MACROINVERTEBRATE INVESTIGATION

By closely examining a stream's macroinvertebrate community, one can learn a great deal about the stream's water quality and overall health. Macroinvertebrates (aquatic insects, worms, clams, snails, leeches and the like) are desirable indictors of water quality because they are fairly sedentary and of course are more or less confined to living in the stream year round (except perhaps for various life stages of various species); thus they are present and have to deal with any introduced perturbations.

Fish are also good indicators of water quality, but typically not to the extent of macroinvertebrates. Fish, depending on the circumstance, can simply leave an impacted area or flee from a pollution event.

Physical and chemical measurements tend to only provide "snap shot" data. That is to say these measurements are instantaneous and only describe conditions at the very point in time in which they were taken.

Still, a thorough water quality investigation or monitoring program should be comprised of and consider all the above – macroinvertebrates, fish, physical and chemical. This chapter deals solely with the macroinvertebrate investigation; the others are discussed elsewhere in this writing.

RETTEW biologists conducted macroinvertebrate sampling at **28 different monitoring stations** strategically located around the Little Conestoga Creek Watershed (as can be seen on the enclosed map). For the record, fish and physical habitat data were also collected at these same 28 monitoring locations/stations.

Macroinvertebrate investigations were performed using the United States Environmental Protection Agency's "rapid bioassessment protocols" – mainly the Biological Reconnaissance or Problem Identification Survey approach (though RETTEW biologist used a modified form for recording collected organisms). This particular protocol is very similar to the one used by Pennsylvania Department of Environmental Protection biologists involved in Pennsylvania's "Surface Waters Assessment" program (SWAP).

Collected organisms were identified to the taxonomic "family" level using a dissecting scope and reference keys such as Aquatic Insects of North America by R.W. Merrit and K.W. Cummins and Freshwater Macroinvertebrates of Northeastern North America by Barbara Peckarsky.

Five biological indices/metrics were utilized and computed at each of the 28 monitoring stations. They are as follows:

Taxa Richness

This metric is simply the number of taxa in a particular community. In this study, taxa were identified to the taxonomic "family" level so the taxa richness value determined for the sampled macroinvertebrate community at each monitoring station refers to the number of different discovered macroinvertebrate families.

Hilsenhoff Biological Index (HBI)

This index involves assigning pollution tolerance values (ranging from zero (0) to ten (10) with a 0 value assigned to taxa with the least amount of pollution tolerance and a 10 value assigned to the most pollution tolerant organisms) to the various collected taxa. All collected organisms within the sample are identified, counted and matched with the appropriate tolerance values. A final value for the whole entire macroinvertebrate sample is then computed allowing comparison and referencing of HBI scores with other sampled sites and streams.

EPT Index

The EPT Index is the summation of all identified mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*) and caddisflies (*Trichoptera*) families. These insect orders are used in this particular index because of their general intolerance for pollution.

Percent EPT

Percent EPT is the percentage of mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*) and caddisflies (*Trichoptera*) individuals within the sample. Again these insect orders are used in this particular metric because of their general intolerance for pollution.

Healthy or impaired decision based on previously computed Hilsenhoff score and Biological Reconnaissance findings

The macroinvertebrate community was suspected of being impaired if the HBI score was higher than 4.00 (except in purely limestone stream conditions as was the case at monitoring station #22 above Rohrer's Quarry) and/or if value target thresholds were not attained through the Biological Reconnaissance process.

LITTLE CONESTOGA CREEK – MACROINVERTEBRATE COMMUNITY SCORES

MONITORING STATION #	# OF FAMILIES	HBI SCORE	EPT INDEX SCORE	% EPT	IMPAIRED YES/NO	RANKING 1 - 28
1	21	3.55	5	76	NO	2
2	16	3.80	4	48	NO	4
3	17	3.68	5	74	NO	3
4	16	3.82	4	54	NO	5
5	10	3.04	4	81	NO	1
6	9	4.32	5	81	YES	7
7	11	5.06	1	6	YES	12
8	15	4.79	3	29	YES	9
9	19	5.65	3	38	YES	20
10	13	5.43	2	34	YES	15
11	18	5.12	5	18.5	YES	13
12	16	6.35	2	8	YES	24
13	16	5.46	3	15	YES	17
14	15	5.96	2	5	YES	23
15	16	5.82	2	10	YES	21
16	11	4.72	3	24	YES	8
17	6	6.77	0	0	YES	26
18	10	4.84	2	45	YES	10
19	15	4.85	3	34	YES	11
20	9	7.00	0	0	YES	27
21	7	6.70	0	0	YES	25
22	5	4.23	0	0	NO	6
23	9	5.22	1	8	YES	14
A1	8	5.58	2	19	YES	19
A2	5	5.88	1	2	YES	22
A3	7	5.45	3	20	YES	16
A4	4	5.48	1	12	YES	18
A5	6	7.71	1	3	YES	28

Through the macroinvertebrate collection process, some interesting observations were made that are worth noting at this time.

Monitoring station #3, located in the upper reaches of Indian Run, stood out as unique because it was the only station where stoneflies (*Plecoptera*) were collected. The station also had a high percent EPT score. Overall, the station ranked 3rd.

Monitoring station #7, located on the West Branch immediately below Columbia Avenue (Rte. 462), is considered impaired based on RETTEW findings and only ranked 12th best out of the 28 stations. However a September 1998 United States Geological Survey study claimed this area had the least impaired aquatic insect community as compared to their other 14 monitoring locations. After reviewing the data sheets and revisiting the site, RETTEW biologists would question the accuracy and conclusions of the USGS macroinvertebrate collection. The USGS study apparently depended heavily upon the use of volunteers for collection purposes. Having worked with such volunteers, RETTEW would argue that however well intending the typical volunteers, they simply lack the necessary training to recognize and distinguish subtleties in aquatic habitat from which to collect a sample that is truly representative of that particular reach of stream. Its appears at best, USGS only came up with 12 different taxa at their top station whereas RETTEW produced 21 different taxa at their monitoring station #1, while three of the others considered unimpaired produced 16 taxa or better. The time of year could account for some of the discrepancies – the USGS collection having been completed in September 1998, the RETTEW collection throughout the spring of 2002. Interesting, USGS found 12 taxa at their top station (#11). RETTEW found 11 taxa at monitoring station #7 which appears to be very close to the USGS station #11. Another fact worth noting is that USGS did not have any monitoring stations in close proximity to the two best scoring RETTEW monitoring stations #1 and #5. Additionally USGS had a total of 15 monitoring stations whereas RETTEW had 28.

Monitoring station #22, located upstream of Rohrer's Quarry in the headwaters of Bachman Run, had low macroinvertebrate diversity and a total absence of EPT taxa but was considered unimpaired due to the fact this upper reach of Bachman Run is truly a limestone stream. One simply cannot compare limestone macroinvertebrate diversity with that of a freestone type stream. Station #22 is very typical of a limestone stream – cold, spring fed water and a considerable amount of watercress (*Cardamine*). It also makes sense that a stream flowing past a limestone quarry would likely be a limestone stream!

Generally speaking, all monitoring stations located upstream of Millersville (with the exception of station #22) scored poorly and showed signs of impairment. These stations tended to have high percentages of beetles (*Coleoptera*) and true flies/midges (*Diptera*). Station #10 was unique in that it was the only station toad bugs (*Gelastocoridae*) were present. Toad bugs are commonly found on sandy beeches and dunes as are present at this Maple Grove monitoring station.

FISHERY INVESTIGATION

A watershed assessment would probably be considered incomplete by most people if it lacked any sort of fish investigation. People relate to fish. People keep fish as pets. People eat fish. People raise fish as a business. People fish for fish - some even fish for fish with fish as bait. Tell someone you are studying a stream and they'll likely ask you (or tell you in some cases) about the fish. Likewise telling someone you're in the midst of a stream improvement project to improve the trout fishery will normally bring about good, positive feedback; while telling them you're in the midst of a stream improvement project to better the in-stream habitat for stoneflies will normally bring about puzzled looks. As said before, people relate to fish.

Much stream improvement work accomplished in Pennsylvania at the grassroots level is done so in the interest of improving the fishery and angling opportunity. Perhaps there is no greater example of this than all the various local TU (Trout Unlimited) chapters scattered across the Keystone State that are involved in stream restoration projects. Many watershed organizations have anglers as members, board members and officers on their rosters. Fishermen learned long ago that good water and good habitat mean good fishing.

Considering the above, the fish community within the Little Conestoga Creek Watershed was thoroughly investigated as part of the overall watershed assessment. Fish assemblages were investigated at 24 strategically located monitoring stations (the same stations used for the macroinvertebrate investigation – stations #1 through #23 and station A1 – fish data was not collected for stations A2 through A5).

Fish were collected using a backpack type electrofishing unit (specifically, a LR-24 Electrofisher by Smith-Root, Inc.) and a variety of nets and seines. The electrofishing unit is used to send an electrical current through the water in the immediate area of the operator and a netter. The operator controls the intensity of the created electrical field so as not to over do it and cause unnecessary physical harm to the fish. The operator controls the voltage, frequency and duration of the electrical impulses so as to only temporarily stun the fish so that they can be netted.

Depending on the situation, fish were either immediately identified and put back into the water or were placed in a water filled tote barge for later streamside or lab identification. Most fish species were identified on-site with the aid of identification manuals such as How to Know the Freshwater Fishes by Samuel Eddy and James C. Underhill, Identification Guide to Pennsylvania Fishes by Clark Shiffer and Fishes of Pennsylvania and the Northeastern United States by Edwin L. Cooper. However there were times when it was necessary to kill and preserve select specimens from the harder to identify genera – dace and shiner species being among the more difficult. In these cases, identification took place in the lab with the aid of proper lighting, a dissecting scope, and identification manuals. Previous collection lists by the Pennsylvania Fish and Boat Commission were also consulted. Specimens were also collected for photography purposes.

In regards to game fish, only one specimen from each species of collected sunfish, sucker and catfish were purposely killed. All trout species were immediately returned to the water. Some thirty specimens from non-game dace and shiner species and one Quillback carpsucker were purposely killed during the investigation. Mortality due to direct electrofishing was near non-existent due to the purposely-selected low voltage, low frequency electrofishing setting. Most fish regained muscle control and escaped the area immediately after floating or twitching their way out of the electrical field.

Field investigations by RETTEW biologists produced 31 species of fish within the Little Conestoga Creek Watershed, with the majority being considered coolwater and warmwater species. The Pennsylvania Fish and Boat Commission has recorded an additional 8 species.

Stocked Brown and Rainbow trout (*Salmo trutta and Oncorhynchus mykiss*), which are considered coldwater species, were captured in the West Branch and the Main Stem upstream of Route 72 (Manheim Pike) to more or less East Petersburg Borough. No trout were observed in Bachman Run. The stocked trout purely exist in a put and take situation. The Pennsylvania Fish and Boat Commission stock trout being in March through May with the regular trout season opening in April; thus the Commission "put" the trout and the anglers in turn "take" them. Given current habitat conditions in these stocked waters, RETTEW biologists feel there is little opportunity for any trout to survive and carryover to the next year. In most cases the water simply gets too warm during the summer months. However there are at least two known locations where private landowners do have small trout ponds that feed into the Main Stem. In these cases, the landowners simply improved spring seeps and made small ponds out of them.

Even though the meager trout fishery now existing in the Little Conestoga Creek Watershed is totally dependent upon stocking and limited to a seasonal condition, there is hope and promise for something a little more substantial. The lower portion of the West Branch and the Main Stem between Millers Road and Quarry Road near East Petersburg Borough seem to be two possible stream reaches where more of a year round trout fishery could be developed.

The lower portion of the West Branch is well vegetated, shaded and contains good in-stream cover. While electrofishing at monitoring station #5, RETTEW biologists encountered a single Brown trout that surfaced underneath a tangle of tree roots. Though the biologists could clearly see the fish, there was no physical way of getting to it with a net for a closer look. It was the only trout observed at that location and it was rather small, approximately 9-inches. The trout was brilliantly colored and just didn't strike the biologists as being a hatchery-raised fish. The conclusion (though it's a guess) was that the fish was either a holdover from the previous year's upstream stocking, or was a stream-bred fish.

The Main Stem (excluding Bachman Run) between Millers Road upstream to Quarry Road (close to the Bent Creek Golf Course) is a very promising stretch of future trout water provided stream restoration takes place throughout much of this headwater area. A number of springs are located along this length of stream, providing a source of cold water.

However the vast majority of the Little Conestoga Creek and its tributaries should be considered and managed as coolwater and warmwater fisheries. By and large, the bulk of monitoring stations were dominated by White sucker (*Catostomus commersoni*), Rock bass (*Ambloplites rupestris*), Bluntnose minnow (*Pimephales notatus*) and Tessellated darter (*Etheostoma olmstedi*). Blacknose dace (*Rhinichthys atratulus*), Longnose dace (*Rhinichthys cataractae*) and Redbreast sunfish (*Lepomis auritus*) were common. Smallmouth bass (*Micropterus dolomieu*) were fairly common where the in-stream habitat was adequately consisting of rocky substrates, woody debris and tree root overhangs.

Smallmouth were found in the Main Stem from its confluence with the Conestoga River upstream to Columbia Avenue at Maple Grove. Upstream from that point, the quality of habitat simply declined. In-stream habitat around Flory's Mill just below Route 283 seemed like it should have harbored at least a bass or two, but none were found. In-stream habitat conditions near Park City were absolutely horrendous, with the substrate being heavily silt laden and very little in-stream overhead structure (rocks, logs) for fish to find refuge under.

However RETTEW biologists see no reason why Smallmouth bass shouldn't exist as far upstream as Route 72 (Manheim Pike) if the in-stream habitat is improved. Likewise, effort should be made to improve in-stream habitat conditions for Smallmouth bass even where they presently exist because their numbers in those locations really are not all that good and are greatly limited by the scarceness of available cover.

Consider this - the biggest Smallmouth bass (15-inches) was found hiding under a 4X8-foot piece of plywood in Manor Park upstream of the footbridge. It's a rather odd thing to ponder that the biggest, best game fish in the entire creek was hiding under a big piece of litter!

Two discovered species that haven't yet been mentioned deserve attention. The two species in mind are the Greenside and Banded darters (*Etheostoma blennioides* and *Etheostoma zonale*), both of which are considered pollution intolerant species. These colorful, little, bottom dwelling fish were found only in the very lower portion of the Main Stem – interestingly within the deemed "unimpaired zone" as per the Pennsylvania Department of Environmental Protection's 303 (d) List of Impaired Waters (monitoring stations #1 through #5). Historically, Banded darters are not indigenous to the Susquehanna River Watershed. It is thought the Banded darter somehow gained access to the Susquehanna via Pine Creek in Potter County sometime in the late 1960's and have since rapidly colonized mainstem riffles and many tributaries downstream into Maryland. So Native American Indians would not have found these colorful little fish swimming in the Little Conestoga. The fish however are native to North America.

The Little Conestoga Creek is also home to some truly exotic fish - Common Carp (*Cyprinus carpio*) from Europe, Goldfish (*Carassius auratus*) from Asia and Brown trout (*Salmo trutta*) from Europe (though a naturally reproducing population does not exist – it is rather through stocking that Brown trout exist within the Little Conestoga Creek). Carp and Goldfish are for the most part considered a nuisance, undesirable species given the fact they routinely displace native fish species. Carp are especially known destroyers of native aquatic habitats via their tendency to dig in the soft sediments while feeding. Aquatic plants are often uprooted and/or die because of the constantly cloudy water and the inability to photosynthesize. Native fish nests and eggs are often destroyed by feeding Carp as are the eggs and larva of aquatic insects.

Even Brown trout can receive an unwelcome response when introduced into Brook trout (*Salvelinus fontinalis*) streams.

