidae		Glyptotendipes		true flies
Gomphida	Arthropoda	Insecta	Odonata		Gomphidae				dragonflies; damselflies
Graptole	Arthropoda	Crustacea	Cladocera		Chydoridae		Graptoleberis		water fleas
GraTestu	Arthropoda	Crustacea	Cladocera		Chydoridae		Graptoleberis	testudunaria	water fleas
Gyraulus	Mollusca	Gastropoda	Basommatophora		Planorbidae		Gyraulus		snails; limpets
GyrDefle	Mollusca	Gastropoda	Basommatophora		Planorbidae		Gyraulus	deflectus	snails; limpets
Gyrinus	Arthropoda	Insecta	Coleoptera		Gyrinidae		Gyrinus		beetles
Haliplus	Arthropoda	Insecta	Coleoptera		Haliplidae		Haliplus		beetles
Harpacti	Arthropoda	Crustacea	Copepoda	Harpacticoida					copepods
HelElong	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Helobdella	elogata	leeches
HelFusca	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Helobdella	fusca	leeches
Helobdel	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Helobdella		leeches
HelStagn	Annelida	Hirudinea	Rhynchobdellida		Glossiphoniidae		Helobdella	stagnalis	leeches
Hemerodr	Arthropoda	Insecta	Diptera		Empididae		Hemerodromia		true flies
Hemipter	Arthropoda	Insecta	Hemiptera						true bugs
Heptagen	Arthropoda	Insecta	Ephemeroptera		Heptageniidae				mayflies
Hexageni	Arthropoda	Insecta	Ephemeroptera		Ephemeridae		Hexagenia		mayflies
HexLimba	Arthropoda	Insecta	Ephemeroptera		Ephemeridae		Hexagenia	limbata	mayflies
Hirudine	Annelida	Hirudinea							leeches
Homptera	Arthropoda	Insecta	Homoptera						semiaquatic true bugs
HyaAztec	Arthropoda	Crustacea	Isopoda		Hyallelidae		Hyalella	azteca	aquatic sow bugs
Hydatoph	Arthropoda	Insecta	Trichoptera		Limnephilidae		Hydatophylax		caddisflies
Hydrachn	Arthropoda	Arachnidae	Hydracarina						water mites
Hydrobii	Mollusca	Gastropoda	Mesogastropoda		Hydrobiidae				snails; limpets
Hydrodae	Arthropoda	Insecta	Trichoptera		Hydroptilidae				caddisflies
Hydropsy	Arthropoda	Insecta	Trichoptera		Hydropsychidae				caddisflies
Hydropti	Arthropoda	Insecta	Trichoptera		Hydroptilidae		Hydroptila		caddisflies

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
Hydrozet	Arthropoda	Arachnida	Hydracarina		Eremaeidae		Hydrozetes		water mites
Hydrozoa	Cnidaria	Hydrozoa							hydrozoans
Hygrobat	Arthropoda	Arachnida	Hydracarina		Hygrobatidae		Hygrobates		water mites
Hymenopt	Arthropoda	Insecta	Hymenoptera						ants; bees; wasps
Ilyocryp	Arthropoda	Crustacea	Cladocera		Macrothricidae		Ilyocryptus		water fleas
Insecta	Arthropoda	Insecta							insects
Isopoda	Arthropoda	Crustacea	Isopoda						aquatic sow bugs
Kurzia	Arthropoda	Crustacea	Cladocera		Chydoridae		Kurzia		water fleas
LabNeopi	Arthropoda	Insecta	Diptera		Chironomidae		Labrundinia	neopilosella	true flies
LabPilos	Arthropoda	Insecta	Diptera		Chironomidae		Labrundinia	pilosella	true flies
Labrundi	Arthropoda	Insecta	Diptera		Chironomidae		Labrundinia		true flies
LaeFuscu	Mollusca	Gastropoda	Basommatophora		Ancylidae		Laevapex	fuscus	snails; limpets
Laevapex	Mollusca	Gastropoda	Basommatophora		Ancylidae		Laevapex		snails; limpets
LarFish									Larval fish
Larsia	Arthropoda	Insecta	Diptera		Chironomidae		Larsia		true flies
LatSetif	Arthropoda	Crustacea	Cladocera		Sididae		Latona	setifera	water fleas
Lebertia	Arthropoda	Arachnida	Hydracarina		Lebertiidae		Lebertia		water mites
Lepidopt	Arthropoda	Insecta	Lepidoptera						butterflies; moths
Leptoced	Arthropoda	Insecta	Trichoptera		Leptoceridae		Leptocerus		caddisflies
Leptocer	Arthropoda	Insecta	Trichoptera		Leptoceridae				caddisflies
Libellul	Arthropoda	Insecta	Odonata		Libellulidae				dragonflies; damselflies
LimHoffm	Annelida	Oligochaeta	Tubificida		Tubificidae		Limnodrilus	hoffmeisteri	aquatic worms
Limnephi	Arthropoda	Insecta	Trichoptera		Limnesiidae				caddisflies
Limnesia	Arthropoda	Arachnida	Hydracarina		Limnephilidae		Limnesia		water mites
Lophopod	Bryozoa	Phylactolaemata			Lophopodidae		Lophopodella		moss animals
Lumbrici	Annelida	Oligochaeta	Lumbricida		Lumbricidae				aquatic worms
Lumbricu	Annelida	Oligochaeta	Lumbriculida		Lumbriculidae				aquatic worms
Lymnaeid	Mollusca	Gastropoda	Basommatophora		Lymnaeidae				snails; limpets
Lype	Arthropoda	Insecta	Trichoptera		Psychomyiidae		Lype		caddisflies
Macromia	Arthropoda	Insecta	Odonata		Corduliidae	Macromiidae	Macromia		dragonflies; damselflies
Macronyc	Arthropoda	Insecta	Coleoptera		Elmidae		Macronychus		beetles
Malacost	Arthropoda	Crustacea	Malacostraca						miscellaneous crustaceans
Mallocho	Arthropoda	Insecta	Diptera		Ceratopogonidae		Mallochohelea		true flies
ManSpeci	Annelida	Polychaeta			Sabellidae		Manayunkia	speciosa	marine worms
MicPedel	Arthropoda	Insecta	Diptera		Chironomidae		Microtendipes	pedellus	true flies
Micromen	Mollusca	Gastropoda	Basommatophora		Planorbidae		Micromenetus		snails; limpets
Mideopsi	Arthropoda	Arachnida	Hydracarina		Mideopsidae		Mideopsis		water mites
Molanna	Arthropoda	Insecta	Trichoptera		Molannidae		Molanna		caddisflies
Mollusca	Mollusca								molluscs
Muscidae	Arthropoda	Insecta	Diptera		Muscidae				true flies
Musculiu	Mollusca	Bivalvia	Heterodonta		Sphaeriidae		Musculium		clams; mussels
Mystacid	Arthropoda	Insecta	Trichoptera		Leptoceridae		Mystacides		caddisflies
Naididae	Annelida	Oligochaeta	Tubificida		Naididae				aquatic worms

