pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF CLEAN WATER

Continuous Instream Monitoring Report (CIMR)

Most recent revision: 06/19/2017
Revised by: Hoger

STATION DESCRIPTIONS:

STREAM CODE: 50702
STREAM NAME: East Branch Clarion River
SITE CODE: 102662633-001
SITE NAME: Upstream of Gum Boot Run

STREAM CODE: 50844
STREAM NAME: Gum Boot Run
SITE CODE: 102662635-001
SITE NAME: Mouth

COUNTY: McKean

LATITUDE: 41.652546 **LONGITUDE:** -78.526986 – East Branch Clarion River
LATITUDE: 41.652621 **LONGITUDE:** -78.526092 – Gum Boot Run

LOCATION DESCRIPTION: Approximately 25 meters upstream of the confluence of Gumboot Run and East Branch Clarion River for each sonde on its respective stream.

HUC: 05010005

DRAINAGE AREA:	East Branch Clarion River	4.92 sq. miles
	Gum Boot Run	1.89 sq. miles
	Total	6.81 sq. miles

BACKGROUND AND HISTORY: East Branch Clarion River and Gum Boot Run are freestone tributaries to the Clarion River encompassing a small portion of southern McKean County (Figure 1). The basins are characterized by relatively steep topography and are nearly all (99%) forested. The entire East Branch Clarion River basin, which includes Gum Boot Run, has a designated use of High Quality Cold Water Fishes (HQ-CWF). The purpose of this study was to measure seasonal variation in water quality and chemistry, and to show the effect of these variations on the biological community.

The primary objectives of the assessment were to:

1. Characterize seasonal water temperature, specific conductance, and pH using 24-hour monitoring.

2. Characterize seasonal variation in water chemistry.
3. Characterize seasonal variation in biological communities.

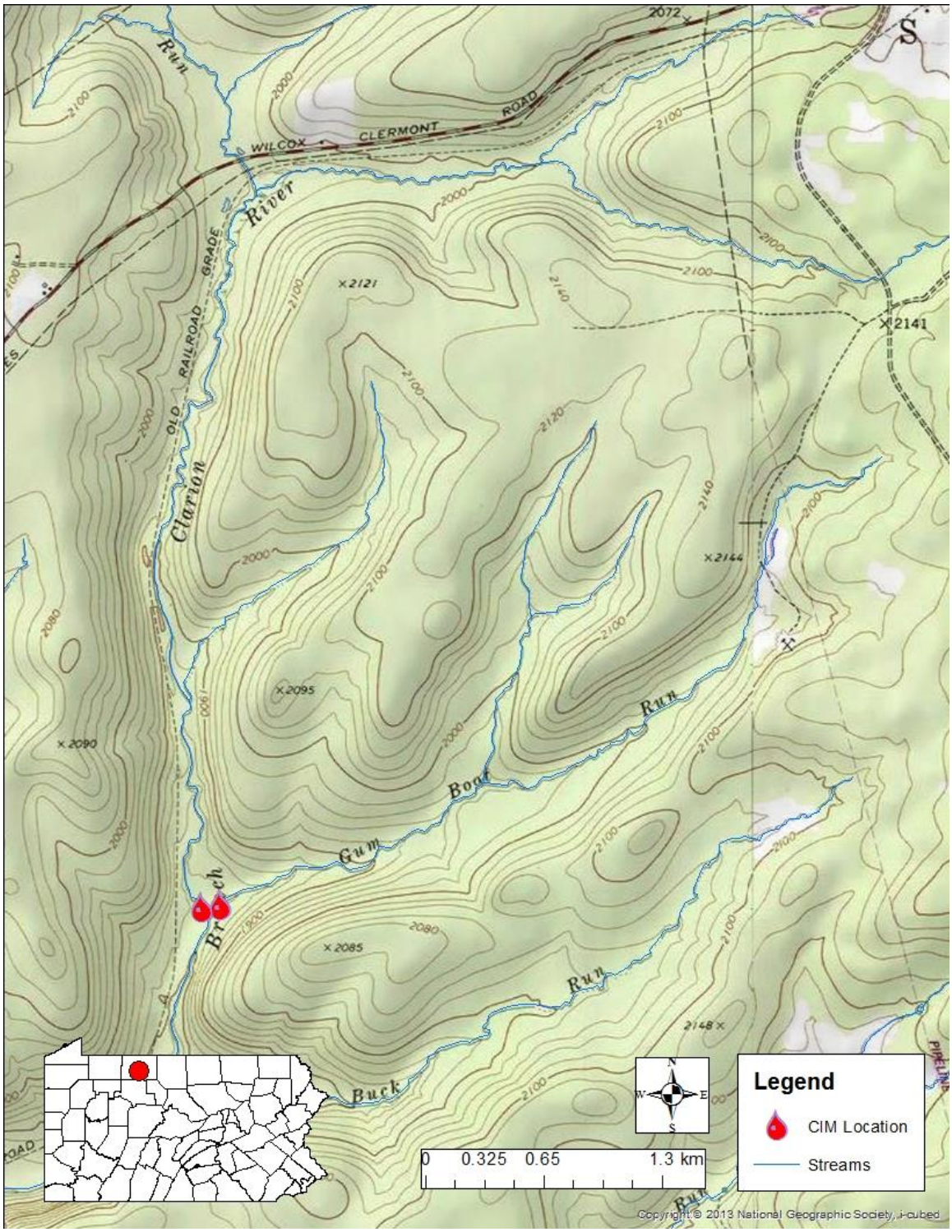

Figure 1. East Branch Clarion River and Gum Boot Run sonde locations

WATER QUALITY PARAMETERS:

Parameter	Units
Depth	feet
Water Temperature	°C
Specific Conductance (@25°C)	µS/cm[c]
pH	standard units

EQUIPMENT:

Yellow Springs Instruments (YSI) 6920 water-quality sondes were used at these stations. The sondes (SN: 10B100981 and 10B100977) were installed on September 2, 2010 and maintained until May 12, 2011.