LITTLE CONESTOGA CREEK – FISH COMMUNITY ASSEMBLAGES

MONITORING STATION #	# OF NATIVE FISH SPECIES (INCLUDES SMALLMOUTH BASS)	# OF DARTER SPECIES	# OF SUNFISH SPECIES	# OF SUCKER SPECIES	# OF POLLUTION INTOLERANT SPECIES	% OF POLLUTION INTOLERANT SPECIES	WILD TROUT PRESENT YES/NO	STOCKED TROUT PRESENT YES/NO
1	9	1	3	2	1	8.8	NO	NO
2	9	2	2	2	2	**13.5**	NO	NO
3	7	1	0	1	1	11	NO	NO
4	8	**3**	0	2	2	15	NO	NO
5	11	1	3	1	**3**	10.6	?	YES
6	10	1	2	2	1	4.2	NO	NO
7	9	1	1	2	1	12.1	NO	NO
8	**13**	1	**5**	2	0	0	NO	NO
9	10	1	3	2	1	2.5	NO	NO
10	11	1	4	2	1	3.1	NO	NO
11	11	1	2	1	0	0	NO	NO
12	10	1	3	2	0	0	NO	NO
13	8	1	3	1	1	1.2	NO	YES
14	9	1	2	1	0	0	NO	YES
15	10	1	3	1	0	0	NO	YES
16	8	1	3	2	0	0	NO	YES
17	8	0	1	1	0	0	NO	NO
18	10	1	2	2	0	0	NO	YES
19	10	1	3	2	1	4.2	NO	NO
20	10	1	3	1	0	0	NO	NO
21	0	0	0	0	0	0	NO	NO
22	3	1	0	0	0	0	NO	NO
23	11	1	2	1	1	0.9	NO	YES
A1	5	0	2	1	0	0	NO	NO

LITTLE CONESTOGA CREEK - COLLECTED FISH SPECIES

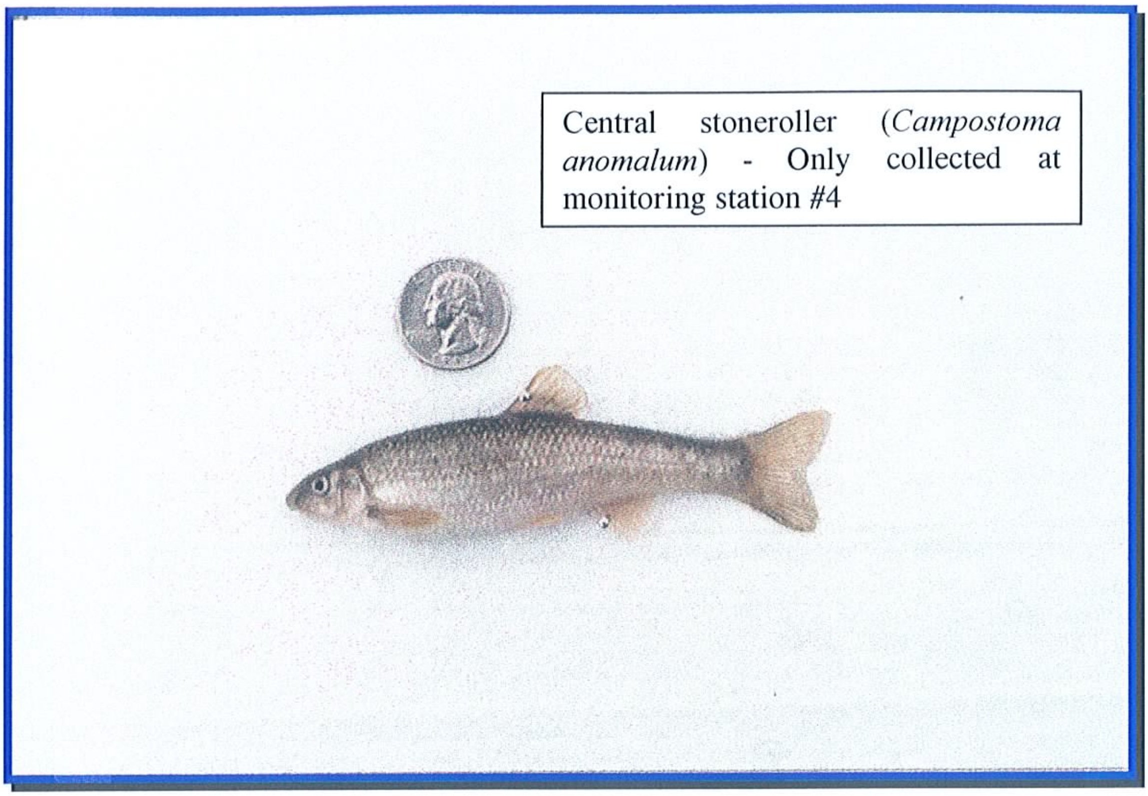
SPECIES	PFBC 4-30-97	PFBC 5-5-97	PFBC 5-12-97	PFBC 5-19-97	PFBC 6-2-97	RETTEW APRIL - JUNE 2002
ANGUILLIDA (Freshwater eels)						
Anguilla rostrata (American eel)						
CLUPEIDAE (Herrings)						
Alosa mediocris (Hickory shad)						
Alosa pseudoharengus (Alewife)						
Alosa sapidissima (American shad)						
Dorosoma cepedianum (Gizzard shad)					X	
CYPRINIDAE (Carps and Minnows)						
Campostoma anomalum (Central stoneroller)	X	X			X	X
Carassius auratus (Goldfish)	X	X	X			X
Clinostomus funduloides (Rosyside dace)						
Cyprinella analostana (Satinfin shiner)	X			X	X	X
Cyprinella spiloptera (Spotfin shiner)	X	X	X	X		X
Cyprinus carpio (Common carp)	X	X	X	X	X	X
Exoglossum maxillingua (Cutlips minnow)	X	X	X	X		X
Luxilus cornutus (Common shiner)	X	X	X	X	X	X
Margariscus margarita (Pearl dace)						
Nocomis micropogen (River chub)						
Notemigonus crysoleucas (Golden shiner)						X
Notropis amoenus (Comely shiner)	X					
Notropis hudsonius (Spottail shiner)	X	X	X	X	X	X
Notropis procne (Swallowtail shiner)		X				
Notropis rubellus (Rosyface shiner)						
Notropis volucellus (Mimic shiner)	X					

Pimephales notatus (Bluntnose minnow)	X	X	X	X	X	X
Pimephales promelas (Fathead minnow)						X
Rhinichthys atratulus (Blacknose dace)	X	X	X	X	X	X
Rhinichthys cataractae (Longnose dace)	X	X	X	X	X	X
Semotilus atromaculatus (Creek chub)	X	X	X	X	X	X
Semotilus corporalis (Fallfish)						X
CATOSTOMIDAE (Suckers)						
Carpiodes cyprinus (Quillback)	X		X			X
Catostomus commersoni (White sucker)	X	X	X	X	X	X
Hypentelium nigricans (Northern hog sucker)	X	X	X	X	X	X
Moxostoma macrolepidotum (Shorthead redhorse)	X	X	X	X		
ICTALURIDAE (Bullhead catfishes)						
Ameiurus natalis (Yellow bullhead)	X			X		X
Ameiurus nebulosus (Brown bullhead)	X		X			
Ictalurus punctatus (Channel catfish)	X		X			
Noturus insignis (Margined madtom)						
ESOCIDAE (Pikes)						
Esox lucius (Northern pike)						
Esox masquinongy (Muskellunge)						
Esox niger (Chain pickerel)						
SALMONIDAE (Trouts)						
Oncorhynchus mykiss (Rainbow trout)					X	X
Salmo trutta (Brown trout)						X
Salvelinus fontinalis (Brook trout)						
CYPRINODONTIDAE (Killifishes)						
Fundulus diaphanus (Banded killifish)						X
COTTIDAE (Sculpins)						

Cottus bairdi (Mottled sculpin)						
Cottus cognatus (Slimy sculpin)						
CENTRACHIDAE (Sunfishes)						
Ambloplites rupestris (Rock bass)	X	X	X	X	X	X
Lepomis auritus (Redbreast sunfish)			X			X
Lepomis cyanellus (Green sunfish)		X		X		X
Lepomis gibbosus (Pumpkinseed)	X		X	X	X	X
Lepomis macrochirus (Bluegill)		X	X	X	X	X
Micropterus dolomieu (Smallmouth bass)	X	X	X		X	X
Micropterus salmoides (Largemouth bass)	X	X	X		X	
Pomoxis annularis (White crappie)						
Pomoxis nigromaculatus (Black crappie)						
PERCIDAE (Perches)						
Etheostoma blennioides (Greenside darter)	X	X	X			X
Etheostoma olmstedi (Tessellated darter)		X		X	X	X
Etheostoma zonale (Banded darter)	X	X	X	X	X	X
Perca flavescens (Yellow perch)						
Stizostedion vitreum (Walleye)						
OTHER						

*******PFBC – Pennsylvania Fish and Boat Commission – Information provided by fishery biologist Bryan Chikotas – Fish collected 90 meters upstream of Route 999 of Main Stem******

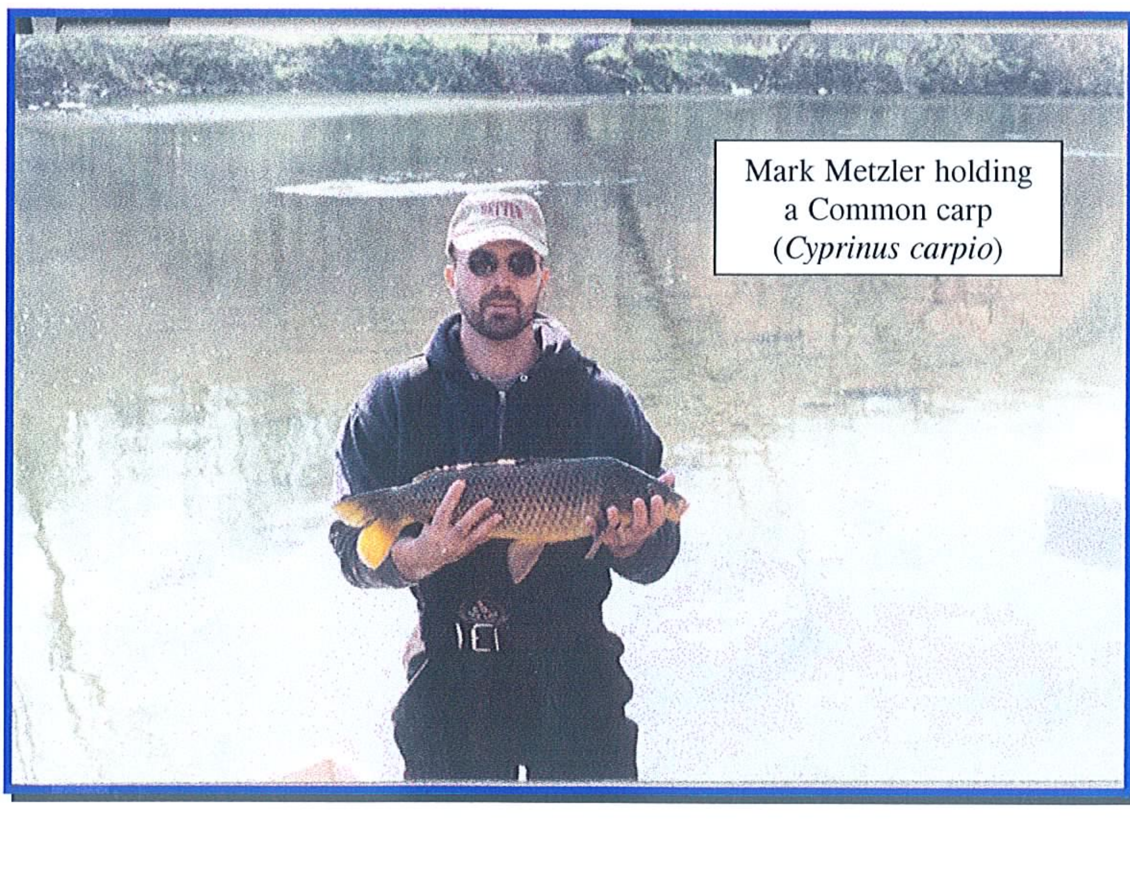
Little Conestoga Creek – Collected Fish Species Photographs



Central stoneroller (*Campostoma anomalum*) - Only collected at monitoring station #4

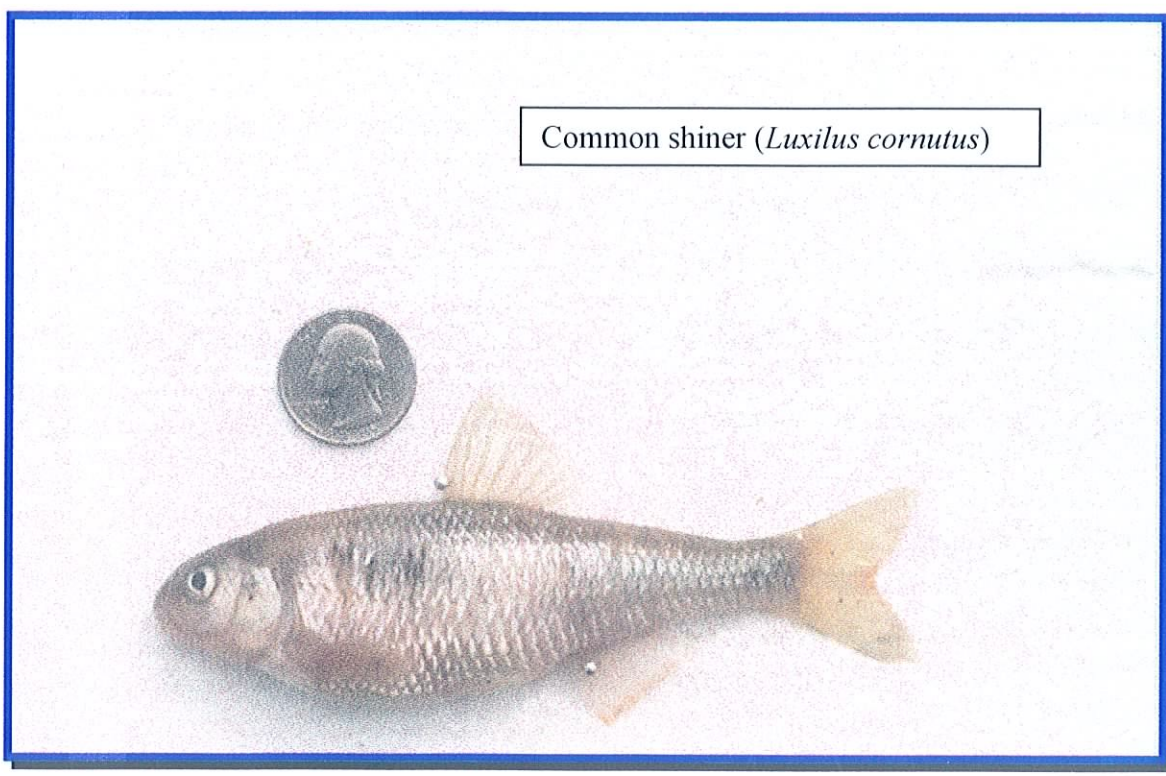
Satinfin shiner (*Cyprinella analostana*)

Spotfin shiner (*Cyprinella spiloptera*)

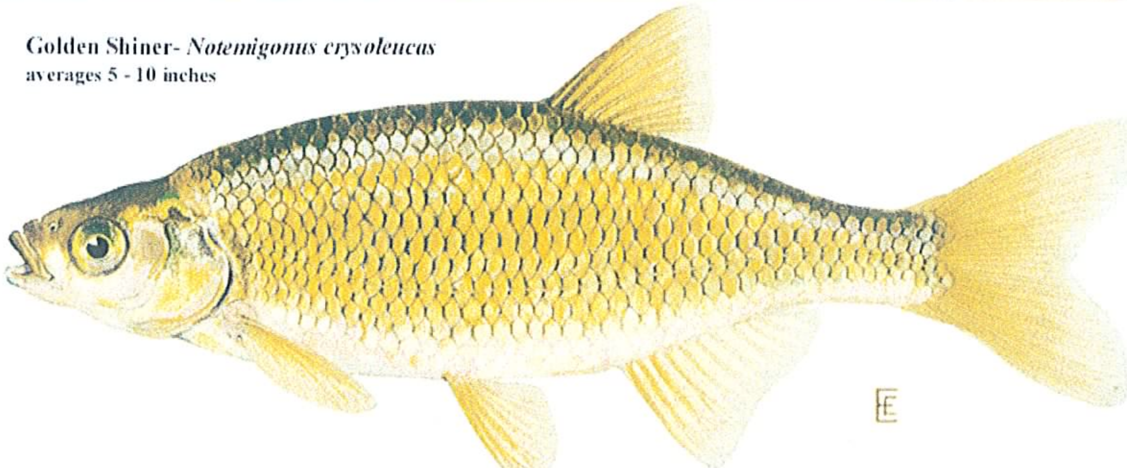


Mark Metzler holding a Common carp (*Cyprinus carpio*)


Cutlips minnow (*Exoglossum maxillingua*)


Common shiner (*Luxilus cornutus*)

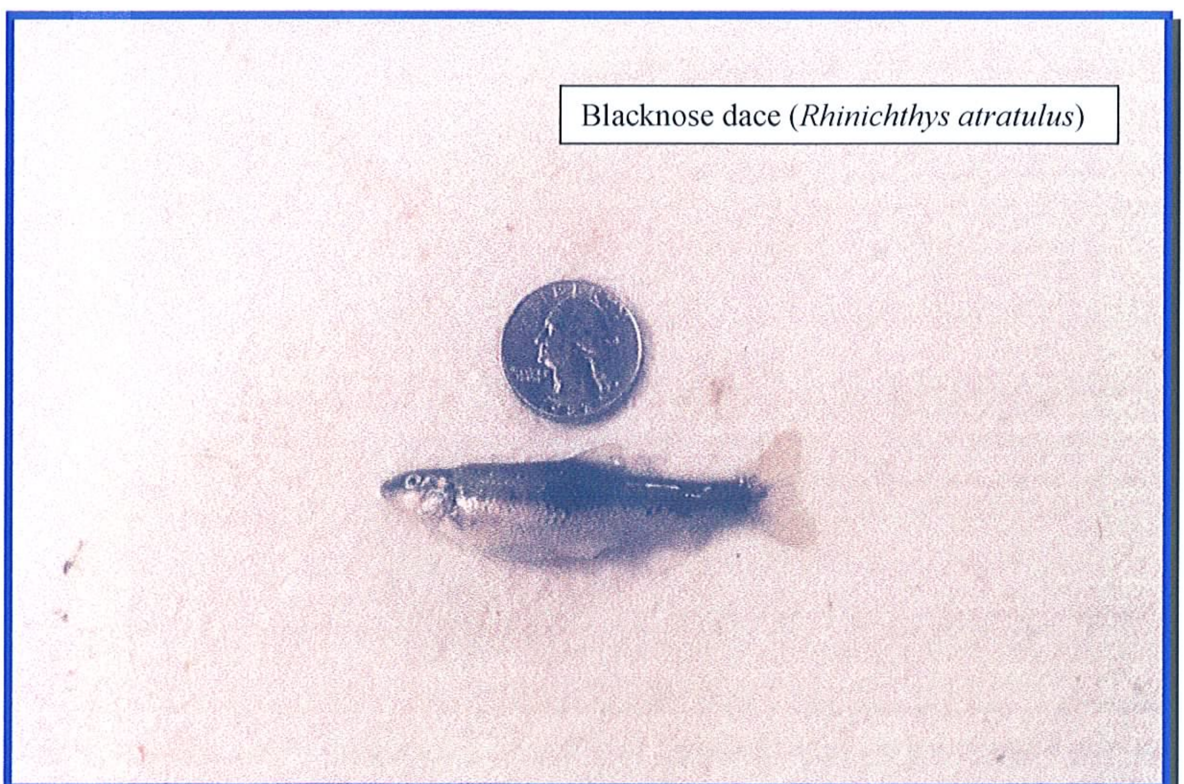
Golden Shiner- ***Notemigonus crysoleucas***
averages 5 - 10 inches