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
NaiEling	Annelida	Oligochaeta	Tubificida		Naididae		Nais	elinguis	aquatic worms
Nais	Annelida	Oligochaeta	Tubificida		Naididae		Nais		aquatic worms
NanCrass	Arthropoda	Insecta	Diptera		Chironomidae		Nanocladius	nr. crassicornus	true flies
NanDisti	Arthropoda	Insecta	Diptera		Chironomidae		Nanocladius	distinctus	true flies
Nanoclad	Arthropoda	Insecta	Diptera		Chironomidae		Nanocladius		true flies
Nematoda	Nematoda	Nematoda							roundworms
Neoplea	Arthropoda	Insecta	Hemiptera		Pleidae		Neoplea		true bugs
Neurecli	Arthropoda	Insecta	Trichoptera		Polycentropidae		Neureclipsis		caddisflies
Neurocor	Arthropoda	Insecta	Odonata		Corduliidae		Neurocordulia		dragonflies; damselflies
Nilothau	Arthropoda	Insecta	Diptera		Chironomidae		Nilothauma		true flies
Odonata	Arthropoda	Insecta	Odonata						dragonflies; damselflies
Oecetis	Arthropoda	Insecta	Trichoptera		Leptoceridae		Oecetis		caddisflies
Oligocha	Annelida	Oligochaeta							aquatic worms
OrcObscu	Arthropoda	Crustacea	Decapoda		Cambaridae		Orconectes	obscurus	crayfish; freshwater shrimps
Orconect	Arthropoda	Crustacea	Decapoda		Cambaridae		Orconectes		crayfish; freshwater shrimps
OrtC	Arthropoda	Insecta	Diptera		Chironomidae	Orthocladiinae		c	true flies
Orthocla	Arthropoda	Insecta	Diptera		Chironomidae	Orthocladiinae			true flies
Orthotri	Arthropoda	Insecta	Trichoptera		Hydroptilidae		Orthotrichia		caddisflies
Ostracod	Arthropoda	Crustacea	Ostracoda						seed shrimps
Oxus	Arthropoda	Arachnida	Hydracarina		Oxidae		Oxus		water mites
Oxyethir	Arthropoda	Insecta	Trichoptera		Hydroptilidae		Oxyethira		caddisflies
PacLongi	Arthropoda	Insecta	Odonata		Libellulidae		Pachydiplax	longipennis	dragonflies; damselflies
Parachir	Arthropoda	Insecta	Diptera		Chironomidae		Parachironomus		true flies
Parakief	Arthropoda	Insecta	Diptera		Chironomidae		Parakiefferiella		true flies
Parapoyn	Arthropoda	Insecta	Lepidoptera		Pyralidae	Nymphulinae	Parapoynx		butterflies; moths
Paratany	Arthropoda	Insecta	Diptera		Chironomidae		Paratanytarsus		true flies
Perithem	Arthropoda	Insecta	Odonata		Libellulidae		Perithemis		dragonflies; damselflies
PhaObedi	Arthropoda	Insecta	Diptera		Chironomidae		Phaenopsectra	obediens	true flies
PhaPunct	Arthropoda	Insecta	Diptera		Chironomidae		Phaenopsectra	punctipes	true flies
Pharygan	Arthropoda	Insecta	Trichoptera		Phryganeidae		Pharyganea		caddisflies
Phrygane	Arthropoda	Insecta	Trichoptera		Phryganeidae				caddisflies
Phylocen	Arthropoda	Insecta	Trichoptera		Dipsendopsidae		Phylocentropus		caddisflies
Physa	Mollusca	Gastropoda	Basommatophora		Physidae		Physa		snails; limpets
Physella	Mollusca	Gastropoda	Basommatophora		Physidae		Physella		snails; limpets
Physidae	Mollusca	Gastropoda	Basommatophora		Physidae				snails; limpets
Physinae	Mollusca	Gastropoda	Basommatophora		Physidae	Physinae			snails; limpets
PimNotat	Chordata	Osteichthyes	Cypriniformes		Cyprinidae		Pimephales	notatus	bluntnose minnow
Piona	Arthropoda	Arachnida	Hydracarina		Pionidae		Piona		water mites
PisDubiu	Mollusca	Bivalvia	Heterodonta		Sphaeriidae		Pisidium	dubium	clams; mussels
Pisidium	Mollusca	Bivalvia	Heterodonta		Sphaeriidae		Pisidium		clams; mussels
Planarii	Platyhelminthes	Turbellaria	Tricladida		Planariidae				flatworms
Planorbi	Mollusca	Gastropoda	Basommatophora		Planorbidae				snails; limpets
PlaScala	Mollusca	Gastropoda	Basommatophora		Planorbidae		Planorbella	scalaris	snails; limpets

