New York State
Department of Environmental Conservation

Division of Water

Butternut Creek

Biological Assessment

2003 Survey

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BUTTERNUT CREEK

BIOLOGICAL ASSESSMENT

Susquehanna River Basin
Otsego County, New York

Survey date: July 3 and 7, 2003
Report date: March 3, 2004

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Stream: Butternut Creek, Otsego County, New York

Reach: Garrattsville to Mt. Upton, New York

NYS Drainage Basin: Susquehanna River

Background:

The Stream Biomonitoring Unit conducted biological sampling on Butternut Creek on July 7, 2003. The purpose of the sampling was to assess general water quality, and determine any spatial or chronological water quality trends. Traveling kick samples for macroinvertebrates were taken in riffle areas at 8 sites, using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT value, and PMA (see Appendices II and III). Table 2 provides a listing of sampling sites, and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including individual site descriptions and raw invertebrate data from each site.

Results and Conclusions:

1. Based on macroinvertebrate sampling, water quality in Butternut Creek ranged from non-impacted to slightly impacted. Siltation and nutrient enrichment were the only impacts noted. Water quality is not considered to be limiting to populations of fish or other stream life.

Discussion

Butternut Creek arises from the slopes of Angel Hill near Exeter Corner in Otsego County, and flows approximately 37 miles in a southwesterly direction before joining the Unadilla River near Mt. Upton.. The watershed is primarily agricultural. Most of the stream is classified as C (T), with portions of C, B(T), and C(TS). It is stocked annually with brown trout. The sites sampled in the present survey were 8-25 meters wide, and had current speeds of 100-125 cm/sec in riffles.

Butternut Creek was sampled once previously by the Stream Biomonitoring Unit, at the Mt Upton site in 1997. Based on field inspection of the macroinvertebrate community, water quality was assessed as non-impacted, and the sample was not processed. The present survey was conducted to provide data towards understanding the apparent decline in hellbender populations at the Mt Upton site (Pers. comm., Alvin Breisch, NYS DEC Fish & Wildlife). Creosoted bridge supports at the Mt Upton site was considered a possible cause of the decline.

Based on macroinvertebrate sampling from Garrattsville to Mt Upton, water quality in Butternut Creek ranged from non-impacted to slightly impacted (Figure 1). Only one site, in Morris, was assessed as slightly impacted. Impact Source Determination (Table 1) did not clearly distinguish the cause of impact at this site, although siltation and nutrient enrichment may be involved. Water quality recovered to upstream conditions 2 miles downstream, at Station 4. At all other sites, Butternut Creek water quality was assessed as non-impacted, and is not considered limiting to populations of fish or other stream life. There was no evidence of toxicity at the Mt Upton site downstream of the bridge.

Aquatic worms were numerous at the Mt Upton sites (Stations 7-8), constituting 30% of the sample upstream of the bridge, and 14% downstream of the bridge. Most aquatic worms feed on bacteria, and an increase in their numbers often signals an increase in decomposable wastes that support the bacteria. These worms are Lumbriculidae; they have been demonstrated to tolerate light degrees of pollution (Lang and Lang-Dobler, 1979), but are most often found at non-impacted sites. Whether the source of wastes is human or livestock, the diverse macroinvertebrate communities at these sites indicate that the stream has adequate assimilative capacity to maintain non-impacted water quality. No indication was found at these sites that would indicate limitations to hellbender populations.

Literature Cited:

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 115 pages.

Overview of field data

On the dates of sampling, July 3 and 7, 2003, Butternut Creek at the sites sampled was 8-25 meters wide, 0.2-0.3 meters deep, and had current speeds of 100-125 cm/sec in riffles. Dissolved oxygen was 7.8-10.2 mg/l, specific conductance was 147-170 µmhos, pH was 6.0-7.4 and the temperature was 18.1-23.2 °C (65-74 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Butternut Creek, 2003. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

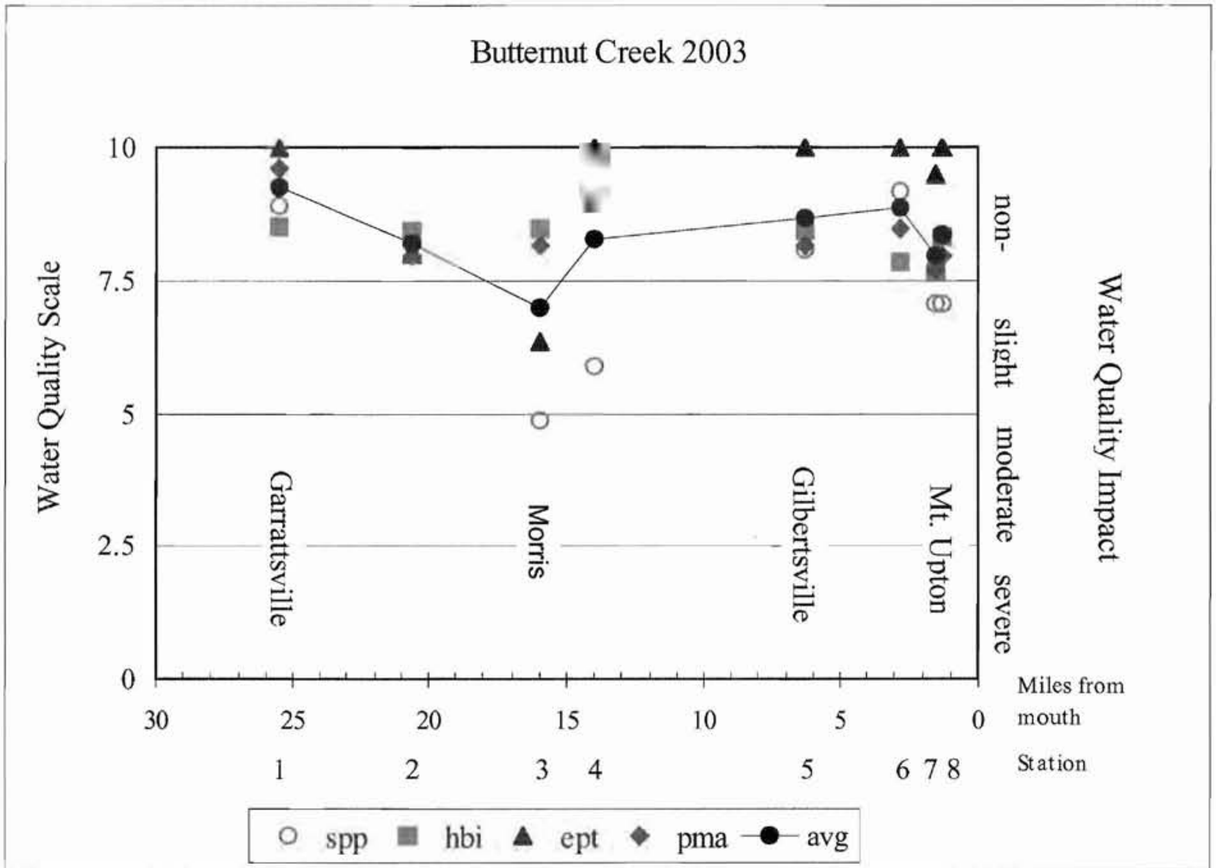


Table 1. Impact Source Determination, Butternut Creek, 2003. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities below 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	Station							
Community Type	01	02	03	04	05	06	07	08
Natural: minimal human impacts	56	56	54	65	64	64	59	51
Nutrient additions; mostly nonpoint, agricultural	49	33	38	40	52	60	44	46
Toxic: industrial, municipal, or urban run-off	28	28	28	37	44	43	50	36
Organic: sewage, animal wastes	30	30	21	29	34	45	57	47
Complex: municipal and/or industrial	24	17	18	22	35	32	50	36
Siltation	34	35	36	35	39	49	50	46
Impoundment	36	22	22	31	40	54	55 *	47 *

TABLE SUMMARY * Impoundment indications are considered spurious

STATION	LOCATION	COMMUNITY TYPE
BTNT-01	Garratsville	Natural
BTNT-02	New Lisbon	Natural
BTNT-03	Morris	Natural
BTNT-04	Below Morris	Natural
BTNT-05	Gilbertsville	Natural
BTNT-06	Copes Corners	Natural, nutrient additions
BTNT-07	Above Mt. Upton	Natural, organic
BTNT-08	Below Mt. Upton	Natural, organic, nutrient additions

TABLE 2. STATION LOCATIONS FOR BUTTERNUT CREEK, OTSEGO COUNTY, NEW YORK (see map).

STATION	LOCATION
1	Garrattsville 40 m above Co. Rte. 16 bridge 25.5 miles above the mouth Latitude/longitude: 42°38'41" 75°10'13"
2	New Lisbon 20 m above Co. Rte. 12 bridge 20.6 miles above the mouth Latitude/longitude: 42°35'22" 75°11'35"
3	Morris 50 m above Rte. 23 bridge 16.0 miles above the mouth Latitude/longitude: 42°32'44" 75°14'18"
4	Below Morris 20 m above Peet Rd. bridge 14.0 miles above the mouth Latitude/longitude: 42°31'27" 75°15'20"
5	Gilbertsville 20 m below Spring St. bridge 6.3 miles above the mouth Latitude/longitude: 42°27'52" 75°19'18"
6	Copes Corner 50 m above Co. Rte. 13 bridge 2.8 miles above the mouth Latitude/longitude: 42°26'14" 75°20'44"
7	Mt. Upton 200 m above Flatiron Rd. bridge 1.5 miles above the mouth Latitude/longitude: 42°25'24" 75°21'28"
8	Mt. Upton 150 m below Flatiron Rd. bridge 1.3 miles above the mouth Latitude/longitude: 42°25'10" 75°21'41"