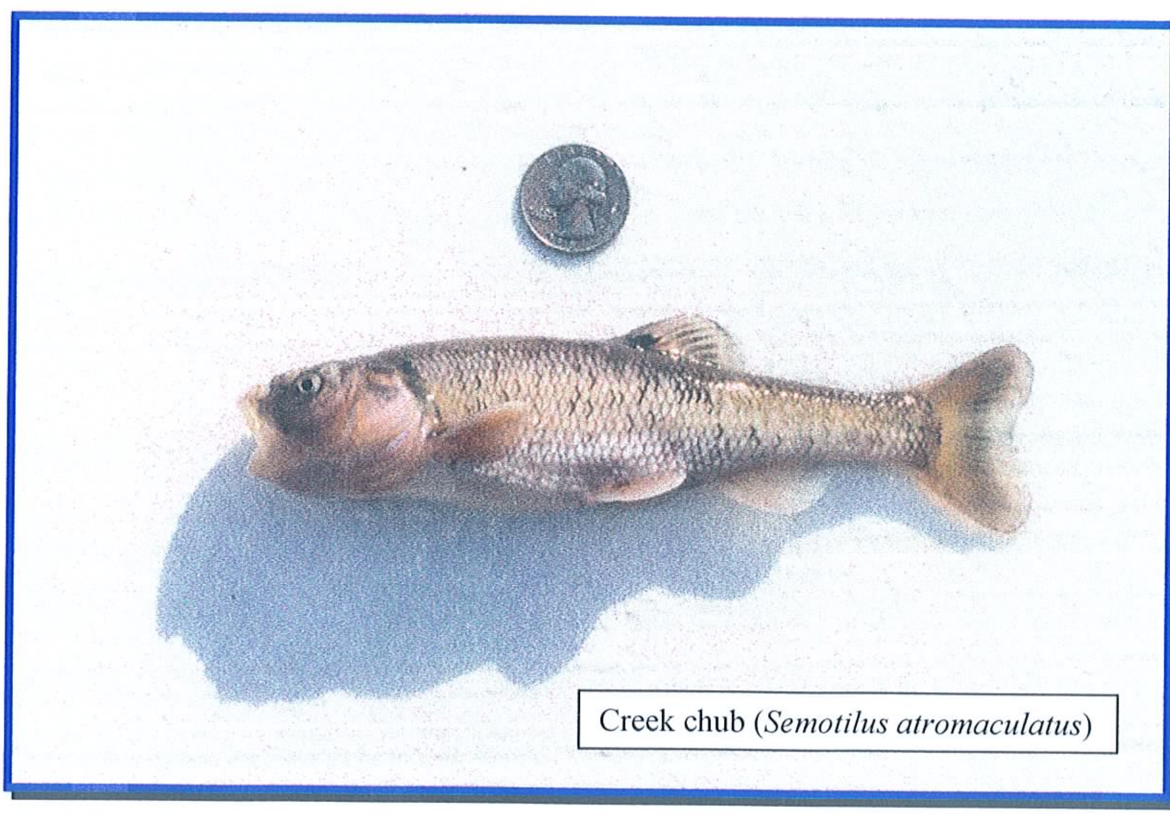
Spottail Shiner - ***Notropis hudsonius***
averages 3-4 inches

Bluntnose minnow (*Pimephales notatus*)


Fathead minnow (*Pimephales promelas*)

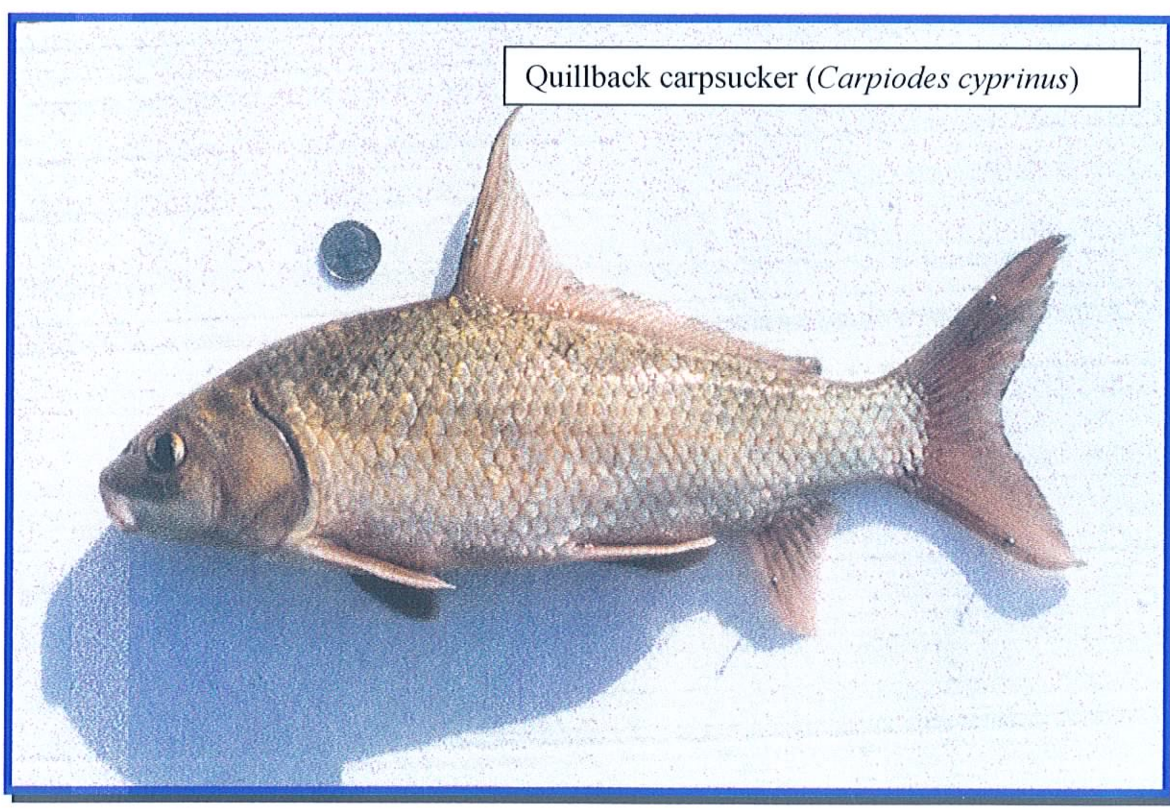

Blacknose dace (*Rhinichthys atratulus*)

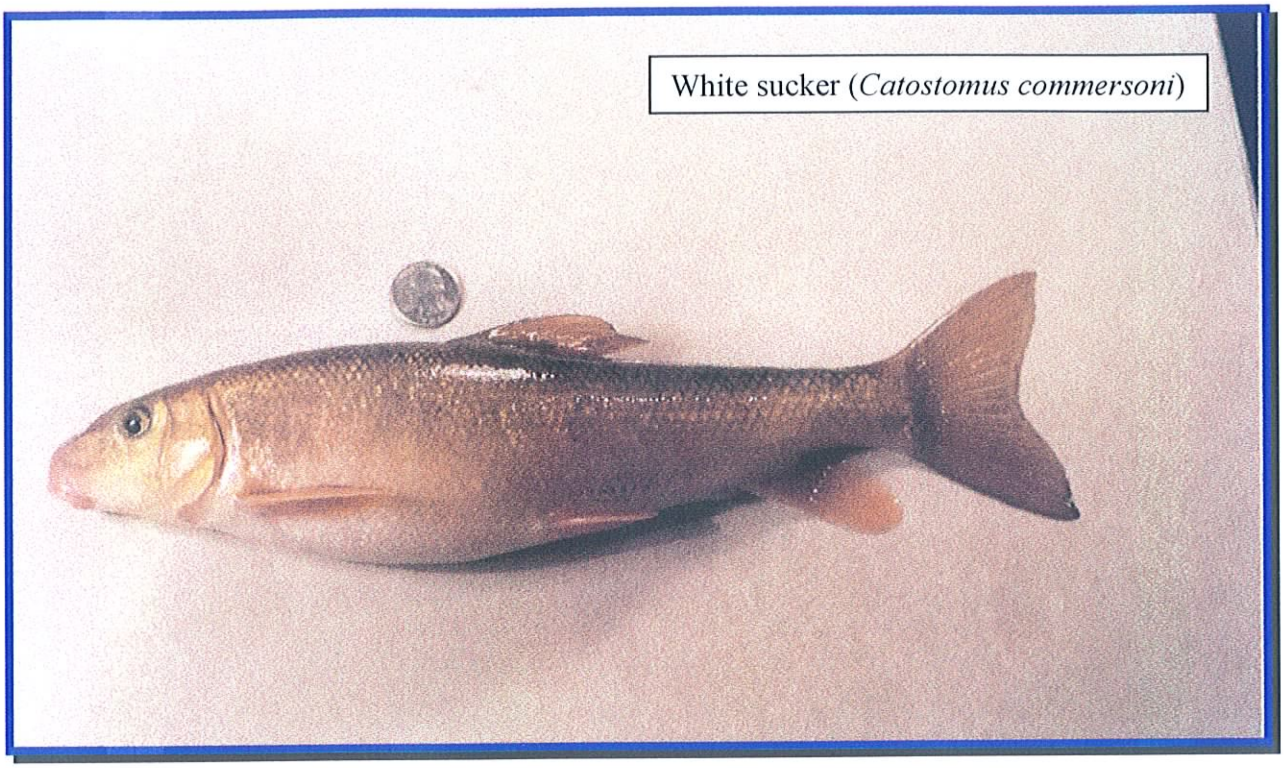
Longnose dace (*Rhinichthys cataractae*)

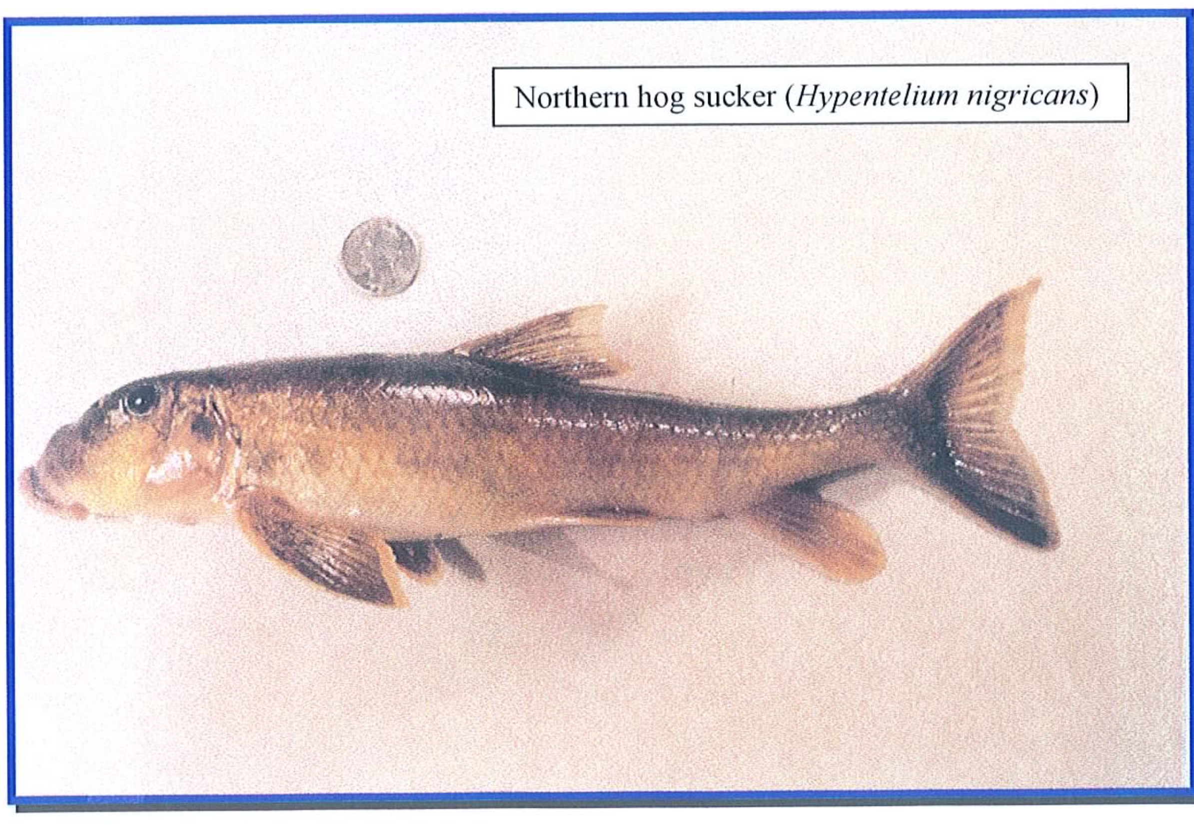


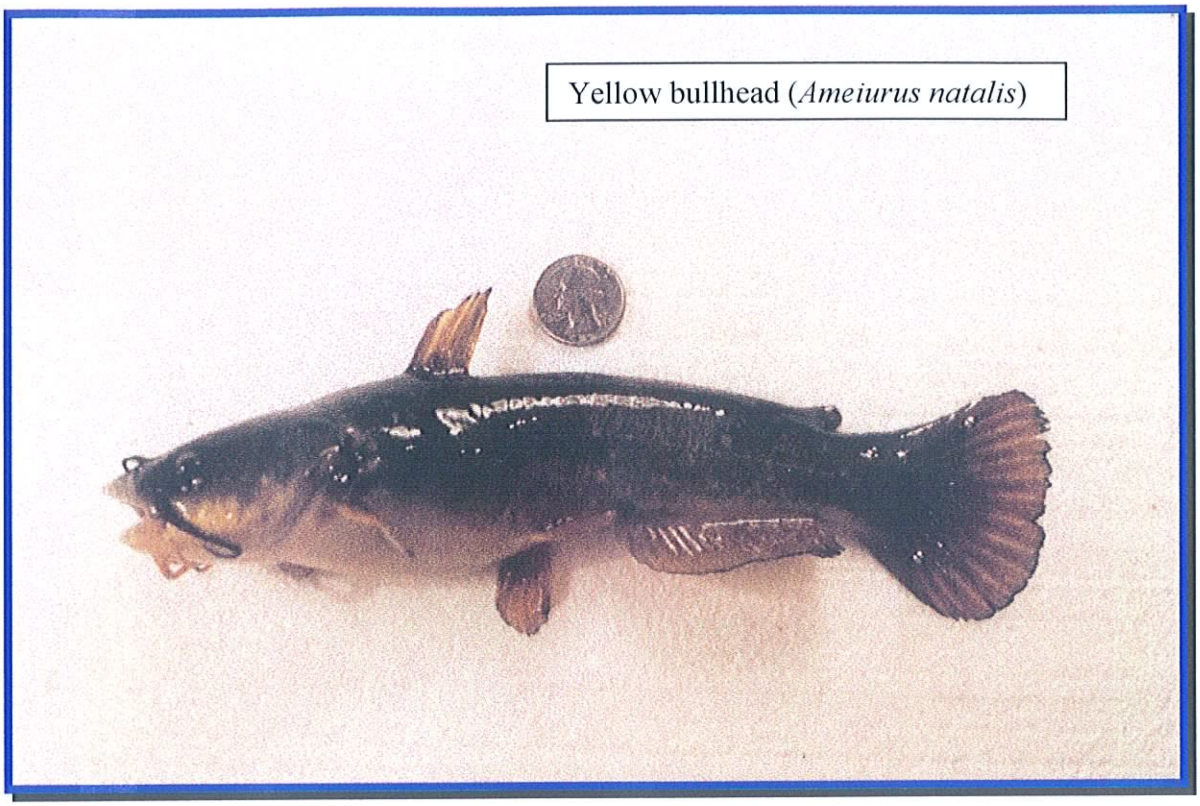
Creek chub (*Semotilus atromaculatus*)


Fallfish (Semotilus corporalis)

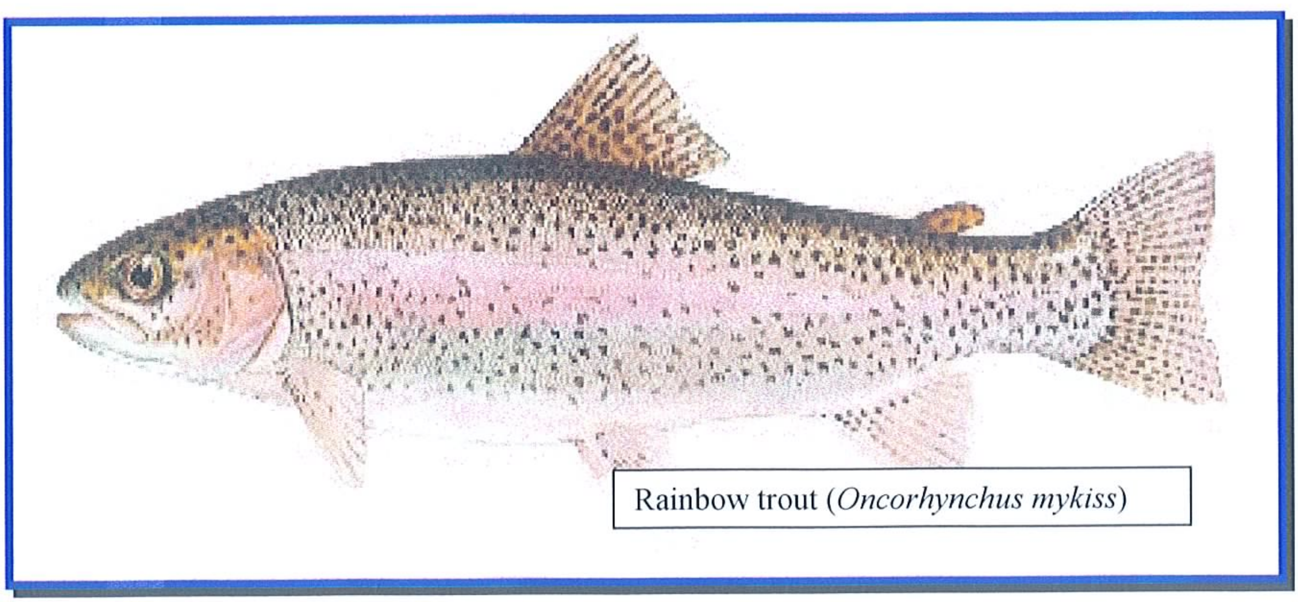

Quillback carpsucker (Carpiodes cyprinus)


