Clarks Creek Watershed Coldwater Conservation Plan

Dauphin County Conservation District
February 2012

I. Watershed Background

The Clarks Creek watershed drains an area of 43.1 square miles in central Dauphin County. The watershed is a long narrow basin approximately 25 miles long with an average width of about 1.5 miles. The stream flows southwest joining the Susquehanna River northeast of Dauphin Borough. There are no significant tributaries, only small streams draining the steep mountainsides; Third and Stony Mountain to the south and Peters Mountain to the north.

Figure 1: Map of Clarks Creek Watershed

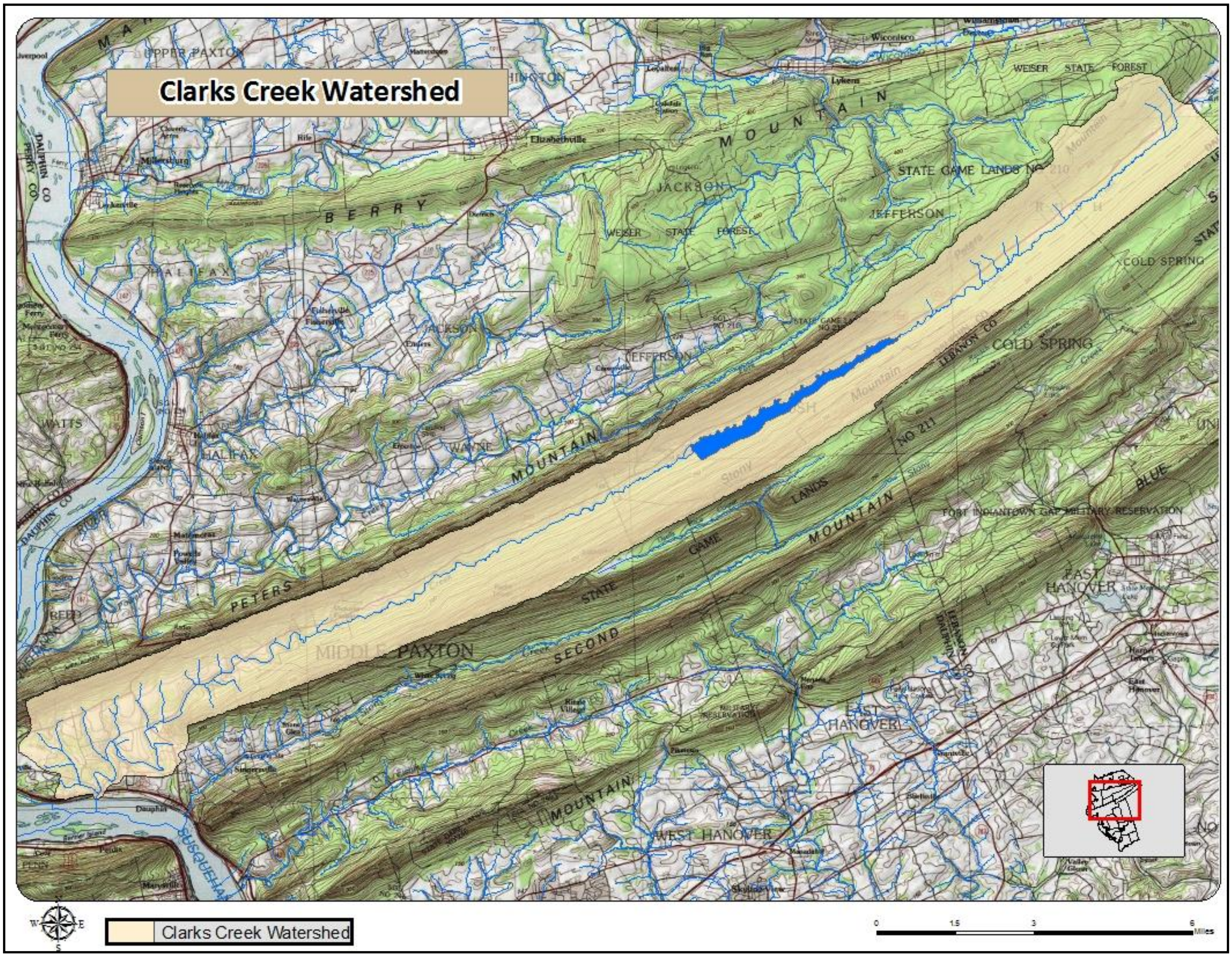
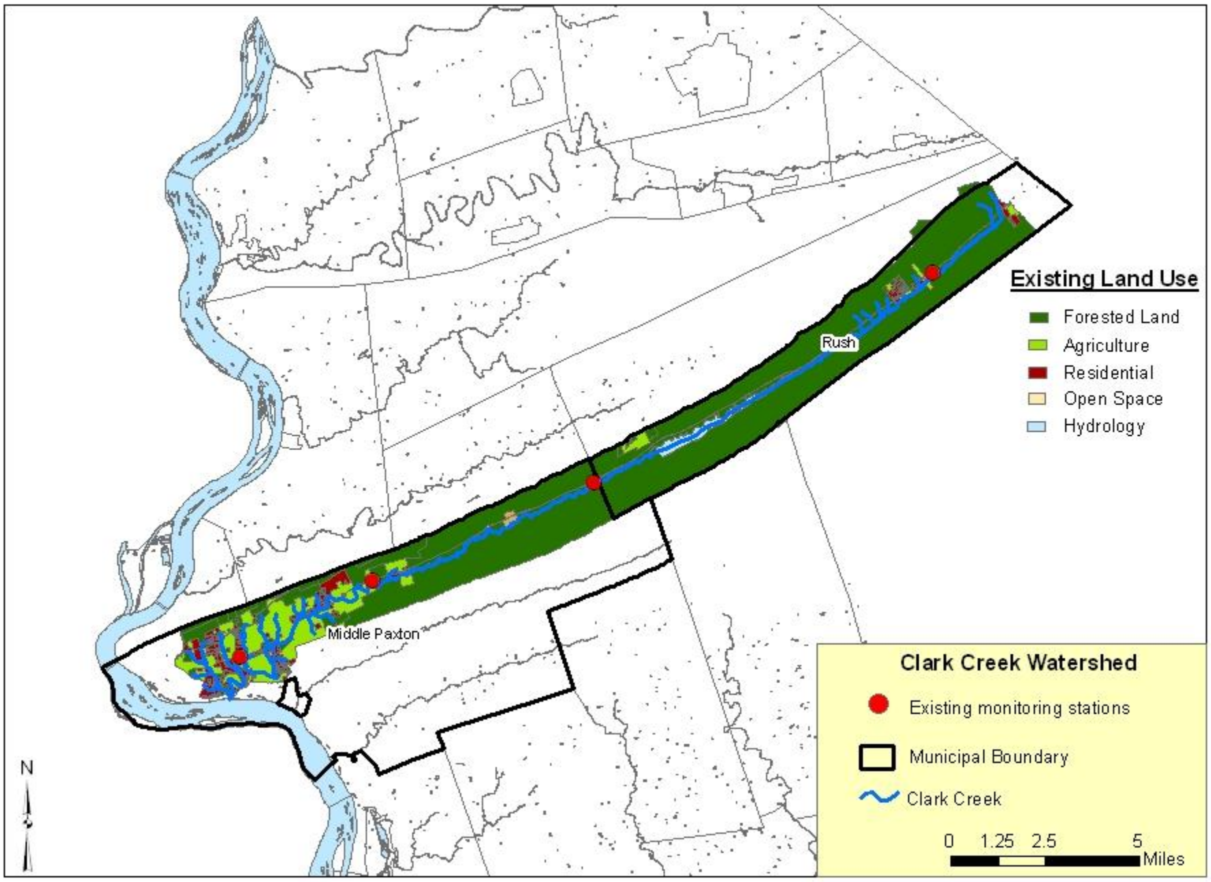


Figure 2: Map of Land Use within Clarks Creek Watershed



The DeHart Dam was constructed from 1939 to 1940. The project cost over $4 million and was partially funded by a grant from the Public Works Administration. In 1954, four feet were added to the dam spillway wall to increase the capacity of the reservoir to six billion gallons. The dam was named in honor of city councilman William T. Dehart who died in 1947. The required conservation release from the dam is 6.5 million gallons per day, or 10.075 cfs, which ensures that there is enough flow in the lower section of Clarks Creek to maintain a healthy aquatic ecosystem throughout the year.

Dehart Reservoir and Surrounding Clarks Creek Watershed.

The topography of Clarks Creek watershed is typical of the Ridge and Valley physiographic province of Pennsylvania. Its ridges are composed of mainly red and gray sandstone with some conglomerate. The valley is underlain with eroded sandstone from the ridges, as well as shale. The underlying geologic formation is the Mauch Chuck Formation, which is comprised of grayish-red shale, sandstone, siltstone, and some conglomerate. The majority of the soils in the Clarks Creek Watershed are Dekalb, Calvin, and Laidig.

Clarks Creek at Angeline, above the reservoir.

Due to the abundant forest and low population density in the Clarks Creek Watershed, there is minimal pollution affecting Clarks Creek. There are a few potential causes of non-point source pollution that may occur in the Clarks Creek Watershed from households, roads, and agriculture related sources. Waste from vehicles, sediment, and salt and other road applications for winter maintenance can be washed into the creek from roadways. The over application of fertilizers and pesticides on lawns and fields can also lead to degraded water quality. Sedimentation can also be a result of land disturbances and agricultural practices. Developed areas, including residential areas, contribute to nonpoint source pollution due to increased amounts of impervious surfaces, such as roofs, driveways, parking lots, and roads. Stormwater runoff from impervious surfaces carries pollutants, including sediment, into the stream.

II. Clarks Creek as a Special Protection Stream

Clarks Creek is designated as a High Quality – Cold Water Fishery (HQ-CWF). In 1979 the State granted all Conservation Areas designation as High Quality, special protection waters in order to protect areas where natural resources have been preserved by setting water quality standards. The densely forested watershed has very little contributing sources of pollution to Clarks Creek, providing clean water and providing wildlife habitat. The following section describes the water quality standards set for High Quality watersheds, detailing parameters that must be met to designate a stream as high quality, and antidegredation methods throughout Pennsylvania's special protection watersheds.

Clarks Creek at the Appalachian Trail.

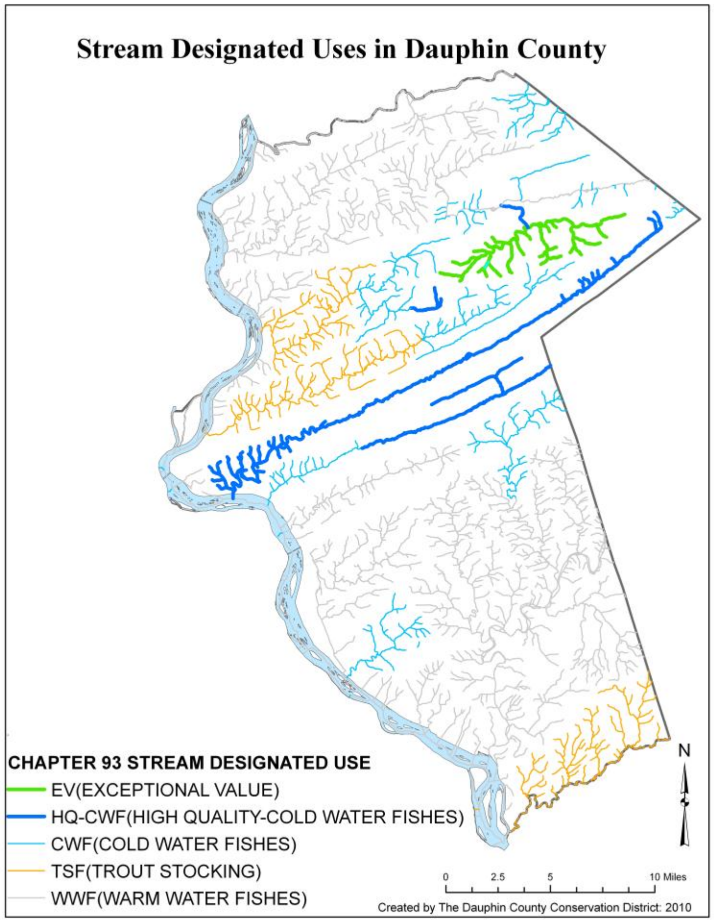
A. Water Quality Standards

The Pennsylvania State Code Chapter 93 details the protection of water quality in surface water throughout the Commonwealth. These standards are based upon designated uses for each stream section, providing guidance to the protection of these uses. Designated uses can be for any of the following: Aquatic Life, Water Supply, Recreation and Fish Consumption, and Special Protection. This report focuses on uses for Aquatic Life and Special Protection.

Aquatic Life

A Stream is designated as a Cold Water Fishery or Warm Water Fishery when describing the aquatic organisms that find habitat in its waters. As defined in Chapter 93, a Cold Water Fishery (CWF) is a stream or a section of a stream that supports life of fish, flora, and fauna of a cold water habitat. Some waterways are protected by canopy, providing shade in the summer months, thus helping to keep the water temperature cooler for trout, among other organisms that can only survive in cool temperatures.

Figure 3: Map of Stream Designated Uses in Dauphin County



Special Protection

Special Protection streams fall into the category of either High Quality (HQ) or Exceptional Value (EV). These categories of streams are designated as special protection waters because they represent the highest quality of waters in the Commonwealth and merit special protection. A High Quality waterway meets the requirements for a chemistry assessment of multiple parameters, such as temperature, dissolved oxygen and pH, among others, or qualifies as High Quality based on the results of a biological assessment. Exceptional Value streams must meet more stringent requirements.