Figure 2	Site Overview Map	Butternut Creek

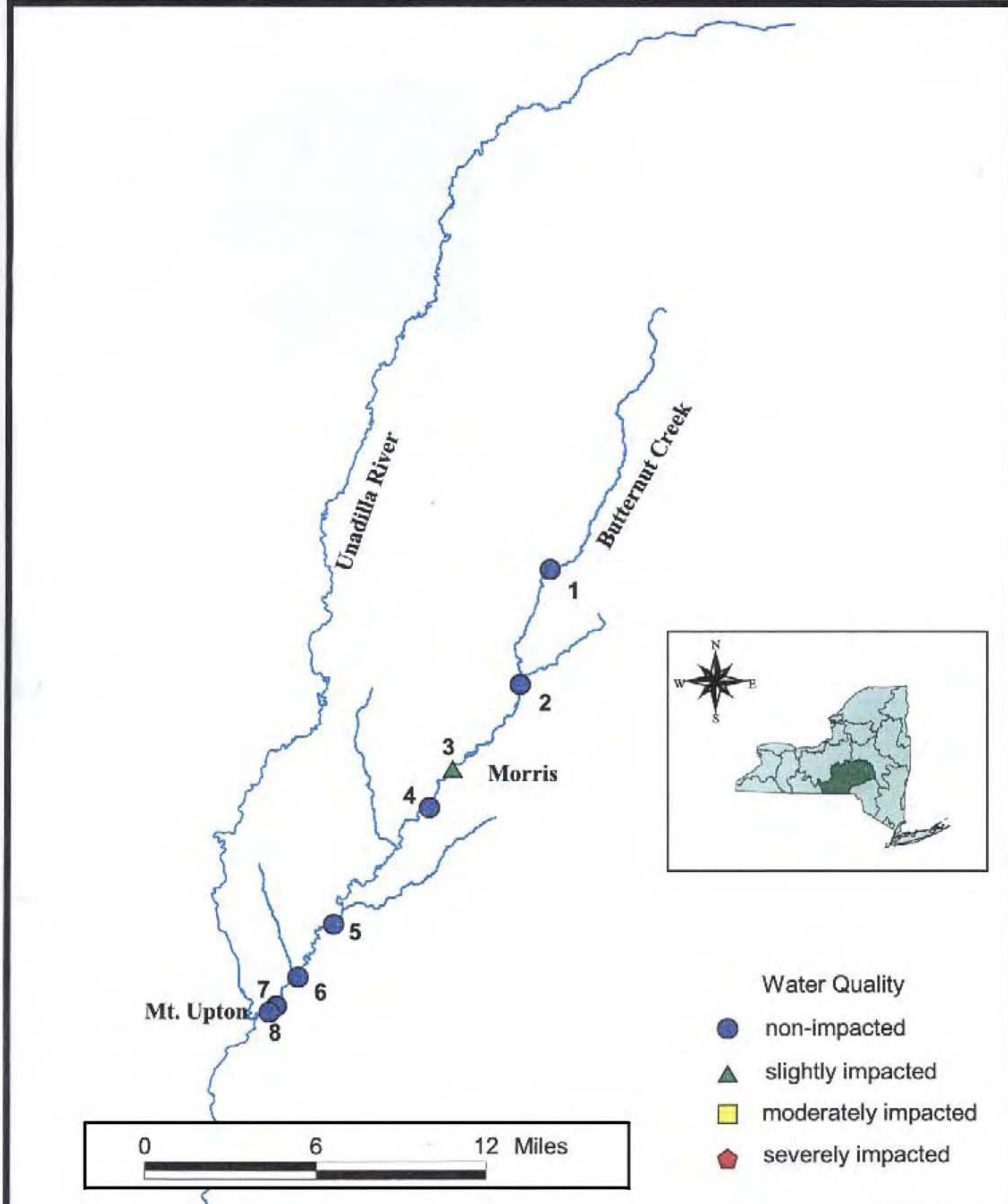
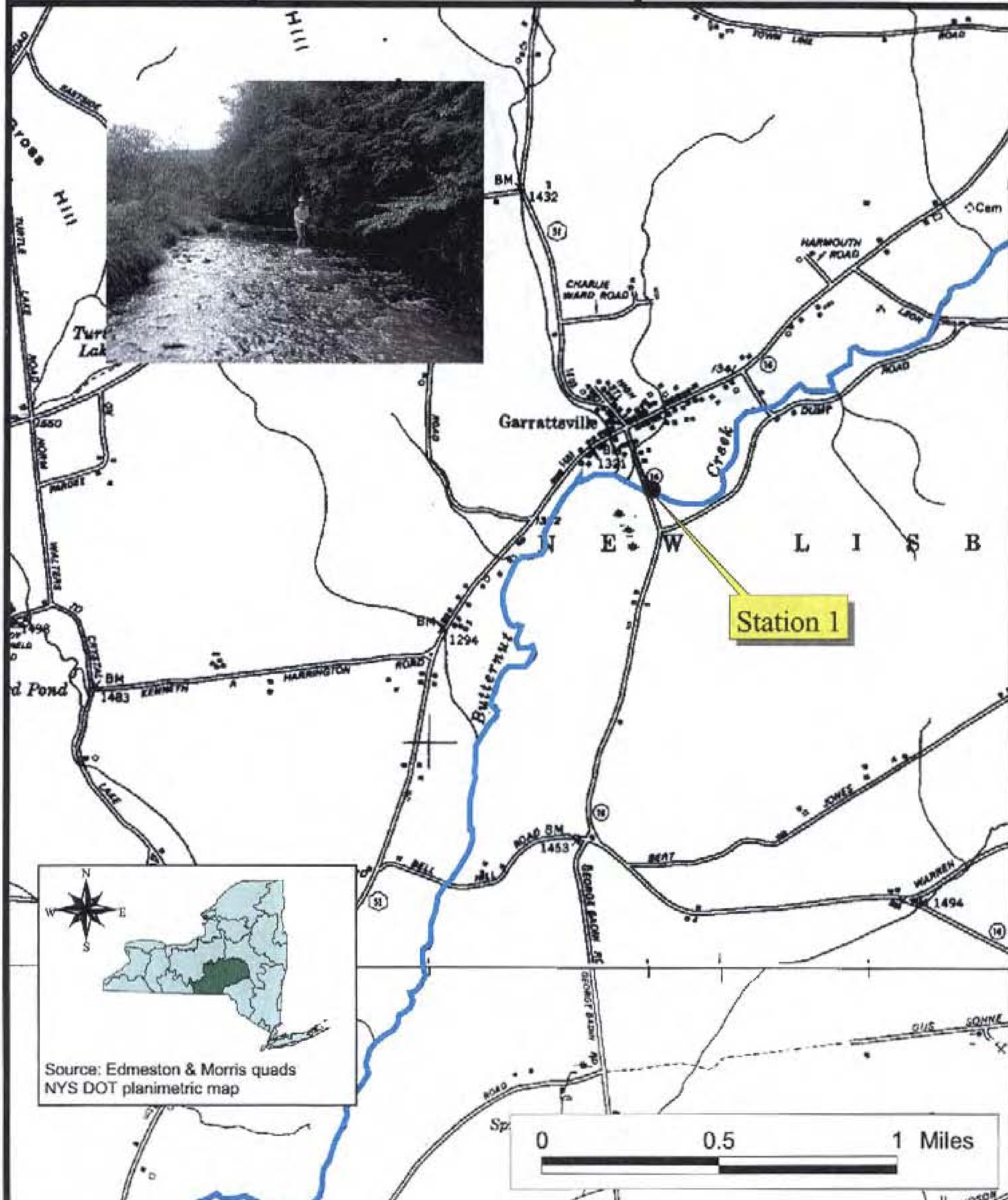
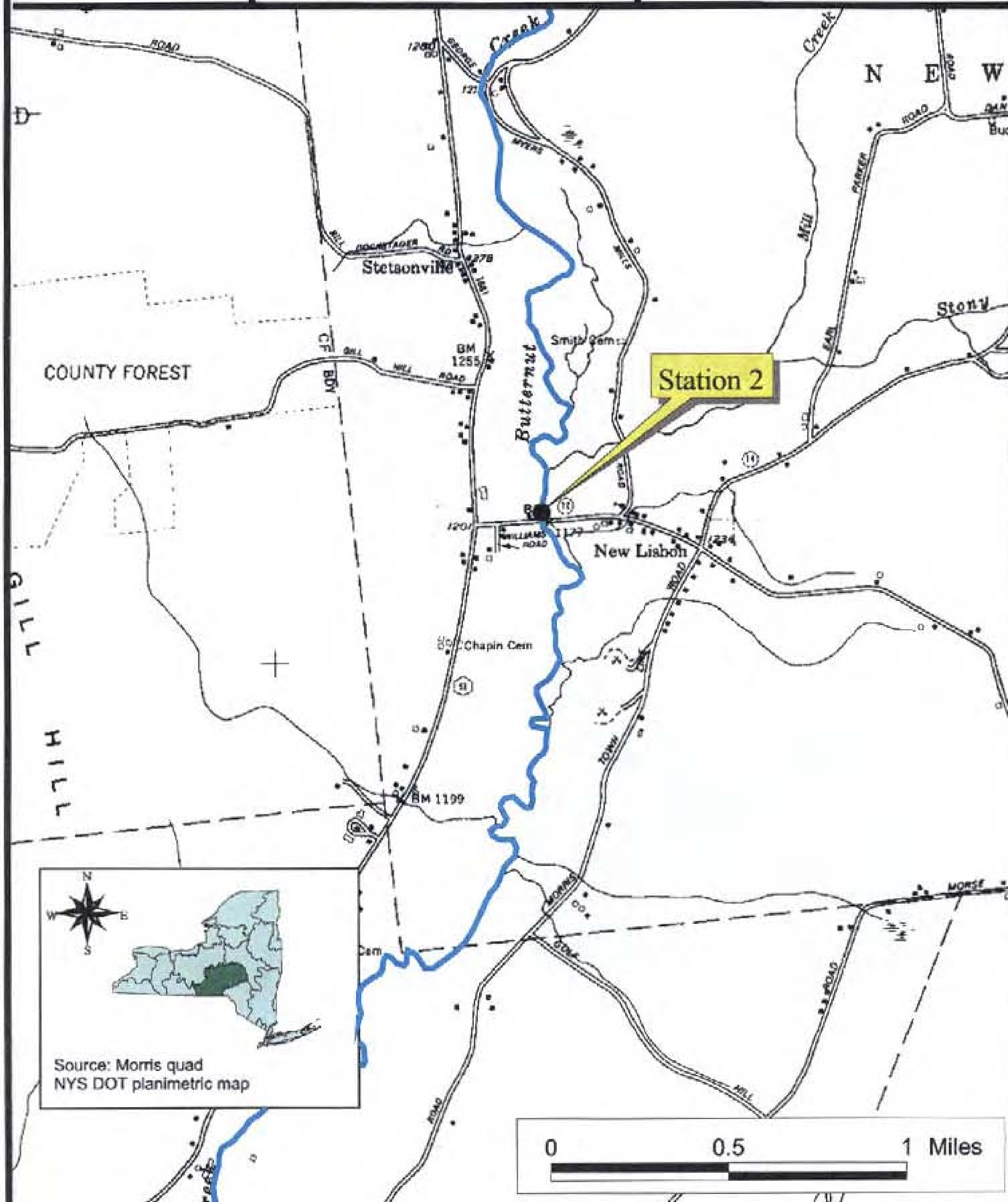