White sucker (*Catostomus commersoni*)

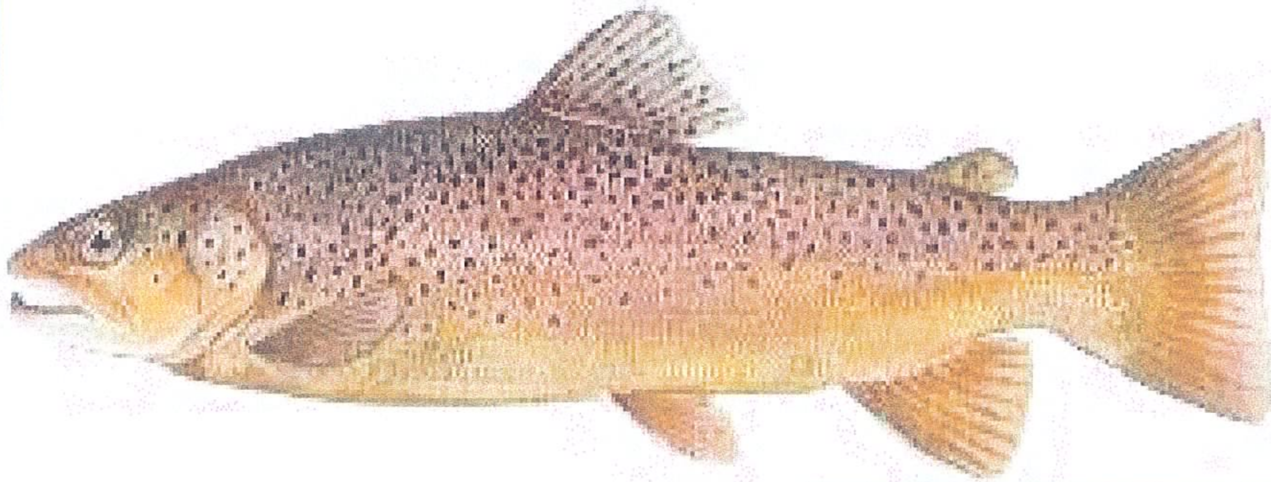

Northern hog sucker (*Hypentelium nigricans*)



Yellow bullhead (*Ameiurus natalis*)

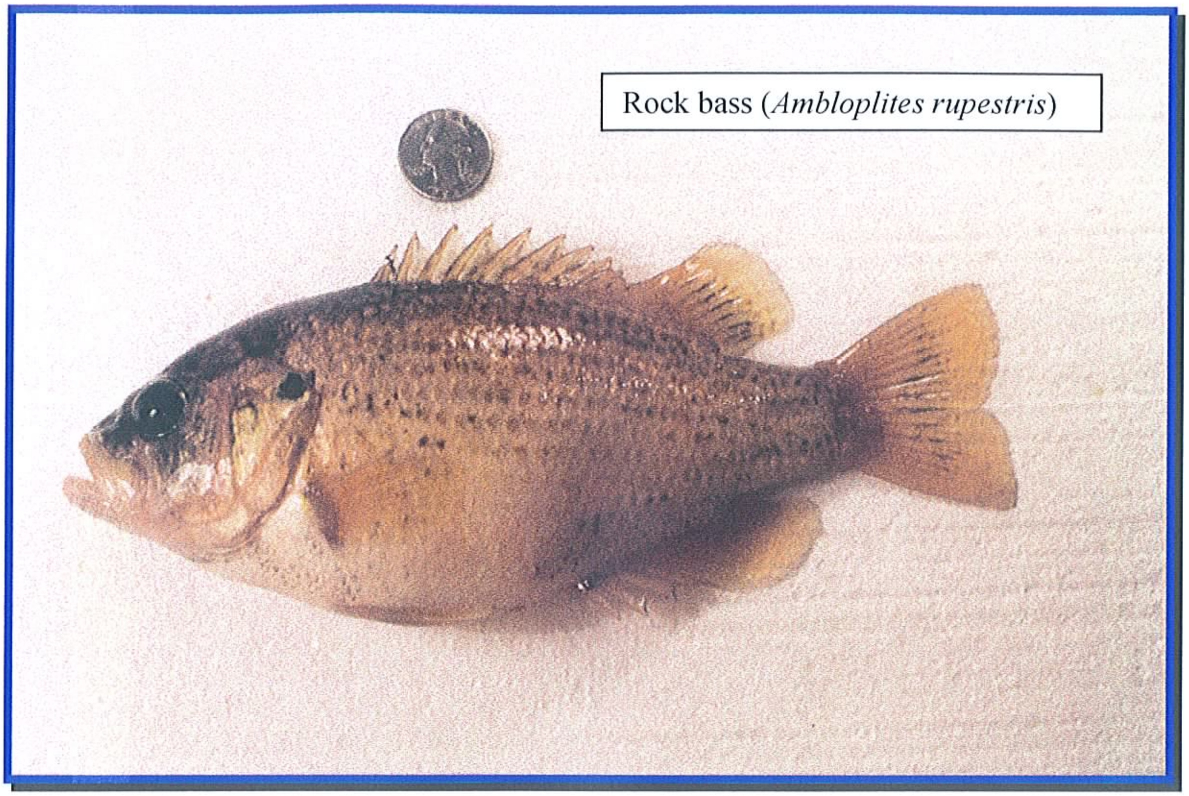


Rainbow trout (*Oncorhynchus mykiss*)



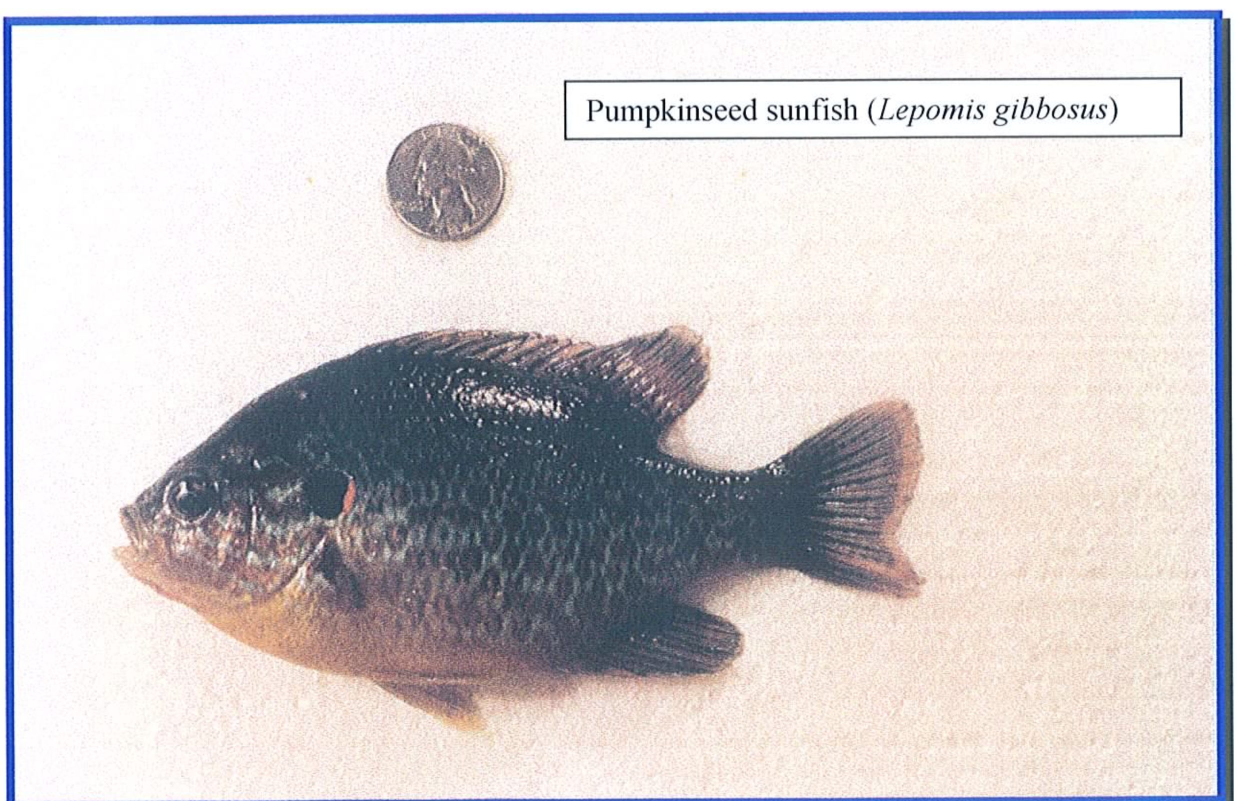
Brown trout (*Salmo trutta*)

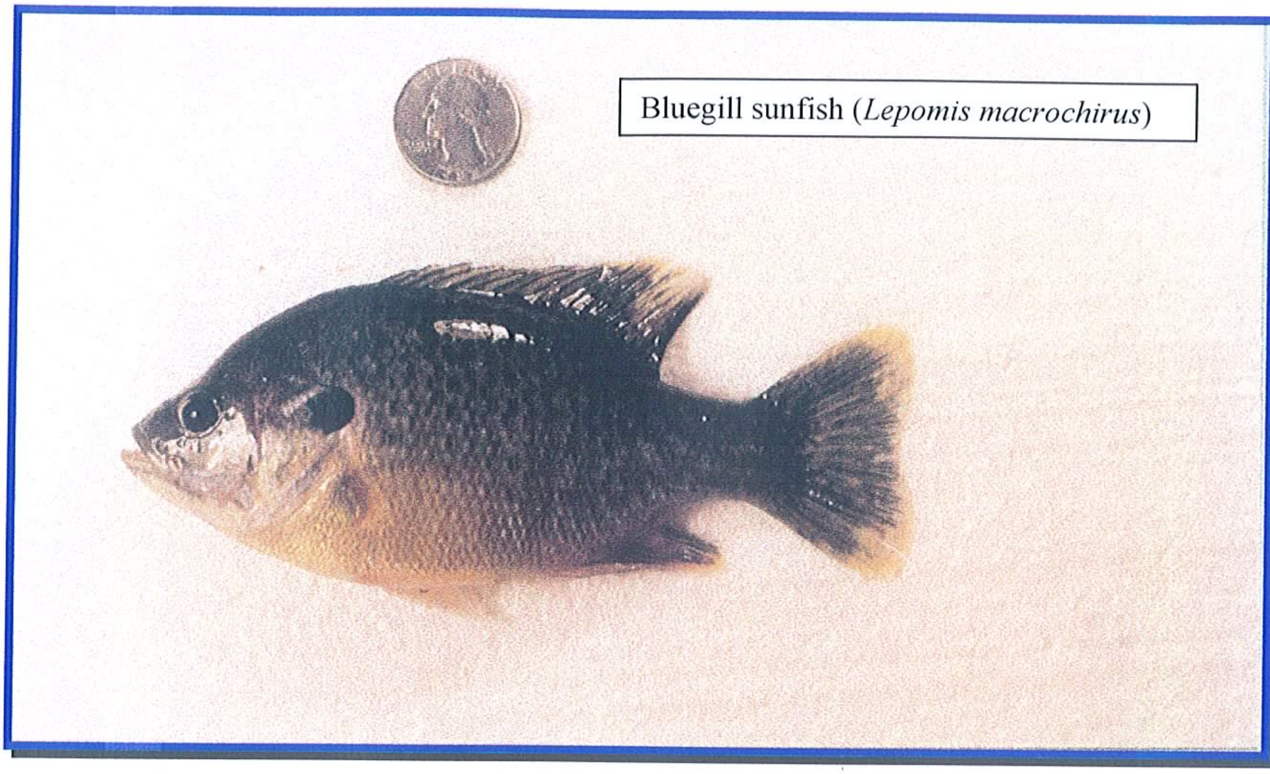
Banded killifish (*Fundulus diaphanus*)


Rock bass (*Ambloplites rupestris*)

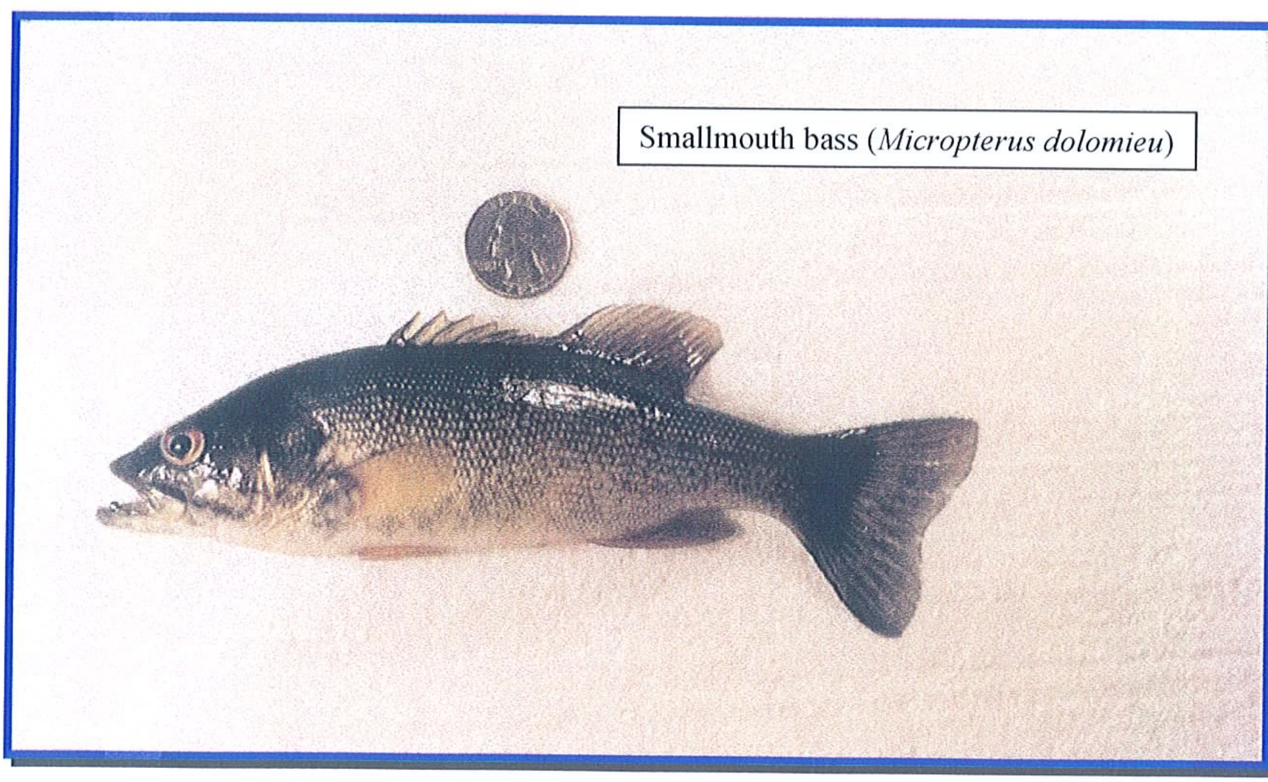

Redbreast sunfish (*Lepomis auritus*)


Green sunfish (*Lepomis cyanellus*)


Pumpkinseed sunfish (*Lepomis gibbosus*)

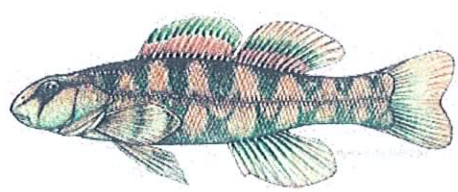


Bluegill sunfish (*Lepomis macrochirus*)