As shown in Figure 3, there are four special protection streams in Dauphin County. Rattling Creek, a tributary to Wiconisco Creek is designated as Exceptional Value on its East and West branches. Clarks Creek is designated as a High Quality Stream. Stony Creek, from its source to Ellendale is designated as a High Quality stream. A section of Conley Run is designated High Quality.

Table 1: Temperature Standards as related to High Quality- Cold Water Fisheries. (25 Pa. Code § 93.4b).

SYMBOL: CRITICAL USE: PERIOD	*TEMP$_1$ CWF*
January 1-31	38
February 1-29	38
March 1-31	42
April 1-15	48
April 16-30	52
May 1-15	54
May 16-31	58
June 1-15	60
June 16-30	64
July 1-31	66
August 1-15	66
August 16-30	66
September 1-15	64
September 16-30	60
October 1-15	54
October 16-31	50
November 1-15	46
November 16-30	42
December 1-31	40

Table 2: Water Quality Standards as related to High Quality- Cold Water Fisheries. (25 Pa. Code § 93.4b).

Bacteria	Bac$_1$	(Fecal coliforms/ 100 ml)—During the swimming season (May 1 through September 30), the maximum fecal coliform level shall be a geometric mean of 200 per 100 milliliters (ml) based on a minimum of five consecutive samples each sample collected on different days during a 30-day period. No more than 10% of the total samples taken during a 30-day period may exceed 400 per 100 ml. For the remainder of the year, the maximum fecal coliform level shall be a geometric mean of 2,000 per 100 milliliters (ml) based on a minimum of five consecutive samples collected on different days during a 30-day period.
	Bac$_2$	(Coliforms/100 ml)—Maximum of 5,000/100 ml as a monthly average value, no more than this number in more than 20 of the samples collected during a month, nor more than 20,000/100 ml in more than 5% of the samples.
Chloride	Ch	Maximum 250 mg/l.
Color	Col	Maximum 75 units on the platinum-cobalt scale; no other colors perceptible to the human eye.
Dissolved Oxygen		The following specific dissolved oxygen criteria recognize the natural process of stratification in lakes, ponds and impoundments. These criteria apply to flowing waters and to the epilimnion of a naturally stratified lake, pond or impoundment. The hypolimnion in a naturally stratified lake, pond or impoundment is protected by the narrative water quality criteria in § 93.6 (relating to general water quality criteria). For nonstratified lakes, ponds or impoundments, the dissolved oxygen criteria apply throughout the lake, pond or impoundment to protect the critical uses.
	DO$_4$	Minimum 7.0 mg/l.
Fluoride	F	Daily average 2.0 mg/l.
Iron	Fe$_1$	30-day average 1.5 mg/l as total recoverable.
	Fe$_2$	Maximum 0.3 mg/l as dissolved.
Manganese	Mn	Maximum 1.0 mg/l, as total recoverable.
Nitrite plus Nitrate	N	Maximum 10 mg/l as nitrogen.
Osmotic Pressure	OP	Maximum 50 milliosmoles per kilogram.
pH	pH	From 6.0 to 9.0 inclusive.
Phenolics (except § 307(a)(1) (33 U.S.C.A. § 1317(a)(1)), Priority Pollutants)	Phen	Maximum 0.005 mg/l.
Sulfate	Sul	Maximum 250 mg/l.
Total Dissolved Solids	TDS	500 mg/l as a monthly average value; maximum 750 mg/l.
Total Residual Chlorine	TRC	Four-day average 0.011 mg/l; 1-hour average 0.019 mg/l.

B. Implementation of Antidegredation Requirements

Special Protection waters are protected under PA Code Chapter 93. When changes within the watershed are proposed, antidegredation requirements must be followed in order to protect the quality of water that exists in the watershed. Nondischarge alternatives are suggested in the case of a potential point source discharge directly entering the stream. Nondischarge alternatives can provide an environmentally sound and cost-effective method of managing waste. Such recommendations are described in Section VIII. In relation to Clarks Creek, it is possible that future point source discharges could be proposed in the form of stormwater discharges. Future land development is a possibility within the watershed and must be considered wisely to protect the existing water quality of Clarks Creek.

In addressing antidegredation requirements for special protection waters, the Pennsylvania Department of Environmental Protection (PA DEP) assures that cost-effective and reasonable best management practices for non-point source control will be achieved. Described in Section I, common non-point source pollution found in Clarks Creek watershed are minimal amounts of road and agriculture related sources, sedimentation from forest land disturbances, and homeowner related sources. Recommendations addressing these and other public concerns are found in Section VIII.

PA Code, Chapter 102 contains Erosion and Sediment Control regulations related to earth disturbance activities. These regulations aim to protect the designated water quality within a watershed including High Quality watersheds such as Clarks Creek. Project plans submitted to Dauphin County Conservation District (DCCD) and PA DEP are reviewed for compliance with these regulations. Also, earth disturbance activities are required to obtain a National Pollution Discharge Elimination System (NPDES) permit which contains requirements for the protection of receiving waters. These permits also contain requirements for post-construction stormwater management designed to control the rate, volume, and quality of stormwater runoff. Requirements for the proper management of post-construction stormwater are also provided through PA Act 167. Act 167 requires that counties in Pennsylvania develop county-wide stormwater management plans. DCCD developed the Dauphin County Stormwater Management Plan in accordance with Act 167. The Plan contains criteria and standards for managing the rate, volume, and quality of stormwater runoff from development. Following PA DEP approval of the Plan, municipalities in the county are required to incorporate the criteria and standards contained in the Plan into their municipal stormwater management ordinances. PA Code, Chapter 105 also provides for protection of water quality through the regulation of stream encroachments. Activities proposed within a designated floodway or within 50 feet of top of bank of a waterway must obtain a permit from PA DEP to proceed.

III. Previous Studies

Previously, water quality data has been collected by the Harrisburg Authority, PA DEP, PA Fish and Boat Commission, the United States Geological Survey (USGS) and DCCD. The PA Fish and Boat Commission sampled Clarks Creek in 1978 and 2008, in which they conducted a fish survey and chemical sampling. Their results are found in Attachment II. PA DEP last sampled Clarks Creek in 2007, reaffirming that the water quality is such that Clarks Creek continues to attain its designated uses as a potable water supply and to support aquatic life. The Harrisburg Authority monitors flow out of the DeHart Dam to verify the minimum conservation release of 6.5 MGD, or just over 10 cfs, to sustain flow in Clarks Creek in order to support aquatic life below the dam.

From October 1, 1937 to December 31, 1996, USGS maintained a gage, station #01568500, 0.3 miles downstream of the DeHart Dam that recorded the stage of the water. Table 3 displays the average flow per month over all recorded data.

Table 3: Average Monthly Flow (cfs) from October 1937 to December 1996 recorded at USGS Station # 01568500

January	22
February	20
March	36
April	43
May	38
June	20
July	11
August	6.7
September	8.8
October	11
November	14
December	19

DCCD carries out a Countywide Stream Assessment Program (CSAP) in which 101 sites are monitored throughout the County on a five year rotation, following PA DEP's Protocol for Instream Comprehensive Evaluations (ICE). Three sites in the Clarks Creek Watershed were sampled in 2008 for macroinvertebrates. IBI health scores appeared lower than expected in two of the locations shown in Table 4, raising concern. Metric calculations used to determine the scores below, as well as previous water quality data that was collected by DCCD can be found in Attachment IV.

Table 4: Clarks Creek 2008 Adjusted metric scores combined into an Index of Biotic Integrity (IBI).

2008		Adjusted Standardized Metric Score (max:1.00)						
Rep. Name	**Station Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% EPT**	**EPT taxa**	**IBI**
CLRK 1	CLRK 22.72	0.57	0.45	0.39	0.57	0.18	0.37	42.22
CLRK 2	CLRK 16.24	0.60	0.61	1.00	0.64	0.15	0.42	56.92
CLRK 4	CLRK 01.85	0.72	0.48	1.00	0.85	0.51	0.37	65.41

IV. <u>Stream Study Methods</u>

A. Macroinvertebrate Community

Macroinvertebrates are small organisms such as insects, worms and crustaceans. The total number of macroinvertebrates and the different types present, give an indication as to the overall health of a stream. Biological assessments of macroinvertebrates are a good way to determine the general water quality of a stream in an inexpensive manner. By identifying the types and numbers of macroinvertebrates, a water quality rating can be given to the stream. This is possible because different species have differing tolerances to water pollution. For example, mayflies, stoneflies, and caddisflies do not survive well in polluted water while leeches, midges, and worms are tolerant to pollution. The various sources of degradation will adversely impact streams. It is the adverse impact that is reflected in the macroinvertebrate sample, not necessarily the specific cause itself. Where a sample does indicate degraded stream health, the specific cause will need to be determined.

A stonefly, pictured here, is a macroinvertebrate that is sensitive to pollution.

It is also important to consider the interconnection of an ecosystem when determining the health of a stream. Stream degradation reflected in the macroinvertebrates does not affect only the macroinvertebrates. Macroinvertebrates feeding on microorganisms found on rocks, sediment, and submerged vegetation are the source of nourishment for fish and other aquatic life higher in the food chain. Changes in the number of any of these organisms can be the broken link of a stream ecosystem's health and productivity. Aquatic macroinvertebrate communities; such as aquatic insects, crustaceans, leeches, worms, and snails; indicate stream health, responding negatively to environmental stressors and positively to favorable environmental conditions. Macroinvertebrate organisms provide an efficient means of characterizing stream health along Clarks Creek.

A comprehensive evaluation of Clarks Creek was designed to sufficiently characterize an overall picture of aquatic habitat and stream health. Seven sample sites were chosen along Clarks Creek, with guidance from existing DCCD monitoring locations, along with recommendations from concerned citizens and DFTU members. Figure 4 is a map of the site locations. In locating sample locations, areas of concern were considered, as well as an even distribution along the 31.8 mile stretch of Clarks Creek. The goal of choosing sample sites is to provide an accurate characterization of stream health for that 100 meter stretch of stream, which translates to stream health of the entire stream when all seven sites are compared.

Sample collection and processing of these studies were as follows. Samples were taken between January and April in order to capture winter insect larvae at a large, identifiable stage. At each site, six kick samples were taken in riffle areas along a 100 meter stretch. Although a riffle area protocol was followed, differing protocols exist for alternate kick sample locations such as leaf packs, pools, undercut bank roots/vegetation, etc. Each protocol provides a slightly different picture of the aquatic community. Collections from each of the six kick samples were washed and course material is removed. Samples were preserved in 95 % ethanol and placed in labeled plastic containers to be sub-sampled at a later date.

After performing a set of calculations on the macroinvertebrate community found at each sampling site, a standardized value resulted as a health score, called the Index of Biotic Integrity (IBI). To summarize this process, six calculations were combined to form the IBI. These calculations look at different strengths; whether the sample is diverse, the number of sensitive types, pollution tolerance of each type, and so on. The IBI resulting from metric calculations corresponds to a stream health score, as well as relating to attaining and impaired aquatic life cut off points used by the PA DEP. Table 5, below, shows the IBI range for each health classification.

Figure 4: Map of Macroinvertebrate sampling locations

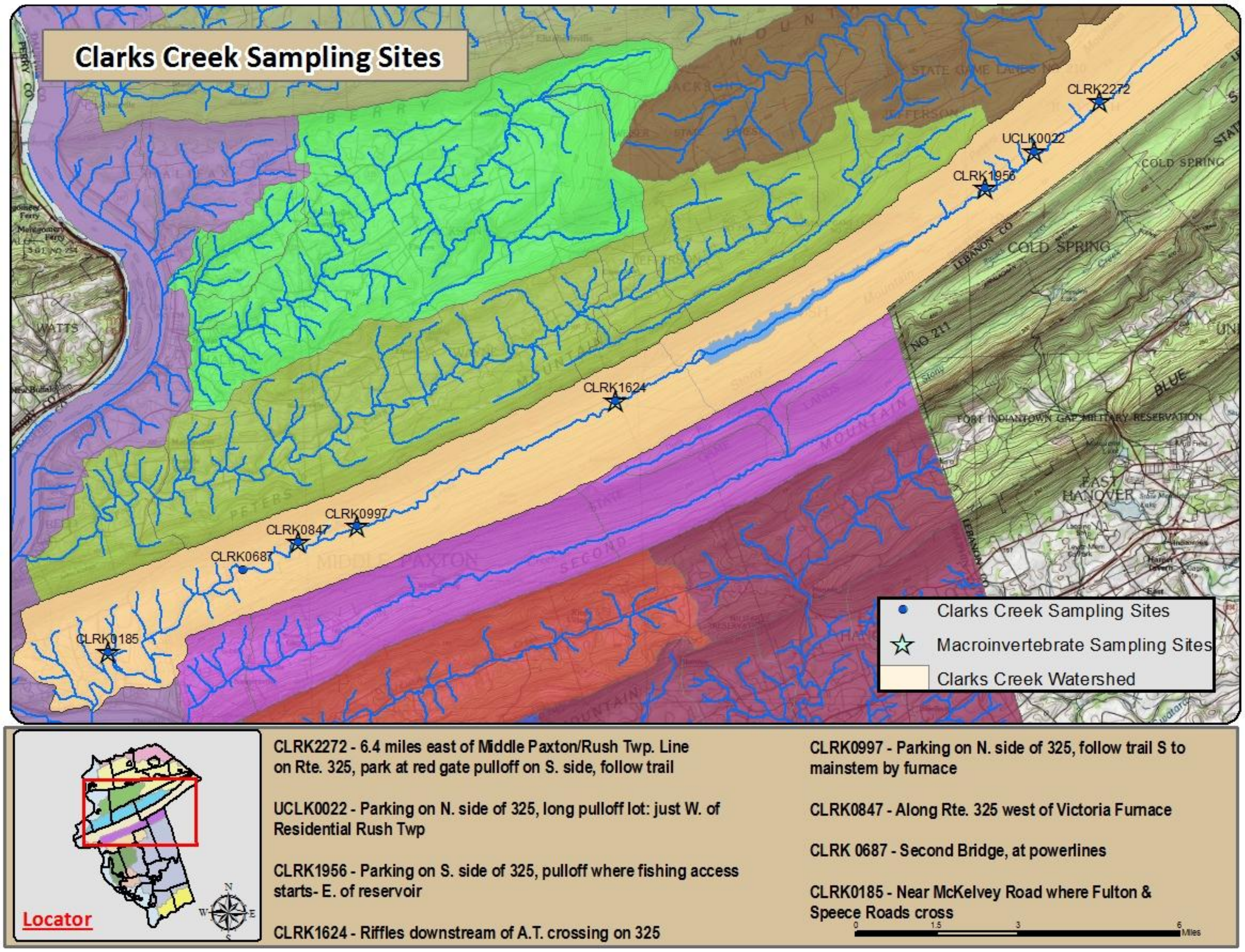


Table 5: Index of Biotic Integrity (IBI) range for health classifications

<u>Good</u> (63-100): Optimal site with a balanced community of pollution sensitive and tolerant organisms.
<u>Fair</u> (50-62): Significant decrease in pollution-sensitive species, unbalanced site with sub-optimal habitat.
<u>Poor</u> (0-49): Degraded site dominated by tolerant organisms. Site is not attaining aquatic life use.