The sondes were housed in 24-inch lengths of 4-inch diameter schedule 80 PVC pipe with holes drilled in them to allow for flow through. One end of each pipe was capped, and a notch was cut to accommodate the metal attachment bar on the top of the sonde. The attachment bar was clipped to an eye-bolt attached to rebar driven into the stream bed. The attachment bar was also clipped to a cable attached to a second piece of rebar located just upstream of the first. The sondes recorded water quality parameters every 60 minutes.

PERIOD OF RECORD: September 2, 2010 to May 12, 2011

The station was visited four times over the eight month deployment for the purpose of calibrating, cleaning, and servicing the sonde.

DATA:

Water chemistry grabs were collected 11 times during the sampling period. Benthic macroinvertebrates were collected on November 18, 2010. Fishes and a second round of macroinvertebrates were collected on May 12, 2011. Biological samples were collected following the Department's ICE protocol (PA DEP, 2013b). Continuous data are graded based on a combination of fouling and calibration error (PA DEP, 2013a). Two sections of specific conductance and one section of pH data were graded unusable from the Gum Boot Run sonde, and were deleted from the final data that are reported. Additionally, the final section of data, beginning March 15, 2011, from the East Branch Clarion River location was lost and therefore is not included in the report.

Depth: Depth recorded by this non-vented sonde is actually the measure of water column pressure plus atmospheric pressure. Therefore, changes in atmospheric pressure appear as changes in depth. Using atmospheric pressure data from the FAA weather station in Bradford, PA, McKean County, these data were corrected by eliminating the variations in depth due to changes in atmospheric pressure.

Depth was similar at the two locations (Figure 2) with nearly identical changes in flow. The last period of data from East Branch Clarion River was lost; therefore, depth from Gum Boot Run was used as the reference in all other parameter charts.

