



SRBC staff member processes the macroinvertebrate sample on the West Branch Susquehanna River.

Staff compared the data collected to water chemistry levels of concern based on current state and federal regulations, background levels of stream chemistry, or references for approximate tolerances of aquatic life (Table 2). For this 2009 survey, SRBC added Total Dissolved Solids (TDS) to the water quality parameters analyzed in the laboratory in order to obtain baseline data in the West Branch Susquehanna Subbasin, which is a significant location for recent natural gas drilling and potential waterways for drilling wastewater disposal or accidental spills. Also, this parameter was added in order to detect any impacts that may already have occurred. Flowback and produced water from natural gas drilling has very high TDS concentrations.

Staff collected macroinvertebrate samples and conducted habitat assessments using a slightly modified version of USEPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (RBP III) (Barbour and others, 1999). Detailed sampling methods, more detailed results for individual watersheds, and a link to the raw data can be found on SRBC's web site at http://www.srbc.net/pubinfo/techdocs/publication_268/techreport268.htm.

RESULTS/DISCUSSION

Water quality, biological (macroinvertebrate) community, and habitat site conditions for each sampling site in 2009 throughout the West Branch Susquehanna Subbasin are depicted in Figure 3. Almost half of the sites (46 percent) had moderately or severely impaired biological conditions and 78 percent exceeded at least one water quality level of concern. This was largely due to AMD pollution problems in this subbasin. The habitat, however, was mostly excellent (43 percent) or supporting (46 percent) due to the remote and forested nature of a large portion of this subbasin. The best quality sites were located in the headwaters of Sinnemahoning Creek Watershed, Pine Creek Watershed, headwaters of Kettle Creek, Bucktail State Park Natural Area (from Renovo to Lock Haven, Pa.), and around Williamsport, Pa. The worst quality sites were located in the headwaters area of the West Branch Susquehanna Subbasin around Clearfield County and in Clinton County, with the largest impaired watershed areas being Clearfield Creek and Moshannon Creek.

Thirty-one sites had the highest water quality rating (higher quality), 32 sites scored the highest biological rating (nonimpaired), and 59 sites had the highest habitat rating (excellent); however, there were no sites that had the highest level of conditions for all three categories. Nineteen of the sites that had nonimpaired biological conditions and excellent habitat had middle water quality due to exceeding alkalinity standards. In fact, alkalinity was the parameter that exceeded levels of concern at the highest number of sites (78) (Table

3). This parameter was exceeded at 55 percent of the sites throughout the West Branch Susquehanna Subbasin. The second highest number of sites to exceed levels of concern was 23 for aluminum. Also, manganese, nitrogen, and nitrate-n had around 20 sites that exceeded the levels of concern for these parameters. The highest number of levels of concern exceeded at a single site was nine for Roaring Run (ROAR 0.9). Muddy Run (MUDR 4.5) had eight parameters that exceeded levels of concern.

The highest or lowest value for each parameter is printed in bold in Table 3. The metals associated with AMD (aluminum, iron, and manganese) had the highest levels at Alder Run (ALDR 4.7) of 8,370 µg/l, 10,400 µg/l, and 5,890 µg/l, respectively. This site also had the lowest pH (2.9), the lowest alkalinity (zero), and the highest acidity (112 mg/l). Many sites (11) had the lowest alkalinity value of zero. The highest values for nitrogen and nitrate-n were 3.23 mg/l and 3.17 mg/l, respectively, at Slab Cabin Run (SLAB 0.2). The highest level of orthophosphate was 0.065 mg/l at Montgomery Creek (MONT 0.2). The highest level of sulfate (352 mg/l) and TDS (608 mg/l) were at MUDR 4.5 (Table 3). For more information on the particular levels of concern and the effects to water quality and aquatic life, please see the references listed in Table 2. A more detailed discussion of the results is available in the long version of the report on SRBC's web site at http://www.srbc.net/pubinfo/techdocs/publication_268/techreport268.htm.

Table 3. West Branch Susquehanna Subbasin Sites with Water Quality Values Exceeding Levels of Concern