Figure 3a	Site Location Map	Butternut Creek



stream flow

Figure 3b	Site Location Map	Butternut Creek



stream flow

Figure 3c	Site Location Map	Butternut Creek

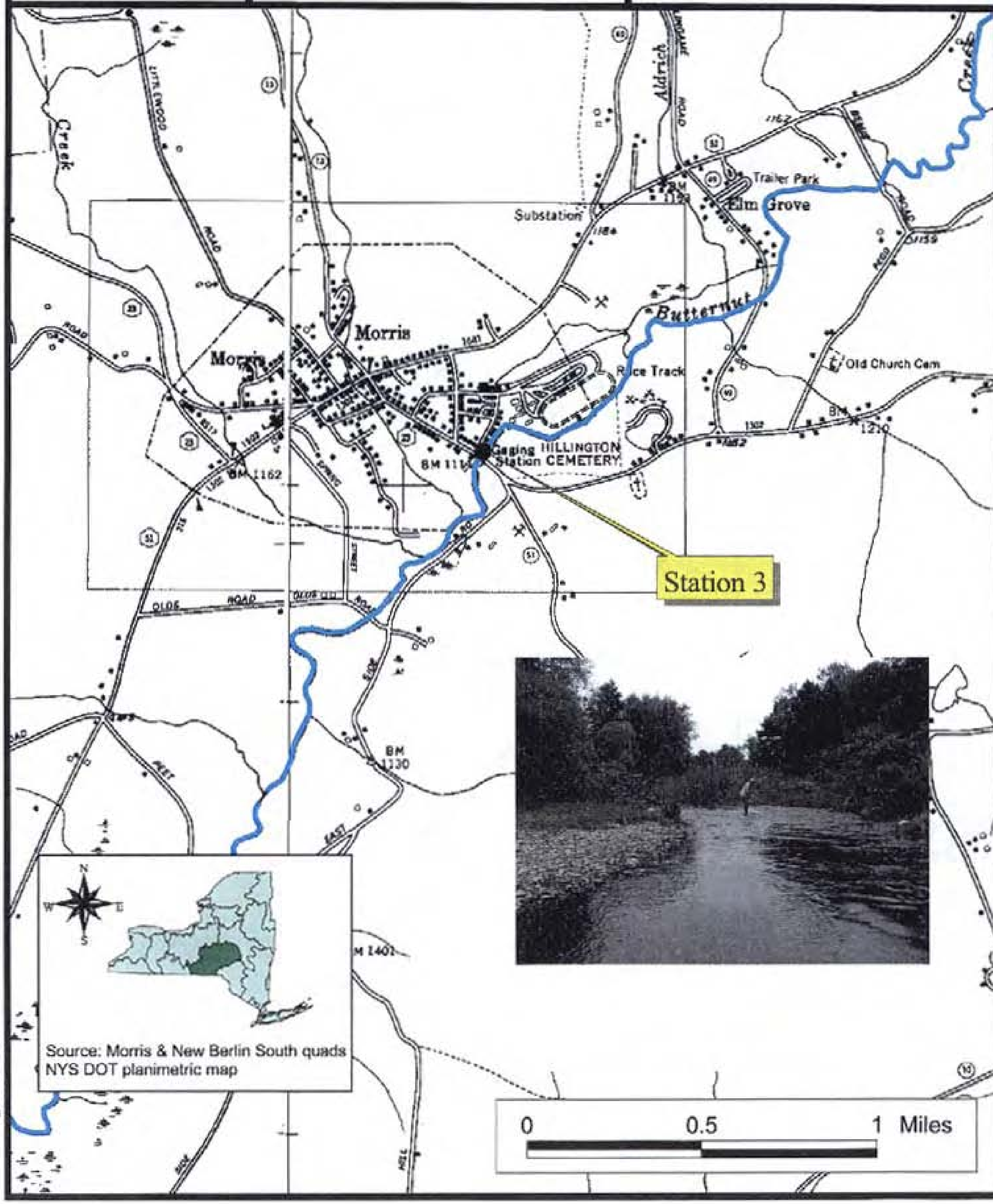


Figure 3d	Site Location Map	Butternut Creek

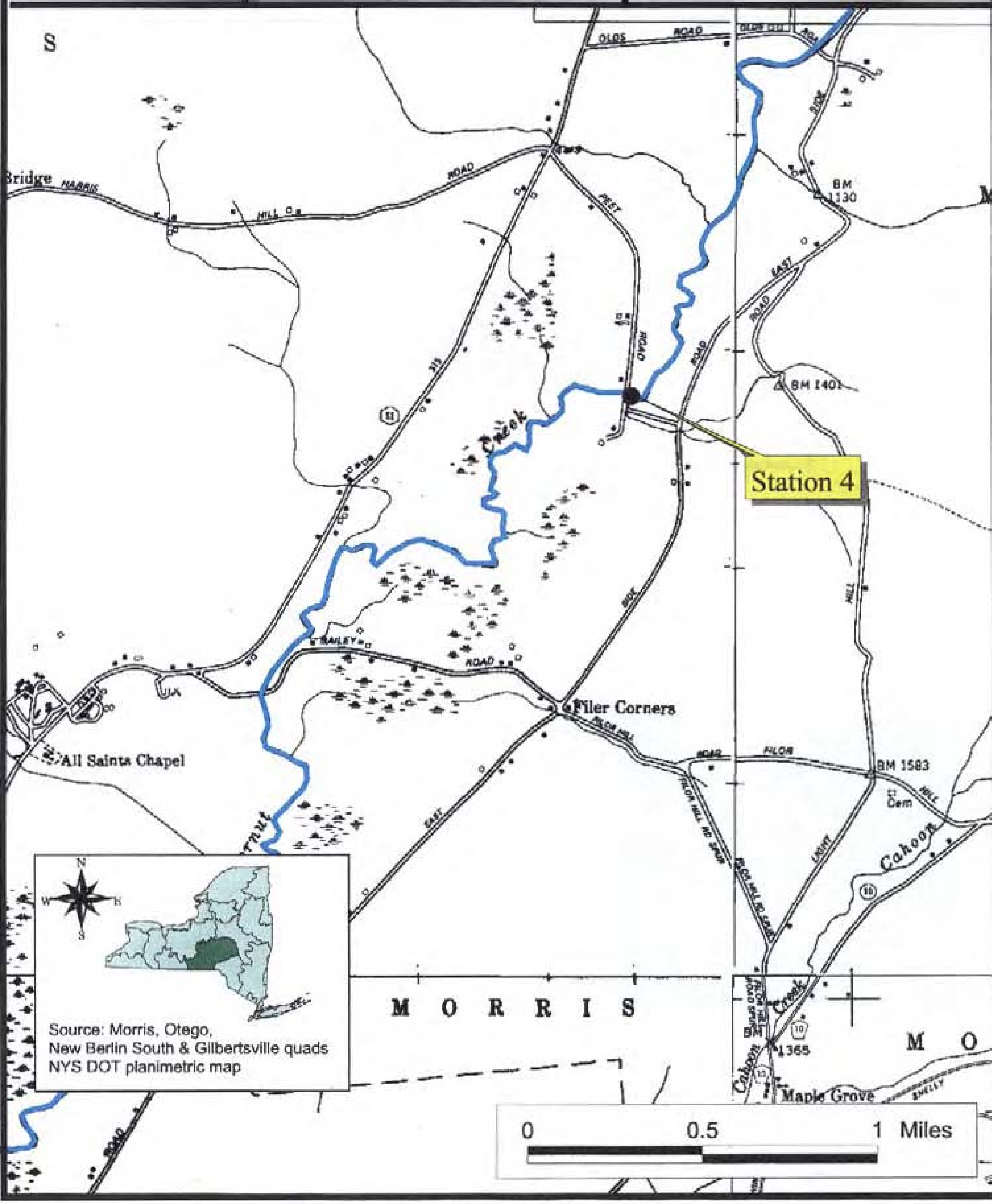
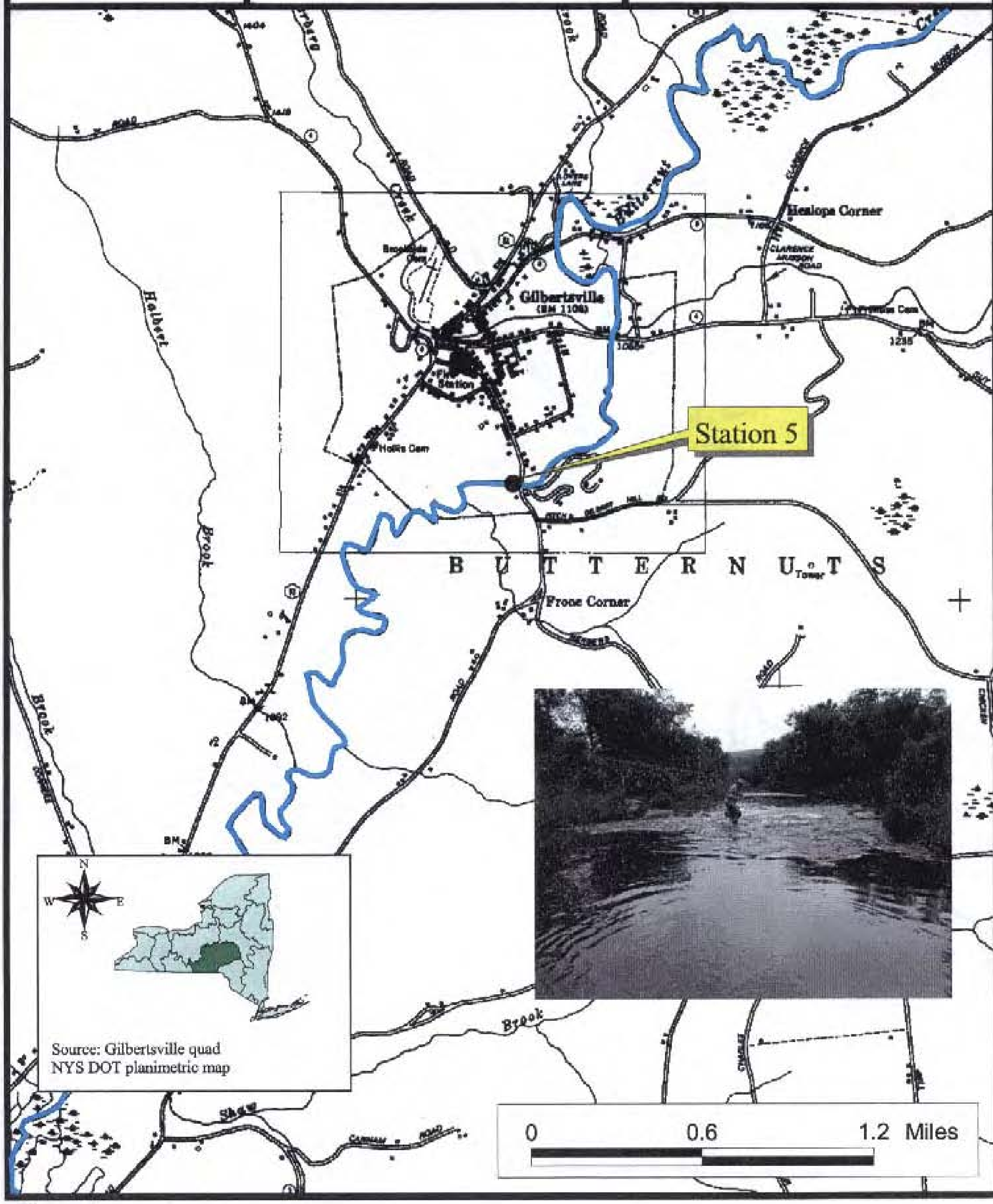