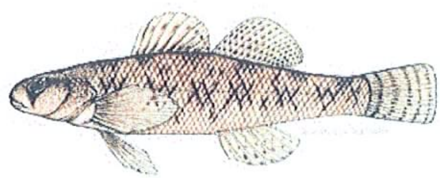


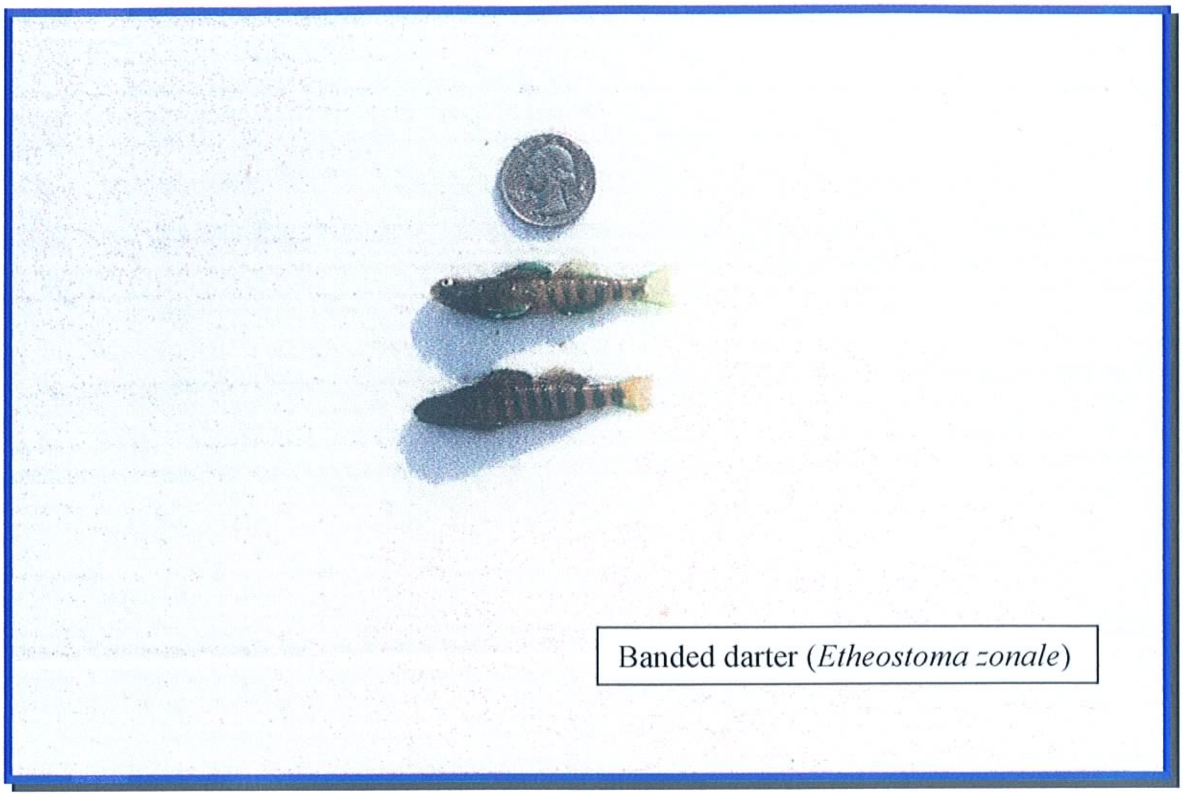
Smallmouth bass (*Micropterus dolomieu*)

Greenside darter (*Etheostoma blennioides*)

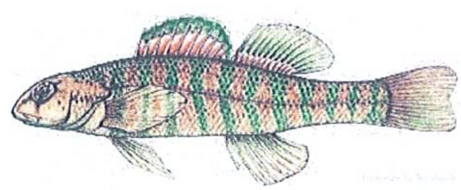


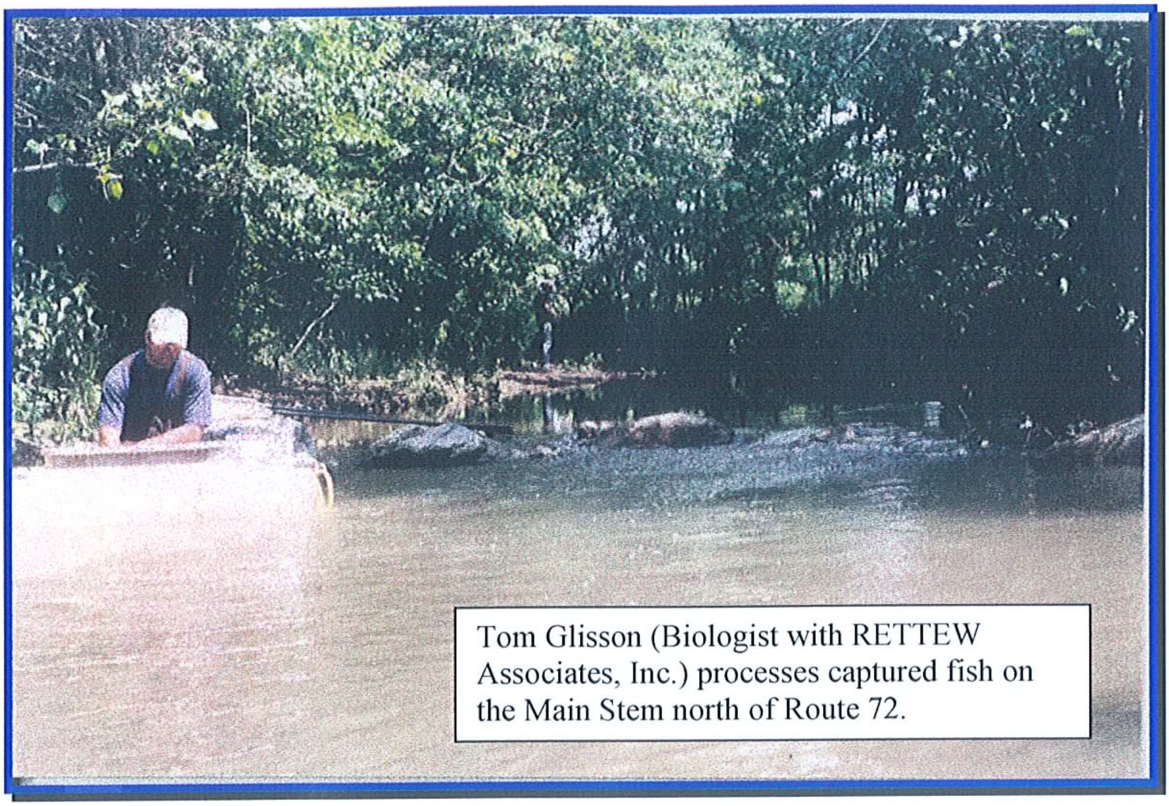
Tessellated darter (*Etheostoma olmstedi*)





Banded darter (*Etheostoma zonale*)





Tom Glisson (Biologist with RETTEW Associates, Inc.) processes captured fish on the Main Stem north of Route 72.

WATER CHEMISTRY

As stated earlier in this writing, chemical measurements only provide "snap shot" data. That is to say these measurements are instantaneous and only describe conditions at the very point in time in which they are taken. For this reason, it is best if water chemistry can be monitored year round on a regular basis as much as possible. Obviously monitoring more locations at a greater frequency will yield better data sets from which to draw conclusions.

In the case of this Little Conestoga Creek Watershed Assessment, it would have been nice to monitor a variety of water chemistry parameters on a monthly basis for two or more years at stations #1 through #23 and station A1 (or had access to that degree of background, baseline data), but such was not within the scope and budget of this project.

Fortunately chemistry data was available from a September 1998 United States Geological Survey study (previously referenced), a local volunteer group known as the Senior Environmental Corps, the "Stream Team" at Lancaster Academy (a local alternative high school) and an environmental problems class at Franklin and Marshall College in Lancaster, Pennsylvania. When coupled with the findings of the RETTEW biologists, conclusions as to the chemical nature of Little Conestoga Creek water could be drawn. As stated earlier in this writing, it is vital water chemistry data be considered in concert with macroinvertebrate, fish and habitat data when drawing overall conclusions about a stream's water quality.

There are seemingly endless chemical tests that can be performed on water, but fishery biologists and stream restoration practitioners typically concern themselves with only a few choice chemical and physical parameters when conducting routine monitoring. Of course there is sometimes due cause for investigating very specific chemical parameters when a specific source of impairment is suspected, but on a routine basis the following parameters are among those typically investigated – and for the following reasons:

Water temperature	Dissolved oxygen	Ammonia
pH	Nitrate	Sediment/turbidity
Alkalinity	Phosphate	

Water temperature can exert great control over aquatic communities. If the overall water body temperature of a system is altered, an aquatic community shift can be expected. Many coldwater fish, such as trout and salmon, will disappear as a result of egg and fry mortality, direct adult mortality or reduced reproductive activity, and be replaced by warmwater fish, such as sunfish.

In water above 30° C (86° F), a suppression of all benthic organisms can be expected (James, 1979). Also, different plankton groups will flourish under different temperatures. For example, diatoms dominate at 20-25° C (68-77° F), green algae dominate at 30-35° C (86-95° F), and cyanobacteria dominate above 35° C (95° F) (USEPA, 1987; Dunne, 1978).

In addition, there is potential for physiological distress if a fish swims into a localized warm area of water. Because of water's high heat capacity, water temperature does not change rapidly under natural conditions. Thus fish have not evolved the ability to adapt to rapid temperature fluctuations. As a consequence, undetectable physiological damage occurs when fish are introduced into warmer water. The damage caused is not great enough in itself to cause death; instead motor functions are impaired that make the fish more susceptible to death via "natural causes". For example, slowed reflexes may cause a fish to be less successful during natural predator-prey interactions. As a result, the fish may starve or be preyed upon (Kennish, 1992).

Fish that have safely acclimated to the warmer water of a thermal discharge plume are still in danger. If the thermal emission ceases at any time, the resulting rapid water temperature drop may cause fish to die of cold shock. When the emission resumes, the fish may then suffer heat shock.

Thus water temperature influences the amount of dissolved oxygen in water, the rate of photosynthesis by algae and other aquatic plants, metabolic rates of aquatic organisms and the sensitivity of aquatic organisms to toxic wastes, parasites and disease.

Nonpoint thermal pollution by way of heated stormwater running off of heated urban surfaces (metal roofs, macadam parking lots, etc.) and the removal of shade providing riparian buffers is common within the Little Conestoga Creek Watershed.

COLDWATER AND WARMWATER FISHERY TEMPERATURE TABLE

****Taken from Chapter 93, Water Quality Standards, Title 25, Pennsylvania Code*

TIME PERIOD	COLDWATER FISHERY		WARMWATER FISHERY	
	°C	°F	°C	°F
January 1-31	3.3	38	4.4	40
February 1-29	3.3	38	4.4	40
March 1-31	5.5	42	7.7	46
April 1-15	8.8	48	11.1	52
April 16-30	11.1	52	14.4	58
May 1-15	12.2	54	17.7	64
May 16-31	14.4	58	22.2	72
June 1-15	15.5	60	26.6	80
June 16-30	17.7	64	28.8	84
July 1-31	18.8	66	30.5	87
August 1-31	18.8	66	30.5	87
September 1-15	17.7	64	28.8	84
September 16-30	15.5	60	25.5	78
October 1-15	12.2	54	22.2	72
October 16-31	10	50	18.8	66
November 1-15	7.7	46	14.4	58
November 16-30	5.5	42	10	50
December 1-31	4.4	40	5.5	42

SPECIES	UPPER LIMIT °C	UPPER LIMIT °F	OPTIMUM °C	OPTIMUM °F
Brook trout (*Salvelinus fontinalis*)				
Adult	24	75.2	11-16	51.8-60.8
Spawning	n/a		4.5-10	40.1-50
Brown trout (*Salmo trutta*)				
Adult	27	80.6	12-19	53.6-66.2
Juvenile	27	80.6	7-19	44.6-66.2
Spawning	27	80.6	2-13	35.6-55.4
Rainbow trout (*Oncorhynchus mykiss*)				
Adult	25	77	12-18	53.6-64.4
Spawning	n/a		10-15.5	50-59.9
Smallmouth bass (*Micropterus dolomieu*)				
Adult	32	89.6	21-27	69.8-80.6
Spawning	n/a		12.8-21	55.0-69.8
Largemouth bass (*Micropterus salmoides*)				
Adult	36	96.8	24-30	75.2-86
Spawning	30	86	21	69.8

The power of hydrogen or **pH** is a very common monitored parameter used to determine acidity. The pH scale is a log-base 10 scale that measures the acidity of a solution on a scale of 0 to 14. Neutral solutions, such as pure water, measure a neutral 7 on the scale. Alkaline solutions will have high pHs between 8 and 14 and acidic solutions will measure between 1 and 6. It is important to remember that since the pH scale is a log-base 10 scale, the pH changes 1 unit for every power of ten change in hydrogen ion concentration. For example, a water sample measuring a pH of 3 would have 100 times the amount of hydrogen ions than a water sample measuring 5.

Th pH of water is controlled by the equilibrium achieved by dissolved compounds (rocks and mineral – the area's geology) in the stream system. In natural waters, pH is mainly a function of the carbonate system composed of carbon dioxide, carbonic acid, bicarbonate and carbonate (USEPA, 1986). The presence of limestone geology for example neutralizes introduced acids which could have originated from acid rain or acid mine drainage from mining operations.

The pH greatly influences how other present, dissolved chemical compounds effect the stream's aquatic life. A reduction in pH (more acidic) may allow the release of toxic metals that would otherwise be sorbed to sediment and essentially removed from the water system (at least not available for intake by aquatic life). Once mobilized, these metals are available for uptake by organisms. For many metals, the rate of uptake is directly proportional to the levels of metal availability in the environment. Thus a decrease in pH increases metal availability, lending itself to greater metal uptake by organisms. Metal uptake can cause extreme physiological damage to aquatic life (Connell, 1984).

An increase in pH may cause heightened ammonia concentrations (USEPA, 1986). At low pH, ammonia combines with water to produce an ammonium ion and a hydroxide ion. The ammonium ion is non-toxic and not of concern to organisms. Above a pH of 9, ammonia (unionized) is formed (NH3) and is very toxic to organisms. Thus organisms experience ammonia toxicity more readily at higher pH levels (Morgan, 1981).

Experiments have shown that a pH decrease of 1.4 units of pH can disturb the aquatic community. After acidification of a test area, the water column concentrations of aluminum, calcium, magnesium and potassium increased: the downstream drift of immature aquatic insect larva increased; the emergence of mature stoneflies (*Plecoptera*) and mayflies (*Ephemeroptera*) decreased; periphyton (attached algae) biomass increased; and trout migrated to areas of higher pH (Smith, 1990).

LIMITING pH values

MINIMUM	MAXIMUM	EFFECTS (Based on various studies)
3.8	10.0	Fish eggs hatch, but deformed young were often produced
4.0	10.1	Limits for the most resistant fish species
4.1	9.5	Range tolerated by trout
4.3	---	Carp die in five days
4.5	9.0	Trout eggs and fry develop normally
4.6	9.5	Limits for perch
5.0	---	Limits for stickleback
5.0	9.0	Tolerable range for most fish
---	8.7	Upper limit for good fishing waters
5.4	11.4	Fish avoided waters beyond these limits
6.0	7.2	Optimum range for fish eggs
1.0	---	Mosquito larvae were destroyed
3.3	4.7	Mosquito larvae will live within this range
7.5	8.4	Best range for algae growth

7.0	Neutral
8.5	Biologically productive
5.5	Damaging, indicates acid rain, acid mine drainage
6.0 – 9.0	Ok for aquatic life

Alkalinity is a measurement expressing the amount and types of dissolved compounds that serve to make water more alkaline than acidic. It relates to the water's ability to buffer acid referred to as "buffering capacity". Alkalinity should be thought of as an expression of how much the water is capable of neutralizing introduced acid rather than exactly how acidic or alkaline the water is (as is expressed through a pH measurement).

Calcium and magnesium carbonates and bicarbonates, such as found in limestone (karst) geology, are the alkaline components found in natural waters. Therefore limestone streams have high buffering capacity and are not as easily effected by acid rain, acid mine drainage and the like. If a stream has a low alkalinity reading, it would mean the stream's buffering capacity is low and that the stream would undergo a quicker shift to being more acidic should acid be introduced. Alkalinity therefore is an important means of defining and discussing the stream's ability to maintain itself in regards to its acidic/alkaline makeup and consequently its aquatic life.

Natural waters range between 20 – 200 mg/L Limestone streams (calcium carbonate geology) = 75 mg/L and higher Readings of 230 mg/L at "limestoner" Donegal Creek, Lancaster Co., PA are common Below 20 mg/L should raise concern

Dissolved oxygen refers to the volume of oxygen that is contained in the water. Oxygen enters water by way of aquatic plant photosynthesis and by the transfer of oxygen across the air-water interface. Wave action and riffle areas in streams serve to aerate the water. The amount of dissolved oxygen water can hold depends on the water's temperature and salinity and the atmospheric pressure at the water's particular elevation. The warmer the water, the less dissolved oxygen it can hold. Freshwater holds more oxygen than does saltwater. The higher the altitude, the less dissolved oxygen water can hold.

Dissolved oxygen of course is used for animal respiration – and plant respiration. It is also involved in microbes aerobically decomposing organic matter. Typically higher levels of dissolved oxygen equate to greater diversity of plant and animal life in the stream; whereas fewer creatures are tolerant and capable of dealing with low oxygen levels.

Coldwater fishery streams should have a minimum of 7 mg/L Warmwater fishery streams should have a minimum of 5 mg/L Lakes and ponds should have a minimum of 4 mg/L

Nitrate is a form of nitrogen. Nitrogen makes up 78% of the atmosphere as gaseous molecular nitrogen, but most plants can use it only in fixed forms of nitrate and ammonium. Nitrate and nitrite are inorganic ions occurring naturally as part of the nitrogen cycle (Smith, 1990).

The nitrogen cycle is composed of four processes. Three of the processes - fixation, ammonification and nitrification - convert gaseous nitrogen into useable chemical forms. The fourth process, denitrification, converts fixed nitrogen back to the unusable gaseous nitrogen state (Smith, 1990).

Nitrification forms nitrate and nitrite from ammonia. Nitrate can be present in water at higher concentrations than nitrite and ammonia without harming the aquatic system. Nitrate ions are easily released from soil unlike phosphate and ammonia. High levels of nutrients such as nitrate and phosphate lead to increased plant growth which ultimately leads to greater amounts of plant decay and the loss of dissolved oxygen – a process known as eutrophication.

Human consumption limit = 10.0mg/L Warmwater fishery limit = 90.0 mg/L Health hazard to juvenile mammals = 20 mg/L and greater

Phosphate is the form of phosphorous normally found in natural water conditions. In turn there are three kinds of phosphates: organic, orthophosphate and condensed. Organic phosphates are found in plant and animal tissues. Orthophosphate and condensed phosphate are inorganic and readily bond to soil particles.