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
PleDenti	Arthropoda	Crustacea	Cladocera		Chydoridae		Pleuroxus	denticulatus	water fleas
PleProcu	Arthropoda	Crustacea	Cladocera		Chydoridae		Pleuroxus	procurvus	water fleas
Pleuroxu	Arthropoda	Crustacea	Cladocera		Chydoridae		Pleuroxus		water fleas
PolConvi	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum	convictum	true flies
PolFalla	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum	fallax	true flies
PolHalte	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum	halterale	true flies
PolIllin	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum	illinoense	true flies
PolLaetu	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum	laetum	true flies
PolScala	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum	scalaenum	true flies
Polycend	Arthropoda	Insecta	Trichoptera		Polycentropodidae				caddisflies
Polycent	Arthropoda	Insecta	Trichoptera		Polycentropodidae		Polycentropus		caddisflies
Polypedi	Arthropoda	Insecta	Diptera		Chironomidae		Polypedilum		true flies
Pristina	Annelida	Oligochaeta	Tubificida		Naididae		Pristina		aquatic worms
ProBellu	Arthropoda	Insecta	Diptera		Chironomidae		Procladius	bellus	true flies
Probezzi	Arthropoda	Insecta	Diptera		Ceratopogonidae		Probezzia		true flies
Procladi	Arthropoda	Insecta	Diptera		Chironomidae		Procladius		true flies
Procloeo	Arthropoda	Insecta	Ephemeroptera		Baetidae		Procloeon		mayflies
ProHolot	Arthropoda	Insecta	Diptera		Chironomidae		Procladius	holotanypus	true flies
PseColum	Mollusca	Gastropoda	Basommatophora		Lymnaeidae		Pseudosuccinea	columella	snails; limpets
Psectroc	Arthropoda	Insecta	Diptera		Chironomidae		Psectrocladius		true flies
PseGlobo	Arthropoda	Crustacea	Cladocera		Chydoridae		Pseudochydorus	globosus	water fleas
Pseudoch	Arthropoda	Insecta	Diptera		Chironomidae		Pseudochironomus		true flies
Pyralida	Arthropoda	Insecta	Lepidoptera		Pyralidae				butterflies; moths
QuiMulti	Annelida	Oligochaeta	Tubificida		Tubificidae		Quistadrilus	multisetosus	aquatic worms
Ranidae	Chordata	Amphibia	Anura		Ranidae				frog
Rheotany	Arthropoda	Insecta	Diptera		Chironomidae		Rheotanytarsus		true flies
Sabellid	Annelida	Polychaeta			Sabellidae				marine worms
Sialis	Arthropoda	Insecta	Megaloptera		Sialidae		Sialis		dobsonflies; alderflies
Sida	Arthropoda	Crustacea	Cladocera		Sididae		Sida		water fleas
SidCryst	Arthropoda	Crustacea	Cladocera		Sididae		Sida	crystallina	water fleas
Sididae	Arthropoda	Crustacea	Cladocera		Sididae				water fleas
Simoceph	Arthropoda	Crustracea	Cladocera		Daphniidae		Simocephalus		water fleas
Siphlonu	Arthropoda	Insecta	Ephemeroptera		Siphlonuridae				mayflies
Somatoch	Arthropoda	Insecta	Odonata		Corduliidae		Somatochlora		dragonflies; damselflies
Sperchon	Arthropoda	Arachnida	Hydracarina		Sperchontidae		Sperchon	b	water mites
Sphaerii	Mollusca	Bivalvia	Heterodonta		Sphaeriidae				clams; mussels
Sphaeriu	Mollusca	Bivalvia	Heterodonta		Sphaeriidae		Sphaerium		clams; mussels
Sphaerom	Arthropoda	Insecta	Diptera		Ceratopogonidae		Sphaeromias		true flies
SphFabal	Mollusca	Bivalvia	Heterodonta		Sphaeriidae		Sphaerium	fabale	clams; mussels
SphStria	Mollusca	Bivalvia	Heterodonta		Sphaeriidae		Sphaerium	striatinum	clams; mussels
Stenacro	Arthropoda	Insecta	Ephemeroptera		Heptageniidae		Stenacron		mayflies
Stenelmi	Arthropoda	Insecta	Coleoptera		Elmidae		Stenelmis		beetles
Stenochi	Arthropoda	Insecta	Diptera		Chironomidae		Stenochironom		true flies

TABLE A-1. (cont.)

Taxon	Phylum	Class	Order	Suborder	Family	Subfamily	Genus	Species	Common Name
Stenonem	Arthropoda	Insecta	Ephemeroptera		Heptageniidae		Stenonema		mayflies
StyLacus	Annelida	Oligochaeta	Tubificida		Naididae		Stylaria	lacustris	aquatic worms
Synortho	Arthropoda	Insecta	Diptera		Chironomidae		Synorthocladius		true flies
Tabanida	Arthropoda	Insecta	Diptera		Tabanidae				true flies
Tan2	Arthropoda	Insecta	Diptera		Chironomidae		Tanytarsus	2	true flies
Tanypodi	Arthropoda	Insecta	Diptera		Chironomidae	Tanypodinae			true flies
Tanypus	Arthropoda	Insecta	Diptera		Chironomidae		Tanypus		true flies
Tanytars	Arthropoda	Insecta	Diptera		Chironomidae		Tanytarsus		true flies
Tanytini	Arthropoda	Insecta	Diptera		Chironomidae	Chirominae	Tanytarsini-tribe		true flies
Thienema	Arthropoda	Insecta	Diptera		Chironomidae		Thienemannimyia		true flies
Thienlla	Arthropoda	Insecta	Diptera		Chironomidae		Thienemanniella		true flies
Tipulida	Arthropoda	Insecta	Diptera		Tipulidae				true flies
Triaenod	Arthropoda	Insecta	Trichoptera		Leptoceridae		Triaenodes		caddisflies
Tribelos	Arthropoda	Insecta	Diptera		Chironomidae		Tribelos		true flies
Trichopt	Arthropoda	Insecta	Trichoptera						caddisflies
Tubifici	Annelida	Oligochaeta	Tubificida		Tubificidae				aquatic worms
Turbella	Platyhelminthes	Turbellaria							flatworms
Unionico	Arthropoda	Arachnida	Hydracarina				Unionicola		water mites
Unionida	Mollusca	Bivalvia	Eulamellibranchia		Unionidae				clams; mussels
ValBicar	Mollusca	Gastropoda	Mesogastropoda		Valvatidae		Valvata	bicarinata	snails; limpets
ValPisci	Mollusca	Gastropoda	Mesogastropoda		Valvatidae		Valvata	piscinalis	snails; limpets
Valvata	Mollusca	Gastropoda	Mesogastropoda		Valvidae		Valvata		snails; limpets
Valvatid	Mollusca	Gastropoda	Mesogastropoda		Valvatidae				snails; limpets
ZavMarmo	Arthropoda	Insecta	Diptera		Chironomidae		Zavreliella	marmorata	true flies
Zygopter	Arthropoda	Insecta	Odonata	Zygoptera					dragonflies; damselflies

Appendix B

Quality Assurance Review Summary

Fish Stomach-Content Taxonomic Analyses

QUALITY ASSURANCE REVIEW SUMMARY

FISH STOMACH-CONTENT TAXONOMIC ANALYSES

This summary documents the results of the quality assurance review of the fish stomach-contents data generated in 1997 for the assessment of ecological value and food web structure in segments of the Upper Hudson River. The quality assurance review was performed to ensure that evaluations were conducted in accordance with the specifications of the study plan (PTI 1997c) and the field sampling plan (PTI 1997a) and that the data are acceptable for use in future stages of the food web study

The quality assurance review consisted of an evaluation of the following major elements of the fish stomach-content investigation:

- **Field Methods**—Were the major specifications of the field sampling procedures followed as described in the field sampling plan (PTI 1997a)?
- **Laboratory Methods**—Were the major specifications of the laboratory testing procedures followed as described in the quality assurance project plan (QAPP) (PTI 1997b) and the statement of work submitted to the taxonomic laboratory?
- **Taxonomic Accuracy**—Were the taxonomic identifications verified by taxonomists outside the taxonomic laboratory?
- **Test Results**—Were there any anomalous results that should be rejected or qualified?