Figure 3e	Site Location Map	Butternut Creek



stream flow

Figure 3f	Site Location Map	Butternut Creek

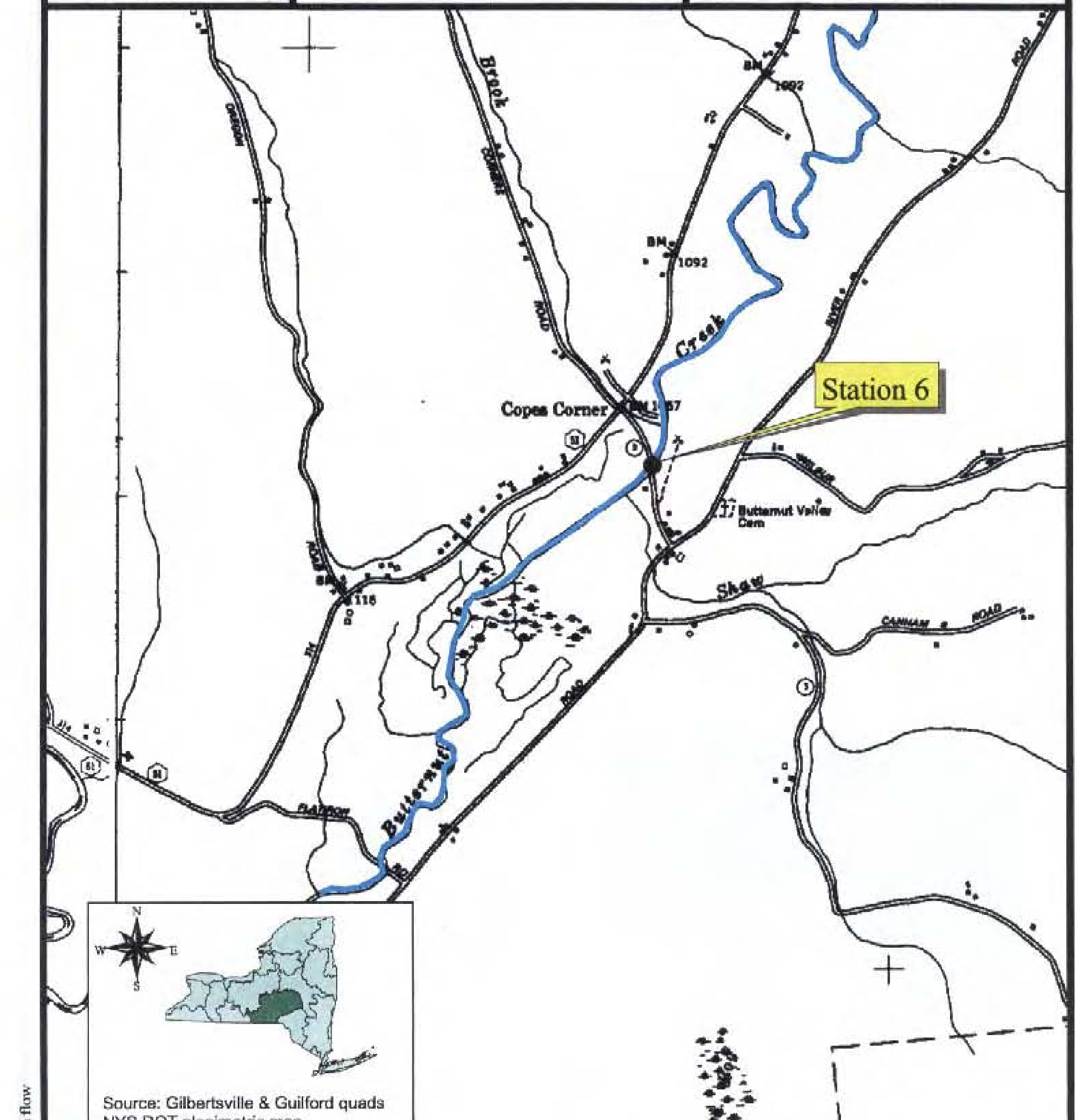


Figure 3g	Site Location Map	Butternut Creek

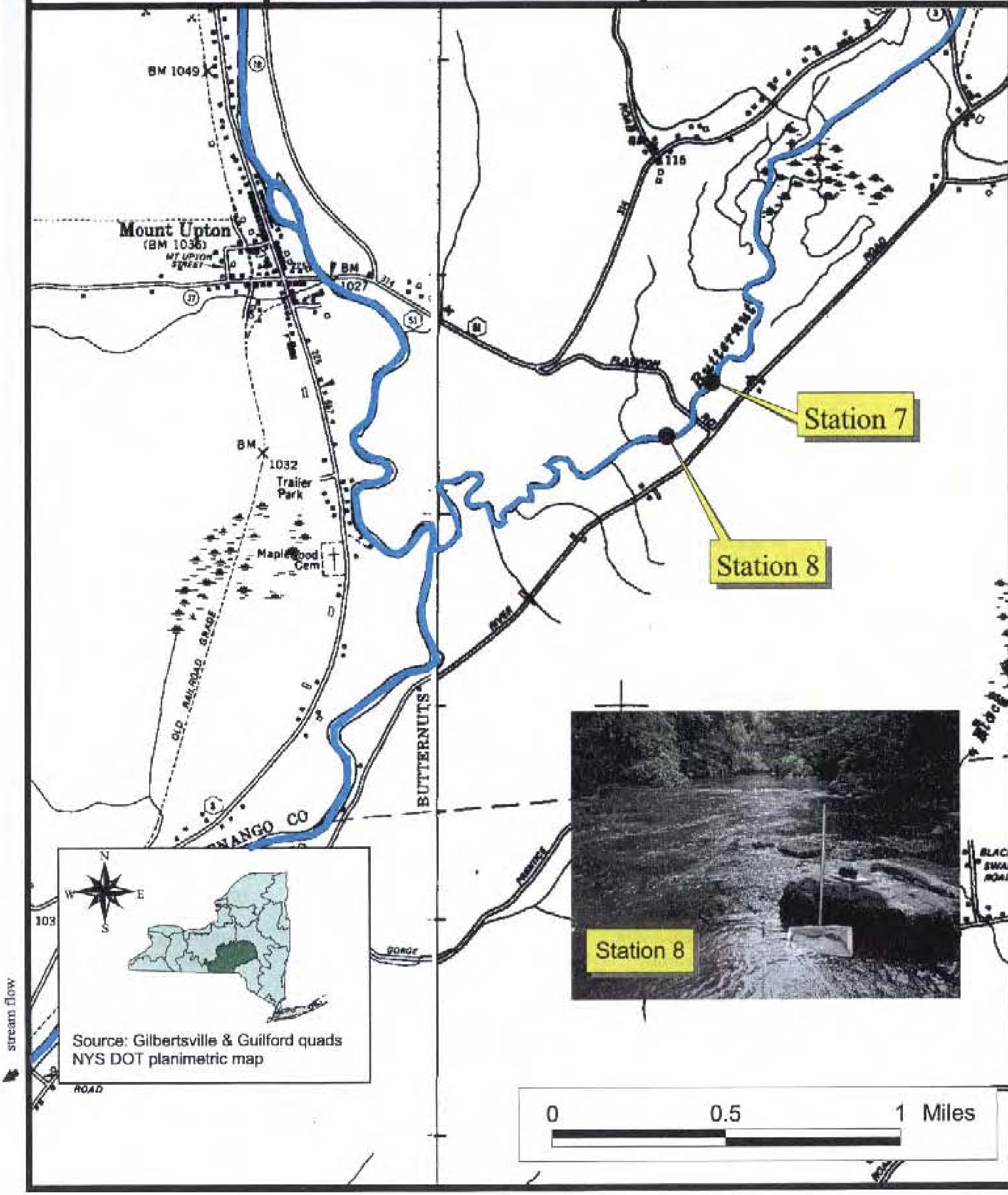


TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN BUTTERNUT CREEK, OTSEGO COUNTY, NEW YORK, 2003.

PLATYHELMINTHES
- TURBELLARIA
  - Undetermined Turbellaria

OLIGOCHAETA
- LUMBRICULIDA
  - Lumbriculidae
    - Undetermined Lumbriculidae
- TUBIFICIDA
  - Enchytraeidae
    - Undetermined Enchytraeidae

MOLLUSCA
- PELECYPODA
  - Sphaeriidae
    - Pisidium sp.
    - Sphaerium sp.
    - Undetermined Sphaeriidae

ARTHROPODA
- INSECTA
  - EPHEMEROPTERA
    - Isonychiidae
      - Isonychia bicolor
    - Baetidae
      - Acentrella sp.
      - Baetis flavistriga
      - Baetis intercalaris
      - Centroptilum sp.
    - Heptageniidae
      - Epeorus (Iron) sp.
      - Heptagenia sp.
      - Leucrocuta sp.
      - Rhithrogena sp.
      - Stenonema ithaca
      - Stenonema terminatum
    - Leptophlebiidae
      - Paraleptophlebia mollis
    - Ephemerellidae
      - Drunella cornuta
      - Serratella deficiens
      - Serratella sp.
    - Ephemeridae
      - Ephemera sp.
  - PLECOPTERA
    - Leuctridae
      - Leuctra sp.
    - Perlidae
      - Agnetina capitata
      - Neoperla sp.
      - Paragnetina immarginata
      - Paragnetina media

COLEOPTERA
- Psephenidae
  - Psephenus herricki
- Elmidae
  - Dubiraphia vittata
  - Optioservus fastiditus
  - Optioservus ovalis
  - Optioservus trivittatus
  - Promoresia elegans
  - Stenelmis crenata

TRICHOPTERA
- Philopotamidae
  - Chimarra aterrima?
  - Chimarra obscura
  - Dolophilodes sp.
- Polycentropodidae
  - Polycentropus sp.
- Hydropsychidae
  - Cheumatopsyche sp.
  - Hydropsyche bronta
  - Hydropsyche morosa
  - Hydropsyche slossonae
  - Hydropsyche sparna
  - Hydropsyche sp.
- Rhyacophilidae
  - Rhyacophila fuscula
- Glossosomatidae
  - Glossosoma sp.
- Brachycentridae
  - Brachycentrus appalachia
- Leptoceridae
  - Oecetis avara

DIPTERA
- Tipulidae
  - Dicranota sp.
  - Hexatoma sp.
- Ceratopogonidae
  - Undetermined Ceratopogonidae
- Simuliidae
  - Simulium sp.
- Athericidae
  - Atherix sp.
- Chironomidae
  - Tanypodinae
    - Thienemannimyia gr. spp.
  - Diamesinae
    - Diamesa sp.
    - Pagastia orthogonia

TABLE 3, cont. MACROINVERTEBRATE SPECIES COLLECTED IN BUTTERNUT CREEK, OTSEGO COUNTY, NEW YORK, 2003.