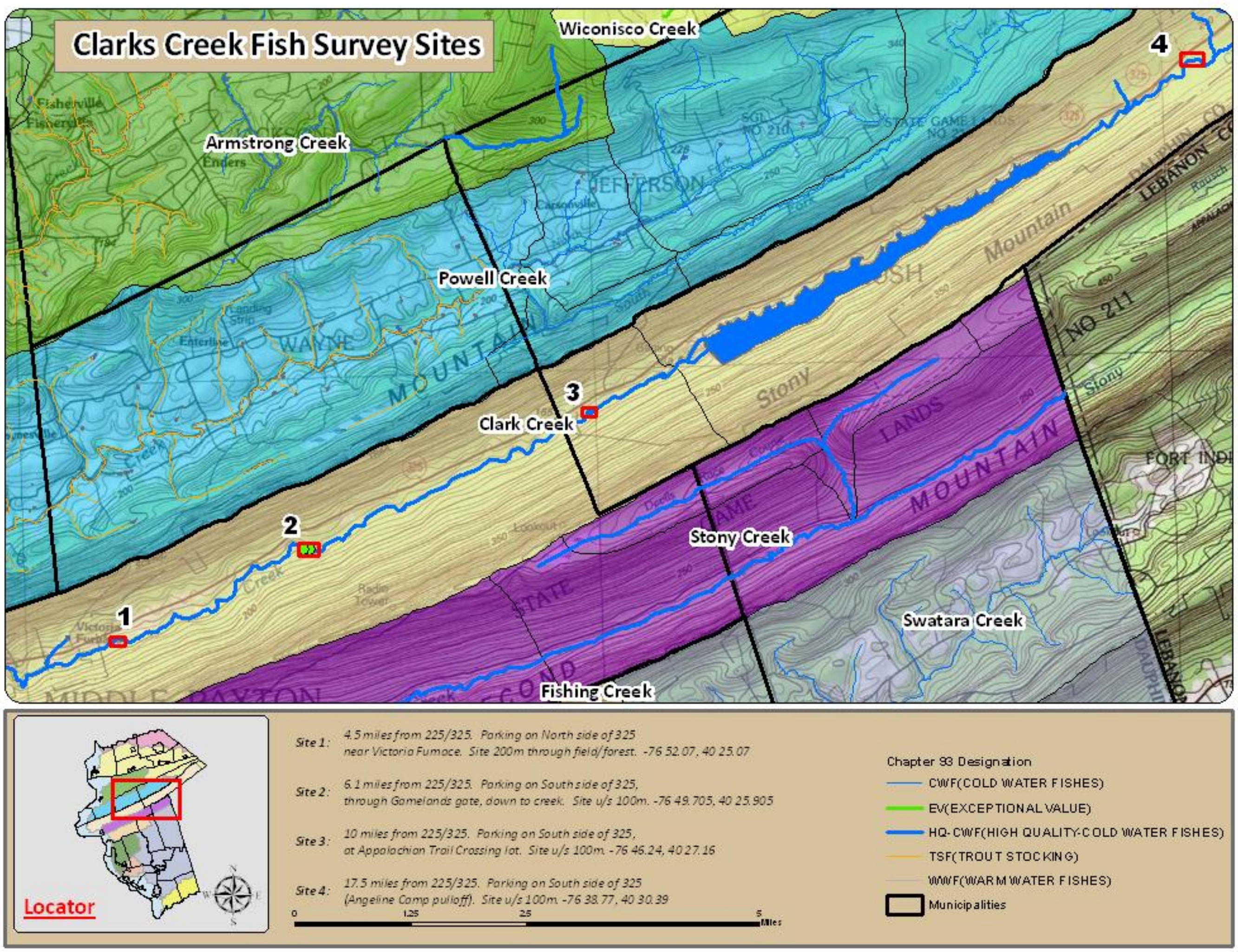
Macroinvertebrate sample results are discussed in Section VI. Please note that classification of "good", "fair", and "poor", are based on DEP's ICE Protocol. When evaluating the data derived from the macroinvertebrate samples it is critical that the information be considered carefully. It is important to understand what the data is and what it is not. It is a general indicator of stream health. It is not evidence of a specific pollutant or source of pollutants.

B. Fish Survey

The fish survey on Clarks Creek was a collaborative effort of PA DEP biologists, DCCD staff, and the Doc Fritchey Chapter of Trout Unlimited (DFTU) volunteers. A presence/absence method was followed in order to study the fish community of Clarks Creek, which entailed documenting the type and count of each fish caught during the study. Two electroshocking units, buckets, and additional nets were shared by roughly 10 staff and volunteers. Four sites were chosen with guidance from DFTU members, each were roughly 100 -130 meters in length. Site length was derived from a factor of the width of the stream as well as location of natural barriers to fish movement. Figure 5 illustrates the location of each of the four fish survey sites.

PA DEP biologists, DCCD staff, and DFTU volunteers conducting the fish survey on Clarks Creek

Figure 5: Clarks Creek fish survey site locations.



C. Physical Habitat Evaluations

Physical habitat related to the stream section and its surrounding drainage area plays a significant role in the quality of life for aquatic organisms. To monitor habitat, DEP's ICE Protocol provides a habitat assessment form which measures 12 characteristics of habitat on a scale of 0-20. These measures include:

- Instream Cover for fish	- Bank Condition	- Embeddedness: % silt covering rocks
- Depth Regime	- Channel Alteration	- Sediment Deposition
- Frequency of Riffles	- Channel Flow	- Epifaunal Substrate: Life on stream bottoms
- Bank Vegetation	- Grazing Pressure	- Riparian Vegetation Width

Documenting these conditions may show changes over time, which can drastically affect macroinvertebrates. For example, increased sediment deposition may show impacts to macroinvertebrates that depend on gravel stream beds to cling to. It is important to identify these changes as this can provide information useful on impacts to the macroinvertebrate community and provide clues as to the source of the degradation. Details of each sample site's habitat assessment can be found in Section VI.

D. Field Chemistry Parameters

Field chemistry parameters provide additional support in characterizing water quality of Clarks Creek. Basic parameters of interest include temperature, pH, dissolved oxygen, and conductivity, acquired through the use of multiparameter meters. A short description of the importance of each follows.

- Temperature of stream water, which can be measured in Celsius or Fahrenheit, determines the aquatic life that can live in the stream. Temperature varies seasonally, but can also depend upon many factors including water depth, flow, and tree cover.

- pH is the measure of hydrogen ions in water and serves as an indication of the intensity of the acidic or basic character of a solution. pH is measured in Standard Units (su) and can range from 0-14 su, however stream water will most often have a pH of between 5 and 9 su.

- Dissolved Oxygen is necessary for aquatic organisms to survive. Dissolved oxygen can enter the water through either the photosynthesis of plants or by fast moving water, in riffles, that can cause oxygen in the air to dissolve in water. Aquatic life and decaying plants and animals consume dissolved oxygen. Concentrations of dissolved oxygen in natural waters ranges from 0-14 ppm and is affected by salinity and temperature.

- Conductivity is the ability of an aqueous solution to carry an electrical current. This is dependent upon the presence of acids, bases, ions, and/or salts.

Water quality parameters were analyzed at each of the 7 macroinvertebrate sample sites one time during the study period. Assessments were done during non-storm events to characterize the most accurate water quality results for typical conditions in Clarks Creek.

Additional monitoring was performed for topics of interest. The following paragraphs will present reasoning for monitoring summer temperature/D.O. and storm events. As described in Section II, streams must meet water quality standards 99% of the time to be designated as HQ-CWF. Specifically of interest in Clarks Creek is monitoring temperature and dissolved oxygen levels during summer months. Water temperatures climb as air and surface temperatures increase. Tree coverage, from the densely forested land surrounding Clarks Creek, provides a cooling effect, as well as shading from direct sunlight. Dissolved oxygen is related to water temperature, in that an increase in water temperature decreases dissolved oxygen. Oxygen is produced and consumed in streams. Photosynthesis of aquatic plants produce oxygen, as well as fast flowing riffles. Oppositely, aquatic life and decomposition consume oxygen. Seasonal cycles as well as diurnal cycles exist in dissolved oxygen concentrations. Tables 1 and 2 detail water quality standards set for HQ-CWF streams. During the months of June through September sections of Clarks Creek were monitored specifically for temperature and D.O. Results are found in Section VI.

Clarks Creek flooding event on March 11th, 2011

Storm events carry sediment and pollutants into surface water and disturbed earth can add to these loads. Sandy soils typical in the watershed are carried down gradient, into stream water. Land use practices such as agriculture, construction, and timber harvest can contribute higher loads during storm events without proper conservation practices. Clarks Creek watershed is mostly forested, providing beneficial infiltration and filtration of stormwater before entering the creek. Stormflow monitoring was not planned as a part of the Clarks Creek study, but one sample was collected to serve as a baseline for storm event water quality. Based on the quality of water during storm event monitoring, additional stormflow monitoring would be considered. The results collected during a November storm event are found in Section VI.

E. Stream Discharge Measurements

Stream discharge is the volume rate of water and suspended materials flowing through a stream channel. Seasonal streamflow fluctuates due to groundwater levels, average rainfall, and snowmelt, among other factors. In order to provide a seasonal hydrograph of Clarks Creek, discharge measurements were taken at 4 locations during each season to account for differences. The De Hart Reservoir divides Clarks Creek's headwaters and the section downstream of the reservoir, and differences between flow measurements above and below the dam were of interest.

Mike Yanchuk, DCCD Watershed Specialist, measuring the flow of Clarks Creek

V. <u>Public Participation</u>

A. Partners

The Doc Fritchey Chapter of Trout Unlimited (DFTU) is an active group of outdoor enthusiasts with an interest in protecting Clarks Creek's trout population for generations to come. DFTU provided an abundance of knowledge pertaining to Clarks Creek which guided planning aspects of the stream study. DFTU members provided volunteer service, supporting the project through stream sampling assistance.

During the stream study, DFTU organized a stream restoration project on Clarks Creek. The project included installing four log veins to direct flow away from eroding streambanks, toward the center of the channel. Natural scouring under the log veins also provides fish habitat, in the form of overhead cover. Various sized stones and boulders were placed on top of the veins as an anchor, along with providing access to the stream. The project was carried out with the help of DFTU volunteers, along with guidance and design by the Pennsylvania Fish and Boat Commission, through the Adopt a stream program.

The Doc Fritchey Chapter of Tourt Unlimited installing four log veins in Clarks Creek to protect streambanks and improve fish habitat

The Middle Paxton Township and Rush Township were also involved in the project, providing meeting announcements in newsletters. Representatives from the townships stayed connected to updates through email notification throughout the study, providing support and local knowledge.

B. Public Meeting April 7, 2010

On April 7, 2010, a public meeting was held at the Dauphin County Agriculture and Natural Resources Center to address project details. Two hundred meeting announcement flyers were created and mailed to parcel landowners located within a half mile of Clarks Creek, using GIS location query capabilities. An informal invitation was presented at the Middle Paxton Township supervisor's meeting proceeding the April meeting. Additionally, email notices circulated through local watershed organizations and the Doc Fritchey Chapter of Trout Unlimited. Flyers presented a basic background on the study, and provided the opportunity for attendees to voice their concerns for the water quality of the stream.

36 people were in attendance at the public meeting who supported the stream study and were willing to participate. Attendees signed up for an email list to be included in monitoring updates and future meetings. Much interest was voiced regarding water quality concerns in the watershed. Interests ranged from those residing along the stream to those who enjoy recreating in the forest and trails that are within the watershed. State Gamelands 211 provides opportunity for many outdoor activities involving, hiking, fishing, and hunting throughout a large piece of public land.

The following concerns were brought to light during the April meeting discussion:

-Storm drains discharging to Clarks Creek on Rt. 325
-Conservation Release requirement for Dehart Dam scheduled for permit renewal in 2012
-Timber harvest operations within Clarks Valley
-Wooly adelgid affecting streamside hemlocks
-An iron seep exists within the Clarks Creek watershed, along the Appalachian Trail. As the trail climbs Stony Mountain, after heading north from the valley, an iron seep spills out of the side of the mountain. A stone channel lines a pathway across the trail, eventually dispersing into soil down the side of the mountain before reaching the creek.