Depth

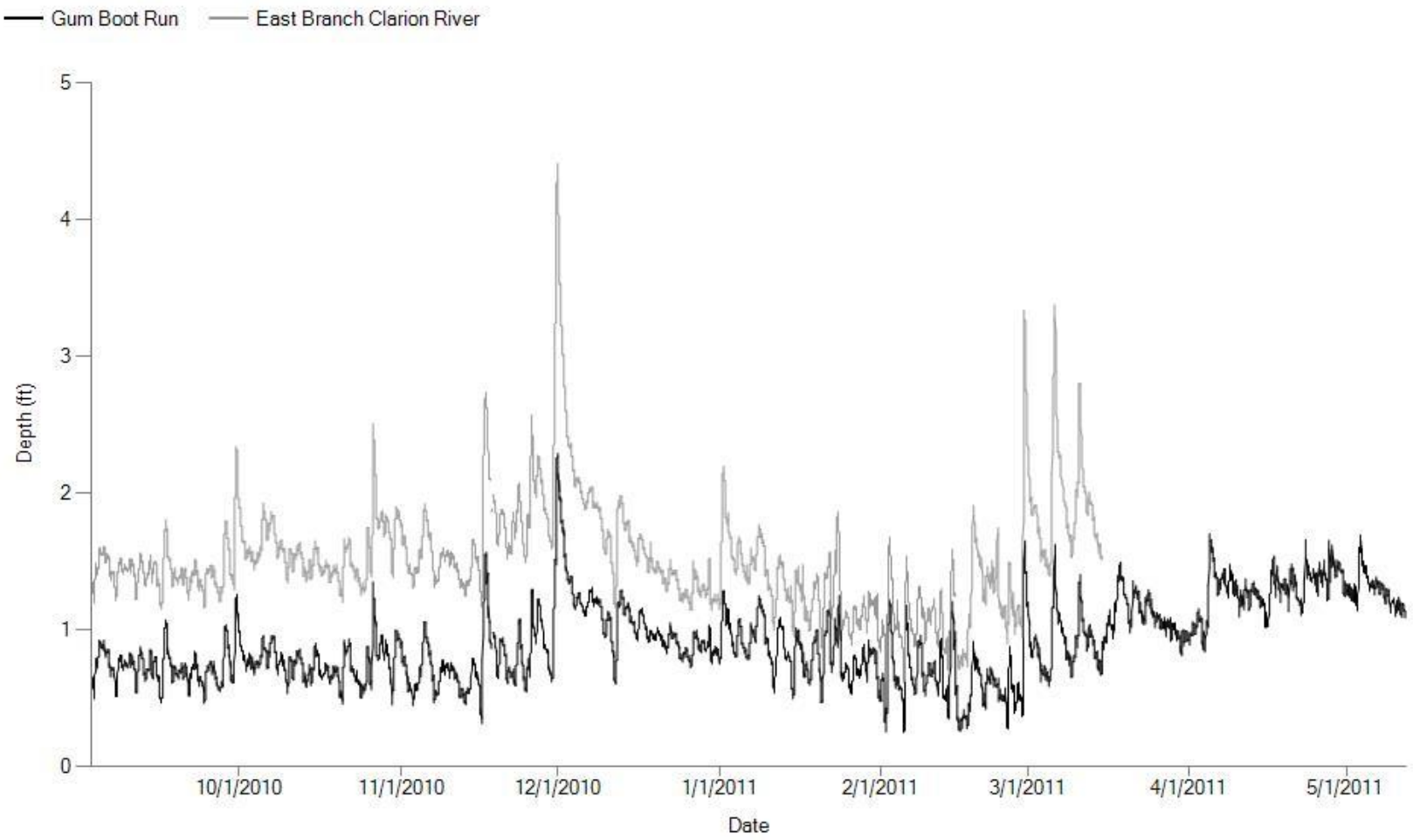

Figure 2. Continuous depth data, corrected for atmospheric pressure.

Temperature:	Gum Boot Run	Min: -0.04°C;	Average: 5.80°C;	Max: 20.39°C
	East Branch Clarion	Min: -0.05°C;	Average: 5.07°C;	Max: 22.32°C

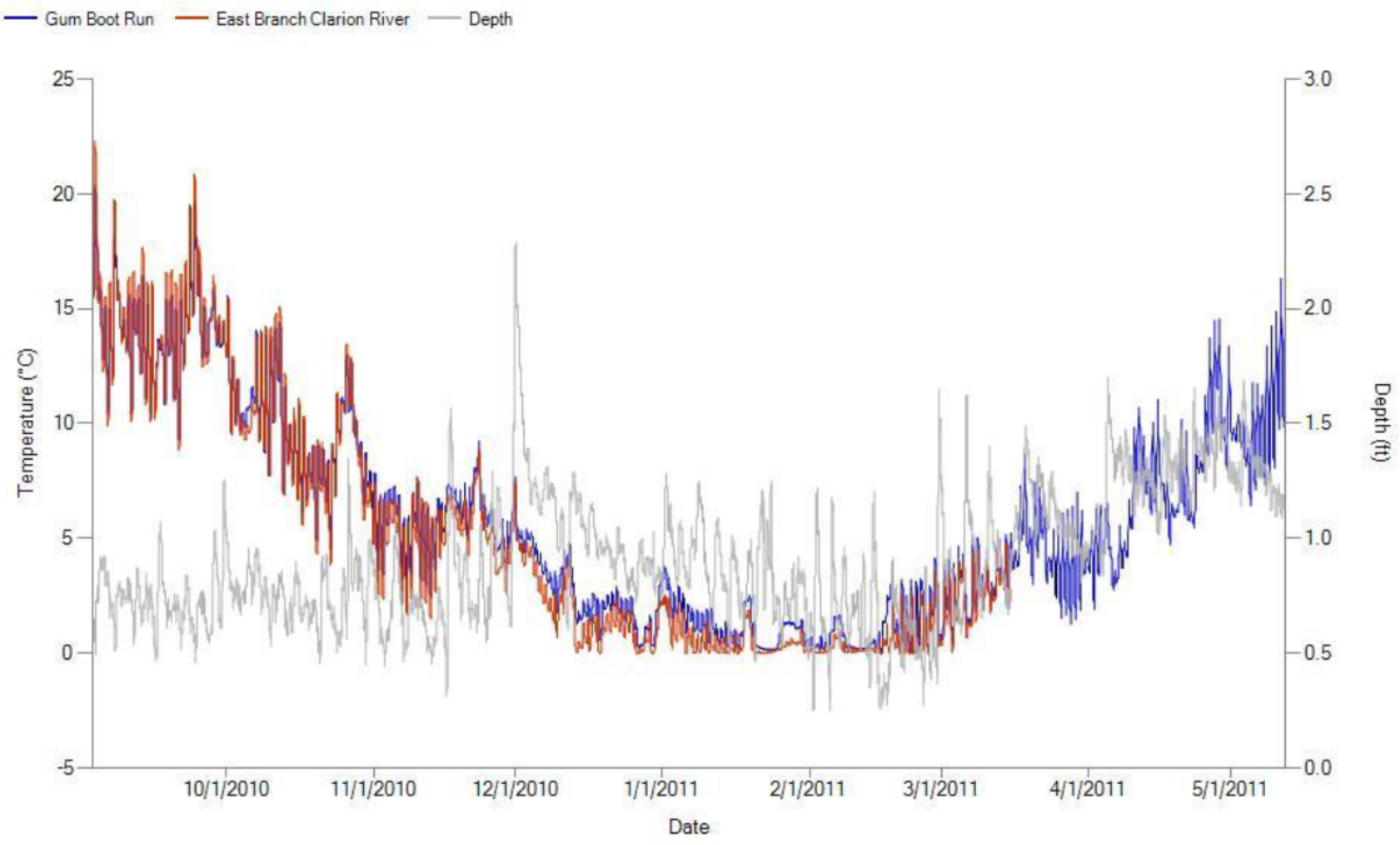

Figure 3. Continuous water temperature and depth from September 2, 2010 to May 12, 2011. Data at East Branch Clarion River ends on March 12, 2011 due to loss of data file.