DIPTERA (cont'd)
- Chironomidae
  - Orthocladiinae
    - Cardiocladius albiplumus
    - Cardiocladius obscurus
    - Cricotopus bicinctus
    - Cricotopus tremulus gr.
    - Cricotopus trifascia gr.
    - Cricotopus vierriensis
    - Eukiefferiella devonica gr.
    - Orthocladius nr. dentifer
    - Parametriocnemus lundbecki
    - Tvetenia vitracies
  - Chironominae
    - Chironomini
      - Microtendipes pedellus gr.
      - Polypedilum aviceps
      - Polypedilum flavum
      - Polypedilum illinoense
    - Tanytarsini
      - Rheotanytarsus exiguus gr.
      - Rheotanytarsus pellucidus
      - Sublettea coffmani
      - Tanytarsus glabrescens gr.
      - Tanytarsus guerlus gr.

STREAM SITE:	Butternut Creek, Station 01
LOCATION:	Garrattsville, New York, 40 meters above County Route 16
DATE:	07 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

MOLLUSCA			
PELECYPODA			
	Sphaeriidae	Undetermined Sphaeriidae	3
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	2
	Baetidae	Acentrella sp.	4
		Baetis intercalaris	4
	Heptageniidae	Heptagenia sp.	6
		Stenonema ithaca	1
	Leptophlebiidae	Paraleptophlebia mollis	17
	Ephemerellidae	Drunella cornuta	2
		Serratella deficiens	4
	Ephemeridae	Ephemera sp.	1
PLECOPTERA	Leuctridae	Leuctra sp.	1
	Perlidae	Agnetina capitata	2
COLEOPTERA	Psephenidae	Psephenus herricki	4
	Elmidae	Dubiraphia vittata	1
		Optioservus ovalis	9
		Promoresia elegans	1
		Stenelmis crenata	2
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	3
	Polycentropodidae	Polycentropus sp.	1
	Hydropsychidae	Cheumatopsyche sp.	1
		Hydropsyche sparna	11
DIPTERA	Tipulidae	Dicranota sp.	1
	Athericidae	Atherix sp.	3
	Chironomidae	Thienemannimyia gr. spp.	1
		Pagastia orthogonia	2
		Cardiocladius obscurus	2
		Eukiefferiella devonica gr.	1
		Parametriocnemus lundbecki	4
		Polypedilum aviceps	3
		Polypedilum flavum	2
		Rheotanytarsus pellucidus	1

SPECIES RICHNESS:	31 (very good)
BIOTIC INDEX:	3.48 (very good)
EPT RICHNESS:	15 (very good)
MODEL AFFINITY:	86 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: This site featured excellent habitat. An excellent macroinvertebrate community was present. While a cornfield was adjacent to the stream, and the stream showed some indication of siltation and algal growth, all macroinvertebrate metrics were within the range of non-impacted water quality.

STREAM SITE:	Butternut Creek, Station 02
LOCATION:	New Lisbon, New York, 20 meters above County Route 12 bridge
DATE:	07 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	3
	Baetidae	Acentrella sp.	21
		Baetis intercalaris	10
		Centroptilum sp.	1
	Heptageniidae	Heptagenia sp.	14
		Stenonema ithaca	1
	Leptophlebiidae	Paraleptophlebia mollis	10
	Ephemerellidae	Drunella cornuta	5
		Serratella deficiens	6
PLECOPTERA	Leuctridae	Leuctra sp.	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus ovalis	2
		Optioservus trivittatus	4
TRICHOPTERA	Hydropsychidae	Hydropsyche sp.	2
DIPTERA	Tipulidae	Antocha sp.	1
		Hexatoma sp.	1
	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Athericidae	Atherix sp.	1
	Chironomidae	Cricotopus bicinctus	1
		Cricotopus trifascia gr.	1
		Cricotopus vierriensis	1
		Parametriocnemus lundbecki	1
		Tvetenia vitracies	1
		Polypedilum aviceps	5
		Polypedilum flavum	1
		Polypedilum illinoense	1
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS:	29 (very good)
BIOTIC INDEX:	3.58 (very good)
EPT RICHNESS:	11 (very good)
MODEL AFFINITY:	69 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: Habitat was acceptable at this site, although the stream had no canopy. Some siltation and algal growth was evident. All macroinvertebrate metrics were within the range of non-impacted water quality.

STREAM SITE:	Butternut Creek, Station 03
LOCATION:	Morris, New York, 50 meters above Route 23
DATE:	07 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	3
	Baetidae	Acentrella sp.	16
		Baetis intercalaris	3
	Heptageniidae	Heptagenia sp.	1
	Leptophlebiidae	Paraleptophlebia mollis	19
	Ephemerellidae	Drunella cornuta	3
COLEOPTERA	Elmidae	Optioservus trivittatus	3
		Stenelmis crenata	1
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	1
	Hydropsychidae	Hydropsyche bronta	3
DIPTERA	Simuliidae	Simulium sp.	1
	Chironomidae	Diamesa sp.	1
		Cardiocladius obscurus	3
		Cricotopus tremulus gr.	1
		Cricotopus vierriensis	3
		Parametriocnemus lundbecki	1
		Polypedilum aviceps	35

SPECIES RICHNESS:	18 (poor)
BIOTIC INDEX:	3.51 (very good)
EPT RICHNESS:	8 (good)
MODEL AFFINITY:	71 (very good)
ASSESSMENT:	slightly impacted

DESCRIPTION: The sample was taken upstream of the Route 23 bridge in the village of Morris. The macroinvertebrate fauna included mayflies, stoneflies, and caddisflies, but species richness was low, resulting in an assessment of slight impact. Many worms were noted in the field. Impact Source Determination did not clearly identify the source of impact, although the community was similar (38%) to communities affected by siltation and nutrient enrichment.

STREAM SITE:	Butternut Creek, Station 04
LOCATION:	Below Morris, New York, 20 meters above Peet Road bridge
DATE:	07 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	4
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	3
	Baetidae	Acentrella sp.	11
		Baetis flavistriga	2
		Baetis intercalaris	10
	Heptageniidae	Epeorus (Iron) sp.	1
		Rhithrogena sp.	1
	Leptophlebiidae	Paraleptophlebia mollis	14
	Ephemerellidae	Drunella cornuta	1
		Serratella deficiens	15
COLEOPTERA	Elmidae	Optioservus trivittatus	8
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	2
	Hydropsychidae	Hydropsyche bronta	2
		Hydropsyche slossonae	1
		Hydropsyche sparna	7
	Glossosomatidae	Glossosoma sp.	2
	Brachycentridae	Brachycentrus appalachia	6
DIPTERA	Tipulidae	Hexatoma sp.	2
	Chironomidae	Orthocladius nr. dentifer	1
		Tvetenia vitracies	2
		Polypedilum aviceps	5

SPECIES RICHNESS:	21 (good)
BIOTIC INDEX:	3.02 (very good)
EPT RICHNESS:	15 (very good)
MODEL AFFINITY:	72 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: The kick sample was taken in a linear riffle downstream of a flat reach of stream. The macroinvertebrate fauna was dominated by clean-water mayflies, and most of the metrics indicated non-impacted conditions.

STREAM SITE:	Butternut Creek, Station 05
LOCATION:	Gilbertsville, New York, 20 meters downstream of Spring Street
DATE:	07 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	4
	Baetidae	Acentrella sp.	6
		Baetis intercalaris	2
	Heptageniidae	Epeorus (Iron) sp.	1
		Heptagenia sp.	2
	Leptophlebiidae	Paraleptophlebia mollis	1
	Ephemerellidae	Drunella cornuta	7
		Serratella deficiens	14
		Serratella sp.	1
PLECOPTERA	Perlidae	Agnetina capitata	3
		Paragnetina immarginata	1
	Perlodidae	Undetermined Perlodidae	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Dubiraphia vittata	1
		Optioservus fastiditus	1
		Optioservus trivittatus	3
		Promoresia elegans	6
		Stenelmis crenata	9
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	2
		Chimarra obscura	3
		Dolophilodes sp.	1
	Hydropsychidae	Hydropsyche bronta	12
		Hydropsyche sparna	10
DIPTERA	Chironomidae	Thienemannimyia gr. spp.	1
		Pagastia orthogonia	2
		Eukiefferiella devonica gr.	2
		Tvetenia vitracies	2
		Polypedilum aviceps	1

SPECIES RICHNESS:	28 (very good)
BIOTIC INDEX:	3.55 (very good)
EPT RICHNESS:	17 (very good)
MODEL AFFINITY:	71 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: This site was downstream of several miles of wetland areas. The water appeared more turbid, and more filter-feeding caddisflies were present. Nevertheless, all macroinvertebrate metrics were within the range of non-impacted water quality.

STREAM SITE:	Butternut Creek, Station 06		
LOCATION:	Copes Corners, New York, 50 meters above County Route 13 bridge		
DATE:	07 July 2003		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100		
ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	6
MOLLUSCA			
PELECYPODA			
	Sphaeriidae	Pisidium sp.	1
		Sphaerium sp.	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	5
	Baetidae	Acentrella sp.	11
	Heptageniidae	Heptagenia sp.	6
	Leptophlebiidae	Paraleptophlebia mollis	3
	Ephemerellidae	Drunella cornuta	5
		Serratella deficiens	1
PLECOPTERA	Perlidae	Agnetina capitata	1
		Neoperla sp.	1
		Paragnetina media	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus trivittatus	4
		Stenelmis crenata	19
TRICHOPTERA	Philopotamidae	Chimarra obscura	2
	Polycentropodidae	Polycentropus sp.	1
	Hydropsychidae	Cheumatopsyche sp.	2
		Hydropsyche morosa	11
		Hydropsyche sparna	2
	Rhyacophilidae	Rhyacophila fuscula	2
	Glossosomatidae	Glossosoma sp.	1
DIPTERA	Athericidae	Atherix sp.	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Pagastia orthogonia	1
		Cardiocladius obscurus	2
		Cricotopus vierriensis	1
		Tvetenia vitracies	1
		Polypedilum aviceps	2
		Polypedilum illinoense	1
		Tanytarsus glabrescens gr.	1
		Tanytarsus guerlus gr.	1
SPECIES RICHNESS:	32 (very good)		
BIOTIC INDEX:	4.17 (very good)		
EPT RICHNESS:	16 (very good)		
MODEL AFFINITY:	74 (very good)		
ASSESSMENT:	non-impacted		

DESCRIPTION: The sample was taken upstream of the County Route 13 bridge at Copes Corners. The habitat was judged to be adequate. Although the macroinvertebrate fauna appeared to have a lower biomass than at the upstream site, all metrics indicated non-impacted water quality.