C. Formation of a Watershed Organization

Such interest in Clarks Creek presented the opportunity for a watershed organization to form following the April public meeting. Watershed organizations provide citizens with a shared interest in protecting the surrounding natural resources. Clarks Creek Watershed Preservation Association (CCWPA) is working to build a foundation from which to develop through growing interest and outreach. The group has met monthly and has become incorporated, developed by-laws, and chosen current board members throughout the past year. For more information on how to get involved in the watershed group, visit the website at www.ccwpa.org.

The mission of the Clarks Creek Watershed Preservation Association is to preserve, protect, and enhance the environmental integrity of Clarks Creek, and to advocate the conservation and sustainability of its natural resources while promoting restoration and safety within the watershed.

The CCWPA and DFTU share common interests in protecting the natural resources of Clarks Creek, and have been working together, partnering on events. One such event is the annual Ned Smith Festival, which took place on July 29-30th, 2011. The DCCD, CCWPA, and DFTU took part in educational outreach, supplying literature through brochures, reports, and fact sheets. The three organizations have worked together in guiding the formation of the CCWPA during early months. Additionally, CCWPA followed the lead of DFTU by adopting two miles of an adjacent section of Clarks Valley Rd, State Highway 325, through Penn DOT's Adopt-A-Highway program. Program participation requires 4 road cleanup events each year. CCWPA held spring and fall cleanups of its stretch of 325.

D. Additional Community Support

Group participation was shared between DFTU and CCWPA in volunteer monitoring opportunities. DFTU assisted stream monitoring events, on multiple occasions. Volunteers aided in macroinvertebrate collection, temperature measurements, and discharge measurements. DCCD also provided an opportunity for members of both groups to attend a stream monitoring training, in order to provide potential for volunteer monitoring committees within each group. The monitoring training was held on June 21, 2011.

Harrisburg Authority's DeHart Dam Supervisor, Dan Galbraith provided a tour of the property for CCWPA board members in Early June. The tour highlighted facts about the dam, its history, and efforts taken to ensure high quality drinking water. For example, the dam release is constant, never changing the amount of water that enters Clarks Creek from the bottom release outlet. The difference in stream level can be attributed to a number of factors. During high water events, reservoir water will spill over the top of the dam wall, adding to the amount of water discharging from the bottom release dam. Rain fall and groundwater entering the creek through mountainside drainage downstream of the reservoir also adds to seasonal differences in stream level. The differences can be seen seasonally, as well as yearly. For example during the study, the summer of 2010 was very dry, which left tributaries and groundwater entering Clarks Creek downstream of the reservoir drastically lower than the rest of the year. Alternately, the summer of 2011 wasn't nearly as dry, allowing tributaries and groundwater to supply the creek with sustainable amounts of water.

Additional outreach and participation involved an environmental science class from Harrisburg Area Community College (HACC). A three hour field demonstration of surface water monitoring methods and techniques took place on November 9, 2010. The group of twelve students was trained on In-Stream Comprehensive Evaluation (ICE) protocol followed during the Clarks Creek Coldwater Conservation stream study. This included macroinvertebrate collection and sub-sampling, discharge measurements, water sample collection and delivery methods, and field chemistry parameters.

VI. Study Results

A. Macroinvertebrate Site Results

Stream sampling in the assessment of Clarks Creek evaluated the aquatic macroinvertebrate communities present at seven sample sites shown in Figure 6 below in March 2011. As explained in Section IV. A., six different biological metrics were calculated for each sample. The metrics measure various factors and indicators, including the number of pollution tolerant and sensitive macroinvertebrates, diversity, and the percentage of the samples that are found to be sensitive of pollution. The metrics are then combined to create the overall Index of Biological Integrity (IBI) for each site. IBI scores range from 0 to 100, with a higher score indicating better stream health as depicted below in Table 6.

Figure 6: Map of Macroinvertebrate sampling sites

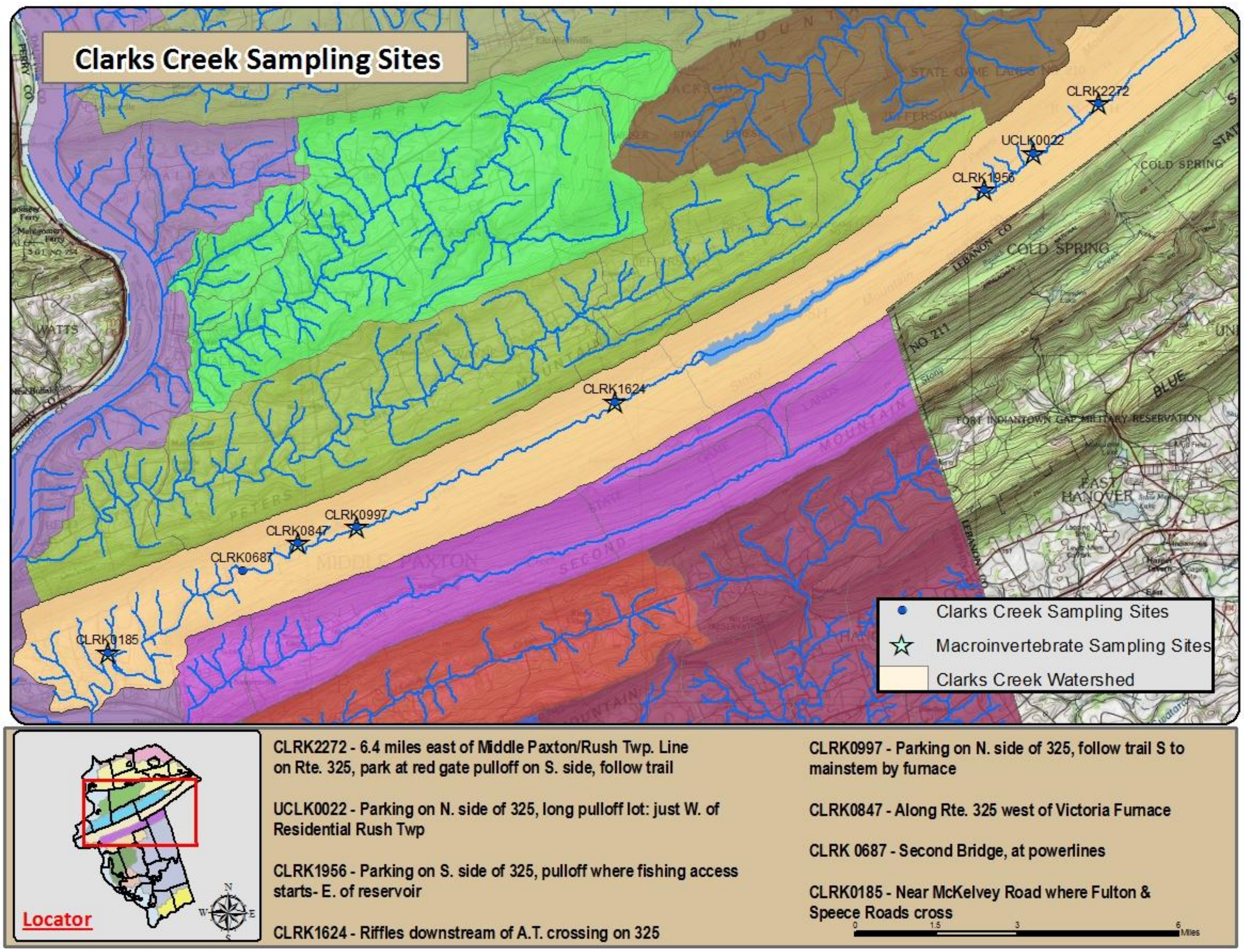


Table 6: Index of Biotic Integrity (IBI) range for health classifications

<u>Good</u> (63-100): Optimal site with a balanced community of pollution sensitive and tolerant organisms.

<u>Fair</u> (50-62): Significant decrease in pollution-sensitive species, unbalanced site with sub-optimal habitat.

<u>Poor</u> (0-49): Degraded site dominated by tolerant organisms. Site is not attaining aquatic life use.

Table 7 displays the IBI scores for the seven sites on Clarks Creek that were sampled for macroinvetebrates, along with the associated health classification and Figure 7 is a graph of the IBI scores. Site CLRK 22.72, in the headwaters of Clarks Creek, was found to have the lowest IBI score of 48.91434, while site CLRK 1956, just downstream of there had the highest score of 82.58701. Figure 8 shows the Shannon Diversity Index scores for each of the sites which, for the most part, correlate closely with the IBI scores. As you can see, site CLRK 22.72 has the lowest Shannon Diversity Index score, while site CLRK 1956 has the highest. Details of the macroinvertebrates found at each site and the IBI calculations can be found in Attachment I.

Table 7: Index of Biotic Integrity (IBI) scores for macroinvertebrate sampling sites on Clarks Creek

Site	IBI	Health
CLRK 0185	64.21422	Good
CLRK 0847	71.97111	Good
CLRK 0997	75.07085	Good
CLRK 1624	71.07419	Good
CLRK 1956	82.58701	Good
UCLK 0022	69.90802	Good
CLRK 2272	48.91434	Fair

Figure 7: Index of Biotic Integrity (IBI) scores for macroinvertebrate sampling sites on Clarks Creek

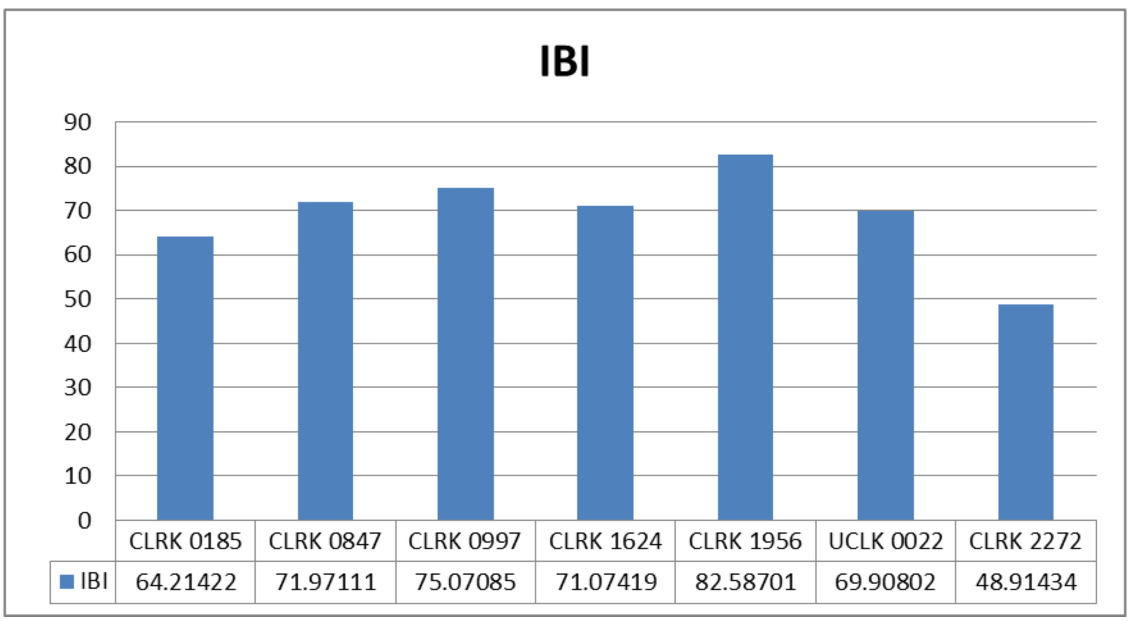
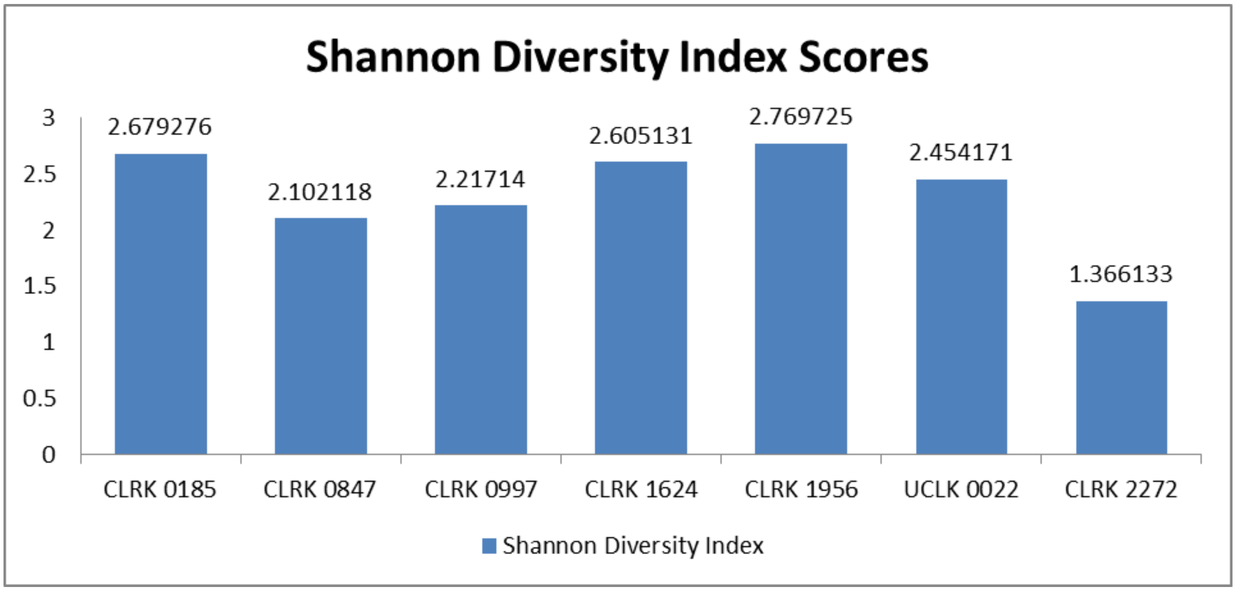