SUMMARY OF QUALIFIED DATA

Taxonomic results were reported for 284 fish stomach-content samples from Griffin Island, for 145 fish stomach-content samples from the northern Thompson Island Pool, and for 213 fish stomach-content samples from Stillwater. Results were not available for 18 fish stomach-content samples from Griffin Island, for 4 fish stomach-content samples from the northern Thompson Island Pool, and for 6 fish stomach-content samples from Stillwater because no organisms were found in those samples. The results of two samples from the northern Thompson Island Pool and one sample from Stillwater are not presented because these fish were misidentified as spottail shiners in the field and accurately identified by Ichthyological Associates, Inc. (IA), as eastern silvery minnows. The results of two samples from Stillwater were rejected because the stomach contents had dehydrated before analyses were conducted, making identifications impossible.

of the quality assurance review, all of the fish stomach-content data presented in this report are considered acceptable for use during the food web study.

FIELD METHODS

The quantities of each species collected are described in the methods section of the main text. The major field collection specifications for the fish stomach-content study were identified in the field sampling plan (PTI 1997a) as follows:

- Fish were collected using a boat electroshocker or pop-net
- Fifty fish of each species were collected at each station
- Stomach contents of bullhead and bass were pumped and immediately preserved in a buffered solution of 10-percent formalin
- Each sample was preserved in a buffered solution of 10-percent formalin
- Proper chain-of custody documentation was maintained at all times.

In addition, a gill net was used to catch bass and bullhead at the Stillwater sampling area. Fifty fish were successfully collected for each forage species in each habitat, but less than 50 bass, bullhead, and pumpkinseed were collected in each habitat because of a lower catch rate. Individuals of more than two forage species were collected in all habitats to allow for later selection of the most appropriate and abundant species for use in the food web analysis. All other specifications of field sampling were followed. Based on the major field procedures used to collect fish stomach-content samples, all of the results of the fish stomach-content evaluations are considered acceptable for use during the food web study.

LABORATORY METHODS

The analytical methods for fish stomach contents were based on the specifications presented in the QAPP (PTI 1997b) and the laboratory statements of work (Attachments B1 and B2) as follows:

- Samples were re-screened and transferred to a solution of 70 percent ethanol between 1 and 10 days after fixation with formalin in the field
- Samples were sorted into major taxonomic groups with the aid of a 10× dissecting microscope or a magnifying lamp
- Organisms were identified to the lowest taxonomic level possible (target = species) by experienced taxonomists using the appropriate taxonomic literature

- Taxonomic identifications were verified by taxonomists outside the analytical laboratory
- A reference collection was prepared (including the various taxa identified during the project) and archived.

Based on the major laboratory methods used for the stomach-content evaluations, all of the results are considered acceptable for use during the food web study.

Taxonomic Accuracy

The accuracy of taxonomic identifications was ensured by using the appropriate taxonomic literature to make the initial identifications (Attachment B3) and by having the identities of representative taxa in the reference collection of Aquatic Resources Center (ARC) verified by outside taxonomists (Table B-1). IA verified all organisms except chironomids in the reference collections. A chironomid expert, Dr. Ferrington, verified all chironomids in the reference collection. ARC also verified reference collections of phytophilous and benthic macroinvertebrates originally identified by BVA (see Appendix C, Tables C-1 and C-2). Additionally, IA and ARC randomly selected samples on which to perform internal verification of identification. A second taxonomist at ARC analyzed these selected samples. With only one in-house taxonomist available, IA compared organisms from selected samples against a second literature reference or the IA reference collection. These internal verifications were not mandated; therefore, the results are not documented for presentation.

The literature used by the laboratory is considered appropriate for identifying invertebrate taxa found in the vicinity of the Hudson River. The results of the reference collection verifications indicated that in nearly all cases the identifications made by ARC were accurate. There were four discrepancies that were identified during verification. A comparison of identifications made by ARC, IA, and Dr. Ferrington, including these discrepancies, is presented in Table B-2. Differences in the level of classification identified by the taxonomists are not considered discrepancies. Changes noted in the comment column of Table B-2 were applied to all samples in the stomach content analysis database.

Errors included differences in identification at the family level and above. The calculation of identification accuracy did not include discrepancies based on differences in specificity. Also, miscellaneous items such as unidentified remains and vegetation were not recorded by the outside taxonomist; thus, they were not used in accuracy calculations. The results of the external taxonomic verifications indicated that significant variation exists in the number of taxa and individuals that were identified by the two different laboratories (Tables B-2 and B-3). Taxa were identified by the outside taxonomist to a more general level than taxa identified by the original taxonomist. For example, ARC identified copepods in a sample (FI0174) to the suborder level of Cyclopoida, but BVA did not specify classification beyond the order, Copepoda. Some

variation due to sample degradation was expected given the fragile and partially digested condition of stomach-content items and the necessity of repeated handling. In most cases, discrepancies are seen as fewer individuals and/or taxa identified by the second taxonomist. Other factors contributed to low recoveries in quality control samples. For example, some samples contained a large proportion of filamentous algae that made identification of organisms, especially small organisms, difficult.

The large variation seen in taxonomic accuracy is considered the result of the sample transfer and handling and does not indicate any errors made by the original taxonomic laboratories. Thus, all of the results of the fish stomach-content evaluations are considered acceptable for use during the food web study.

DATA MANAGEMENT

Each cell in the final Exponent database was checked against the original laboratory bench sheets to detect errors due to data entry and formatting. Unclear entries in laboratory bench sheets were confirmed by telephone with laboratory taxonomists. All errors were corrected in both the laboratory records and the Exponent database.

QUALITY ASSURANCE RESULTS

Based on the results of the quality assurance review, all fish stomach-content data are considered acceptable for use during the food web study except for the data from five samples (CFI117, CFI118, FI0573, FI0587, and FI0696). Unusual test results occurred in two samples that had dehydrated before analysis (CFI117, CFI118) and in three samples that were misidentified species (FI0573, FI0587, FI0696). Data from these five samples should be excluded from data analysis and interpretation for the food web study.

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PTI. 1997c. Ecological value and food web structure of aquatic vegetation communities in the Upper Hudson River: study plan. Prepared for General Electric Company, Albany, NY. PTI Environmental Services, Bellevue, WA.