STREAM SITE:	Butternut Creek, Station 07
LOCATION:	Mt. Upton, New York, 200 meters upstream of Flatiron Road bridge
DATE:	03 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	30
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	4
		Baetis flavistriga	4
		Baetis intercalaris	6
	Heptageniidae	Heptagenia sp.	1
		Rhithrogena sp.	4
		Stenonema terminatum	1
	Leptophlebiidae	Paraleptophlebia mollis	1
	Ephemerellidae	Drunella cornuta	2
		Serratella sp.	3
PLECOPTERA	Perlidae	Agnetina capitata	6
COLEOPTERA	Psephenidae	Psephenus herricki	3
	Elmidae	Optioservus trivittatus	4
		Stenelmis crenata	10
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	1
	Hydropsychidae	Cheumatopsyche sp.	1
		Hydropsyche bronta	8
		Hydropsyche sparna	1
DIPTERA	Chironomidae	Cardiocladius obscurus	2
		Cricotopus trifascia gr.	2
		Cricotopus vierriensis	2
		Orthocladius nr. dentifer	1
		Tvetenia vitracies	1
		Microtendipes pedellus gr.	1
		Sublettea coffmani	1

SPECIES RICHNESS:	25 (good)
BIOTIC INDEX:	4.37 (very good)
EPT RICHNESS:	14 (very good)
MODEL AFFINITY:	66 (very good)
ASSESSMENT:	non-impacted.

DESCRIPTION: The sample was taken 200 meters upstream of the Flatiron Road bridge. Aquatic worms were numerous in the sample, constituting 30% of the macroinvertebrate fauna. However, they were not a tolerant species, and the remainder of the fauna appeared to indicate very good water quality. The site was assessed as non-impacted.

STREAM SITE:	Butternut Creek, Station 08
LOCATION:	Mt. Upton, New York, 150 meters downstream of Flatiron Road bridge
DATE:	03 July 2003
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	1
ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	14
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	1
	Baetidae	Acentrella sp.	3
	Heptageniidae	Leucrocuta sp.	13
		Stenonema terminatum	1
	Leptophlebiidae	Paraleptophlebia mollis	1
	Ephemerellidae	Drunella cornuta	4
		Serratella deficiens	1
		Serratella sp.	1
PLECOPTERA	Perlidae	Agnetina capitata	8
COLEOPTERA	Psephenidae	Psephenus herricki	7
	Elmidae	Stenelmis crenata	11
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	7
		Chimarra obscura	2
		Dolophilodes sp.	1
	Hydropsychidae	Hydropsyche morosa	9
	Brachycentridae	Brachycentrus appalachia	1
	Leptoceridae	Oecetis avara	1
DIPTERA	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Chironomidae	Thienemannimyia gr. spp.	3
		Cardiocladius albiplumus	1
		Tvetenia vitracies	1
		Polypedilum aviceps	6
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS:	25 (good)
BIOTIC INDEX:	3.70 (very good)
EPT RICHNESS:	15 (very good)
MODEL AFFINITY:	66 (very good)
ASSESSMENT:	non-impacted

DESCRIPTION: Riffles were sampled 150 meters downstream of the Flatiron Road bridge. The fauna was similar to that found upstream of the bridge, although fewer worms were present. Water quality was similarly assessed as non-impacted.

FIELD DATA SUMMARY

STREAM NAME: Butternut Creek DATE SAMPLED: 7/3/2003 & 7/7/2003

REACH: Garrattsville to Mt. Upton

FIELD PERSONNEL INVOLVED: Bode, Novak, Smith

STATION	01	02	03	04
ARRIVAL TIME AT STATION	10:30	11:05	11:55	12:35
LOCATION	Garrattsville	New Lisbon	Morris	Below Morris
PHYSICAL CHARACTERISTICS				
Width (meters)	8	8	8	10
Depth (meters)	0.2	0.2	0.2	0.2
Current speed (cm per sec.)	110	100	125	125
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	0	0	20
Rubble (6.35 - 25.4 cm)	40	40	40	20
Gravel (0.2 – 6.35 cm)	30	30	30	20
Sand (0.06 – 2.0 mm)	10	10	10	20
Silt (0.004 – 0.06 mm)	20	20	20	20
Embeddedness (%)	30	20	20	20
CHEMICAL MEASUREMENTS				
Temperature (^{o}C)	18.9	18.1	18.4	19.4
Specific Conductance (umhos)	164	166	169	170
Dissolved Oxygen (mg/l)	10.2	9.6	9.3	9.3
pH	7.4	6.0	6.9	6.9
BIOLOGICAL ATTRIBUTES				
Canopy (%)	50	0	10	10
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae - diatoms	X		X	
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	
Megaloptera(dobsonflies,alderflies)	X		X	
Odonata (dragonflies, damselflies)		X		X
Chironomidae (midges)			X	
Simuliidae (black flies)			X	
Decapoda (crayfish)	X	X	X	X
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)			X	X
Other				
FAUNAL CONDITION	Very good	Very good	Very good	Very good

FIELD DATA SUMMARY				
STREAM NAME: Butternut Creek DATE SAMPLED: 7/3/2003 & 7/7/2003 **REACH: Garrattsville to Mt. Upton** **FIELD PERSONNEL INVOLVED: Bode, Novak, Smith**				
STATION	05	06	07	08
ARRIVAL TIME AT STATION	1:00	1:30	10:30	11:25
LOCATION	Gilbertsville	Copes Corner	Mt. Upton	Mt. Upton
PHYSICAL CHARACTERISTICS				
Width (meters)	10	20	15	25
Depth (meters)	0.3	0.2	0.3	0.2
Current speed (cm per sec.)	125	110	125	100
Substrate (%)				
Rock (>25.4 cm, or bedrock)	20	20	0	
Rubble (6.35 - 25.4 cm)	30	30	10	10
Gravel (0.2 – 6.35 cm)	20	20	50	50
Sand (0.06 – 2.0 mm)	10	10	20	20
Silt (0.004 – 0.06 mm)	20	20	20	20
Embeddedness (%)	20	20	20	
CHEMICAL MEASUREMENTS				
Temperature (^{o} C)	22.9	23.2	20.5	20.8
Specific Conductance (umhos)	169	166	147	147
Dissolved Oxygen (mg/l)	8.6	7.8	9.6	9.8
pH	6.9	6.8	6.9	7.3
BIOLOGICAL ATTRIBUTES				
Canopy (%)	30	40	10	50
Aquatic Vegetation				
algae – suspended	X			
algae – attached, filamentous	X	X	X	XX
algae - diatoms			XX	X
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X		X	X
Megaloptera(dobsonflies,alderflies)	X			
Odonata (dragonflies, damselflies)				X
Chironomidae (midges)				
Simuliidae (black flies)				
Decapoda (crayfish)	X			X
Gammaridae (scuds)				
Mollusca (snails, clams)		X		
Oligochaeta (worms)	X	X	X	X
Other				
FAUNAL CONDITION	Very good	Very good	Good	Good

BIOLOGICAL METHODS FOR KICK SAMPLING

A. Rationale. The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection. Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel, and sand. Depth should be one meter or less, and current speed should be at least 0.4 meters per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged organisms are carried into the net. Sampling is continued for a specified time and for a specified distance in the stream. Rapid assessment sampling specifies sampling five minutes for a distance of five meters. The net contents are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

D. Sample Sorting and Subsampling. In the laboratory the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula, rinsed with water, and placed in a petri dish. This portion is examined under a dissecting stereo microscope and 100 organisms are randomly removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. The total number of organisms in the sample is estimated by weighing the residue from the picked subsample and determining its proportion of the total sample weight.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the subsample is recorded on a data sheet. All organisms from the subsample are archived (either slide-mounted or preserved in alcohol). If the results of the identification process are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

MACROINVERTEBRATE COMMUNITY PARAMETERS

1. Species richness is the total number of species or taxa found in the sample. For subsamples of 100-organisms each that are taken from kick samples, expected ranges in most New York State streams are: greater than 26, non-impacted; 19-26, slightly impacted; 11 - 18, moderately impacted; less than 11, severely impacted.

2. EPT Richness denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organism subsample. These are considered to be mostly clean-water organisms, and their presence generally is correlated with good water quality (Lenat, 1987). Expected ranges from most streams in New York State are: greater than 10, non-impacted; 6- 10 slightly impacted; 2-5, moderately impacted; and 0- 1, severely impacted.

3. Hilsnhoff Biotic index is a measure of the tolerance of the organisms in the sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.5 1-6.50, slightly impacted; 6.5 1-8.50, moderately impacted; and 8.51 - 10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percent abundances in the model community are 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other.   Impact ranges are: greater than 64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and less than 35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NY S DEC technical report, 89 pp.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina DEM Tech. Report. 12 pp.

Novak, M.A., and R. W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc. 11(1):80-85.

LEVELS OF WATER QUALITY IMPACT IN STREAMS

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter, and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT richness, biotic index, and percent model affinity (*see Macroinvertebrate Community Parameters Appendix*). The consensus is based on the determination of the majority of the parameters. Since parameters measure different aspects of the macroinvertebrate community, they cannot be expected to always form unanimous assessments. The assessment ranges given for each parameter are based on subsamples of 100-organism each that are taken from macroinvertebrate riffle kick samples. These assessments also apply to most multiplate samples, with the exception of percent model affinity.

1. *Non-impacted* Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; EPT richness is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