Testing for total phosphate involves putting the water sample through an acid heat digestion process in order to convert all phosphate to dissolved orthophosphate. Excessive phosphate leads to an unnatural increase in algae and aquatic plant growth and the accelerated eutrophication of lakes and ponds. The sudden die off of these massive crops of algae and aquatic plants, due to decomposing bacteria respiration, leads to critical drops in dissolved oxygen.

Recommended maximum for rivers and streams = 0.1 mg/L
Accelerated eutrophication process in lakes = 0.025 mg/L
Amount of phosphate-phosphorus in most uncontaminated lakes – 0.01 – 0.03 mg/L

Ammonia, like nitrate, is a form of nitrogen. Danger to aquatic life depends on temperature, pH and length of exposure along with dissolved oxygen and carbon dioxide levels. The higher the pH and the warmer the temperature, the more toxic the ammonia. Also, ammonia is much more toxic to fish and aquatic life when the water contains very little dissolved oxygen and carbon dioxide.

General limit = 0.002 mg/L
Fish gill damage = 0.06 mg/L
Indicates polluted water = 0.1 mg/L
Trout and salmon begin to die = 0.2 mg/L
Kills carp = 2.0 mg/L

Sediment and **turbidity**

By volume, sediment is the largest freshwater pollutant in Pennsylvania. Sediment is composed of organic and inorganic particles of various sizes. The series of sediment-induced changes that can occur in a water body may change the composition of an aquatic community (Wilber, 1983). First, a large volume of suspended sediment will reduce light penetration, thereby suppressing photosynthetic activity of phytoplankton, algae, and macrophytes. This leads to fewer photosynthetic organisms available to serve as food sources for many invertebrates. As a result, overall invertebrate numbers may also decline, which may then lead to decreased fish populations.

In addition, sediment may interfere with essential functions of organisms. The numbers of filter-feeding invertebrates will decline if their filter mechanisms are choked by suspended particles (James, 1979). Some zooplankton suffer decline due to clogged feeding mechanisms (McCabe, 1985). Likewise, fish may suffer clogging and abrasive damage to gills and other respiratory surfaces. Abrasion of gill tissue triggers excess mucous secretion, decreased resistance to disease, and a reduction or complete cessation of feeding (Wilber, 1983).

Suspended sediment may also affect predator-prey relationships by inhibiting the predator's visual abilities.

In natural water, fish avoid areas of high-suspended solids when possible by hiding in quieter pools or moving away from the source of sediment. Thus, although experimental studies may suggest certain degrees of injury to aquatic fauna in a given level of turbidity, the actual effects observed may be less pronounces because of the avoidance behavior.

Reproductive success may decline with an increase in fine sediment. If spawning habitats are altered by sediment deposition, fish may be unable to lay eggs and/or their eggs may be smothered because of the lack of water circulation around the egg and resulting decrease in oxygenation.

Benthic macroinvertebrates requiring a low-silt substrate will suffer a similar fate. Deposited sediments may obscure sources of food, habitat, hiding places and nesting sites (Wilber, 1983). Most aquatic insects will simply drift with the current out of the affected area. Silt-loving macroinvertebrate communities and consequently those able to withstand low dissolved oxygen levels will replace benthic macroinvertebrates requiring a low-silt substrate.

TURBIDITY

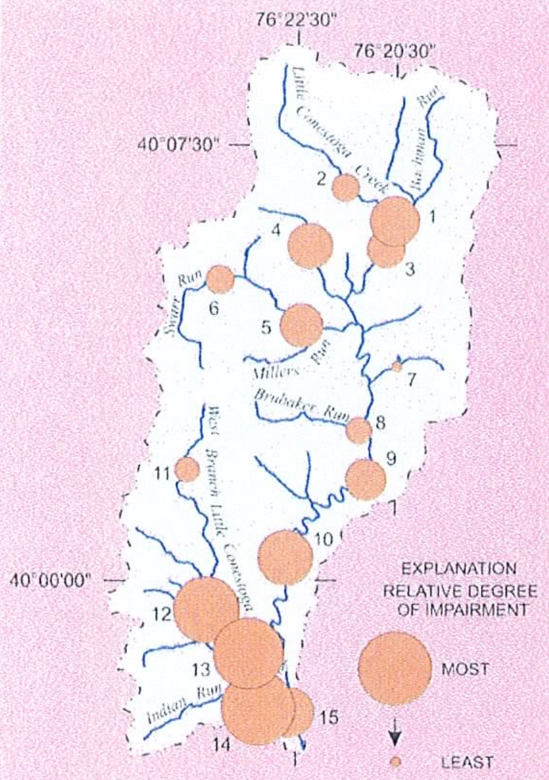
Limit for rivers = <100 NTU
10 day average for aquatic life – no problem = <25 NTU
Maximum for swimming = 5 NTU

The September 1998 United States Geological Survey study closely examined nitrate, total phosphorous, and ammonia concentrations. Nitrate concentrations ranged from 2.56 to 13.2 mg/L (Durlin and Schaffstall, 1998). This range is directly related to the predominant land use in the Little Conestoga Creek Basin (watershed) and the associated underlying bedrock. Sites in the lower basin having greater than 80% agricultural land use had the highest nitrate concentrations (11.7 – 13.2 mg/L). Elevated nitrate concentrations, in relation to the other sites, were also measured at al the remaining predominately agricultural (greater than 80%) subbasins. Nitrate concentration at these sites ranged from 7.31 to 9.61 mg/L. Sites 1, 12, 13 and 14 had nitrate concentrations that approximated or exceeded the nitrate drinking water standard. Nitrate in drinking water at levels in excess of 10 mg/L can result in methemoglobinemia (blue-baby syndrome) in bottle-fed infants up to 6 months old (USGS, 1998).

Probably because of the predominantly agricultural land use in the basin, nitrate concentrations were sufficiently elevated (Significantly above 0.3 mg/L) to cause increased plant productivity that could lead to reduced levels of oxygen in ponds. Levels of oxygen that are too low can adversely affect or be fatal to aquatic organisms (USGS, 1998).

A comparison between nitrate data from Site 15 (5.77 mg/L) and data from a similarly located site in a 1976 base-flow study (3.96 mg/L) indicates a small positive difference in nitrate concentration (Brezina, 1980). Another study in 1985 measured an 8.57 mg/L nitrate concentration in the Little Conestoga Creek north of the confluence with the West Branch (McMorran, 1986).

The heaviest nitrate loads entering Little Conestoga Creek were at Site 1 (166 lb/d), Site 12 (272 lb/d) and Site 13 (366 lb/d). Even though Site 14 (Indian Run) had the highest nitrate concentration, the nitrate load was not excessive because of the relatively small stream flow (USGS, 1998).



Site number on figure 1	Total nitrogen, in milligrams per liter as nitrogen	Total phosphorus, in milligrams per liter as phosphorus	Relative degree of nutrient impairment, as a percentage of most impaired nutrient water quality
1	9.88	0.048	68
2	8.60	[1]<.01	38
3	8.90	.027	52
4	7.60	.053	62
5	5.85	.061	59
6	5.58	.028	39
7	2.66	[1]<.01	14
8	4.50	.031	36
9	5.42	.058	56
10	4.04	.097	72
11	2.89	.039	34
12	13.30	.060	90
13	12.06	.081	96
14	13.46	.077	100
15	6.21	.073	68

[1] Set to 0.005 for use in calculations.

Figure 6. Relative degree of nutrient impairment, as percentage of most impaired nutrient water quality, at sites sampled in the Little Conestoga Creek Basin, Lancaster County, Pa., on Sept. 13, 1997.

USGS 1998 Graphic

To further characterize the degree of nutrient impairment in the Little Conestoga Creek Basin, phosphorous concentrations were evaluated. Phosphorus concentrations were evaluated at sites in the basin were consistently below the 0.1 mg/l recommended upper limit for total phosphorus established by USEPA. More than 50% of the total phosphorus at all sites was comprised of dissolved phosphorus. This indicates that the phosphorus originated from groundwater base flow or from the flushing of dissolved phosphorus from the soil rather than from suspended phosphorus, which is bound to stream sediment (USGS, 1998).

Daily phosphorus loads leaving the tributaries and Main Stem of the Little Conestoga Creek Basin are small in comparison to the respective nitrate loads. The cumulative phosphorus load from Site 15, at the mouth of the basin, was 11 lb/d. The phosphorus load nearly doubled between Main Stem Sites 9 and 10 because of a rise in phosphorus concentration. The cause of this rise was not determined and be related to several factors, such as leaking sewer pipes, fertilizer application, or stormwater runoff (USGS, 1998).

Concentration of dissolved ammonia ranged from less than 0.015 to 0.079 mg/L. Evaluation for ammonia toxicity to aquatic life at Site 8-15 determined for ammonia concentrations were not sufficiently high to be harmful to fish (USGS, 1998).

The Senior Environmental Corps and "Stream Team" from the Lancaster Academy routinely monitor four locations within the Little Conestoga Creek Watershed. These locations are near RETTEW monitoring stations #4 (Main Stem below confluence with West Branch), #6 (West Branch), #14 (Swarr Run, but one farm below the RETTEW site) and #19 (Main Stem upstream of Miller Road).

Both groups monitor for alkalinity, dissolved oxygen, pH, conductivity, air temperature, water temperature, nitrate, phosphate, flow and sulfate. Alkalinity measurements at all stations were 160 mg/L or greater indicating good buffering capacity for acid precipitation and good biological productivity potential. Power of hydrogen (pH) readings are typically alkaline (7 to 8.6), except for a few high 6 ratings (6.5 to 7.0) at times on the Main Stem at monitoring station #4. Dissolved oxygen readings at all station have been 7.0 mg/L or better. Nitrate and phosphate readings are similar to the 1998 USGS findings in regards to how the stations compare with each other, but Senior Environmental Corps readings of nitrates have been consistently higher in concentration; the end result is the same however – that being the Little Conestoga tends to have a nitrate overload problem.

Water temperatures readily agree with the fish assembles found there in regards to warmwater and coldwater species. One interesting note is that water temperatures on the Main Stem above Miller Road near East Petersburg Borough are just slightly warmer in the summer months (22° C – 71.7° F) than are tolerated by coldwater species. This shows promise that indeed this section of stream could potentially be good "trout water" if stream restoration focusing on thermal pollution takes place. Restoring forested riparian buffers in this area could really make a difference in the aquatic community, changing it potentially from a coolwater fishery to a coldwater fishery as was likely the original/natural case.

RARE, THREATENED AND ENDANGERED SPECIES

The last word in ignorance is the man who says of an animal or plant "what good is it?". If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

- Aldo Leopold (1949)

In Pennsylvania, the Pennsylvania Natural Diversity Inventory (PNDI) program is the means by which rare, threatened and endangered animals and plants are inventoried, tracked and protected. PNDI is also associated with the protection of unique natural communities and outstanding geologic features.

The Pennsylvania Department of Natural Resources, Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission, United States Fish and Wildlife Service and Pennsylvania Biological Survey are all associated with Pennsylvania's PNDI program. Each agency provides the program's huge database with up to date information; thus the inventory is ongoing and ever changing.

Mr. Robert Corbin, Conservation Data Manager with the Bureau of Forestry, Pennsylvania Department of Natural Resources, was most helpful in providing information regarding rare, threatened and endangered species within the Little Conestoga Creek Watershed.

According to Corbin, PNDI's database indicates the presence and/or historical presence of 5 species/features of concern. They are as listed below:

Geologic feature	Invertebrate fossil animals	
Bird	Yellow-crowned night heron (*Nyctanassa violacea*)	Threatened
Bird	King Rail (*Rallus elegans*)	Endangered
Plant	Limestone petunia (*Ruellia strepens*)	Threatened
Plant	Lance fog-fruit (*Phyla lanceolata*)	Undetermined

The purpose of this particular chapter is not to provide a specific location for the various rare, threatened and endangered species within the watershed. PNDI withholds specific locations for security and protection reasons. However this chapter is intended to make the Little Conestoga Watershed Alliance aware of the fact that these species and features are within the watershed. Hopefully the Alliance can remain cognizant of their existence and be on the lookout for possible impacts. By understanding what each specie or feature is, the Alliance may be able to recognize potential impacts and serve as a first line of defense. The Alliance membership may in fact discover or reestablish a new or historic finding.

Invertebrate Fossil Animals

There are various invertebrate fossil beds within the watershed. For years, Franklin and Marshall College geology professors and students have known about and frequented such fossil beds within the Millers Run Sub-watershed.

Trilobite fossils are routinely found in the watershed if you know where to look and what to look for.

Yellow-crowned night heron (*Nyctanassa violacea*)

This bird is similar in size and body configuration to the closely related black-crowned night heron, except that the yellow-crowned has slightly longer legs (standing height about 1.5-feet). It has a yellow patch on its head, a gray body, and a black and white face. The call, a strident *kwawk*, is slightly higher-pitched than that of the black-crowned.

Yellow-crowned night herons hunt mainly at night but also at times during the day. They eat frogs, fish, salamanders, lizards, and insects. They nest colonially, sometimes with other herons (in rookeries). The stick nest is built in a tree or shrub and may be lined with fine twigs, rootlets, or leaves. Both sexes build, or they may re-use an old nest. This species is more secretive in its nesting habits than our other herons, with the exception of the bitterns. Eggs: 3-4 smooth, pale bluish-green, unmarked. Incubation is by both sexes.

In spring, yellow-crowned night herons migrate through our state in April and early May. In summer, they are breeding residents in the southeastern area; most nesting that does occur is concentrated in Cumberland, Lancaster, and Montgomery counties. In fall, they are rare August-October migrants; and they winter principally in the southern U.S., Middle America, and South America. (PA Game Commission – Wildlife Notes)

The Pennsylvania Department of Conservation and Natural Resources

THREATENED

Yellow-Crowned Night Heron

Nycticorax violaceus

Photo Credit: A. & E. Morris, VIREO

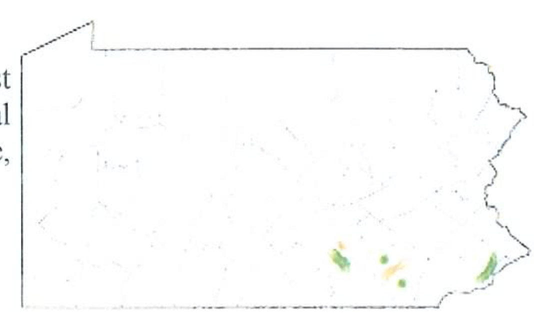
IDENTIFYING CHARACTERISTICS: Adults are 22 to 28 inches in length, from bill tip to tail tip, gray with black head and a whitish cheek patch and crown. Eyes are red and legs yellowish. Immature is brown, finely spotted and streaked with white buff.

BIOLOGY-NATURAL HISTORY: Pennsylvania lies at the northern fringe of this species' breeding range, which is mainly in the south-central United States. It nests singly or in small groups in the lower reaches of the Susquehanna. A typical clutch contains three or four eggs. Nesting starts as early as April. By mid-summer most young have fledged. Crayfish are a major part of this bird's diet.

PREFERRED HABITAT: Feeds mainly along small shallow streams. Nests in brush or trees, usually sycamores, found on islands or along streams. Most nests found in recent years are along the Susquehanna River and its tributaries, in Lancaster County.

REASONS FOR BEING THREATENED: As a breeding bird, the combination of rarity and tendency to nest in small groups makes this species particularly vulnerable to local habitat disturbance or loss. The largest nesting colony known in Pennsylvania, representing more than half the state's known breeding population, is on a small river island. The integrity of this site and nearby shallow-water feeding areas are threatened by a proposed dam. Degradation of water quality, along with loss of the primary food source – crayfish – is an ever-present threat.

MANAGEMENT PRACTICES: Known nest sites for this species are monitored and potential new sites need to be surveyed. Whenever possible, nesting habitats need to be protected.



King Rail (*Rallus elegans*)

A large, rusty rail with a long, slender bill; twice the size of a Virginia Rail, or about that of a small hen. Similar to Clapper Rail but more rusty; prefers fresh marshes.

Height: 15-19-inches (38-48-centimeters)

Voice: A low, grunting bup-bup, bup-bup-bup, etc., or chuck-chuck-chuck.

Range: East U.S. to Cuba, Mexico (rarely). Migrant in North.

Habitat: Fresh and brackish marshes, rice fields, swamps. In winter, sometimes salt marshes.

Nesting: 6-16 spotted buff eggs in a deep bowl of grass, often with surrounding marsh grass pulled down and woven into a dome.

DCNR The Pennsylvania Department of Conservation and Natural Resources

ENDANGERED

King Rail

Rallus elegans

Photo Credit: Lawrence Wales, Cornell Lab of Ornithology

IDENTIFYING CHARACTERISTICS: The king rail is so named because of its large size and bright coloration. This plump chicken-sized bird is a bright rusty color. They range from 15 to 19 inches in height and have 21- to 25-inch wingspans. Males are larger than females. Bills are long, slightly decurved, and yellow with brown tips. These birds are extremely secretive and would rather run than fly to escape detection. They are rarely seen, therefore, and are most often located by their loud calls, a resonant grunting bup-bup, bup, bup, bup, more rapid at the end.

BIOLOGY-NATURAL HISTORY: King rail nests are platforms up to nine inches in diameter, six to 18 inches above the water. They are built of grasses, sedges and cattails in shallow water marshes, and roadside ditches. From six to 15 pale, slightly spotted brown eggs are laid in a shallow depression of the nest. Overhead cover is often pulled over the nest. Young are able to fly about 60 days after hatching. Wading in shallow water, king rails feed on crustaceans, small fish, frogs and insects. In winter, food items consist of grains – particularly rice – and berries.

PREFERRED HABITAT: This rail lives in freshwater and brackish marshes and roadside ditches in eastern North America, primarily along the Atlantic coast. It is a very rare breeder in the few larger marshes remaining in Pennsylvania.