Tables

TABLE B-1. TAXONOMISTS USED TO VERIFY TAXONOMIC IDENTIFICATION OF FISH STOMACH CONTENTS

Taxonomist	Expertise
Marianne Whitehurst Asst. Project Manager Barry A. Vittor & Associates Mobile, AL	Benthic invertebrate taxonomy
Len Ferrington Professor, University of Kansas Lawrence, KS	Chironomid taxonomy
Thomas Hansknecht Taxonomist Barry A. Vittor & Associates Mobile, AL	Crustacean taxonomy
Barbara Gibbs Taxonomist Barry A. Vittor & Associates Mobile, AL	Arthropod and mollusc taxonomy
Pamela Guy Taxonomist Barry A. Vittor & Associates Mobile, AL	Polychaete taxonomy
Matthew Williams Taxonomist Barry A. Vittor & Associates Mobile, AL	Crustacean, mollusc, and echinoderm taxonomy
J. Dobs Lee Taxonomist Barry A. Vittor & Associates Mobile, AL	Crustacean, mollusc, and echinoderm taxonomy

TABLE B-2. RESULTS OF VERIFICATION OF ARC VOUCHER COLLECTION BY IA AND DR. FERRINGTON

	Identification by ARC	Identification by IA or Dr. Ferrington	Changes
Cladocera			
1	*Acroperus*	*Acroperus*	
2	*Alona affinis*	*Alona affinis*	
3	*Alona quadrangularis*	*Alona quadrangularis*	
4	*Bosmina*	*Bosmina*	
5	*Camptocercus*	*Camptocercus*	
6	*Ceriodaphnia reticulata*	*Ceriodaphnia reticulata*	
7	*Ceriodaphnia*	*Ceriodaphnia*	
8	*Chydorus*	*Chydorus*	
9	*Eurycercus*	*Eurycercus*	
10	*Graptoleberis*	*Graptoleberis*	
11	*Ilyocryptus*	*Ilyocryptus*	
12	*Kurzia*	*Kurzia*	
13	*Latona setifera*	*Latona setifera*	
14	*Pleuroxus*	*Pleuroxus*	
15	*Pleuroxus procurvus*	*Pleuroxus procurvus*	
16	*Sida*	*Sida*	
17	*Simocephalus*	*Simocephalus*	
Copepoda			
18	Cyclopoida	Cyclopoida	
19	Harpacticoida	Harpacticoida	
Nematoda			
20	Nematoda	Nematoda	
Bryozoa			
21	*Lophopodella*	*Lophopodella*	
Hirudinea			
22	*Batracobdella*	*Batracobdella*	
23	*Batracobdella phalera*	*Batracobdella phalera*	
24	*Helobdella stagnalis*	*Helobdella stagnalis*	
Planariidae			
25	Planariidae	Planariidae	
Oligochaeta			
26	Lumbricidae	Lumbricidae	
Amphipoda			
27	*Crangonyx*	*Crangonyx*	
28	*Gammarus fasciatus*	*Gammarus fasciatus*	
29	*Gammarus*	*Gammarus*	
30	*Hyalella azteca*	*Hyalella azteca*	
Isopoda			
31	*Caecidotea*	*Caecidotea*	
Hydrachnida			
32	*Axonopsis*	*Axonopsis*	
33	*Hygrobates (larva)*	*Hygrobates (larva)*	
34	*Lebertia (larva)*	*Lebertia (larva)*	
35	*Oxus*	*Oxus*	
36	*Unionicola*	*Unionicola*	
Hemiptera			
37	Corixidae	Corixidae	

TABLE B-2. (cont.)

	Identification by ARC	Identification by IA or Dr. Ferrington	Changes
Odonata			
38	Coenagrionidae	Coenagrionidae	
39	*Enallagma*	*Enallagma*	
40	*Epitheca (Tetragoneuria)*	*Epitheca (Tetragoneuria)*	
41	*Pachydiplax longipennis*	*Leucorrhinia sp.*	*Libellulidae*
42	Cordulidae/Libellulidae	Cordulidae/Libellulidae	
Ephemeroptera			
43	Baetidae	Baetidae	
44	*Baetis*	*Baetis*	
45	*Callibaetis*	*Callibaetis*	
46	*Caenis*	*Caenis*	
47	*Hexagenia limbata*	*Hexagenia limbata*	
48	*Procleon*	*Procleon*	
49	*Stenacron*	*Stenacron*	
50	*Stenonema*	*Stenonema*	
51	Heptageniidae	Heptageniidae	
Trichoptera			
52	*Trichoptera pupa*	*Trichoptera pupa*	
53	*Agraylea*	*Agraylea*	
54	*Ceraclea*	*Ceraclea*	
55	*Hydatophylax*	*Hydatophylax*	
56	*Hydropsyche*	*Hydropsyche*	
57	*Hydroptila*	*Hydroptila*	
58	*Leptocerus*	*Leptocerus*	
59	*Molanna*	*Molanna*	
60	*Mystacides*	*Mystacides*	
61	*Oecetis*	*Oecetis*	
62	*Orthotrichia*	*Orthotrichia*	
63	*Oxyethira*	*Oxyethira*	
64	*Phryganea*	*Phryganea*	
65	*Phylocentropus*	*Phylocentropus*	
66	Polycentropodidae	Polycentropodidae	
67	*Polycentropus*	*Polycentropus*	
68	*Trianodes*	*Trianodes*	
Coleoptera			
69	*Berosus*	*Berosus*	
70	*Dubiraphia*	*Dubiraphia*	
71	Dytiscidae	Dytiscidae	
72	*Ectopria*	*Ectopria*	
73	*Gyrinus*	*Gyrinus*	
74	*Haliplus*	*Haliplus*	
75	*Oulimnius*	*Macronychus* sp.	*Macronychus*
76	*Stenelmis*	*Stenelmis*	
Lepidoptera			
77	*Paraponyx*	*Paraponyx*	
78	*Acentria*	*Acentria*	
Megaloptera			
79	*Sialis*	*Sialis*	
80	Corydalidae	Berosus	*Berosus*

TABLE B-2. (cont.)