Figure 8: Shannon Diversity Index scores for macroinvertebrate sampling sites on Clarks Creek

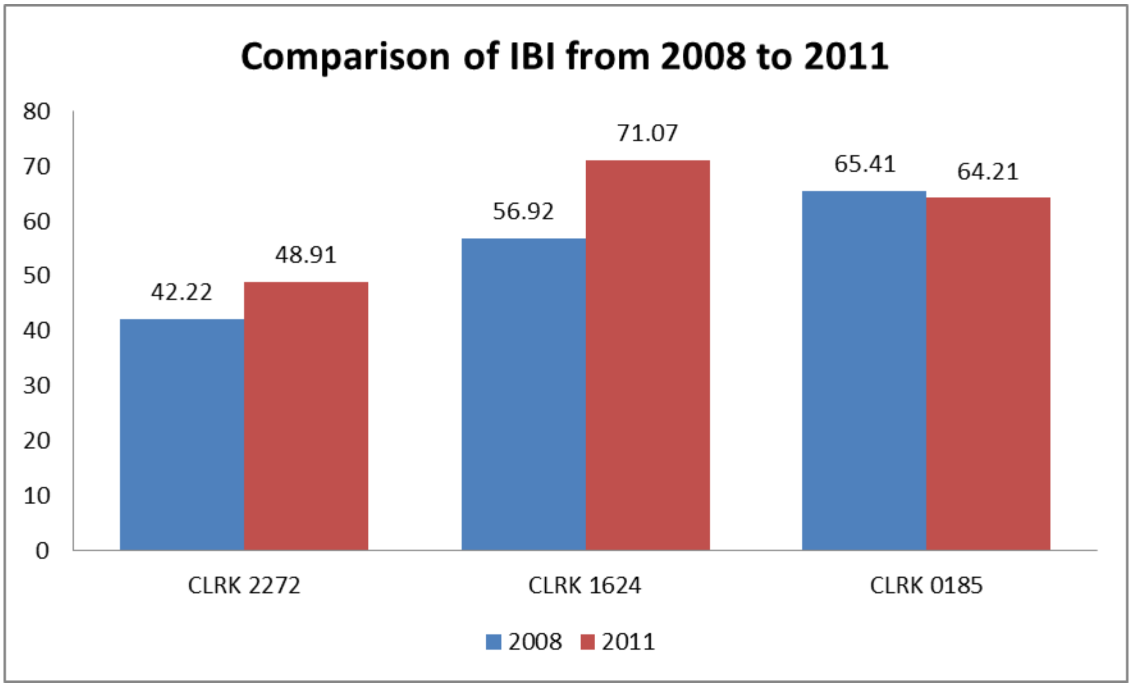


Flooding near site CLRK 0185 in early March 2011

Unfortunately, extreme flooding events occurred early-mid March, just before the collection of macroinvetebrate samples. This may have affected the aquatic community, and possibly sampling results. Three of the sites; CLRK 2272, CLRK 1624, and CLRK 0185; were sampled in 2008 by DCCD for the Countywide Stream Assessment Program. Figure 9 compares the IBI scores determined in 2008 to those calculated in this study. They are comparable at all three sites, with the greatest change occurring at site CLRK 1624, where the IBI score increased from 56.92 in 2008 to 71.07 in 2011.

It can be concluded from both studies that stream health conditions in the headwaters of Clarks Creek need improvement to support a healthy aquatic community. For DEP assessment purposes, an IBI score of equal to or greater than 80 is a benchmark for High Quality and Exceptional Value streams. The only site that qualified for that benchmark is site CLRK 1956. IBI scores at the other sites indicated good stream health; however, there is room for improvement.

Figure 9: IBI Scores from the 2008 CSAP compared to the 2011 Coldwater Conservation Plan



B. Habitat Assessments

Qualitative habitat assessments were performed on 100 meter stretches at each of the seven macroinvertebrate sites. These assessments take into account twelve parameters including the quality of streambanks, streambeds, and the surrounding land use. Each parameter is rated 0-20, with the scores of 16-20 indicating an optimal stream and 11-15 indicating a suboptimal stream. All seven habitat assessments scored very high, with all of the sites scoring in the highest category, or optimal. Site CLRK 0185, the furthest downstream site, had a slightly lower score due to some sediment deposition, minimal human impacts to the riparian zone, and some disruption of plant growth. Table 8, below, displays the scores of each parameter for every site.

Table 8: Habitat Assessment scores of sites on Clarks Creek

Habitat Parameter	CLRK 0185	CLRK 0847	CLRK 0997	CLRK 1624	CLRK 1956	UCLK 0022	CLRK 2272
Instream Cover	19	20	20	17	20	19	20
Epifaunal Substrate	16	20	20	19	19	20	20
Embeddedness	17	20	19	19	18	19	19
Volocity/Depth Regimes	18	20	20	19	20	18	20
Channel Alteration	19	20	20	18	20	19	20
Sediment Deposition	15	18	19	20	15	18	19
Frequency of Riffles	16	18	19	17	18	19	19
Channel Flow Status	17	19	20	19	17	20	20
Condition of Banks	16	19	18	17	17	20	18
Bank Vegetative Protection	19	19	20	19	20	20	20
Grazing or Other Disruptive Pressure	15	19	20	17	20	20	20
Riparian Vegetative Zone Width	13	19	20	12	20	20	20
Total	200	231	235	213	224	232	235

C. Field Chemistry

Water quality parameters including flow rates, temperature, conductivity, and dissolved oxygen were monitored at eight sampling sites. As shown in the table below, the pH at all of the sites was consistently between 6.4 and 7.1. Dissolved oxygen concentrations were all above 7.0 mg/L, which is the water quality standard for High Quality-Cold Water Fisheries as outlined in Ch. 93 of the Pennsylvania Code. Flow rates below the dam (sites CLRK 1624, CLRK 0997, CLRK 0847, CLRK 0687, and CLRK 0185) are controlled by the dam release. There is a required minimum conservation release of 6.5 million gallons per day, or 10.075 cfs. Temperature is discussed below in Section VI D.

Table 9: Water chemistry data from Clarks Creek

Site Code	Date	Flow (cfs)	T (°C)	pH	Conductivity (µS/cm)	DO (mg/L)
CLRK0185	6/4/2010	26				
	6/29/2010		20	7.1	48.8	7.04
	7/30/2010		20		66	7.06
	8/20/2010		19.6			8.51
	9/24/2010	15.23				
	3/17/2011	188				
CLRK0687	6/29/2010		18	6.9	38.5	7.6
	7/30/2010		18		31.9	9.07
	8/20/2010		18.6			7.62
CLRK0847	3/18/2010	160				
CLRK0997	6/29/2010	12.42	17	6.6	38	8.2
	7/30/2010		17		34.9	9.9
	8/20/2010		16.8			9.02
	11/15/2010	27.23	7.7	6.9	29.4	
CLRK1624	5/17/2010	23				
	6/7/2010	12.77				
	6/29/2010	12.79	14.8	6.4	27.6	9.4
	7/30/2010		12.5		27.9	11.9
	8/20/2010		12.7			10.46
	9/24/2010	10.77	14.7		30.8	9.4
	11/9/2010	27.29	8	7	31	11.2
	3/15/2011	169				
CLRK1956	7/30/2010		17.6		36.4	7.65
	8/20/2010		17.3			8.36
UCLK0022	7/30/2010		17.6		10.5	7.7
CLRK2272	6/4/2010	3.11				
	7/30/2010		17		30.5	8.5
	8/20/2010		16.6			7.9
	9/24/2010	0.59	15.7		31	8.06
	11/15/2010	2	7.5	6.8	28	11.3
	3/14/2011	55.69				

D. Summer Temperature/ D.O.

Below, Table 10 displays temperature and dissolved oxygen measurements that were taken during the summer months, June through August. Shown to the right of Table 10 is Table 11, an excerpt from the Water Quality Standards for High Quality – Cold Water Fisheries. As you can see, the temperature at site CLRK0185, near the mouth of the stream, was greater than 66° F, or the water quality standard. With the exception of the June sample at site CLRK0687, the other six sites that were sampled during the summer months had temperatures that were within the standards. The results show an increase of temperature through the watershed, until the reservoir. Below the dam, the temperature is lower. This is due to a conservation discharge of 10 cfs that Harrisburg Water Authority releases to maintain water quality in the stream. The stream then gradually warms until the mouth. The dissolved oxygen readings stayed above 7 mg/L, the water quality standard for HQ-CWF streams, throughout the summer.

Table 10: Clarks Creek summer monitoring data

Site Code	Date	T (°C)	T (°F)	DO (mg/L)
CLRK2272	7/30/2010	17	62.6	8.5
	8/20/2010	16.6	61.88	7.9
UNTC0030	7/30/2010	17.6	63.68	7.7
CLRK1956	7/30/2010	17.6	63.68	7.65
	8/20/2010	17.3	63.14	8.36
CLRK1624	6/29/2010	14.8	58.64	9.4
	7/30/2010	12.5	54.5	11.9
	8/20/2010	12.7	54.86	10.46
CLRK0997	6/29/2010	17	62.6	8.2
	7/30/2010	17	62.6	9.9
	8/20/2010	16.8	62.24	9.02
CLRK0687	6/29/2010	18	64.4	7.6
	7/30/2010	18	64.4	9.07
	8/20/2010	18.6	65.48	7.62
CLRK0185	6/29/2010	20	68	7.04
	7/30/2010	20	68	7.06
	8/20/2010	19.6	67.28	8.51

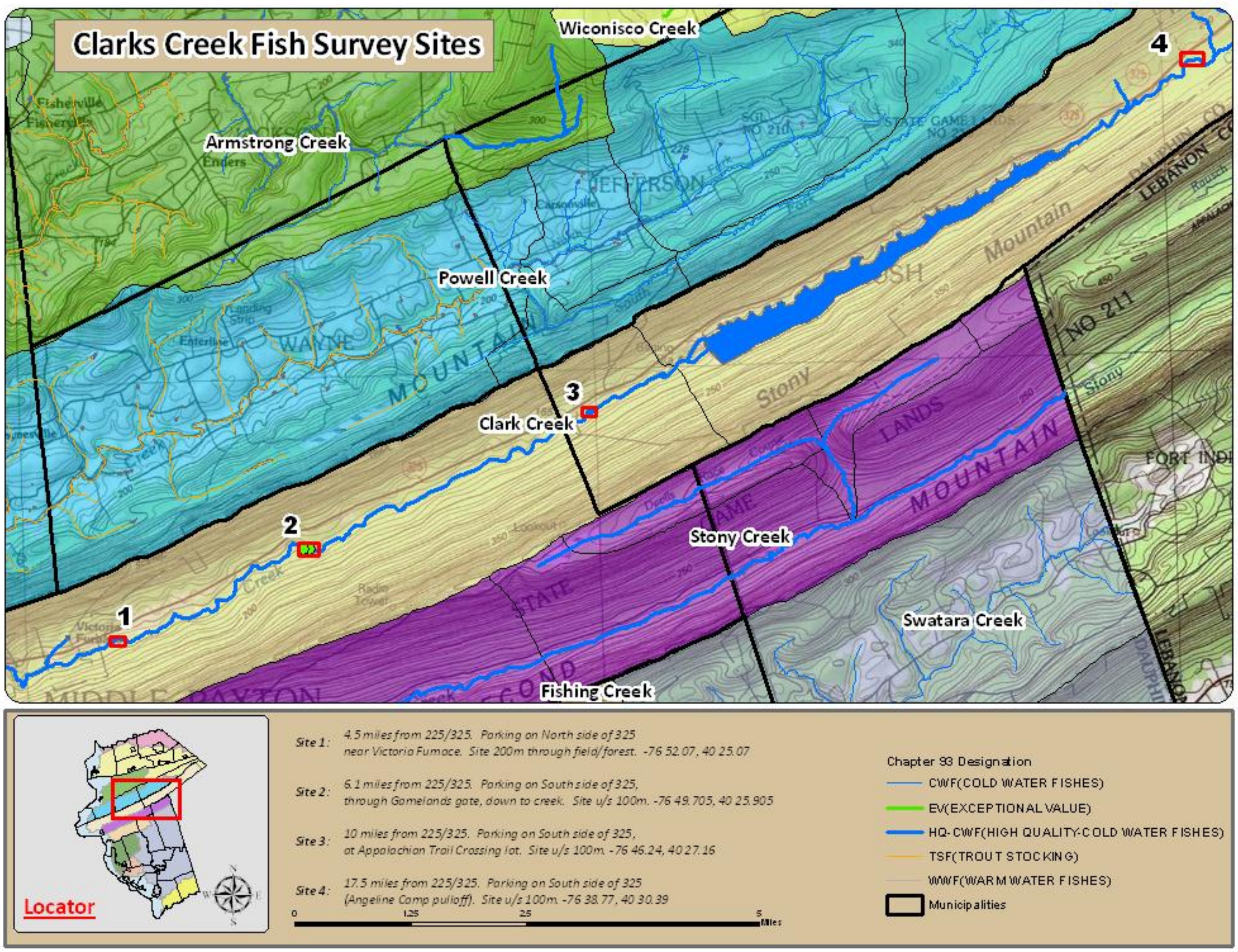
Table 11: Water Quality Standards as related to High Quality-Cold Water Fisheries. (25 Pa. Code § 93.4b).