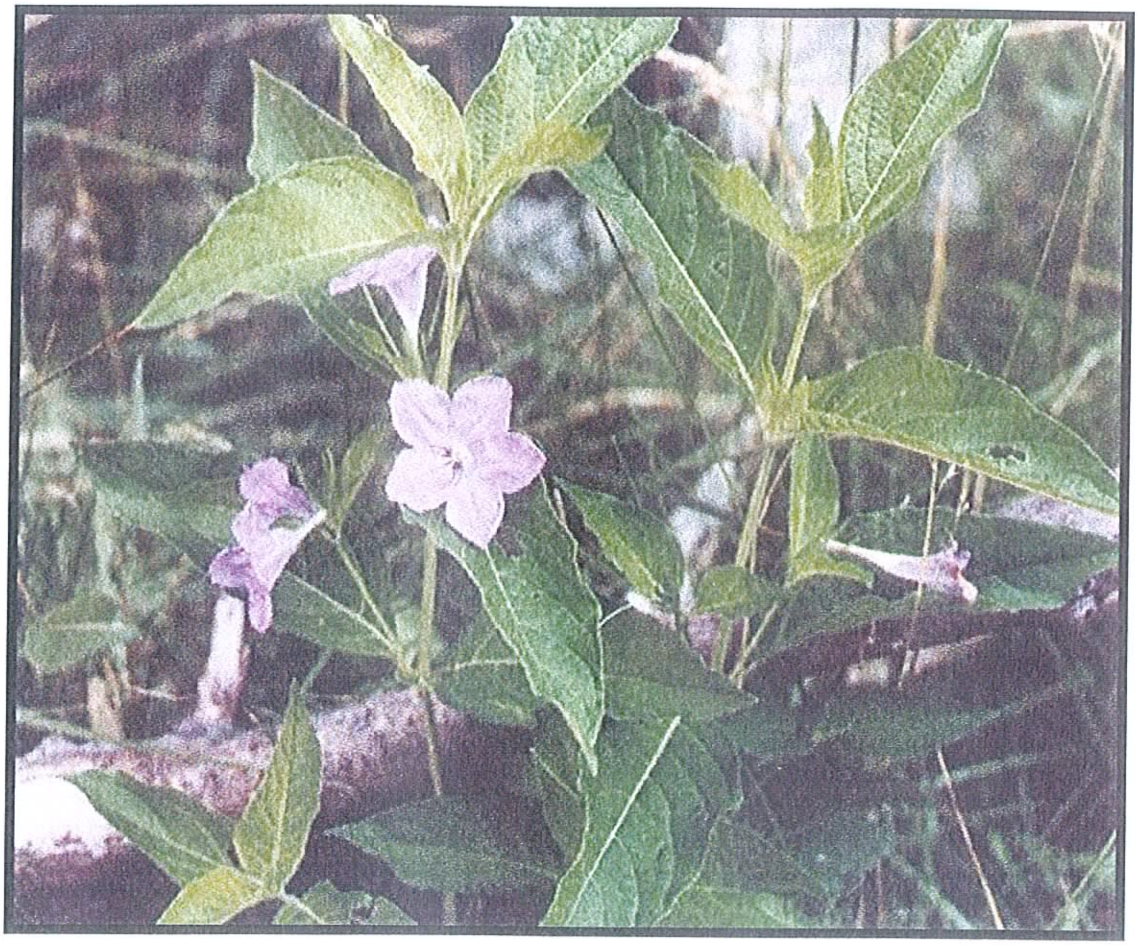
REASONS FOR BEING ENDANGERED: King rails were never common in Pennsylvania, but annual reports indicate the bird today is much less abundant than historically. This apparent decline is considered to be due primarily to losses of marshland habitat.

MANAGEMENT PROGRAMS: As with many other endangered and threatened species, the king rail needs wetlands in order to exist. Maintaining stable water levels during the summer will enhance the species' breeding success here.

Limestone petunia (*Ruellia strepens*)

Lance fog-fruit (*Phyla lanceolata*)

Ruellia strepens L.



Family - *Acanthaceae*

Stems - To 1m tall, erect, simple or branching, herbaceous, somewhat angled, glabrous or with pubescence in vertical rows.

Leaves - Opposite, petiolate, ovate, ovate-lanceolate, to oblong, typically entire or merely crenulate, glabrous to sparsely hairy, to 15cm long, 6cm wide. Petiole typically winged.

Inflorescence - One or two flowers, on peduncle, from leaf axils near middle of stem. Flowers subtended by a pair of foliaceous bracts.

Flowers - Corolla zygomorphic, to +5cm long, +/-4cm broad, 5-lobed, typically blue. Corolla tube with a constricted portion at base. Constriction white, to 2.5cm long, 3mm in diameter. Expanded portion of corolla tube to +1cm long, 1cm in diameter, pubescent. Corolla lobes +/-1.5cm long and broad, glabrous internally, pubescent externally with some glandular pubescence near the base. Stamens 4, didynamous, adnate at the apex of the constricted portion of the corolla tube. Filaments white, 1.3cm long, sparse pubescent at the base, glabrous above. Anthers yellow, 3mm long. Style -4cm long, sparse pubescent below, white. Stigma 2-lobed, curled. Ovary superior, with some glandular pubescence at apex near style, 4mm long, 1.3mm in diameter, conic, 2-locular. Calyx tube to 5mm long, 5-lobed. Lobes linear-lanceolate, 2-3cm long, 3mm broad, with long and short glandular pubescence, entire, erect. Capsules brown, glabrous, to 2cm long, explosively dehiscing.

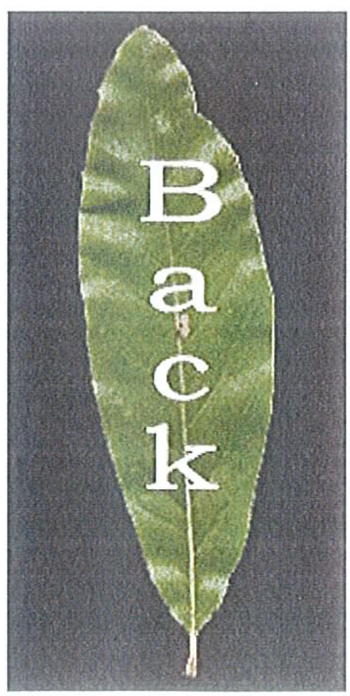
Flowering - May - October.

Habitat - Waste ground, disturbed sites, moist, open woods, streambanks.

Origin - Native to U.S.

Other info. - Although the corolla looks regular, it is typically zygomorphic, with one petal being slightly larger than the other four. The flowers of this species only last for one day but the plant produces many flowers while in bloom. This species is common and reminds many people of the non-related "Petunia" of cultivation.
Steyermark lists three forms for the plant based on flower color and size. Form ***strepens*** is shown above. Form ***alba*** **Steyermark** has a white corolla. Form ***cleistantha*** **(Gray) McCoy** has cleistogamous flowers but may not be a distinct form, rather a phase of form ***strepens***.

Photograph taken at the Kansas City Zoo, 5-28-99.

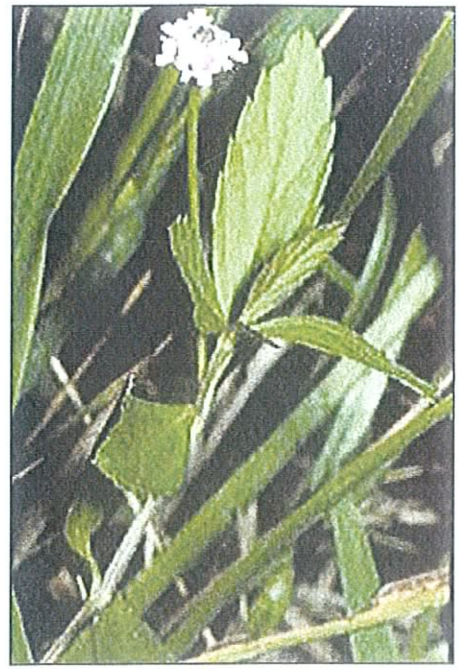


USDA Natural Resources Conservation Service

PLANTS Profile

Phyla lanceolata (Michx.) Greene
lanceleaf fogfruit

Symbol:	PHLA3
Group:	Dicot
Family:	Verbenaceae
Growth Habit:	Vine Forb/herb
Duration:	Perennial
U.S. Nativity:	Native



Printer-Friendly Version

Classification Distribution Images Invasive Links More Info Noxious Related Taxa Synonyms Wetland

Plant Photographs:

View all *Phyla* thumbnails at the PLANTS Gallery

More Information About lanceleaf fogfruit

classification

source & reference

Plant Synonyms:

PHLA3 ***Phyla lanceolata*** **(Michx.) Greene**

- LILA10 *Lippia lanceolata* Michx.
- LILAR *Lippia lanceolata* Michx. var. *recognita* Fern. & Grisc.
- PHLAR *Phyla lanceolata* (Michx.) Greene var. *recognita* (Fern. & Grisc.) Soper

« Back to Top »

Plant Distribution by State

Phyla lanceolata (Michx.) Greene

PHLA3

See county distributions for

© Image generated using gd 1.8

the following states by clicking on them below or on the map.

AR	CA*	FL*
IL	IA	KS
KY	MI	MO
NC	SC	SD
TN*	VA	WV
WI*		

* Offsite source.

Alabama	Florida	Kentucky	Missouri	North Carolina	Tennessee
Arizona	Georgia	Louisiana	Nebraska	Ohio	Texas
Arkansas	Illinois	Maryland	Nevada	Oklahoma	Utah
California	Indiana	Michigan	New Jersey	Pennsylvania	Virginia
Colorado	Iowa	Minnesota	New Mexico	South Carolina	West Virginia
Delaware	Kansas	Mississippi	New York	South Dakota	Wisconsin

«Back to Top»

Related Taxa:

Phyla lanceolata (Michx.) Greene

View 31 genera in Verbenaceae, 7 species in *Phyla*

«Back to Top»

Classification:

Phyla lanceolata (Michx.) Greene

Click on a scientific name below to expand it in the PLANTS Classification Report.

Kingdom	Plantae – Plants
Subkingdom	Tracheobionta – Vascular plants
Superdivision	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Subclass	Asteridae –
Order	Lamiales –
Family	Verbenaceae – Verbena family
Genus	*Phyla* Lour. – fogfruit
Species	*Phyla lanceolata* (Michx.) Greene – lanceleaf fogfruit

«Back to Top»

Threatened and Endangered Plant Information:

This plant is protected by the U. S. federal government or a state. Common names are from state and federal lists. Click on a place name to get a complete protected plant list for that location.

New Jersey:
fogfruit Endangered

Pennsylvania:
fog-fruit Rare

«Back to Top»

Wetlands Indicator Status:
Phyla lanceolata (Michx.) Greene

Nat. Ind.	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Reg. 5	Reg. 6	Reg. 7	Reg. 8	Reg. 9	Reg. 0	Reg. A	Reg. C	Reg. H
FACW,OBL	OBL	FACW+	OBL	OBL	OBL	FACW	OBL	OBL	NO	FACW	NO	NO	NO

Interpreting wetland indicator status

«Back to Top»

Other Species Accounts and Images:
Phyla lanceolata (Michx.) Greene

View species account from CalFlora.
View species account from USF Atlas of Florida Vascular Plants.
View taxonomic account from Integrated Taxonomic Information System (ITIS) for ITIS Taxonomic Serial Number 32196.
View species account or photographs from Wisconsin State Herbarium (UW-Madison).

«Back to Top»

Time Generated: Mon 8:57 AM - 10/28/2002

AQUATIC AND TERRESTRIAL HABITAT

An evaluation of habitat quality is critical to any assessment of ecological integrity and should be performed at each site at the time of the biological sampling. In general, habitat and biological diversity in rivers are closely linked (Raven, 1998).

RETTEW biologists performed a habitat assessment at each of the previously mentioned 28 monitoring stations (the same stations used for collecting macroinvertebrate and fishery data). Habitat investigations were performed using the United States Environmental Protection Agency's "rapid bioassessment protocols"; specifically the visual-based habitat assessment for low gradient streams (Form #3). A copy of the assessment procedure, taken from the United States Environmental Protection Agency's "Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers" is included in this writing so that the various assessed habitat parameters may be clearly understood by the reader.

Habitat scores for each of the 28 monitoring stations is as follows:

LITTLE CONESTOGA CREEK – HABITAT SCORES

****The higher the number, the better the habitat component****

MONITORING STATION	EPIFAUNAL SUBSTRATE/ AVAILABLE COVER	POOL SUBSTRATE CHARACTERIZATION	POOL VARIABILITY	SEDIMENT DEPOSITION	CHANNEL FLOW STATUS	CHANNEL ALTERATION	CHANNEL SINUOSITY	BANK STABILITY	VEGETATIVE PROTECTION	RIPARIAN VEGETATIVE ZONE	TOTAL SCORE	RANKING (#1 being best station)
1	13	16	15	**17**	17	18	9	11	8	2	126	10
2	11	13	11	12	17	10	11	13	16	13	127	9
3	15	15	6	13	16	14	7	15	18	**17**	136	7
4	16	**18**	18	15	18	15	8	15	14	14	151	3b
5	17	16	18	15	16	19	14	10	12	12	149	4
6	18	14	17	15	17	16	8	9	8	9	131	8
7	13	12	10	11	18	12	6	9	7	3	101	15
8	19	**18**	**19**	15	18	18	6	**18**	**19**	**17**	167	2
9	17	16	15	15	18	17	6	16	11	4	135	8
10	10	13	14	13	18	12	10	10	11	12	123	11
11	8	16	14	13	16	14	13	14	17	16	151	3a
12	9	9	13	11	18	13	11	14	11	3	112	14
13	5	7	8	6	17	13	7	11	11	2	87	18
14	1	7	10	8	16	14	13	0	2	0	71	20
15	**20**	**18**	**19**	16	**19**	**20**	**17**	17	16	12	**174**	**1**

16	12	11	9	11	15	7	9	13	**19**	15	121	12
17	10	8	7	5	12	8	12	16	12	10	100	16
18	16	16	16	14	15	14	10	13	16	9	139	6
19	17	14	13	12	16	13	14	16	16	10	141	5
20	8	8	11	5	14	10	6	8	6	2	78	19a
21	4	6	5	6	11	10	6	12	10	8	78	19b
22	7	9	8	10	16	7	5	14	10	2	88	17
23	14	13	10	12	16	13	13	13	12	4	120	13
A1	14	13	13	12	15	13	9	16	10	8	123	N/A
A2	10	9	9	9	11	9	10	11	8	4	90	N/A
A3	13	13	10	11	16	14	9	12	14	10	122	N/A
A4	12	13	12	10	12	13	11	14	10	8	115	N/A
A5	17	17	10	15	15	18	13	14	18	12	149	N/A

Monitoring Station #1

Monitoring stations #1 and #2 are located on the Main Stem at the very bottom of the watershed, with station #1 being located at the confluence with the Conestoga River and station #2 being located approximately 5, 200-feet upstream at the mouth of Indian Run. Both stations exhibited similar in-stream habitat characteristics with station #2 having a better riparian zone of trees and shrubs along its banks. Both pools have sediment free substrates comprised of cobble, boulder and bedrock seams providing good cover for fish and aquatic insects.


Monitoring Station #2


Monitoring Station #3

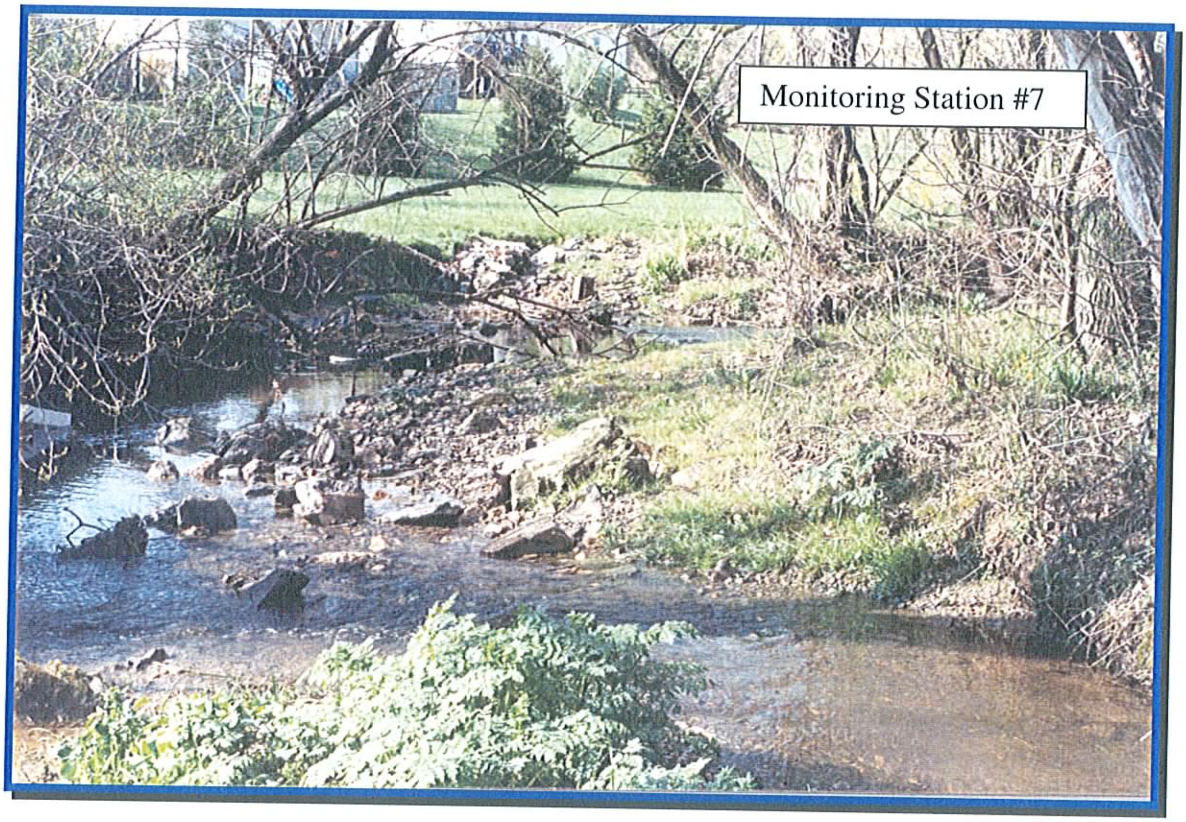
Monitoring station #3 is located in Indian Run upstream of Indian Run Road. This section of stream flows through a wooded valley surrounded by farmland. The riparian zone surrounding this station is excellent, with a variety of native hardwood trees and shrubs providing an excellent forest buffer between the stream and cropland. Streambank erosion is typical of such a wooded setting and the substrate is fairly sediment free. The only shortcoming is the actual size of the stream. It is small - quite narrow and shallow (averaging less than 3-inches in depth); thus limiting the variety, numbers and size of fish. There are a few deeper pools (up to 1.5-feet deep) that harbored some larger white sucker.