	Identification by ARC	Identification by IA or Dr. Ferrington	Changes
84	*Dasyhelea*	*Dasyhelea*	
85	*Hemerodromia*	*Hemerodromia*	
86	*Muscidae*	*Muscidae*	
87	*Probezzia*	*Probezzia*	
88	*Chrysops*	*Chrysops*	
Chironomidae			
89	*Ablabesmyia annulata*	*Ablabesmyia annulata*	
90	*Ablabesmyia idei*	*Ablabesmyia idei*	
91	*Ablabesmyia mallochi*	*Ablabesmyia mallochi*	
92	*Ablabesmyia simpsoni*	*Ablabesmyia simpsoni*	
93	*Chironomus*	*Chironomus*	
94	*Cladopelma*	*Cladopelma*	
95	*Cladotanytarsus*	*Cladotanytarsus*	
96	*Clinotanypus*	*Clinotanypus*	
97	*Coelotanypus*	*Coelotanypus*	
98	*Corynoneura*	*Corynoneura*	
99	*Cricotopus bicinctus*	*Cricotopus bicinctus*	
100	*Cricotopus intersectus grp.*	*Cricotopus intersectus grp.*	
101	*Cricotopus sylvestris grp.*	*Cricotopus sylvestris grp.*	
102	*Cricotopus/Orthocladius*	*Cricotopus/Orthocladius*	
103	*Cryptochironomus*	*Cryptochironomus*	
104	*Cryptotendipes*	*Cryptotendipes*	
105	*Demicryptochironomus*	*Demicryptochironomus*	
106	*Dicrotendipes modestus*	*Dicrotendipes modestus*	
107	*Discrotendipes neomodestus*	*Discrotendipes neomodestus*	
108	*Einfeldia natchitochae*	*Einfeldia natchitochae*	
109	*Glyptotendipes*	*Glyptotendipes*	
110	*Labrundinia pilosella*	*Labrundinia pilosella*	
111	*Labrundinia neopilosella*	*Labrundinia neopilosella*	
112	*Microtendipes pedellus grp.*	*Microtendipes pedellus grp.*	
113	*Nanocladius nr. Crassicornus*	*Nanocladius nr. Crassicornus*	
114	*Nanocladius distinctus*	*Nanocladius distinctus*	
115	*Nilothauma*	*Nilothauma*	
116	Orthocladiinae	Orthocladiinae	
117	*Parakiefferiella*	*Parakiefferiella*	
118	*Paratanytarsus*	*Paratanytarsus*	
119	*Phaenopsectra obediens grp.*	*Phaenopsectra obediens grp.*	
120	*Phaenopsectra punctipes grp.*	*Phaenopsectra pucntipes grp.*	
121	*Polypedilum convictum grp.*	*Polypedilum convictum grp.*	
122	*Polypedilum fallax*	*Polypedilum fallax*	
123	*Polypedilum halterale grp.*	*Polypedilum halterale grp.*	
124	*Polypedilum illinoense grp.*	*Polypedilum illinoense grp.*	
125	*Polypedilum laetum grp.*	*Polypedilum laetum grp.*	
126	*Polypedilum scalaenum grp.*	*Polypedilum scalaenum grp.*	
127	*Procladius (Holotanypus)*	*Procladius (Holotanypus)*	
128	*Procladius bellus*	*Procladius bellus*	
129	*Psectrocladius*	*Psectrocladius*	
130	*Pseudochironomus*	*Pseudochironomus*	
131	*Rheotanytarsus*	*Rheotanytarsus*	
132	*Stenochironomus*	*Stenochironomus*	

TABLE B-2. (cont.)

	Identification by ARC	Identification by IA or Dr. Ferrington	Changes
133	*Synorthocladius*	*Synorthocladius*	
134	*Tanypus*	*Tanypus*	
135	*Tanytarsus*	*Tanytarsus*	
136	*Tanytarsus sp. 2*	*Tanytarsus sp. 2*	
137	*Thienemannimyia*	*Thienemannimyia*	
138	*Thienemannimyia grp.*	*Thienemannimyia grp.*	
139	*Tribelos*	*Tribelos*	
140	Pupae	Pupae	
Bivalvia			
141	*Musculium*	*Musculium*	
142	*Pisidium*	*Pisidium*	
143	*Sphaerium*	*Sphaerium*	
Gastropoda			
144	*Amnicola limosa*	*Amnicola limosa*	
145	Ancylidae	Ancylidae	
146	*Ferrissia*	*Ferrissia*	
147	*Gyraulus*	*Gyraulus*	
148	*Leaevapex fuscus*	*Leaevapex fuscus*	
149	*Micromenetus*	*Micromenetus*	
150	*Physella*	*Physella*	
151	Planorbidae	Planorbidae	
152	*Pseudosuccinea columella*	*Pseudosuccinea columella*	
153	*Valvata bicarinata*	*Valvata bicarinata*	
154	*Valvata piscinalis*	*Valvata piscinalis*	

Attachment B1

Taxonomic Literature Used to Identify Fish Stomach Contents

312996

TAXONOMIC LITERATURE USED TO IDENTIFY FISH STOMACH CONTENTS

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Appendix C

Quality Assurance Review Summary

Phytophilous and Benthic Macroinvertebrate Taxonomic Analysis

QUALITY ASSURANCE REVIEW SUMMARY PHYTOPHILOUS AND BENTHIC MACROINVERTEBRATE TAXONOMIC ANALYSES

This summary documents the results of the quality assurance review of the phytophilous and benthic macroinvertebrate assemblages data generated from the 1997 survey of ecological value and food web structure in the Upper Hudson River. The quality assurance review was performed to ensure that evaluations were conducted in accordance with the specifications of the Study Plan (PTI 1997c) and the field sampling plan (PTI 1997a) and that the data are acceptable for use in future stages of the food web study.

The quality assurance review consisted of an evaluation of the following major elements of the phytophilous and benthic macroinvertebrate investigation:

- **Field Methods**—Were the major specifications of the field sampling procedures followed as described in the field sampling plan (PTI 1997a)?
- **Laboratory Methods**—Were the major specifications of the laboratory testing procedures followed as described in the quality assurance project plan (QAPP) (PTI 1997b) and the statement of work submitted to the taxonomic laboratory?
- **Sorting Efficiency**—Was each sample sorted with an efficiency of ≥95 percent?
- **Taxonomic Accuracy**—Were the taxonomic identifications verified by taxonomists outside the taxonomic laboratory?
- **Test Results**—Were there any anomalous results that should be rejected or qualified?

SUMMARY OF QUALIFIED DATA

Taxonomic and biomass results were reported for 6 phytophilous macroinvertebrate and 41 benthic macroinvertebrate samples from Griffin Island, for 3 phytophilous macroinvertebrate and 18 benthic macroinvertebrate samples from the northern Thompson Island Pool, and for 12 phytophilous macroinvertebrate and 27 benthic macroinvertebrate samples from Stillwater.

As specified in the QAPP (PTI 1997b), Barry A. Vittor and Associates, Inc. (BVA), re-sorted 20 percent of the phytophilous and 20 percent of the benthic macroinvertebrate

samples. In addition, the voucher collection assembled by BVA was sent to Aquatic Resources Center (ARC) for confirmation of taxonomy. Based on the results of the quality assurance review, all of the phytophilous and benthic macroinvertebrate data are considered acceptable for use during the food web study.

FIELD METHODS

Phytophilous and benthic macroinvertebrate assemblages were collected September 17-22, 1997. Unvegetated habitat in deep and shallow water and vegetated shallow habitat in *Trapa natans* (water chestnut) and *Vallisneria americana* (water celery) beds were sampled at Griffin Island. Vegetated (*V. americana*) and unvegetated habitats in shallow water were sampled at the northern Thompson Island Pool, and shallow unvegetated and vegetated (*V. americana* and *T. natans*) habitats were sampled at Stillwater.

Three replicate stations were located in each vegetated habitat in each sampling area. A single phytophilous macroinvertebrate sample was collected at each station, except at Stillwater, where duplicate samples were collected at each station. The duplicate samples were collected to ensure that at one site there would be a sufficient number of samples (two replicate samples at each of three replicate stations) to allow additional statistical analysis (e.g., evaluation of species richness data). To obtain sufficient numbers of organisms in *T. natans* habitat, two original field samples of 6 L each were combined to yield a single composite sample of phytophilous macroinvertebrates. Duplicate samples in *T. natans* habitat represent two composite samples.