Specific Conductance: Gum Boot Run Min: 23 µS/cm; Average: 60.8 µS/cm; Max: 119 µS/cm
East Branch Clarion Min: 23 µS/cm; Average: 44.2 µS/cm; Max: 77 µS/cm

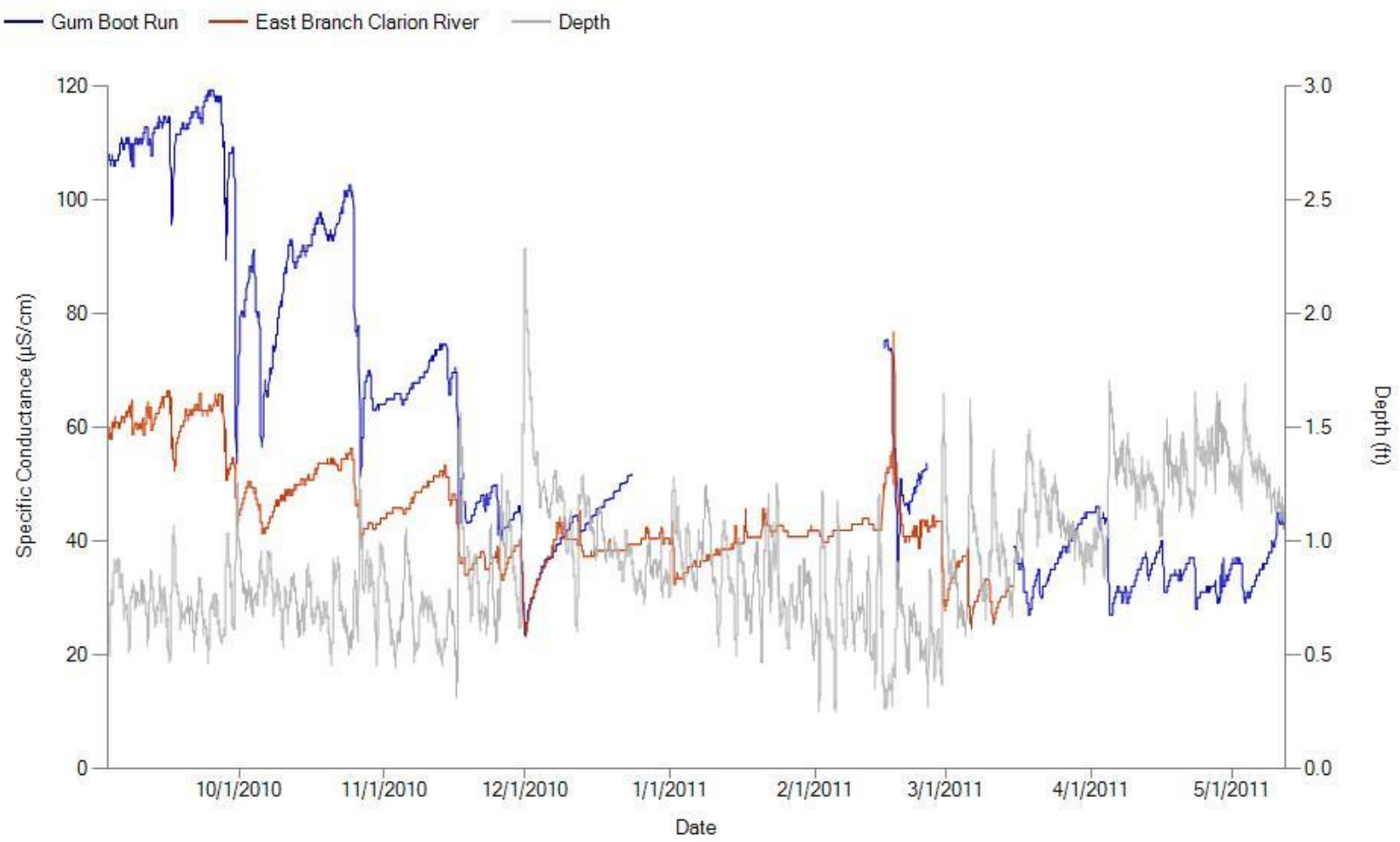

Figure 4. Continuous specific conductance and depth from September 2, 2010 to May 12, 2011. Both gaps in the Gum Boot Run signal are due to probe fouling. Data at East Branch Clarion River ends on March 12, 2011 due to loss of data file.

pH:	Gum Boot Run	Min: 5.29 units;	Average: 6.47 units;	Max: 7.28 units
	East Branch Clarion	Min: 5.10 units;	Average: 6.18 units;	Max: 7.11 units