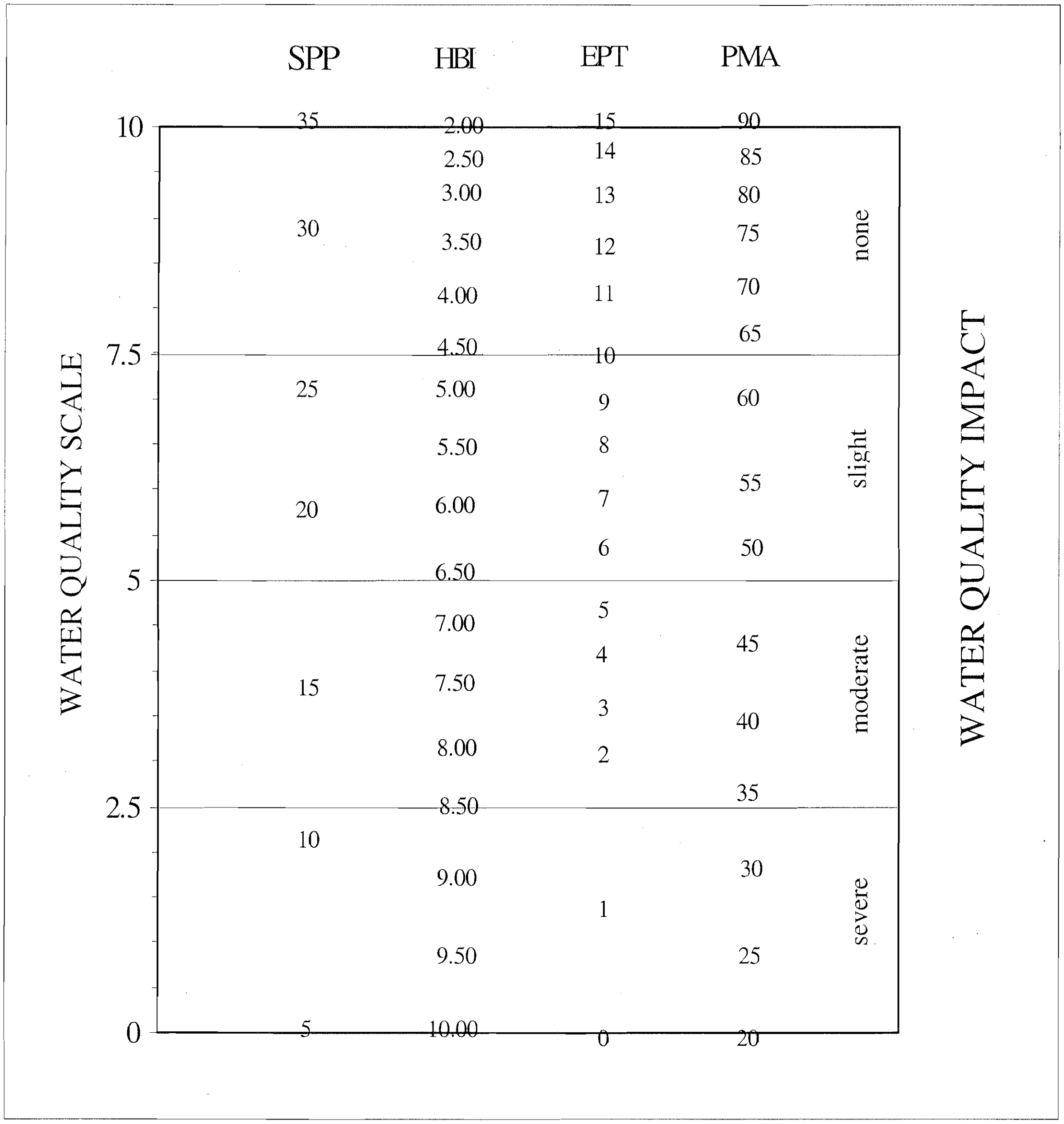
2. *Slightly impacted* Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. *Moderately impacted* Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT richness is 2-5. The biotic index value is 6.51- 8.50. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. *Severely impacted* Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or less. Mayflies, stoneflies, and caddisflies are rare or absent; EPT richness is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Biological Assessment Profile: Conversion of Index values to Common 10-Scale

The Biological Assessment Profile of index values, developed by Phil O'Brien, Division of Water, NYSDEC, is a method of plotting biological index values on a common scale of water-quality impact. Values from the four indices, defined in the Macroinvertebrate Community Parameter Appendix, are converted to a common 0-10 scale using the formulae in the Quality Assurance document (Bode, et al., 2002) and as shown in the figure below.



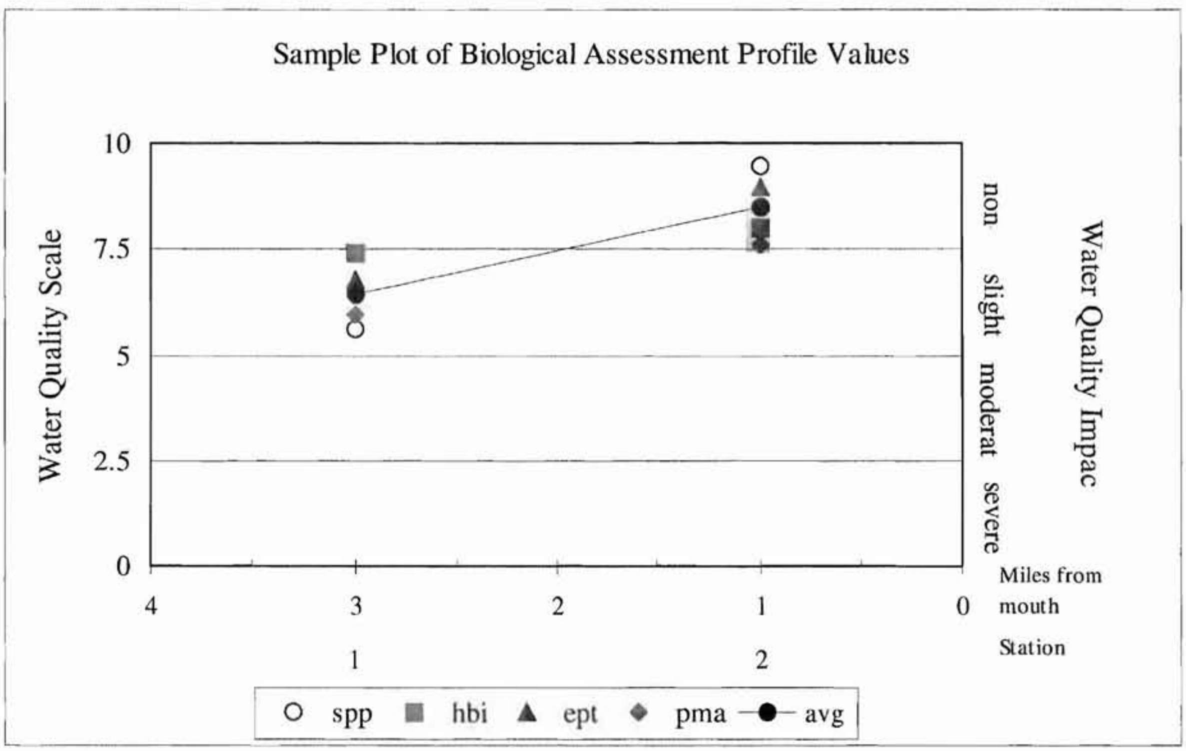
Biological Assessment Profile: Plotting Values

To plot survey data:
1. Position each site on the x-axis according to miles or tenths of a mile upstream of the mouth.
2. Plot the values of the four indices for each site as indicated by the common scale.
3. Calculate the mean of the four values and plot the result. This represents the assessed impact for each site.

Example data:

	Station 1		Station 2	
	metric value	10-scale value	metric value	10-scale value
Species richness	20	5.59	33	9.44
Hilsenhoff biotic index	5.00	7.40	4.00	8.00
EPT richness	9	6.80	13	9.00
Percent model affinity	55	5.97	65	7.60
Average		6.44 (slight)		8.51 (non-)

Table IV-B. Sample Plot of Biological Assessment Profile values



Water Quality Assessment Criteria

Water Quality Assessment Criteria for Non-Navigable Flowing Waters

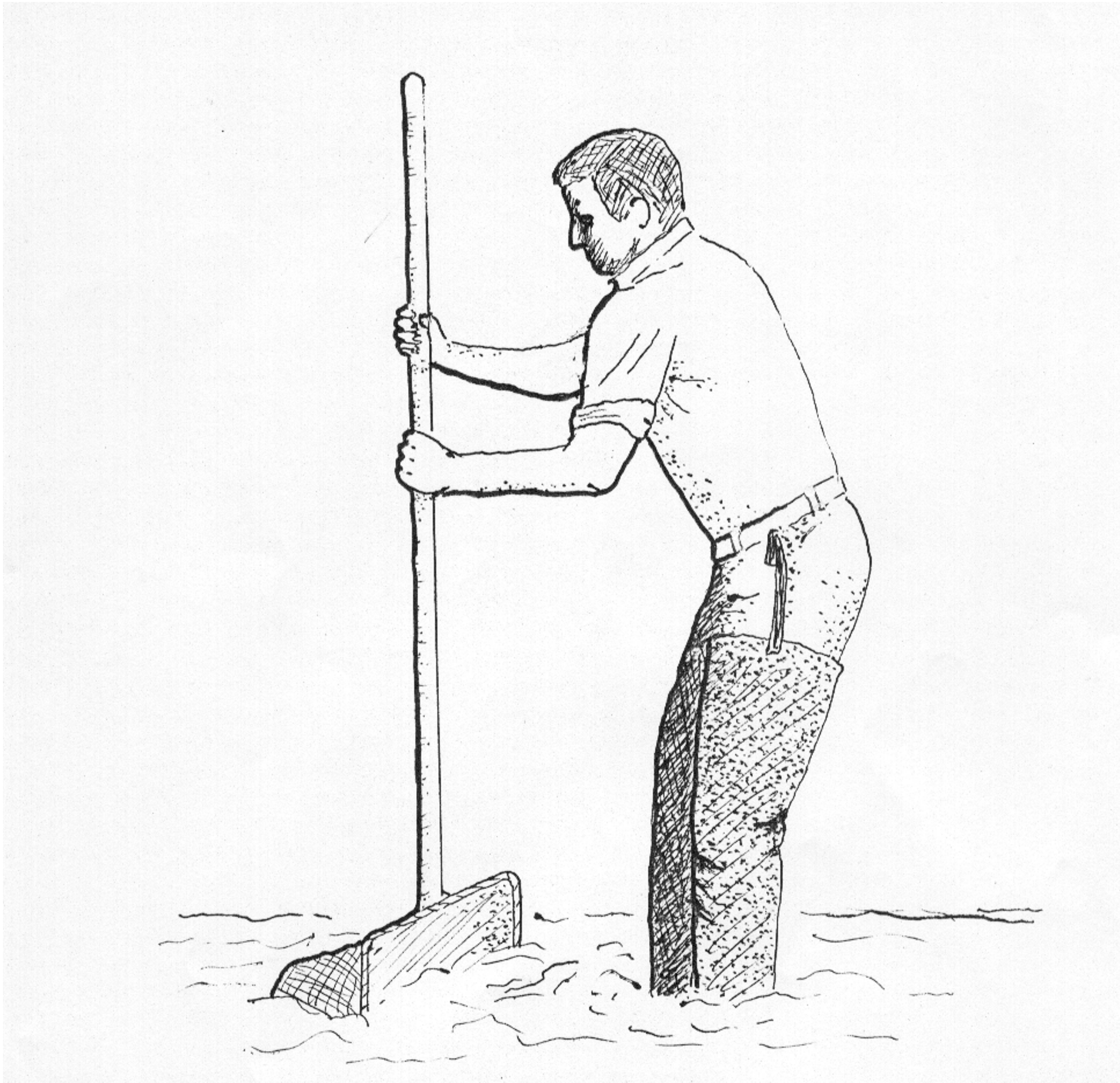
	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Percent Model Affinity#	Species Diversity*
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

Water Quality Assessment Criteria for Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Species Diversity
Non-Impacted	>21	0.00-7.00	>5	>3.00
Slightly Impacted	17-21	7.01-8.00	4-5	2.51-3.00
Moderately Impacted	12-16	8.01-9.00	2-3	2.01-2.50
Severely Impacted	0-11	9.01-10.00	0-1	0.00-2.00

Appendix VI. The Traveling Kick Sample



⟵current

Rocks and sediment in a riffle are dislodged by foot upstream of a net. Dislodged organisms are carried by the current into the net. Sampling continues for five minutes, as the sampler gradually moves downstream to cover a distance of five meters

Appendix VII-A. Aquatic Macroinvertebrates Usually Indicative of Good Water Quality

Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides and acidity. Most mayflies are found clinging to the undersides of rocks.