Three benthic macroinvertebrate samples were collected at each of the three replicate stations in vegetated habitat. Five additional samples were collected at one station in *T. natans* habitat at Griffin Island to allow for additional analysis of species richness data at one station. Nine replicate samples of benthic macroinvertebrates were collected in each unvegetated habitat.

The field collection procedures for the phytophilous and benthic macroinvertebrate study were identified in the field sampling plan (PTI 1997a) as follows:

- Phytophilous macroinvertebrate assemblages were sampled using Plexiglas® boxes as described by Downing (1986). The inside dimensions of the boxes were 30 x 20 x 10 cm (6-L volume).
- Benthic macroinvertebrate assemblages were sampled using titanium core tubes. The core tubes were 3 in. in diameter and 16 in. long. The top 8 in. of sediment was removed for analysis.
- The sediment surface of all acceptable benthic macroinvertebrate samples was relatively undisturbed, and a minimum penetration of 8 in. was achieved for all cores.

- Each sample was preserved in a 10 percent solution of buffered formalin.
- Proper chain-of custody documentation was maintained at all times.

Based on the major field procedures used to collect phytophilous and benthic macroinvertebrate samples, all of the results of the phytophilous and benthic macroinvertebrate evaluations are considered acceptable for use during the food web study.

LABORATORY METHODS

The analytical methods for the phytophilous and benthic macroinvertebrate assemblages were based on the specifications presented in the QAPP (PTI 1997b) and the laboratory statement of work as follows:

- Samples were re-screened and transferred to a solution of 70 percent ethanol between 1 and 10 days after fixation with formalin in the field
- Samples were sorted into major taxonomic groups with the aid of a 10× dissecting microscope or a magnifying lamp
- Sorting efficiency was monitored by having at least 20 percent of each sample resorted by a person other than the original sorter
- Organisms were identified to the lowest taxonomic level possible (target = species) by experienced taxonomists using the appropriate taxonomic literature
- Taxonomic identifications were verified by taxonomists outside the analytical laboratory
- A reference collection was prepared (including the various taxa identified during the project) and archived.

In the laboratory, phytophilous macroinvertebrate samples were sieved into two size fractions (0.25–0.5 mm and ≥0.5 mm). For each original sample, organisms in the 0.5 mm fraction were counted and the 0.25–0.5 mm fraction was archived. Benthic macroinvertebrate samples were sieved using a 0.5 mm mesh. All other specifications listed above were followed. Based on the major laboratory methods used for the phytophilous and benthic macroinvertebrate evaluations, all of the results are considered acceptable for use during the food web study.

Sorting Efficiency

Sorting efficiency was monitored by having at least 20 percent of each sample re-sorted by a person other than the original sorter. Sorting efficiency for each sample was calculated

by dividing the total errors or missing taxa by the total number of taxa in the original analysis. Then, this number was deducted from 1.0 and multiplied by 100 for conversion to a percent efficiency.

The specified minimum acceptable sorting efficiency was 95 percent of the total number of organisms present in a sample. After initial sorting, 0 of the 21 phytophilous macroinvertebrate samples and 2 of the 86 benthic macroinvertebrate samples did not meet the 95 percent criterion. Relative to the organism counts during the re-sorting, Sample BM-30 was originally sorted with 77 percent efficiency, and Sample BM-13 was sorted with 94 percent efficiency. The taxonomist who originally sorted Sample BM-30 was a trainee and did not count any midges. The missed taxa were identified by the second taxonomist and added to the results. Because the original taxonomist analyzed only this one sample out of all the taxonomic samples, this original low efficiency of sorting is considered corrected and does not require further action.

Taxonomic Accuracy

The accuracy of taxonomic identifications was ensured by using the appropriate taxonomic literature to make the initial identifications (Attachment C1) and by having the identities of representative taxa in reference collections verified by taxonomists outside the taxonomic laboratory (Table C-1). The literature used by the laboratory is considered appropriate for identifying phytophilous and benthic macroinvertebrate taxa found in the Hudson River. The results of the taxonomic verifications indicated that in most cases the identifications made by the taxonomic laboratory (i.e., BVA) were accurate. There were nine discrepancies that were identified during verification. A comparison of identifications made by BVA and ARC, including these discrepancies, is shown in Table C-2. Differences in the level of classification identified by the taxonomists are not considered discrepancies. Specimens that could not be identified to the same level as BVA identifications without destroying the organism were identified by ARC to the lowest level possible from external diagnostic features. Changes noted in the comment column of Table C-2 were applied to all samples in the phytophilous and benthic macroinvertebrate database. Based on taxonomic accuracy, all of the results of the phytophilous and benthic macroinvertebrate evaluations are considered acceptable for use during the food web study.

DATA MANAGEMENT

Each cell in the final Exponent database was checked against the original laboratory bench sheets to detect errors due to data entry and formatting. Unclear entries in laboratory bench sheets were confirmed by telephone with laboratory taxonomists. All errors were corrected in both the laboratory records and the Exponent database.

QUALITY ASSURANCE RESULTS

Based on the results of the quality assurance review, all of the phytophilous and benthic macroinvertebrate data are considered acceptable for use as part of the food web study.

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Tables

TABLE C-1. TAXONOMISTS USED TO VERIFY TAXONOMIC IDENTIFICATION OF BENTHIC AND PHYTOPHILOUS MACROINVERTEBRATE

Taxonomist	Area of Expertise
Deedee Kathman Director, Aquatic Resources Center Franklin, Tennessee	Oligocheate taxonomy
Todd Askegaard Asst. Director, Aquatic Resources Center Franklin, Tennessee	Zooplankton, crustacean, trichopteran and water mite taxonomy
Charles Watson, Jr. Project Manager, Aquatic Resources Center Franklin, Tennessee	Chironomid taxonomy
Lewis Long Project Biologist, Aquatic Resources Center Franklin, Tennessee	Mayfly, snail, mussel and beetle taxonomy