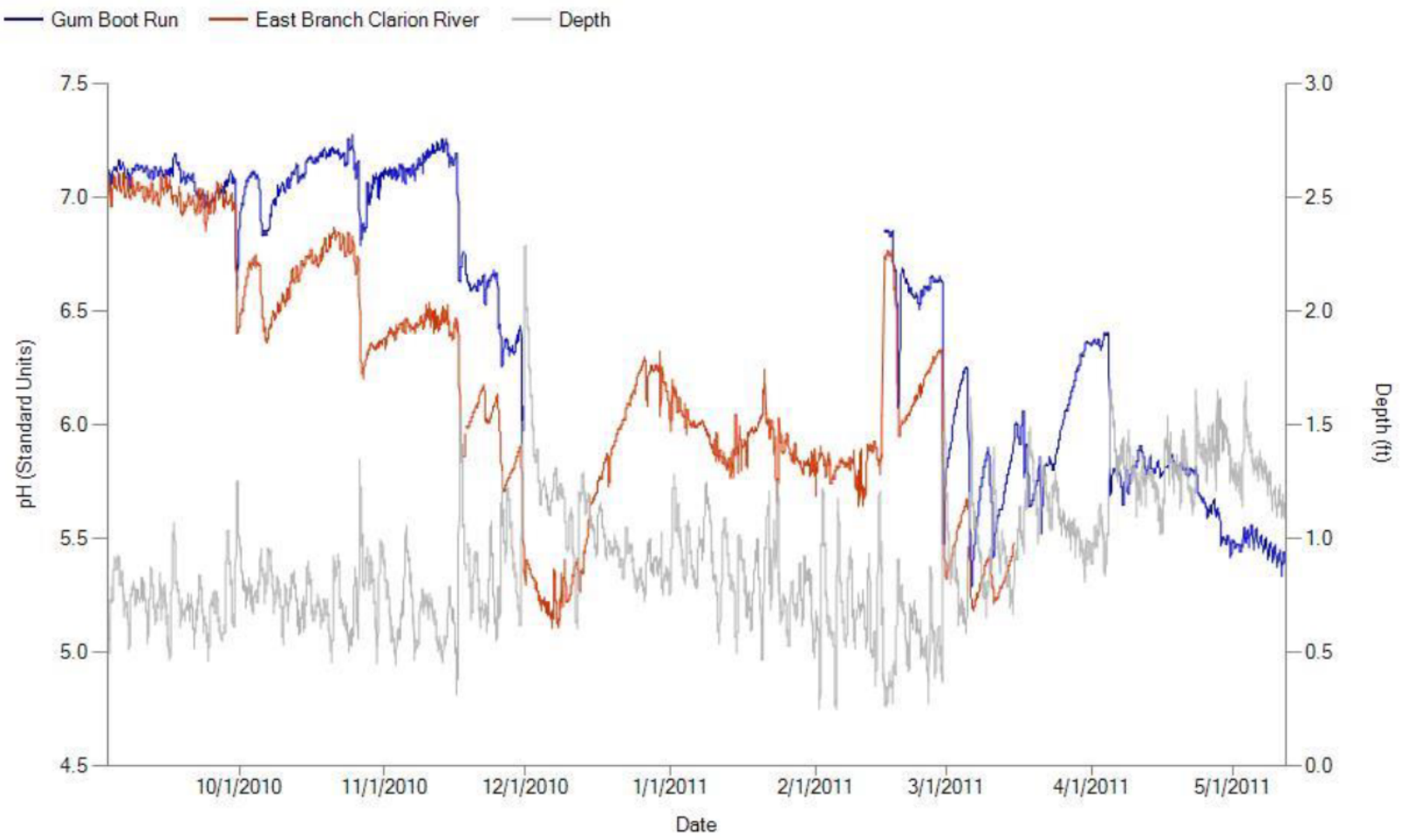

Figure 5. Continuous pH and depth from September 2, 2010 to May 12, 2011. The gap in the Gum Boot Run signal is due to probe fouling. Data at East Branch Clarion River ends on March 12, 2011 due to loss of data file.

In-situ Water Chemistry: Samples were collected six times from each site using standard analysis code 046.

Table 1. Chemical grab sample results from Gum Boot Run (gray columns) and East Branch Clarion River (white columns).

PARAMETER	UNITS	09/02/10 14:00	09/02/10 14:15	09/29/10 12:01	09/29/10 12:10	10/27/10 12:15	10/27/10 12:25	11/18/10 12:25	11/18/10 12:35	12/29/10 12:40	12/29/10 12:50
DISCHARGE	CFS	0.271	0.303								
ALUMINUM T	UG/L	< 200	< 200	< 200	< 200	306.000	273.000	236.000	225.000	< 200	< 200
ARSENIC T	UG/L	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
BARIUM T	UG/L	42.000	32.000	30.000	44.000	47.000	37.000	28.000	43.000	44.000	43.000
BORON T	UG/L	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
BROMIDE	UG/L	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00
CALCIUM T	MG/L	13.700	5.424	4.579	12.300	2.612	5.715	4.691	2.130	3.539	7.774
CHLORIDE T	MG/L	0.94	3.20	3.64	1.24	2.95	1.04	0.93	2.69	2.77	0.75
IRON T	UG/L	56.000	1157.000	2500.000	108.000	1013.000	291.000	231.000	440.000	269.000	87.000
MAGNESIUM T	MG/L	2.410	1.434	1.417	2.741	0.840	1.135	0.970	0.684	1.211	1.648
MANGANESE T	UG/L	10.000	32.000	35.000	19.000	167.000	94.000	96.000	115.000	94.000	185.000
SELENIUM T	UG/L	< 7	< 7	< 7	< 7	< 7	< 7	< 7	< 7	< 7	< 7
SODIUM T	MG/L	0.591	1.724	2.158	0.598	1.454	0.459	0.379	1.312	1.576	0.513
STRONTIUM T	UG/L	74.000	25.000	24.000	81.000	18.000	35.000	28.000	17.000	20.000	43.000
SULFATE T	MG/L	32.30	11.20	7.13	31.40	6.12	13.52	12.33	7.20	10.71	18.67
ZINC T	UG/L	< 10.0	< 10.0	< 10.0	10.000	17.000	12.000	13.000	18.000	16.000	12.000
AMMONIA T	MG/L	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	0.03	< .02
NITRATE & NITRITE T	MG/L	0.20	0.11	< 0.04	< 0.04	0.07	0.04	0.13	0.08	0.30	0.35
PHOSPHORUS T	MG/L	0.014	< .01	0.014	0.019	0.015	< .01	< .01	< .01	< .01	< .01
ALKALINITY	MG/L	10.8	8.0	7.6	11.4	1.6	4.0	4.8	1.2	2.6	5.6
BOD	MG/L	0.30	0.30	0.80	0.40	0.50	< 0.20	0.30	0.20	0.50	0.30
HARDNESS T	MG/L	44	19	17	42	10	19	16	8	14	26
OSMOTIC PRESSURE	MOSM	1	< 1	3	4	1	1	< 1	< 1	2	2
pH	UNITS	7.3	7.2	6.9	7.2	6.1	6.6	6.8	6.1	6.3	6.7
SPECIFIC COND @ 25C	µS/cm	108.00	59.20	52.20	110.50	36.00	52.40	46.30	33.30	48.60	69.80
TDS @ 180C	MG/L	72	48	40	70	< 5	26	52	40	44	58
TSS	MG/L	< 5	< 5	12	< 5	6	< 5	< 5	6	< 5	< 5