MAYFLIES

Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies, except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained for several months.

STONEFLIES

Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.

CADDISFLIES

The most common beetles in streams are riffle beetles (adult and larva pictured) and water pennies (not shown). Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

BEETLES

Appendix VII-B. Aquatic Macroinvertebrates Usually Indicative of Poor Water Quality

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called "bloodworms" indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.

MIDGES

Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.

BLACK FLIES

The segmented worms include the leeches and the small aquatic worms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution indicators. Many leeches are also tolerant of poor water quality.

WORMS

Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. They are classic indicators of sewage pollution, and can also thrive in toxic situations.

SOWBUGS

Digital images by Larry Abele, New York State Department of Environmental Conservation, Stream Biomonitoring Unit.

THE RATIONALE OF BIOLOGICAL MONITORING

Biological monitoring refers to the use of resident benthic macroinvertebrate communities as indicators of water quality. Macroinvertebrates are larger than-microscopic invertebrate animals that inhabit aquatic habitats; freshwater forms are primarily aquatic insects, worms, clams, snails, and crustaceans.

Concept

Nearly all streams are inhabited by a community of benthic macroinvertebrates. The species comprising the community each occupy a distinct niche defined and limited by a set of environmental requirements. The composition of the macroinvertebrate community is thus determined by many factors, including habitat, food source, flow regime, temperature, and water quality. The community is presumed to be controlled primarily by water quality if the other factors are determined to be constant or optimal. Community components which can change with water quality include species richness, diversity, balance, abundance, and presence/absence of tolerant or intolerant species. Various indices or metrics are used to measure these community changes. Assessments of water quality are based on metric values of the community, compared to expected metric values.

Advantages

The primary advantages to using macroinvertebrates as water quality indicators are:

1) they are sensitive to environmental impacts
2) they are less mobile than fish, and thus cannot avoid discharges
3) they can indicate effects of spills, intermittent discharges, and lapses in treatment
4) they are indicators of overall, integrated water quality, including synergistic effects and substances lower than detectable limits
5) they are abundant in most streams and are relatively easy and inexpensive to sample
6) they are able to detect non-chemical impacts to the habitat, e.g. siltation or thermal changes
7) they are vital components of the aquatic ecosystem and important as a food source for fish
8) they are more readily perceived by the public as tangible indicators of water quality
9) they can often provide ail on-site estimate of water quality
10) they can often be used to identify specific stresses or sources of impairment
11) they can be preserved and archived for decades, allowing for direct comparison of specimens
12) they bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

Limitations

Biological monitoring is not intended to replace chemical sampling, toxicity testing, or fish surveys. Each of these measurements provides information not contained in the others. Similarly, assessments based on biological sampling should not be taken as being representative of chemical sampling. Some substances may be present in levels exceeding ambient water quality criteria, yet have no apparent adverse community impact.

Anthropogenic: caused by human actions

Assessment: a diagnosis or evaluation of water quality

Benthos: organisms occurring on or in the bottom substrate of a waterbody

Bioaccumulate: accumulate contaminants in the tissues of an organism

Biomonitoring: the use of biological indicators to measure water quality

Community: a group of populations of organisms interacting in a habitat

Drainage basin: an area in which all water drains to a particular waterbody; watershed

EPT richness: the number of species of mayflies (**E**phemeroptera), stoneflies (**P**lecoptera), and caddisflies (**Tr**ichoptera) in a sample or subsample

Facultative: occurring over a wide range of water quality; neither tolerant nor intolerant of poor water quality

Fauna: the animal life of a particular habitat

Impact: a change in the physical, chemical, or biological condition of a waterbody

Impairment: a detrimental effect caused by an impact

Index: a number, metric, or parameter derived from sample data used as a measure of water quality

Intolerant: unable to survive poor water quality

Longitudinal trends: upstream-downstream changes in water quality in a river or stream

Macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

Multiplate: multiple-plate sampler, a type of artificial substrate sampler of aquatic macroinvertebrates

Organism: a living individual

PAHs: Polycyclic Aromatic Hydrocarbons, a class of organic compounds that are often toxic or carcinogenic

Rapid bioassessment: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short time; usually involves kick sampling and laboratory subsampling of the sample

Riffle: wadeable stretch of stream usually having a rubble bottom and sufficient current to break the water surface; rapids

Species richness: the number of macroinvertebrate species in a sample or subsample

Station: a sampling site on a waterbody

Survey: a set of samplings conducted in succession along a stretch of stream

Synergistic effect: an effect produced by the combination of two factors that is greater than the sum of the two factors

Tolerant: able to survive poor water quality

Impact Source Determination Methods and Community Models

Definition: Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. ISD uses community types or models to ascertain the primary factor influencing the fauna.

Development of methods: The method found to be most useful in differentiating impacts in New York State streams was the use of community types based on composition by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode, 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: agricultural nonpoint, toxic-stressed, sewage (domestic municipal), sewage/toxic, siltation, impoundment, and natural. Each group initially contained 20 sites. Cluster analysis was then performed within each group, using percent similarity at the family or genus level. Within each group, four clusters were identified. Each cluster was usually composed of 4-5 sites with high biological similarity. From each cluster, a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. These community type models formed the basis for ISD (see tables following). The method was tested by calculating percent similarity to all the models and determining which model was the most similar to the test site. Some models were initially adjusted to achieve maximum representation of the impact type. New models are developed when similar communities are recognized from several streams.

Use of the ISD methods: Impact Source Determination is based on similarity to existing models of community types (see tables following). The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural," lacking an impact. In the graphic representation of ISD, only the highest similarity of each source type is identified. If no model exhibits a similarity to the test data of greater than 50 percent, the determination is inconclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

Limitations: These methods were developed for data derived from subsamples of 100-organisms each that are taken from traveling kick samples of New York State streams. Application of these methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

Impact Source Determination Models

NATURAL

	A	B	C	D	E	F	G	H	I	J	K	L	M
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	5	-	5	-	5	5	-	-	-	5	5
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia	5	5	-	5	20	-	-	-	-	-	-	-	-
BAETIDAE	20	10	10	10	10	5	10	10	10	10	5	15	40
HEPTAGENIIDAE	5	10	5	20	10	5	5	5	5	10	10	5	5
LEPTOPHLEBIIDAE	5	5	-	-	-	-	-	-	5	-	-	25	5
EPHEMERELLIDAE	5	5	5	10	-	10	10	30	-	5	-	10	5
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	5	5	-	5	5	15	5	5	5	5
Psephenus	5	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	5	-	20	5	5	-	5	5	5	5	-	-	-
Promoresia	5	-	-	-	-	-	25	-	-	-	-	-	-
Stenelmis	10	5	10	10	5	-	-	-	10	-	-	-	5
PHILOPOTAMIDAE	5	20	5	5	5	5	5	-	5	5	5	5	5
HYDROPSYCHIDAE	10	5	15	15	10	10	5	5	10	15	5	5	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	5	5	-	-	-	20	-	5	5	5	5	5	-
SIMULIIDAE	-	-	-	5	5	-	-	-	-	5	-	-	-
Simulium vittatum	-	-	-	-	-	-	-	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE													
Tanypodinae	-	5	-	-	-	-	-	-	5	-	-	-	-
Diamesinae	-	-	-	-	-	-	5	-	-	-	-	-	-
Cardiocladius	-	5	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	5	-	-	10	-	-	5	-	-	5	5	5
Eukiefferiella/ Tvetenia	5	5	10	-	-	5	5	5	-	5	-	5	5
Parametriocnemus	-	-	-	-	-	-	-	5	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	20	-	-	10	20	20	5	-
Polypedilum (all others)	5	5	5	5	5	-	5	5	-	-	-	-	-
Tanytarsini	-	5	10	5	5	20	10	10	10	10	40	5	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100

Impact Source Determination Models

NONPOINT NUTRIENTS, PESTICIDES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	5	-	-	-	-	-	-
Isonychia	-	-	-	-	-	-	-	5	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-
Caenis/Tricorythodes	-	-	-	-	5	-	-	5	-	5
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	5	-	-	5	-	5	5	-	-	-
Optioservus	10	-	-	5	-	-	15	5	-	5
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	15	-	10	15	5	25	5	10	5
PHILOPOTAMIDAE	15	5	10	5	-	25	5	-	-	-
HYDROPSYCHIDAE	15	15	15	25	10	35	20	45	20	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	5	-	15	5	5	-	-	-	40	-
Simulium vittatum	-	-	-	-	-	-	-	-	5	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	-	5
CHIRONOMIDAE										
Tanypodinae	-	-	-	-	-	-	5	-	-	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	10	15	10	5	-	-	-	-	5	5
Eukiefferiella/ Tvetenia	-	15	10	5	-	-	-	-	5	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Microtendipes	-	-	-	-	-	-	-	-	-	20
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	20	10	5	10	5	5
Tanytarsini	10	10	10	5	20	5	5	10	-	10
TOTAL	100	100	100	100	100	100	100	100	100	100

Impact Source Determination Models

	MUNICIPAL/INDUSTRIAL								TOXIC					
	A	B	C	D	E	F	G	H	A	B	C	D	E	F
PLATYHELMINTHES	-	40	-	-	-	5	-	-	-	-	-	-	5	-
OLIGOCHAETA	20	20	70	10	-	20	-	-	-	10	20	5	5	15
HIRUDINEA	-	5	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	5	-	-	-	5	-	-	-	5
SPHAERIIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	10	5	10	10	15	5	-	-	10	10	-	20	10	5
GAMMARIDAE	40	-	-	-	15	-	5	5	5	-	-	-	5	5
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	5	-	-	-	5	-	10	10	15	10	20	-	-	5
HEPTAGENIIDAE	5	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	-	-	10	5	-	5	5	10	15	-	40	35	5
PHILOPOTAMIDAE	-	-	-	-	-	-	-	40	10	-	-	-	-	-
HYDROPSYCHIDAE	10	-	-	50	20	-	40	20	20	10	15	10	35	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	-	-	-	20	10	-	20	-	-	-	5
EMPIDIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	10	-	-	5	15	-	-	5	10	-	-	-	25
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	10	20	-	5	10	5	5	15	10	25	10	5	10
Eukiefferiella/ Tvetenia	-	-	-	-	-	-	-	-	-	-	20	10	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	-	-	-	10	20	40	10	5	10	-	-	-	-	5
Tanytarsini	-	-	-	10	10	-	5	-	-	-	-	-	-	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Impact Source Determination Models

SEWAGE EFFLUENT, ANIMAL WASTES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

Impact Source Determination Models

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Optioservus	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
Eukiefferiella/ Tvetenia	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	5	5	5	-	-	20	-	-	5	5	5	5
Tanytarsini	10	10	10	10	5	5	10	5	30	-	-	5	10	10	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100