SYMBOL: CRITICAL USE: PERIOD	*$TEMP_1$ CWF*
June 16-30	64
July 1-31	66
August 1-15	66
August 16-30	66

Clarks Creek monitoring site near confluence with Susquehanna in August 2010.

E. Fish Survey Results

Figure 10: Fish Survey Sites



Tables 12-15 below display results from the four sites where the fish surveys were conducted. There was a diversity at each site, with the most trout found at Sites 2 and 3. There were more brown trout than brook trout at all four sites. The reservoir most likely contributed to a high number of sunfish, especially at Sites 3 and 4.

Table 12: Results of fish survey at Site 1, Victoria Furnace

Fish	Count
Brown Trout	11
Brook Trout	2
Chain Pickerel	1
Cutlips minnow	1
Shield Darter	2
Longnose Dace	1
Blacknose Dace	11
Pumpkinseed Sunfish	4
Teselated Darter	1

Table 13: Results of fish survey at Site 2, Gamelands Gate

Fish	Count
Brown Trout	21
Brook Trout	6
Chain Pickerel	1
Cutlips minnow	3
Shield Darter	0
Longnose Dace	1
Blacknose Dace	3
Pumpkinseed Sunfish	8
Teselated Darter	3
Fall Fish	1
Bluegills	4
white sucker	11

Table 14: Results of fish survey at Site 3, Appalachian Trail crossing at Rte. 325

Fish	Count
Brown Trout	73
Brook Trout	6
Chain Pickerel	2
Cutlips minnow	0
Shield Darter	0
Longnose Dace	0
Blacknose Dace	0
Pumpkinseed Sunfish	13
Teselated Darter	0
Fall Fish	0
Green sunfish	35
Bluegill	35
white sucker	25
skull fish	1
largemouth bass	1
brown chute	2

Table 15: Results of fish survey at Site 4, Upstream of Reservoir – Angeline Camp

Fish	Count
Brown Trout	11
Brook Trout	1
Chain Pickerel	1
Cutlips minnow	0
Shield Darter	1
Longnose Dace	0
Blacknose Dace	0
Pumpkinseed Sunfish	69
Teselated Darter	5
Fall Fish	0
Green Sunfish	79
Bluegill	80
white sucker	3
skull fish	0
largemouth bass	0
brown chute	0
Brown Bullhead Catfish	8


Native brown trout, pictured above, that were found during the fish survey of Clarks Creek

F. Storm Event Analysis

After a late November storm event in 2010, water chemistry was monitored at the sampling site that is nearest to the mouth of the stream. As shown in Table 16, the water quality was still good despite the high water. Nutrient levels are low and turbidity is not very high either. The natural surroundings in the Clarks Creek watershed filter and buffer pollutants, so water conditions are good even in high water events.

Table 16: Storm Event Monitoring Results at Site CLRK 0185

Site Code	Date	T (°C)	Conductivity (µS/cm)	DO (mg/L)	Tubidity (FTU)	Nitrate-N (mg/L)	Orthophosphate (mg/L)
CLRK0185	**12/1/2010**	**8**	**65**	**11**	**31.7**	**0.5**	**0**

Clarks Creek monitoring site near confluence with Susquehanna in November 2010.

VII. Context of Results

When evaluating data derived from macroinvertebrate samples, it is critical that the information be considered carefully. It is important to understand what the data is and what it is not. It is a general indicator of stream health. It is not evidence of a specific pollutant or source of pollutants. It is also important to consider the data in conjunction with other known information regarding the stream and its watershed. Are there chemical test results available for the site? What are the land uses and activities occurring in the watershed? Is there significant stream channel erosion in the stream itself? The value of the data should not be overstated, nor should it be understated. The following points should be kept in mind when considering the results of the macroinvertebrate sampling done for this project.

1. Macroinvertebrate samples can give us an idea of the general health of a stream. While the data does indicate the conditions present at the sample site the specific causes of any degradation that manifest themselves in the macroinvertebrate sample are more difficult to determine and will require additional information.

2. The results of the sample are valid for the site itself and may not reflect the conditions throughout the watershed. This is particularly true for sites upstream and downstream of the reservoir.

3. The data collected is the first sample data in an ongoing Countywide Stream Assessment Program conducted by the Conservation District. As we accumulate more data, the picture of stream quality will become increasingly clear.

4. The data collected can be used to guide future data collection needs in order to gain better understanding of watershed conditions and sources of impacts.

5. The data collected now and in the future can be used to guide decisions on how and where to expend resources for stream habitat improvements.

6. The information and data in this report are intended to increase public understanding of stream health in Clarks Creek watershed. It is hoped that this Coldwater Conservation Plan can help stimulate active citizens, organizations, and Municipalities within the watershed in stream protection and restoration efforts

VIII. Future Protection and Recommendations

In order to improve aquatic habitat, it would be helpful to conduct fish habitat improvement projects, such as installing log vanes or deflectors. This would be especially beneficial in the headwaters of Clarks Creek, where the macroinvertebrate sample had the lowest IBI. Another possible benefit of these structures is to stabilize the streambanks and reduce sedimentation in the stream, which was identified as a concern in the habitat assessments at a couple of the sampling sites.

Developed areas, including residential areas and land used for agricultural purposes, contribute to nonpoint source pollution due to increased runoff. In developed area, there is often less vegetation to hold the soil in place and to filter out pollutants from the runoff which carries pollutants and sediment into Clarks Creek. Stormwater runoff increases from impervious surfaces, such as roofs, driveways, parking lots, and roads. Runoff from properties that are not adjacent to the stream are still a concern since runoff from these areas is captured by storm sewer systems which deliver pollutants to local streams.

There are a number of actions that can be taken to capture, filter, and infiltrate stormwater so that it does not degrade Clarks Creek. Depending upon the site, best management practices (BMPs) to control stormwater can be relatively low cost and easy to implement. Some BMPs are non-structural, in which land owners avoid using impervious surface where possible. Non-structural BMP's can be incorporated into future development by proper planning to minimize the footprint of development; utilize natural features, such as forests, to help control stormwater; and to leave open space. Landowners can also use structural BMPs to retrofit existing structures or incorporate them into new development. Examples of structural BMPs include infiltration basins, vegetated swales, and infiltration trenches. Rain gardens, or planted depressions, can be a very attractive way to capture and filter or infiltrate runoff from driveways, roofs, walks, patios and other impervious surfaces. Rain gardens are relatively inexpensive and can be designed to fit in almost any site. When constructing driveways, patios, sidewalks or other areas, porous pavers can be used to allow infiltration. Disconnect downspouts from storm sewer systems, gutters or roads. Allowing the downspout to drain over vegetated areas such as lawns or to rain gardens will promote infiltration of storm water. This reduces the volume of runoff entering streams.

It is important to establish and maintain riparian buffers along Clarks Creek and tributaries by planting trees and shrubs and by removing invasive species. Vegetation helps to stabilize the bank, preventing erosion, and help to filter pollutants and sediment from runoff from nearby farm fields, lawns, parking lots, and other land uses. This will not only help reduce sediment in streams, but will also keep property from eroding away by the stream and help to keep water temperatures cooler, thus more suitable for aquatic life.

There are many other ways for homeowners in the Clarks Creek watershed to reduce water pollution. Excessive nutrients applied to lawns or landscaped areas can be washed into streams. Directions should be followed carefully when applying fertilizers and pesticides and consideration should be given to possibly eliminating or reducing the use of chemicals on lawns. Eliminating or minimizing fertilizer and pesticide use will reduce pollution to streams and save money. Pet wastes should not be disposed of in or near streams and care should be taken with yard, auto and other chemicals used outside. These substances should never be dumped in streams, storm sewers or on the ground. Malfunctioning septic systems can contribute nutrients to groundwater and streams. Septic systems should be maintained by having it pumped out regularly. Also, chemicals and pharmaceuticals should never be flushed down toilets or dumped into

Porous pavers, like these installed at the Dauphin County Agriculture and Natural Resource Center, allow rain to infiltrate into the ground, instead of becoming runoff.

septic systems. These can damage the functioning of the system or end up in groundwater. Regular maintenance can eliminate the need for costly repairs. Wash your car on grassed areas to prevent detergents and other cleaners from entering streams or storm sewers. An alternative is to use a commercial car wash that recycles wash water.

In developing areas of the watershed, it is important to keep in mind natural stream and water resource conditions when evaluating the environmental consequences of land use. The need for housing, farming, roads, and economic development should be balanced with the need to protect water resources. By implementing sound stormwater management planning mechanisms in development, both the adverse impacts of development and the need for costly retrofit projects can be minimized.

The rain garden helps to infiltrate and control stormwater

IX. <u>Conclusion</u>

Thousands of people visit and recreate in the Clarks Creek Watershed each year. The stream is widely known as an excellent habit for trout and other aquatic organisms. The health of Clarks Creek is due to its forested and protected watershed that provides vital benefits of stream cover, erosion control, supply of nutrients, and much more. As development pressure increases, it is important to protect the Clarks Creek Watershed so that the stream can continue to be a thriving, healthy ecosystem and fishery.

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Attachments

Attachment I. Clarks Creek Coldwater Conservation Plan Macroinvertebrate Sampling Data, 2011

Sample ID:	CLRK 01.85
Collection Date:	3/17/2011
Collector(s):	MRY
Subsample Target:	200+/-20%
Subsample Size:	153
% of Sample Picked:	100.0%
Subsample Date:	5/6/2011
Subsampled By:	MRY
ID Date:	1/17/2012
Taxonomist:	EAN
Notes:	

Metrics	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**
HBI=	4.68	0.656012508	0.65601251
Total Taxa =	28	0.848484848	0.84848485
Becks 3=	15	0.394736842	0.39473684
Shannon Div=	2.679276197	0.936809859	0.93680986
EPT Taxa (0-4)=	13	0.684210526	0.68421053
%PTV (0-3)=	28.10457516	0.332598523	0.33259852
	IBI		64.2142184

EPT breakdown	**Individuals**	**Taxa types (count)**
0	2	1
1	14	3
2	8	3
3	13	5
4	4	1
5	1	1
6	16	1

Becks & %PTV	**Individual**	**Taxa types**
0	2	1
1	15	4
2	9	4
3	17	6

Order (or higher)	**Family**	**Genus**	**Lifestage**	**Count**	**PTV**	**Hils Mult**
Coleoptera-beetles						
Coleoptera	Elmidae	*Optioservus*	L	5	4	20
Coleoptera	Elmidae	*Optioservus*	A	1	4	4
Coleoptera	Elmidae	*Oulimnius*	L	1	5	5
Coleoptera	Elmidae	*Promoresia*	L	1	2	2
Coleoptera	Elmidae	*Stenelmis*	A	1	5	5
Coleoptera	Psephenidae	*Psephenus*	L	5	4	20
Diptera (True Flies)						0
Diptera	Chironomidae		L	31	6	186
Diptera	Empididae	*Clinocera*	L	3	6	18
Diptera	Simuliidae	*Prosimulium*	L	32	5	160
Diptera	Tipulidae	*Antocha*	L	4	3	12
Ephem. (Mayflies)						0
Ephemeroptera	Ephemerellidae	*Drunella*	L	5	1	5
Ephemeroptera	Ephemerellidae	*Ephemerella*	L	6	1	6
Ephemeroptera	Ephemerellidae		L	3	1	3
Ephemeroptera	Ephemeridae	*Ephemera*		1	2	2
Ephemeroptera	Heptageniidae	*Stenonema*	L	3	3	9
Ephemeroptera	Isonychiidae	*Isonychia*	L	2	3	6
Megaloptera Dobsonfly						0
Megaloptera	Corydalidae	*Nigronia*	L	1	1	1
Oligochaeta			A	9	10	90
Plecoptera (Stonefly)						0

Plecoptera	Capniidae	*Allocapnia*	L	1	3	3
Plecoptera	Nemouridae	*Ostrocerca*		6	2	12
Plecoptera	Perlodidae	*Isoperla*	L	1	2	2
Plecoptera	Taeniopterygidae	*Strophopteryx*		3	3	9
Trichoptera-Caddisfly						0
Trichoptera	Glossosomatidae	*Glossosoma*	L	2	0	0
Trichoptera	Hydropsychidae	*Cheumatopsyche*	L	16	6	96
Trichoptera	Hydropsychidae	*Hydropsyche*	L	1	5	5
Trichoptera	Philopotamidae	*Chimarra*	L	4	4	16
Trichoptera	Polycentropodidae	*Neureclipsis*		1	7	7
Trichoptera	Uenoidae	*Neophylax*	L	4	3	12
				Total:		
				153		

Sample ID: CLRK 08.47

Collection Date: 3/18/2011
Collector(s): MRY
Subsample Target: 200+/-20%
Subsample Size: 177
% of Sample Picked: 3.1%
Subsample Date: 5/19/2011
Subsampled By: MRY
ID Date: 1/11/2012
Taxonomist: EAN
Notes:

Metrics	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**
HBI=	3.80	0.764906268	0.76490627
Total Taxa =	29	0.878787879	0.87878788
Becks 3=	29	0.763157895	0.76315789
Shannon Div=	2.102117727	0.735006198	0.7350062
EPT Taxa (0-4)=	16	0.842105263	0.84210526
%PTV (0-3)=	28.24858757	0.334302811	0.33430281
	IBI		71.9711052

EPT breakdown	**Individuals**	**Taxa types (count)**
0	23	5
1	16	5
2	1	1
3	3	2
4	13	3
5	3	1
6	0	0