(Table 1 continued)

PARAMETER	UNITS	02/15/11 12:40	02/15/11 12:45	03/15/11 09:40	03/15/11 09:55	04/05/11 11:45	04/05/11 12:00	04/14/11 10:50	04/14/11 11:11	04/21/11 11:40	04/21/11 12:00
DISCHARGE	CFS										
ALUMINUM T	UG/L	228.000	< 200	229.000	249.000	524.000	322.000	244.000	403.000	201.000	272.000
ARSENIC T	UG/L	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
BARIUM T	UG/L	41.00	43.00	40.00	46.00	37.000	29.000	45.000	40.000	45.000	39.000
BORON T	UG/L	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
BROMIDE	UG/L	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00	< 50.00
CALCIUM T	MG/L	8.701	3.859	3.664	2.361	1.504	2.357	2.166	3.859	2.144	3.544
CHLORIDE T	MG/L	0.83	3.62	0.57	2.85	1.91	< 0.50	2.25	0.58	2.03	0.60
IRON T	UG/L	156.000	475.000	142.000	184.000	638.000	298.000	201.000	134.000	166.000	122.000
MAGNESIUM T	MG/L	1.816	1.245	0.952	0.962	0.543	0.602	0.823	0.909	0.785	0.823
MANGANESE T	UG/L	151.000	91.000	173.000	156.000	109.000	113.000	121.000	156.000	114.000	146.000
SELENIUM T	UG/L	< 7	< 7	< 7	< 7	< 7	< 7	< 7	< 7	< 7	< 7
SODIUM T	MG/L	0.541	2.040	0.371	1.638	1.378	0.309	1.450	0.389	1.409	0.370
STRONTIUM T	UG/L	48.000	21.000	22.000	15.000	12.000	15.000	14.000	23.000	14.000	21.000
SULFATE T	MG/L	22.25	10.41	11.97	10.06	6.07	8.12	9.32	11.36	8.24	10.98
ZINC T	UG/L	12.000	14.000	20.000	19.000	19.000	13.000	23.000	14.000	21.000	16.000
AMMONIA T	MG/L	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02
NITRATE & NITRITE T	MG/L	0.31	0.26	0.35	0.26	0.14	0.13	0.17	0.24	0.16	0.24
PHOSPHORUS T	MG/L	< .01	< .01	< .01	< .01	0.011	< .01	< .01	< .01	< .01	< .01
ALKALINITY	MG/L	6.6	3.4	1.2	0.0	0.0	1.4	0.0	1.4	0.2	1.2
BOD	MG/L	0.60	0.80	0.30	0.70	0.50	0.50	0.80	0.60	0.70	0.40
HARDNESS T	MG/L	29	15	13	10	6	8	9	13	9	12
OSMOTIC PRESSURE	MOSM	3	5	4	3	1	1	1	2	3	3
pH	UNITS	7.0	6.7	6.2	5.5	5.4	6.2	5.6	6.4	5.5	6.0
SPECIFIC COND @ 25C	µS/cm	75.00	50.10	39.20	41.60	30.10	28.20	36.40	38.40	35.30	37.40
TDS @ 180C	MG/L	72	54	38	28	34	< 5	< 5	18	32	36
TSS	MG/L	10	8	< 5	< 5	8	< 5	< 5	< 5	10	6

(Table 1 continued)