Monitoring station # 4 is located on the Main Stem at the confluence with the West Branch. This station is located in a very scenic forested valley. Because of its undisturbed, natural stream channel and riparian zone condition, this location should be thought of and used as a reference and/or model for future restoration endeavors in the lower half of the Main Stem. This station exhibits all the "good things" one strives to restore when going about improvement projects – forest buffer, in-stream cover, stabile streambanks, sediment free substrate, riffle and pool habitats.

Monitoring Station #4

Monitoring station #5 is located on the West Branch approximately 1,000-feet upstream from the confluence with the Main Stem. Remnants of a breached earthen dam are evident in this location, with station #5 being located behind where the dam had once stood. The station is located in a forested valley. The northern streambank is very high (over 10-feet), vertical and eroding at an accelerated rate, while the southern streambank (located on the inside of the stream channel's bend) consists mainly of a large gravel bar gently sloping up into the adjoining woodland. Though the northern streambank is eroding, it none-the-less provides great fish habitat in its undercuts. Still an effort should be made to stabilize the northern bank.

Monitoring station #6 is located on the West Branch just upstream of Bender Mill Road in farm country. Here the West Branch is obviously impacted by the surrounding agricultural landuse. Streambank erosion is occurring on both banks and little exists in the way of a forest buffer; rather much of the area adjacent to the stream is either in pasture or consists of mowed grass fields. This reach of stream could be vastly improved by simply planting an adequate forest buffer.

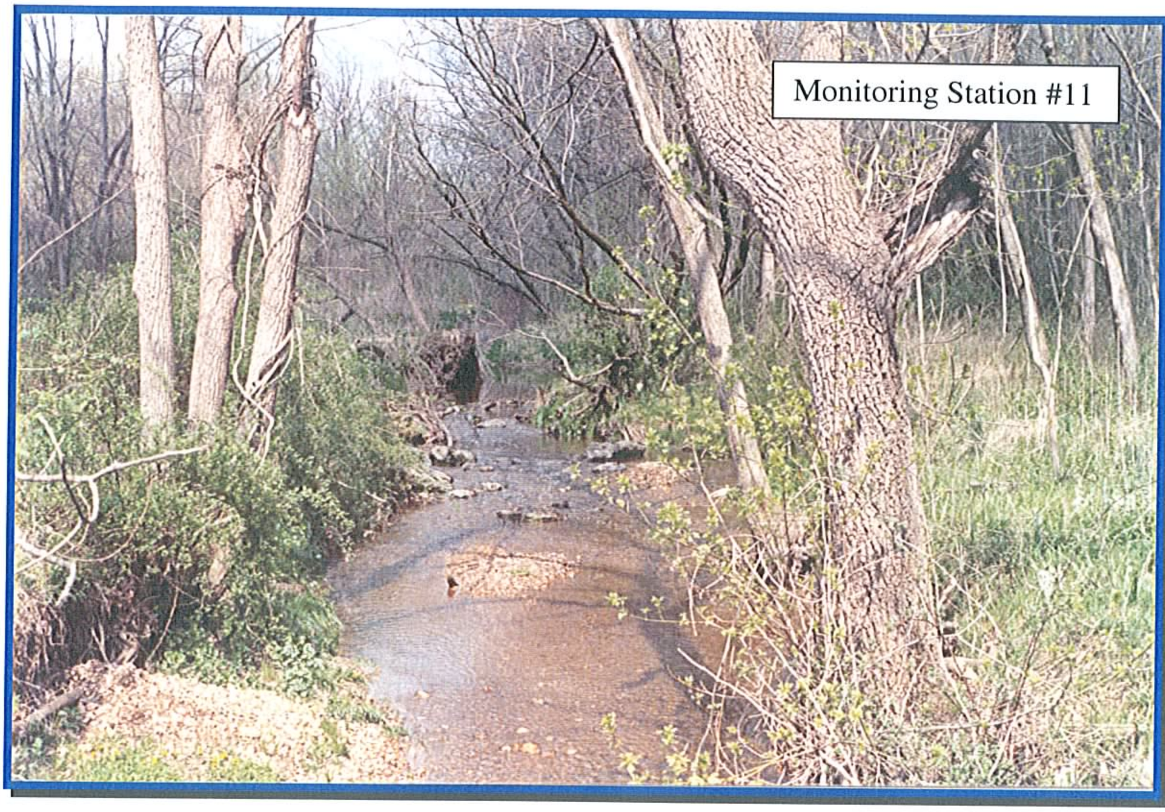


Monitoring station #7 is located in the West Branch headwaters immediately downstream of Route 464 "Columbia Avenue". This area is highly developed, consisting of commercial and residential landuse. This section of stream ranked rather low in all habitat categories. Stormwater from Columbia Avenue and the surrounding developed area certainly influences water quality in this location. A considerable amount of litter was observed in the stream in this location, as well as dump lawn clippings from area residents.

Monitoring station #8 is located on the Main Stem upstream of Route 999 "Blue Rock Road". The western streambank is steeply sloped and forested, while the eastern bank gives way to a large floodplain serving as backyards to adjoining properties. This reach a stream scored very high in most of the evaluated habitat parameters, coming in second best when compared with the other stations. Long deep pools with woody debris for fish cover characterized this location.

Monitoring station #9 is located on the Main Stem in Manor Park just downstream and south of Charlestown Road. Much of the stream in this area is immediately bordered by mowed lawn. Only a few larger trees line the streambank, native shrubs and other herbaceous plants are rare. Obviously the forest buffer in this area could be much improved. In-stream cover was adequate for smaller fish, but larger cover structure for larger fish such as Smallmouth bass was limited.

Monitoring station #10 is located on the Main Stem within Maple Grove Park just south and downstream from Route 462 "Columbia Avenue". This area has recently undergone some habitat improvement work consisting of a forest buffer planting and stream channel stability measures such as the rock cross-vane depicted in the above photograph. The habitat quality in this reach of stream should improve somewhat as the forest buffer matures. However, the western streambank below the Maple Grove Mill building consists of a vertical concrete wall that will likely continue to limit site recover unless it is removed and the natural streambank restored.



Monitoring station #11 is located on Brubaker Run within a park owned by East Hempfield Township approximately 1,300-feet upstream from the confluence with the Main Stem. This reach of stream is surrounded by a healthy forest buffer and for the most part is in a wooded setting. Brubaker Run, although a smaller stream, exhibits good habitat features in this location. Such is not the case further upstream where Brubaker Run is surrounded by commercial landuse.

Monitoring station #12 is located on the Main Stem immediately downstream of Route 23 "Marietta Pike". This section of stream is located in a residential setting where backyard lawns encroach right up to the top of the streambank, offering little in the way of forest buffer and riparian habitat. Habitat under the water and within the channel isn't any better. Much of the substrate is sediment laden and little overhead cover exists for larger fish.

Monitoring station #13 is located in an urban/commercially developed setting on the upstream side of the Old Harrisburg Pike near Park City. The lack of in-stream cover for fish and the tightly embedded, sediment laden substrate really limits fishery potential in this Main Stem reach. Litter was quite common. The majority of the Park City shopping complex does not have any sort of stormwater management in the way of detainment. The stream channel in this location shows signs of streambank erosion due to flashy stormwater flooding events. The stream channel is very wide compared to its overall depth and baseflow depth. The channel is overly wide to accommodate flashy flooding events.

The worst monitoring station in regards to habitat quality was station #14 located immediately downstream of State Road in East Hempfield Township. Station #14 is located in a pasture where dairy heifers have free access to Swarr Run. The pastureland is severely overgrazed and streambank erosion is excessive. Swarr Run's substrate in this local is sediment-laden and severely trampled by wading livestock. No other single farm within the entire Little Conestoga Creek Watershed exhibited such an overwhelming abuse of the stream and riparian zone. Other farms have "hot spots", like a small feed lot or exercise lot, but no other single farm impacts over one-half mile of stream corridor!


Monitoring Station #14


Monitoring Station #15

Ironically, the best monitoring station in regards to habitat quality was monitoring station #15 located upstream of State Road and station #14. The difference between stations #14 and #15 is dramatic; with channel width being the most apparent difference. The un-trampled stream channel at station #15 is less than half the width of the trampled stream channel at station #14. Station #15 is located in a sheep pasture that fortunately is not overgrazed. The stream isn't bordered by many trees and shrubs, but a good stand of filtering grasses and other herbaceous plants line the streambanks. The streambanks are stabile and do not show signs of accelerated erosion, though they are undercut in some locations providing excellent overhead cover for fish. The substrate in the riffle areas is fairly void of sediment.

Monitoring Station #16

Monitoring station #16 is located on the Main Stem just downstream from Flory's Mill south of Route 283. Below Flory's Mill, the stream channel is unaltered and flows through a forested area whereas at Flory's Mill, the stream is artificially channeled and actually flows under a portion of the old mill building. Station #16 had suitable in-stream habitat for larger fish and is a popular stocked trout fishing location.

Monitoring station #17 is located on a small un-named tributary just south of Route 283 on the Kolb Farm. The un-named tributary enters the Main Stem just below Flory's Mill. In 1997, students from the Lancaster County Academy installed streambank fencing and planted trees and shrubs along this pastured section of stream. The pasture had previously been overgrazed and streambank erosion due to excessive cattle trampling resulted. Since the fencing project, the stream has shown signs of recovery. The streambanks are re-vegetated and the channel is being to narrow and deepen. This section of stream should improve as the planted forest buffer matures and the stream purges itself of its previous sediment load.

Monitoring Station #18

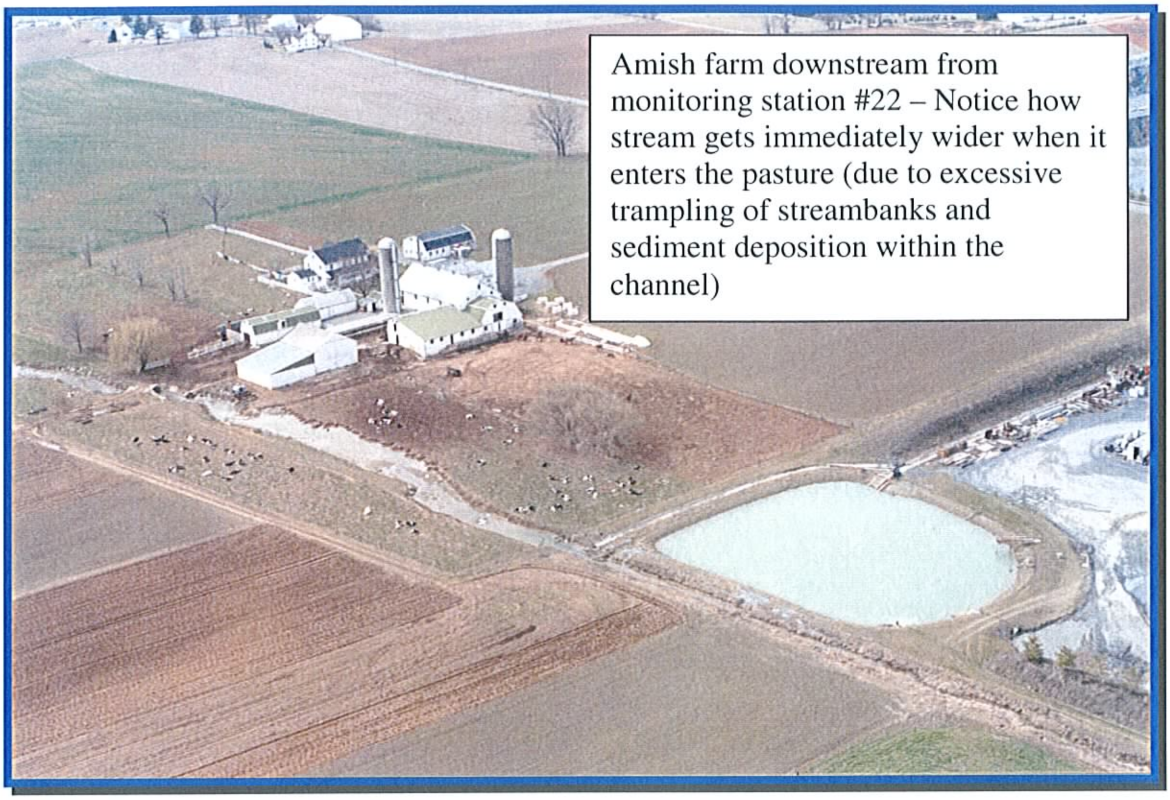
Monitoring station #18 is located on the Main Stem on property owned by PPL just north of Route 72 "Manheim Pike". In 1997, PPL completed a stream restoration project involving a forest buffer planting and installation of in-stream channel stability controls designed by consulting firm LandStudies of Lititz, Pennsylvania. This section of stream is recovering quite nicely. The various channel stability controls (rock weirs, cross-vanes and root wads) seem to be functioning properly, providing both stability and riffle/pool habitats for fish. The Little Conestoga Watershed Alliance should consider this restoration work a prime example of properly designed and installed in-stream channel stability control measures.

Monitoring station #19 is located on the Main Stem just above Miller Road east of East Petersburg Borough. This area shows great promise for a future trout fishery. In-stream cover for fish is excellent. Much of the immediate upstream area is wooded and/or fallow. The area also contains several springs that serve to recharge the stream and steady cool water temperatures.

Monitoring station #20 is located on Bachman Run immediately upstream of Fruitville Pike in the Wetherburn residential development. Currently this reach of stream is in poor condition. The substrate is heavily sediment laden. Little exists in the way of a forest buffer, only a few trees in backyard lawns line the eastern bank. Much of the eastern streambank from Fruitville Pike upstream to Route 772 "Petersburg Road" (a distance of approximately 2,300-feet) is grass lawn. A crop field that is usually planted in either corn or soybeans, but is slated for residential development in the near future borders the western bank. The Little Conestoga Watershed Alliance has received a Growing Greener Grant in the amount of $52,125.00 to restore Bachman Run more-or-less from Fruitville Pike upstream to Route 772 "Petersburg Road". Residents of Wetherburn and developer Barry Hogan are supportive of the restoration project.

Monitoring station #21 is located on Bachman Run just north and upstream of Koser Road in the Wetherburn North development. In the spring and summer of 2002, Donegal Trout Unlimited and Little Conestoga Watershed Alliance members planted various trees and shrubs along this section of stream and established a good rapport with area residents. As was discussed earlier in this writing, the flow in this section of stream is heavily influenced by pumped water (or the lack of it) from Rohrer's Quarry located upstream. When the quarry pumps are running, the stream has plenty of flow and offers adequate cover and suitable habitat for fish. However when the pumps are off, the water nearly vanishes from the stream channel during the summer months, making the stream an unsuitable habitat for fish. Upstream sink holes and East Petersburg's drawing of water from a municipal well also likely play a role in the fluctuation of baseflow volume. This entire situation deserves closer attention and investigation.

Monitoring station #23 is located in the very headwaters of Bachman Run above Rohrer's Quarry. This spring fed section of Bachman Run supports a fishery though the channel itself has been realigned to follow property lines. The section of stream along Rohrer's Quarry is well vegetated with herbaceous plants, but lacks trees and shrubs. The stream itself appears healthy. The substrate is sediment free and the streambanks are stabile. The stream however takes an immediate turn for the worst when it exits the quarry property and enters into the adjoining downstream Amish farm. The stream flows through an exercise/turnout lot for dairy cattle where it surely collect animals waste during storm events and direct defecation into the water by wading livestock. Piles of manure and household trash were observed in back of the barn along the stream; to be easily washed away downstream with the next sizable storm event.



Amish farm downstream from monitoring station #22 – Notice how stream gets immediately wider when it enters the pasture (due to excessive trampling of streambanks and sediment deposition within the channel)

Monitoring Station #23

Monitoring station #23 is located in the headwaters of the Main Stem at Route 772 "Petersburg Road/Graystone Road". Downstream of Route 772, habitat conditions are fair as the stream flows through fallowing pastureland. Above Route 772, the stream is bordered on the west by East Petersburg Water Authority's pump station and to the east by residential properties.

Monitoring station #A1 is located on an un-named tributary located just north of Charlestown Road in Manor Township. The above pictured section of stream (where station #A1 is located) was the site of a recent (spring 2002) stream restoration project by the Little Conestoga Watershed Alliance. RETTEW Associates, Inc. provided project design and construction oversight. This section of stream previously suffered from severe streambank erosion due to ill-managed stormwater and the encroachment of lawn mowers into the riparian zone. The restoration project included a forest buffer planting, bioengineering, and the installation of rock weirs, mud sills and boulder placements to provide channel stability and fish habitat. After one growing season and some rather intense storm events, all improvements seem to be doing fine.

Monitoring stations #A2, #A3 #A4 and #A5 are all located further upstream from station #A1.


Monitoring Station #A4


Monitoring Station #A5