Becks & %PTV	**Individual**	**Taxa types**
0	23	5
1	18	6
2	5	2
3	4	3

Order (or higher)	**Family**	**Genus**	**Lifestage**	**Count**	**PTV**	**Hils Mult**
Coleoptera-beetles						
Coleoptera	Elmidae	*Dubiraphia*	L	1	6	6
Coleoptera	Elmidae	*Optioservus*	L	1	4	4
Coleoptera	Elmidae	*Promoresia*	L	4	2	8
Coleoptera	Psephenidae	*Psephenus*	L	1	4	4
Diptera (True Flies)						0
Diptera	Chironomidae		L	15	6	90
Diptera	Simuliidae	*Prosimulium*	L	89	5	445
Diptera	Tipulidae	*Antocha*	L	1	3	3
Diptera	Tipulidae	*Limonia*		1	6	6
Ephem. (Mayflies)						0
Ephemeroptera	Ephemerellidae	*Drunella*	L	1	1	1

Ephemeroptera	Ephemerellidae	*Ephemerella*	L	8	1	8
Ephemeroptera	Ephemerellidae	*Eurylophella*	L	10	4	40
Ephemeroptera	Heptageniidae	*Epeorus*	L	14	0	0
Ephemeroptera	Heptageniidae	*Maccaffertium*		1		0
Ephemeroptera	Heptageniidae	*Stenonema*	L	2	3	6
Ephemeroptera	Heptageniidae		L	2	4	8
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*		2	1	2
Megaloptera Dobsonfly						0
Megaloptera	Corydalidae	*Nigronia*	L	2	1	2
Oligochaeta			A	1	10	10
Plecoptera (Stonefly)						0
Plecoptera	Capniidae			2	1	2
Plecoptera	Chloroperlidae	*Alloperla*		4	0	0
Plecoptera	Nemouridae	*Ostrocerca*		1	2	2
Plecoptera	Perlidae	*Acroneuria*	L	2	0	0
Plecoptera	Taeniopterygidae	*Oemopteryx*		1		0
Trichoptera-Caddisfly						0
Trichoptera	Hydropsychidae	*Diplectrona*	L	1	0	0
Trichoptera	Hydropsychidae	*Hydropsyche*	L	3	5	15
Trichoptera	Philopotamidae	*Chimarra*	L	1	4	4
Trichoptera	Philopotamidae	*Dolophilodes*	L	2	0	0
Trichoptera	Rhyacophilidae	*Rhyacophila*	L	3	1	3
Trichoptera	Uenoidae	*Neophylax*	L	1	3	3
				Total:		
				177		

Sample ID:	CLRK 09.97			
Collection Date:	3/15/2011			
Collector(s):	MRY			
Subsample Target:	200+/-20%			
Subsample Size:	177			
% of Sample Picked:	14.2%			
Subsample Date:	11/22/2011			
Subsampled By:	EAN			
ID Date:	12/12/2011			
Taxonomist:	EAN			
Notes:				

Metrics	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**
HBI=	2.79	0.888907466	0.88890747
Total Taxa =	25	0.757575758	0.75757576
Becks 3=	25	0.657894737	0.65789474
Shannon Div=	2.217140486	0.775223946	0.77522395
EPT Taxa (0-4)=	15	0.789473684	0.78947368
%PTV (0-3)=	53.67231638	0.635175342	0.63517534
	IBI		75.0708489

EPT breakdown	**Individuals**	**Taxa types (Count)**
0	25	4
1	48	4
2	3	3
3	3	3
4	1	1
5	2	1
6	7	2

Becks & %PTV	**Individual**	**Taxa types**
0	25	4
1	48	4
2	19	5
3	3	3

Order (or higher)	**Family**	**Genus**	**Lifestage**	**Count**	**PTV**	**Hils Mult**
Coleoptera-beetles						

Coleoptera	Elmidae	*Optioservus*	L	2	4	8
Coleoptera	Elmidae	*Promoresia*	L	15	2	30
Coleoptera	Elmidae	*Stenelmis*	A	1	5	5
Diptera (True Flies)						0
Diptera	Chironomidae		L	10	6	60
Diptera	Simuliidae	*Prosimulium*	L	54	5	270
Diptera	Tipulidae	*Hexatoma*	L	1	2	2
Ephem. (Mayflies)						0
Ephemeroptera	Baetidae	*Baetis*	L	1	6	6
Ephemeroptera	Ephemerellidae	*Ephemerella*	L	43	1	43
Ephemeroptera	Heptageniidae	*Epeorus*	L	18	0	0
Ephemeroptera	Heptageniidae	*Maccaffertium*		5		0
Ephemeroptera	Heptageniidae		L	1	4	4
Ephemeroptera	Isonychiidae	*Isonychia*	L	1	3	3
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*		2	1	2
Plecoptera (Stonefly)						0
Plecoptera	Chloroperlidae	*Alloperla*		1	0	0
Plecoptera	Perlidae	*Acroneuria*	L	3	0	0
Plecoptera	Perlidae		L	1	1	1
Plecoptera	Perlodidae	*Isoperla*	L	1	2	2
Plecoptera	Perlodidae		L	1	2	2
Plecoptera	Taeniopterygidae	*Strophopteryx*		1	3	3
Trichoptera-Caddisfly						0
Trichoptera	Brachycentridae	*Micrasema*	L	1	2	2
Trichoptera	Hydropsychidae	*Cheumatopsyche*	L	6	6	36
Trichoptera	Hydropsychidae	*Hydropsyche*	L	2	5	10
Trichoptera	Philopotamidae	*Dolophilodes*	L	3	0	0
Trichoptera	Rhyacophilidae	*Rhyacophila*	L	2	1	2
Trichoptera	Uenoidae	*Neophylax*	L	1	3	3
				Total:		
				177		

Sample ID:	CLRK 16.24
Collection Date:	3/15/2011
Collector(s):	MRY
Subsample Target:	200+/-20%
Subsample Size:	134
% of Sample Picked:	10.7%
Subsample Date:	8/19/2011
Subsampled By:	MRY
ID Date:	1/11/2012
Taxonomist:	EAN
Notes:	

Metrics	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**
HBI=	3.54	0.796878738	0.79687874
Total Taxa =	22	0.666666667	0.66666667
Becks 3=	23	0.605263158	0.60526316
Shannon Div=	2.605130814	0.9108849	0.9108849
EPT Taxa (0-4)=	13	0.684210526	0.68421053
%PTV (0-3)=	50.74626866	0.600547558	0.60054756
	IBI		71.0741925

EPT breakdown	**Individuals**	**Taxa types (Count)**
0	24	4
1	19	4
2	1	1
3	6	3

Becks & %PTV	**Individual**	**Taxa types**
0	24	4
1	19	4

4	1	1		2	19	3
5	5	1		3	6	3
6	12	2				

Order (or higher)	Family	Genus	Lifestage	Count	PTV	Hils Mult
Coleoptera-beetles						
Coleoptera	Elmidae	*Optioservus*	L	2	4	8
Coleoptera	Elmidae	*Promoresia*	L	15	2	30
Coleoptera	Elmidae	*Promoresia*	A	3	2	6
Diptera (True Flies)						0
Diptera	Chironomidae		L	20	6	120
Diptera	Simuliidae	*Prosimulium*	L	18	5	90
Ephem. (Mayflies)						0
Ephemeroptera	Baetidae	*Baetis*	L	10	6	60
Ephemeroptera	Ephemerellidae	*Ephemerella*	L	14	1	14
Ephemeroptera	Ephemerellidae	*Eurylophella*	L	1	4	4
Ephemeroptera	Heptageniidae	*Epeorus*	L	4	0	0
Ephemeroptera	Heptageniidae	*Stenonema*	L	4	3	12
Oligochaeta			A	8	10	80
Plecoptera (Stonefly)						0
Plecoptera	Chloroperlidae	*Alloperla*		17	0	0
Plecoptera	Nemouridae	*Nemoura*		1	1	1
Plecoptera	Pteronarcyidae	*Pteronarcys*	L	1	0	0
Plecoptera	Taeniopterygidae	*Strophopteryx*		1	3	3
Trichoptera-Caddisfly						0
Trichoptera	Brachycentridae	*Micrasema*	L	1	2	2
Trichoptera	Hydropsychidae	*Cheumatopsyche*	L	2	6	12
Trichoptera	Hydropsychidae	*Hydropsyche*	L	5	5	25
Trichoptera	Lepidostomatidae	*Lepidostoma*	L	1	1	1
Trichoptera	Philopotamidae	*Dolophilodes*	L	2	0	0
Trichoptera	Rhyacophilidae	*Rhyacophila*	L	3	1	3
Trichoptera	Uenoidae	*Neophylax*	L	1	3	3
				Total:		
				134		

Sample ID: CLRK 19.56
Collection Date: 3/14/2011
Collector(s): MRY
Subsample Target: 200+/-20%
Subsample Size: 104
% of Sample Picked: 100.0%
Subsample Date: 10/28/2011
Subsampled By: EAN
ID Date: 1/12/2012
Taxonomist: EAN
Notes:

Metrics	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**
HBI=	2.92	0.872616902	0.8726169
Total Taxa =	29	0.878787879	0.87878788
Becks 3=	33	0.868421053	0.86842105
Shannon Div=	2.769724903	0.968435281	0.96843528
EPT Taxa (0-4)=	13	0.684210526	0.68421053
%PTV (0-3)=	57.69230769	0.682749203	0.6827492
	IBI		82.5870141

Becks & %PTV	**Individual**	**Taxa types**
0	10	5
1	28	6
2	21	6
3	1	1

EPT breakdown	**individuals**	**Taxa types**

0	10	5
1	23	4
2	6	3
3	1	1
4	0	0
5	0	0
6	1	1

Order (or higher)	Family	Genus	Lifestage	Count	PTV	Hils Mult
Coleoptera-beetles						
Coleoptera	Elmidae	*Optioservus*	L	1	4	4
Coleoptera	Elmidae	*Oulimnius*	L	3	5	15
Coleoptera	Elmidae	*Promoresia*	L	11	2	22
Coleoptera	Elmidae	*Promoresia*	A	1	2	2
Coleoptera	Ptilodactylidae	*Anchytarsus*	L	1	5	5
Coleoptera	Scritidae	*Scirtes*		1	8	8
Diptera (True Flies)						0
Diptera	Chironomidae		L	8	6	48
Diptera	Simuliidae	*Prosimulium*	L	25	5	125
Diptera	Simuliidae			1	6	6
Diptera	Tipulidae	*Hexatoma*	L	3	2	6
Diptera	Tipulidae	*Tipula*	L	1	4	4
Ephem. (Mayflies)						0
Ephemeroptera	Ephemerellidae	*Ephemerella*	L	13	1	13
Ephemeroptera	Heptageniidae	*Epeorus*	L	2	0	0
Ephemeroptera	Heptageniidae	*Stenonema*	L	1	3	3
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*		3	1	3
Megaloptera Dobsonfly						0
Megaloptera	Corydalidae	*Nigronia*	L	4	1	4
Odonata Dragon/damsel						0
Odonata	Gomphidae			1	1	1
Oligochaeta			A	1	10	10
Plecoptera (Stonefly)						0
Plecoptera	Chloroperlidae	*Alloperla*		4	0	0
Plecoptera	Chloroperlidae			4	1	4
Plecoptera	Nemouridae		L	1	2	2
Plecoptera	Perlidae	*Acroneuria*	L	1	0	0
Plecoptera	Pteronarcyidae	*Pteronarcys*	L	2	0	0
Plecoptera	Taeniopterygidae	*Taenionema*		1		0
Trichoptera-Caddisfly						0
Trichoptera	Brachycentridae	*Micrasema*	L	4	2	8
Trichoptera	Hydropsychidae	*Cheumatopsyche*	L	1	6	6
Trichoptera	Limnephilidae	*Hydatophylax*		1	2	2
Trichoptera	Odontoceridae	*Psilotreta*	L	1	0	0
Trichoptera	Rhyacophilidae	*Rhyacophila*	L	3	1	3
				Total:		
				104		

Sample ID:	UCLK 00.22	**Metrics**	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**

Collection Date:	3/14/2011
Collector(s):	MRY
Subsample Target:	200+/-20%
Subsample Size:	164
% of Sample Picked:	
Subsample Date:	6/11/2011 & 6/13/2011
Subsampled By:	MRY
ID Date:	1/23/2012
Taxonomist:	EAN
Notes:	

HBI=	3.18	0.84132808	0.84132808
Total Taxa =	25	0.757575758	0.75757576
Becks 3=	20	0.526315789	0.52631579
Shannon Div=	2.454170649	0.858101626	0.85810163
EPT Taxa (0-4)=	9	0.473684211	0.47368421
%PTV (0-3)=	59.75609756	0.707172752	0.70717275
	IBI		69.4029703

Other Metrics	
EPT Taxa (0-6)	11
EPT % <6	53.65853659

EPT breakdown	**Individuals**	**Taxa types (count)**
0	3	2
1	67	4
2	1	1
3	15	2
4	0	0
5	0	0
6	2	2

Becks & %PTV	**Individual**	**Taxa types**
0	3	2
1	68	5
2	8	4
3	19	4

Order (or higher)	**Family**	**Genus**	**Lifestage**	**Count**	**PTV**	**Hils Mult**
Coleoptera-beetles						
Coleoptera	Elmidae	*Optioservus*	L	3	4	12
Coleoptera	Elmidae	*Oulimnius*	L	5	5	25
Coleoptera	Elmidae	*Promoresia*	L	3	2	6
Coleoptera	Elmidae	*Promoresia*	A	1	2	2
Diptera (True Flies)						
Diptera	Ceratopogonidae	*Probezzia*		1	6	6
Diptera	Chironomidae		L	31	6	186
Diptera	Simuliidae	*Prosimulium*	L	18	5	90
Diptera	Tipulidae	*Dicranota*	L	3	3	9
Diptera	Tipulidae	*Hexatoma*	L	3	2	6
Diptera	Tipulidae		L	1	3	3
Ephem. (Mayflies)						0
Ephemeroptera	Baetidae	*Pseudocloeon*		1	6	6
Ephemeroptera	Ephemerellidae	*Ephemerella*	L	41	1	41
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*		19	1	19
Hemiptera (true bugs)						0
Isopoda	Asellidae	*Caecidotea*		2	6	12
Megaloptera Dobsonfly						0
Odonata Dragon/damsel						0
Odonata	Gomphidae			1	1	1
Oligochaeta			A	3	10	30
Plecoptera (Stonefly)						0
Plecoptera	Capniidae			4	1	4
Plecoptera	Chloroperlidae	*Alloperla*		1	0	0
Plecoptera	Nemouridae	*Amphinemura*	L	10	3	30
Plecoptera	Perlodidae	*Isoperla*	L	1	2	2