PARAMETER	UNITS	05/12/11 08:35	05/12/11 08:40
DISCHARGE	CFS	10.779	4.223
ALUMINUM T	UG/L	< 200	227.000
ARSENIC T	UG/L	< 3.0	< 3.0
BARIUM T	UG/L	43.000	40.000
BORON T	UG/L	< 200	< 200
BROMIDE	UG/L	< 50.00	< 50.00
CALCIUM T	MG/L	2.720	5.288
CHLORIDE T	MG/L	2.37	0.60
IRON T	UG/L	300.000	131.000
MAGNESIUM T	MG/L	0.983	1.087
MANGANESE T	UG/L	94.000	109.000
SELENIUM T	UG/L	< 7	< 7
SODIUM T	MG/L	1.371	0.439
STRONTIUM T	UG/L	16.000	30.000
SULFATE T	MG/L	10.04	14.53
ZINC T	UG/L	14.000	< 10.0
AMMONIA T	MG/L	0.02	0.03
NITRATE & NITRITE T	MG/L	0.18	0.24
PHOSPHORUS T	MG/L	< .01	< .01
ALKALINITY	MG/L	1.0	4.2
BOD	MG/L	0.80	0.60
HARDNESS T	MG/L	11	18
OSMOTIC PRESSURE	MOSM	3	3
pH	UNITS	6.4	7.0
SPECIFIC COND @ 25C	µS/cm	42.20	52.20
TDS @ 180C	MG/L	44	46
TSS	MG/L	< 5	< 5

Biology: The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of water quality. Benthic macroinvertebrates were collected at Gum Boot Run on November 18, 2010 and at both sites on May 12, 2011 (Table 2). Fish were collected at both sites on May 12, 2011 (Table 3).

Table 2. Taxa list for benthic macroinvertebrate surveys at Gum Boot Run (gray columns) and East Branch Clarion River (white columns). Red text indicates total was out of range for metric calculations.

Family	Genus	20101118-1235-jessimille	20101118-0701-mlookenbil	20110512-0910-censor	20110512-0940-censor
Baetidae	*Acerpenna*	2	4		
Heptageniidae	*Epeorus*	28	29		
	Stenacron	7	1		1
	Maccaffertium	1	3	1	
Ephemerellidae	*Eurylophella*	20	2		
Leptophlebiidae	*Habrophlebia*			2	
	Habrophlebiodes	4			
	Paraleptophlebia		2		1
Aeshnidae	*Boyeria*		1		2
Taeniopterygidae	*Taeniopteryx*	4	2		
	Taenionema	1	3		
Nemouridae	*Amphinemura*			3	4
	Ostrocerca		1		
Leuctridae	*Leuctra*	1	48	15	28
Capniidae	*Paracapnia*	3	6		
Perlidae	*Acroneuria*	5	4	21	11
Perlodidae	*Isoperla*		2		
Chloroperlidae	*Alloperla*	1			
	Haploperla		5	6	5
Sialidae	*Sialis*	5	1	5	1
Corydalidae	*Nigronia*	2	1	3	
Philopotamidae	*Chimarra*		1		
	Dolophilodes		19		
	Wormaldia		2		
Polycentropodidae	*Polycentropus*		1	1	1
Hydropsychidae	*Diplectrona*		19	3	9
	Ceratopsyche		7	11	
	Cheumatopsyche		1	3	
	Hydropsyche	6		1	
Rhyacophilidae	*Rhyacophila*		2		1
Limnephilidae	*Pycnopsyche*		2		
Elmidae	*Optioservus*	4	2	1	
	Promoresia	12		2	
Empididae	*Oreogeton*		1		1
Tipulidae	*Dicranota*		3	1	4
	Hexatoma			21	3
Simuliidae	*Prosimulium*	2	5		
Chironomidae		60	27	7	
Oligochaeta			2		
Cambaridae	*Cambarus*	1			3
	TOTALS	**169**	**209**	**107**	**75**

Table 3. Taxa list for fish surveys at Gum Boot Run (gray column) and East Branch Clarion River (white column).

Family	Scientific Name	Common Name	20110512-1113-mlookenbil	20110512-1213-mloookenbil
Cottidae	*Cottus bairdii*	Mottled Sculpin	1	6
Cyprinidae	*Semotilus atromaculatus*	Creek Chub	2	4
Salmonidae	*Salvelinus fontinalis*	Brook Trout	3	3
Centrachidae	*Lepomis macrochirus*	Bluegill	2	
Catostomidae	*Catostomus commersonii*	White Sucker		1

ASSESSMENT:

Continuous: Continuous instream monitors (CIMs) record instream parameters that have defined water quality standards (WQS) in 25 Pa Code §93.7 (temperature, pH and DO). Certain conditions must be met in order to properly assess data from CIMs. Any readings that do not comply with the applicable numeric WQS criteria are considered exceedances and are reviewed to determine if representative of the stream segment and if representative of natural quality as stated in 25 Pa Code §93.7(d). All data reviews are consistent with requirements as described in 25 Pa Code §96.3 which includes the 99 percent frequency measurement rule.

Defining Criteria Exceedance

The WQS criteria for pH and DO are expressed as either a discrete minimum, discrete maximum, or as a daily average (continuous 24-hour period, §93.1) concentration. The individual recordings exceeding the listed criteria are summed and the percent of the year (%Y) that those readings represent is calculated using the following equation:

$$\%Y = 100 * [\ n / (525{,}600 / i\ )\ ]$$

Where

n = number of exceedances
i = recording interval in minutes
The constant (525,600) is the number of minutes in a year (365 days * 24 hrs/day * 60 min/hr)

If %Y > 1, then the criterion is not achieved 99% of the time as required by §96.3(c), and the waterbody is considered in violation of water quality standards. A period of one year is applied as a rolling year to avoid arbitrary divides as with a calendar year or water year. The 99 percent frequency measurement calculation is based on one continuous 365-day period.