TABLE C-2. VERIFICATION OF VITTOR VOUCHER COLLECTION

Vial Number	BVA Identification	ARC Identification	Change
1	Lumbriculidae	*Eiseniella tetraedra* (Lumbricidae)	No change
2	*Sialis*	*Sialis*	
3	*Sialis*	*Sialis*	
4	*Oxus*	*Oxus*	
5	*Lebertia*	*Lebertia*	
6	*Mideopsis* sp. A	*Mideopsis* - 1; *Koenikea* - 2	No change
7	*Sperchon* sp. B	*Limnesia*	*Limnesia*
8	*Arrenurus*	*Arrenurus*	
9	*Hygrobates*	*Hygrobates*	
10	*Piona*	*Piona*	
11	*Hydrozetes*	*Hydrozetes*	
12	Corixidae	Corixidae	
13	*Caecidotea*	*Caecidotea*	
14	Chironomidae	Orthocladiinae	No change
15	*Tanytarsus*	*Tanytarsus*	
16	*Cricotopus*	*Cricotopus*	
17	*Ilyocryptus*	*Ilyocryptus*	
18	Bosminidae	*Bosmina*	No change
19	*Sida*	*Sida*	
20	*Hexagenia*	*Hexagenia*	
21	*Baetis*	*Baetis*	
22	*Caenis*	*Caenis*	
23	Elmidae	*Stenelmis*	
24	*Dubiraphia*	*Dubiraphia*	
25	*Berosus*	*Berosus*	
26	*Stenelmis*	*Stenelmis* - 3; *Macronychus* - 1	No change
27	*Macronychus*	*Macronychus*	
28	*Gammarus* cf. *fasciatus*	*Gammarus fasciatus*	
29	*Hyalella azteca*	*Hyalella azteca*	
30	*Cypridopsis* sp. B	Cypridinae	
31	*Cypretta*	Podocopida	No change
32	*Candona*	Podocopida	No change
33	*Hemerodromia*	*Hemerodromia*	
34	*Chrysops*	*Chrysops*	

TABLE C-2. (cont.)

Vial Number	BVA Identification	ARC Identification	Change
35	*Helobdella stagnalis*	*Helobdella stagnalis*	
36	Hirudinea	*Helobdella stagnalis*	No change
37	*Batracobdella phalera*	*Batracobdella phalera*	
38	*Helobdella fusca*	*Helobdella fusca*	
38	*Helobdella elongata*	*Helobdella elongata*	
40	*Alboglossiphonia heteroclita*	*Alboglossiphonia heteroclita*	
41	Coenagrionidae	Coenagrionidae	
42	*Enallagma*	*Enallagma*	
43	*Perithemis*	*Epitheca (Epicordulia) princeps*	*Epitheca princeps*
44	*Neurocordulia*	*Neurocordulia*	
45	*Pachydiplax*	*Pachydiplax*	
46	*Paraponyx*	*Paraponyx*	
47	*Hydroptila*	*Hydroptila*	
48	*Oecetis*	*Oecetis*	
49	*Orthotrichia*	*Orthotrichia*	
50	*Neureclipsis*	*Phylocentropus*	*Phylocentropus*
51	*Polycentropus*	*Polycentropus*	
52	*Oxyethira*	*Oxyethira*	
53	*Phryganea*	*Phryganea*	
54	Sphaeriidae	*Pisidium*	
55	*Pisidium dubium*	*Pisidium*	No change
56	*Sphaerium striatinum*	*Sphaerium striatinum*	
57	*Spaherium fabale*	*Sphaerium* prob. *corneum*	
58	*Elliptio complanata*	*Elliptio complanata*	
59	Physidae BM66	*Physa/Physella*	No change
60	Pyramidellidae	? (marine)	delete
61	*Planorbella scalaris*	*Planorbella scalaris*	
62	Physidae PM-1	Lymnaeidae	Lymnaeidae
63	*Laevapex fuscus*	*Ferrissia* prob. *parallela*	*Ferrissia*
64	*Ferrissia parallela*	*Ferrissia parallela*	
65	*Physa*	*Physa/Physella integra*	
66	*Amnicola limosa*	prob. *Amnicola limosa*	No change

TABLE C-2. (cont.)

Annelids:

BVA Identification	ARC Identification	Comments
Manayunkia speciosa	*Manayunkia speciosa*	
Quistadrilus multisetosus	*Quistadrilus multisetosus*	
Aulodrilus pigueti	*Aulodrilus pigueti*	
Stylaria lacustris	*Stylaria lacustris*	
Nais elinguis	*Nais elinguis*	

Chironomids:

Slide Number	BVA Identification	ARC Identification	Comments
1	*Microtendipes pedellus* grp.	*Microtendipes pedellus* grp.	
1	*Ablabesmyia*	*Ablabesmyia*	
1	*Thienemanniella*	*Thienemanniella*	
2	*Synorthocladius*	*Synorthocladius*	
3	*Synorthocladius*	*Synorthocladius*	
4	*Epoicocladius flavens*	*Epoicocladius* sp.	*Epoicocladius* sp.
5	Orthocladiinae sp. C	Orthocladiinae sp. C	
6	*Labrundinia*	*Labrundinia neopilosella*	No change
7	*Cricotopus*	*Cricotopus*	
8	*Ablabesmyia annulata*	*Ablabesmyia annulata*	
9	*Polypedilum convictum*	*Polypedilum convictum* grp.	*Polypedilum convictum* grp
9	*Pseudochironomus*	*Pseudochironomus*	
10	*Tribelos*	*Tribelos*	
11	*Chironomus*	*Chironomus*	
11	*Glyptotendipes*	*Glyptotendipes*	
12	*Chironomus*	*Chironomus*	
12	*Zavreliella marmorata*	*Zavreliella marmorata*	
13	*Tanytarsus*	*Tanytarsus*	
14	*Rheotanytarsus*	*Paratanytarsus*	*Paratanytarsus*
14	*Polypedilum*	*Polypedilum laetum*	No change
14	*Clinotanypus*	*Clinotanypus*	
14	*Procladius*	*Procladius bellus*	No change
15	*Polypedilum scalaenum* grp.	*Polypedilum scalaenum* grp.	

TABLE C-2. (cont.)

Slide Number	BVA Identification	ARC Identification	Comments
16	*Endotribelos*	aberrant *Polypedilum*	*Polypedilum*
17	*Corynoneura*	*Corynoneura*	
18	*Parachironomus*	*Parachironomus*	
19	*Cladotanytarsus*	*Cladotanytarsus*	
20	*Cryptochironomus*	*Cryptochironomus*	
21	*Coelotanypus*	*Coelotanypus*	
22	*Ablabesmyia*	*Ablabesmyia*	
23	*Polypedilum illinoense* grp.	*Polypedilum illinoense* grp.	
24	*Thienemannimyia* grp.	*Thienemannimyia* grp.	
25	*Polypedilum halterale* grp.	*Polypedilum halterale* grp.	
25	*Dicrotendipes*	*Dicrotendipes modestus*	No change
25	*Nanocladius*	*Nanocladius distinctus*	No change

Attachment C1

Taxonomic Literature Used by BVA to Identify Phytophilous and Benthic Macroinvertebrates

TAXONOMIC LITERATURE USED BY BVA TO IDENTIFY PHYTOPHILOUS AND BENTHIC MACROINVERTEBRATES

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