Trichoptera	Hydropsychidae	*Cheumatopsyche*	L	1	6	6
Trichoptera	Hydropsychidae	*Diplectrona*	L	2	0	0
Trichoptera	Polycentropodidae	*Neureclipsis*		1	7	7
Trichoptera	Rhyacophilidae	*Rhyacophila*	L	3	1	3
Trichoptera	Uenoidae	*Neophylax*	L	5	3	15
				Total:		
				164		

Sample ID:	CLRK 22.72
Collection Date:	3/14/2011
Collector(s):	MRY
Subsample Target:	200+/-20%
Subsample Size:	157
% of Sample Picked:	100.0%
Subsample Date:	12/2/2011
Subsampled By:	EAN
ID Date:	12/2/2011
Taxonomist:	EAN
Notes:	

Metrics	**OB** (observed value)	**SV** (Standardized value)	**CorrectSV**
HBI=	4.38	0.692704611	0.69270461
Total Taxa =	20	0.606060606	0.60606061
Becks 3=	16	0.421052632	0.42105263
Shannon Div=	1.366132696	0.477668775	0.47766877
EPT Taxa (0-4)=	10	0.526315789	0.52631579
%PTV (0-3)=	17.8343949	0.211057928	0.21105793
	IBI		48.914339

Other Metrics	
EPT Taxa (0-6)	11
EPT % <6	18.47133758

EPT breakdown	**Individuals**	**Taxa types (Count)**
0	3	2
1	19	3
2	3	3
3	1	1
4	2	1
5	0	0
6	1	1

Becks & %PTV	**Individual**	**Taxa types**
0	3	2
1	19	3
2	4	4
3	2	2

Order (or higher)	**Family**	**Genus**	**Lifestage**	**Count**	**PTV**	**Hils Mult**
Coleoptera-beetles						
Coleoptera	Elmidae	*Promoresia*	L	1	2	2
Diptera (True Flies)						0
Diptera	Chironomidae		L	10	6	60
Diptera	Simuliidae	*Prosimulium*	L	109	5	545
Diptera	Tipulidae	*Antocha*	L	1	3	3
Diptera	Tipulidae	*Pedicia*		2	4	8
Ephem. (Mayflies)						0
Ephemeroptera	Baetidae	*Acerpenna*		1	6	6
Ephemeroptera	Ephemerellidae	*Ephemerella*	L	10	1	10
Ephemeroptera	Ephemerellidae	*Eurylophella*	L	2	4	8
Ephemeroptera	Heptageniidae	*Maccaffertium*		1		0
Ephemeroptera	Leptophlebiidae		L	1	2	2
Oligochaeta			A	2	10	20
Plecoptera (Stonefly)						0
Plecoptera	Capniidae	*Paracapnia*		2	1	2

Plecoptera	Peltoperlidae	*Tallaperla*	L	2	0	0
Plecoptera	Perlodidae	*Isoperla*	L	1	2	2
Plecoptera	Taeniopterygidae	*Taenionema*		2		0
Trichoptera-Caddisfly						0
Trichoptera	Brachycentridae	*Micrasema*	L	1	2	2
Trichoptera	Hydropsychidae	*Diplectrona*	L	1	0	0
Trichoptera	Rhyacophilidae	*Rhyacophila*	L	7	1	7
Trichoptera	Uenoidae	*Neophylax*	L	1	3	3
Other Non-insects						0
Sphaeriidae				1	8	8
				Total:		
				157		

Attachment II. PA Fish and Boat Commission Data

Table 1. Site species collection matrix from Clarks Creek Sub-SubBasin 07C. Data collected within 2008 survey year.
Column Headings Legend:
1- Section 2 Rivermile 27.49 Site Date 3/11/2008 SiteLatLon 403119763655
2- Section 2 Rivermile 24.19 Site Date 3/11/2008 SiteLatLon 403009763910
3- Section 2 Rivermile 27.49 Site Date 3/1/2008 SiteLatLon 403119763655

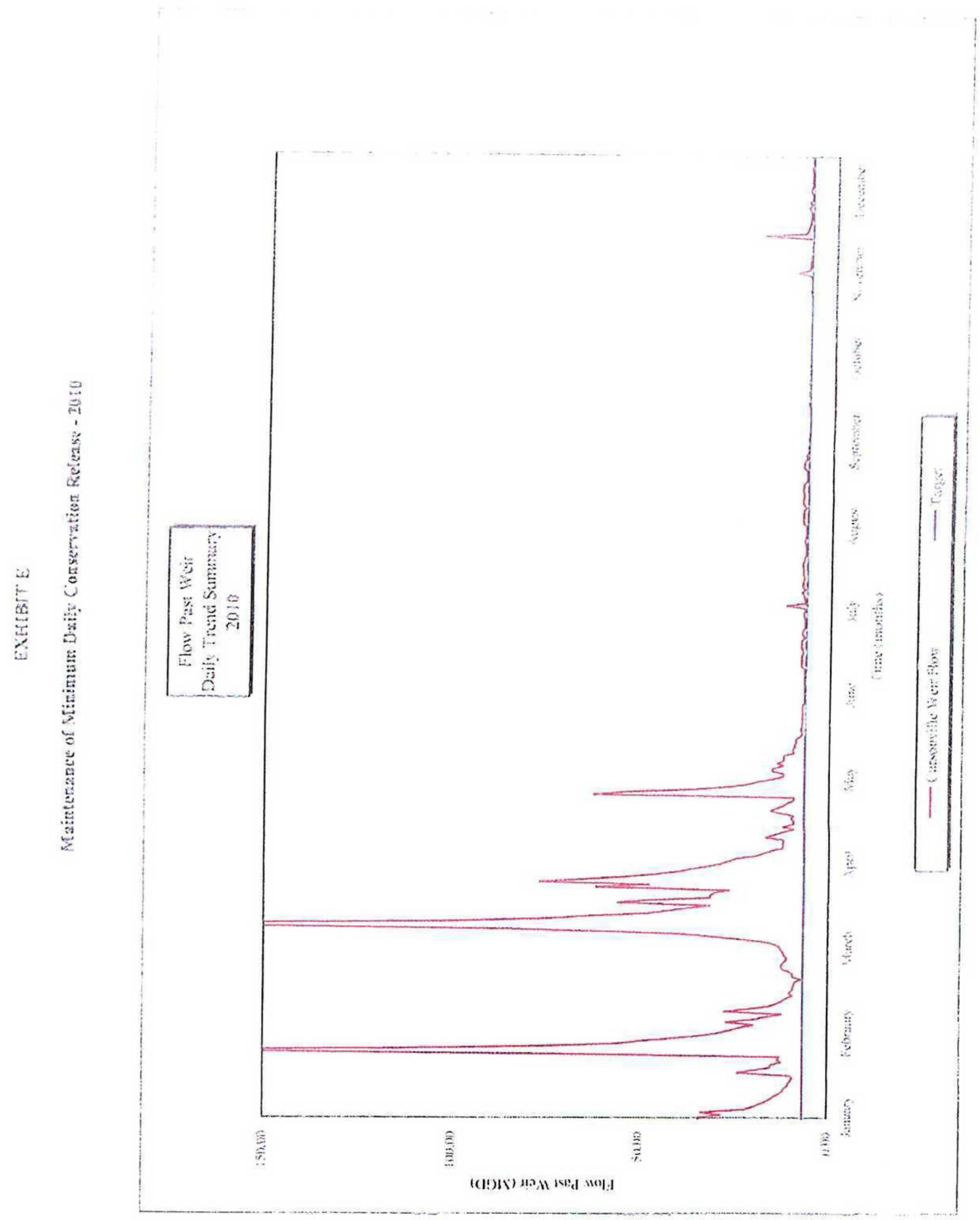
Common Name	Scientific Name	1	2	3	Code
Bluegill	Lepomis macrochirus	X	X		674
Brook Trout	Salvelinus fontinalis	X			131
Brook Trout - Hatchery	Salvelinus fontinalis	X	X		136
Brown Trout	Salmo trutta	X	X		122
Brown Trout - Hatchery	Salmo trutta	X	X		135
Chain Pickerel	Esox niger	X	X		195
Common Shiner	Luxilus cornutus		X		306
White Sucker	Catostomus commersonii	X			401

Table 2. Chemical-thermal analyses of Clarks Creek located within Pennsylvania drainage sub-subbasin 07C.

River Mile	SiteLatLon	Section	Site Date	Air Temp	Water Temp	pH	Sp Conductance	Total Alkalinity	Total Hardness
28.45	403210763539	2	8/1/1978	20	15	6.4	28	6	9
27.49	403119763655	2	3/11/2008	13	8	5.4	28	3	
27.49	403119763655	2	3/1/2008		4.2	5.6	77	2	4
25.97	403057763734	2	8/2/1978	21	15.5	6.3	26	6	8
24.19	403009763910	2	3/11/2008	13	5	5.4	30	2	
23.35	402956763932	2	8/1/1978	21	16	6.4	26	4	5
16.62	402715764600	3	8/3/1978	28	15	6.4	30	6	10
13.58	402616764846	3	8/4/1978	24	16.5	6	36	3	7
12.27	402554764956	3	8/23/1978	26	16.3	6.6	32	4	5
6.64	402421765431	5	8/23/1978	22	18.9	6.8	38	6	7
4.79	402334765552	5	7/18/1978	27	21.5	6.9	41	8	10
1.7	402258765730	5	8/24/1978	20	17.2	6.8	53	9	10
0.23	402215765739	5	7/17/1978	23	19	7	60	12	24

*Data provided through email by Deb Nardone, collected by PFBC 2008.

Attachment III: Conservation Release from the DeHart Reservoir from the Harrisburg Authority



Attachment IV. DCCD Clarks Creek Data from the Dauphin County Water Quality Database

Table 1. Clarks Creek Water Chemistry Data

Site	Date	Flow	T	pH	Conductivity	DO	Alkalinity	Nitrate-N	Orthophosphate	**Iron**	Total Phosphorus
CLRK0185	6/23/99		17	6.38	75	9.1	3				
CLRK0185	8/18/99	11.03	22	6.87	51	7.96	8	0.16	0.11		0.11
CLRK0185	6/9/00		14	6.4	45	9.6	6	0.1	0	**0.19**	0
CLRK0185	9/5/01		18	6.54	41	10	15	0.09	0	**0.248**	0
CLRK0185	10/8/02	12.04	13	6.5	59	8.6	11	0.38	1.07		1.07
CLRK0185	8/7/03	24.85	20	6.7	85	9.2	11	0.26	0	**0.11**	0
CLRK0185	8/10/04		18	7	61	9.8	13	0.46	0.01		0.01
CLRK0185	8/24/05		19	6.9	49	9.2	20	0.5	0.01		0.01
CLRK0847	6/23/99		16.5	6	39	9.1	5				
CLRK0847	8/18/99	12.81	18.25	6.2	40	8.61	4.2	0.36	0		0
CLRK0847	6/9/00		14.5	6.29	33	9.6	4.2	0	0	**0.172**	0
CLRK0847	9/5/01		15.5	6.22	36	10	12	0.06	0	**0.409**	0
CLRK2272	8/18/99	1.9	19.25	6.41	38	8.6	7.8	0.05	0		0
CLRK2272	6/9/00		12	5.99	26	10.5	3.4	0	0.02	**0.17**	0.02
CLRK2272	9/5/01		17	6.49	35	9.7	17.5	0	0	**0.192**	0
CLRK2272	10/8/02	2.224	13.5	6.6	35	10	8	0.12	0.63		0.63

Table 2. Clarks Creek 2008 Macroinvertebrate sampling metric calculations.

		HBI=		**Total Taxa =**		**Becks Index**		**Shannon Div=**		**% EPT <4**		**EPT**
Rep. Name	**Station Name**	OB	SV=(10-OB) / (10-1.86)	OB	SV=OB / 33	OB	SV=OB / 38	OB	SV=OB / 2.86	OB	SV=OB / 84.5%	OB
CLRK 1	10949 22.72	5.41	0.57	15	0.45	15	0.39	1.63	0.57	15.2%	0.180	7
CLRK 2	10949 AT	5.12	0.60	20	0.61	38	1.00	1.83	0.64	12.4%	0.147	8
CLRK 4	10949-01.85	4.18	0.72	16	0.48	87	2.29	2.42	0.85	42.9%	0.508	7

Table 3. Clarks Creek 2008 Adjusted metric scores combined into an Index of Biotic Integrity (IBI).

2008		**Adjusted Standardized Metric Score (max:1.00)**						
Rep. Name	**Station Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% EPT**	**EPT taxa**	**IBI**
CLRK 1	CLRK 22.72	0.57	0.45	0.39	0.57	0.18	0.37	42.22
CLRK 2	CLRK 16.24	0.60	0.61	1.00	0.64	0.15	0.42	56.92
CLRK 4	CLRK 01.85	0.72	0.48	1.00	0.85	0.51	0.37	65.41