Specific conductance at both sites was low—typically less than 100 µS/cm. This is reflective of both the geology and the low human impact in the basin. The pH signals from the sondes showed extremely muted diel signals, another indication of low nutrients and little human influence. However, pH showed significant decreases during flow events demonstrating an inability of the streams to buffer acid deposition from rain or snow melt. Values decreased to a low of 5.1 in early December at East Branch Clarion River, with the number of readings below the Chapter 93 minimum criterion of 6.0 representing 22.1% of a year. The same

trend was observed at Gum Boot Run. Despite losing data due to sensor fouling during the critical period, the readings below the criterion represented 16.2% of a year.

Biological: The acidification of these two streams that started in the late fall and continued through the winter had dramatic impacts to the biological community (Table 2). The Gum Boot Run macroinvertebrate sample taken in mid-November showed a diverse community with numerous pollution intolerant taxa (Table 4). Four of the five most common taxa (*Leuctra*, *Epeorus*, *Dolophilodes*, and *Diplectrona*) have pollution tolerance values (PTV) of 0. The November sample at East Branch Clarion River did not show the same high quality macroinvertebrate community. While some pollution intolerant taxa were present, *Epeorus* was the only one present in high numbers. Over a third of the sample was Chironomidae, a group generally tolerant of pollution. In addition, the November sample at East Branch Clarion River showed much less diversity with only 20 taxa present. The samples taken at both sites in the spring did not even have enough individuals to meet the minimum number according to the PA DEP protocol (PA DEP, 2012). The dominant taxa in the spring samples, *Leuctra* and *Acroneuria*, are known to be more tolerant of acidic conditions (Bell and Nebeker, 1969; Rosemond et al., 1992). The number of fish collected was low but this is more likely attributable to the type of stream than water quality conditions. The species present, with the exception of the Bluegill, are those that are expected in a cold, headwater stream.

Table 4. Benthic macroinvertebrate metric calculations at Gum Boot Run (gray rows) and East Branch Clarion River (white rows). Red text means subsample out of range and metrics should be evaluated with caution.

Date	IBI	Richness	Mod EPT	HBI	% Dom	% Mod May	Beck3	Shannon Div
November 10, 2010	59.5	20	10	3.76	35.5	33.1	18	2.21
November 10, 2010	94.3	32	19	1.71	23.0	17.7	33	2.67
May 12, 2011	65.8	18	7	2.20	19.6	2.8	15	2.40
May 12, 2011	68.0	15	8	1.01	37.3	2.7	18	2.10

SUMMARY:

Water quality varied dramatically during this study period. Low specific conductance and muted diel pH swings pointed to excellent water quality at both sites at the beginning of the study. Gum Boot Run also showed a diverse, pollution-intolerant macroinvertebrate community in November. Acid deposition and an inability of the streams to adequately buffer resulted in a rapidly decreasing stream pH starting in late November. This reduced pH lasted throughout the winter and into the spring at levels outside Pennsylvania water quality criteria, significantly affecting the biological communities in these streams. Overall abundance of macroinvertebrates was so low in the spring that samples did not reach the minimum number of individuals for metric calculations. Further, Ephemeropterans (mayflies), a group generally sensitive to low pH (Rosemond et al., 1992), were nearly eliminated from the spring samples. Taxa that are generally acid-tolerant such as Plecopterans (stoneflies; Rosemond et al., 1992) were relatively unaffected. Despite the low total number of individuals, the May macroinvertebrate samples still had somewhat average IBI scores due to the high proportion of pollution-intolerant taxa. The May score at Gum Boot Run, however, still represents a drop in IBI score of more than 26 points from the November sample. While Gum Boot Run showed an ability to recover from the sustained drop in pH, the low IBI score at East Branch Clarion River in November suggests an inability of the biological community to recover in the same way.

In conclusion, the severe, sustained drop in pH from late fall through spring created a stressful aquatic environment in both Gum Boot Run and East Branch Clarion River that was reflected in the biological communities and represents a violation of Pennsylvania Chapter 93 pH water quality criteria. While all data collected strongly point to a cause of acid deposition, the acid precipitation protocol (Appendix G of PA DEP, 2013b) could not be used to designate acid precipitation as the cause because certain components, such as monomeric aluminum samples, were not collected as they were not part of the original intent of the project. A review of the acid precipitation protocol is recommended to incorporate new data types like the CIM data in this report.

LITERATURE CITED

Bell, H. L. and Nebeker, A. V. 1969. Preliminary studies on the tolerance of aquatic insects to low pH. *Journal of the Kansas Entomology Society*, 42:230-236.

PA DEP. 2012. A Benthic Macroinvertebrate Index of Biotic Integrity for Wadeable Freestone Riffle-Run Streams in Pennsylvania. http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Technical%20Documentation/freestoneIBImarch2012.pdf

PA DEP. 2013a. Continuous Instream Monitoring Protocol. http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Methodology/2013%20Methodology/CIM_PROTOCOL.pdf

PA DEP. 2013b. Instream Comprehensive Evaluations (ICE). http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Methodology/2013%20Methodology/ICE.pdf

Rosemond, A. D., Reice, S. R., Elwood, J. W., and Mulholland, P. J. 1992. The effects of stream acidity on benthic invertebrate communities in the south-eastern United States. *Freshwater Biology,* 27:193-209.