Site #	Station ID	Date	Time	Alkalinity < 20 mg/l	Al > 750 ug/l	Hardness > 300 mg/l	Iron > 1,500 ug/l	Mg > 35 mg/l	Mn > 1,000 ug/l	Nitrate > 0.6 mg/l	Nitrogen > 1.0 mg/l	OrthoP > 0.05 mg/l	Sodium > 20 mg/l	Sulfate > 250 mg/l	TSS > 25 mg/l	TDS > 500 mg/l	Acidity > 20 mg/l	D.O. < 5.0 mg/l	pH < 5.0	# Exceeds
1	ALDR 4.7	06-02-2009	11:00:00	0	8370		10400		5890					263			112		2.9	7
2	ANDR 0.4	06-02-2009	15:00:00	4																1
3	ANDR 12.3	06-02-2009	10:45:00	5.2																1
4	ANTE 0.1	06-03-2009	13:30:00							1.2	1.33									2
5	BABB 0.1	06-02-2009	15:30:00	17.4																1
6	BABB 7.2	06-02-2009	14:30:00	4.6																1
7	BAKR 0.1	06-17-2009	14:45:00	3.8																1
8	BALD 4.5	06-30-2009	13:30:00							0.99	1.33									2
9	BALD 14.0	06-30-2009	11:20:00							1.1	1.57									2
10	BALD 24.7	06-24-2009	09:55:00							1.94	2									2
12	BBSC 3.8	06-08-2009	14:50:00	4																1
13	BBSC 17.6	06-08-2009	12:50:00	2.2																1
16	BEAR 0.1	03-26-2009	10:00:00	0.8	850		2520		1680											4
17	BECH 1.7	05-01-2009	08:30:00	0.2	536		4190		2900								30		4.7	3
18	BECH 20.3	06-15-2009	12:30:00	0	1660														3.7	6
19	BILG 0.1	06-02-2009	13:15:00	8.6																1
21	BLMO 0.1	06-02-2009	13:25:00	2																1
22	BUFF 0.2	06-08-2009	12:00:00							1.68	1.95									2
23	BUFF 10.4	06-08-2009	11:00:00							1.66	1.83									2
25	CHLL 0.9	06-08-2009	08:00:00							1.52	1.76									2
26	CHLL 19.3	06-08-2009	09:30:00							0.95	1.15									2
28	CHST 13.2	06-04-2009	07:00:00							0.78										1
29	CHST 24.5	06-04-2009	14:50:00							0.92	1.12									2
30	CHTM 0.1	06-03-2009	16:00:00	1025			1844								38					3
31	CLFD 0.9	06-03-2009	07:00:00						1819											1
32	CLFD 8.2	04-07-2009	13:30:00							1.46										1
33	CLFD 22.8	06-03-2009	12:51:00				1531		1553											2
34	CLFD 42.2	06-04-2009	12:00:00						1360											1
35	CLFD 60.5	06-04-2009	14:00:00							0.77										1
36	COKR 0.1	05-01-2009	12:49:00	0	1790		2250										32		3.1	5
37	COLD 1.1	06-01-2009	10:40:00	1			1630													2
38	COLD 3.6	06-01-2009	14:35:00	7.4																1
40	DEER 0.2	05-04-2009	15:00:00	0	735		1500		1500										4.65	4
41	DENT 0.6	06-08-2009	14:00:00		1200		2230												4.2	3
42	DRFT 0.1	06-10-2009	08:40:00	14.8																1
43	DRFT 9.9	06-10-2009	07:20:00	15																1
44	DRFT 21.2	06-09-2009	13:45:00	11.6																1
45	DRUR 0.7	06-16-2009	17:25:00	0.2	836															2
46	EAST 0.1	06-09-2009	09:20:00	13.4																1
47	FISH 2.1	06-18-2009	09:15:00							2.15	2.29									2
48	FISH 13.3	06-18-2009	11:40:00							1.3	1.48									2
49	FRST 5.3	06-10-2009	10:00:00	13.8																1
50	FRST 19.1	06-09-2009	07:30:00	17.4																1
51	GIFF 1.6	06-03-2009	11:45:00	2.2															4.9	2
52	HYNR 0.1	06-15-2009	18:45:00	9.4																1
54	KTTL 0.2	06-16-2009	15:20:00	11																1
55	KTTL 2.1	06-16-2009	14:05:00	11.8																1
56	KTTL 25.3	06-16-2009	11:15:00	13.2																1
57	KTTL 34.1	06-16-2009	09:00:00	11.8																1
58	LAND 1.7	06-02-2009	12:00:00	0	4150		3470		3710								60		3.1	6
59	LARR 2.9	06-03-2009	10:00:00	13.6																1
60	LAUR 0.1	06-01-2009	16:15:00	7.4	307			39.4	3980					302						5
61	LAUR 3.2	06-08-2009	10:40:00	3.8																1
63	LICK 0.2	06-22-2009	17:05:00	7.4																1
64	LICK 0.3	04-23-2009	14:30:00	0.6																1

Site #	Station ID	Date	Time	Alkalinity <20 mg/l	Al >150 ug/l*	Hardness >300 mg/l	Iron >1,500 ug/l	Mg >35 mg/l	Mn >1,000 ug/l	Nitrate >0.6 mg/l	Nitrogen >1.0 mg/l	Ortho P >0.05 mg/l	Sodium >20 mg/l	Sulfate >250 mg/l	TSS > 25 mg/l	TDS > 500 mg/l	Acidity > 20 mg/l	D.O. < 5.0 mg/l	pH < 5.0	# Exceeds
66	LLSK 1.2	06-01-2009	17:00:00	13.4																1
67	LLSK 37.2	06-01-2009	11:15:00	4.8																1
68	LMUN 0.1	06-01-2009	14:00:00							1.46										2
69	LPIN 0.2	06-02-2009	18:00:00	15																1
71	LYCO 2.0	06-03-2009	08:30:00	15.8																1
72	LYCO 17.7	06-03-2009	07:30:00	11.6																1
74	MCEL 2.0	06-03-2009	14:30:00	7.4																1
75	MEDX 0.1	06-08-2009	11:50:00	8.2																1
76	MONT 0.2	04-07-2009	14:10:00	0.2	529						1.3	0.065								4
77	MORG 0.2	06-03-2009	11:15:00	0	2081				5145								24		3.4	5
78	MOSH 5.1	06-02-2009	13:30:00	0	2490				2230										3.2	4
79	MOSH 19.1	06-04-2009	13:15:00	0	2000	301	2880		2580								28		3.9	7
80	MOSH 39.9	05-07-2009	10:43:00		2019		4778		2218										4.6	4
82	MOSQ 1.0	06-03-2009	14:30:00	2																1
83	MOSQ 13.8	06-03-2009	09:50:00	0.8	207														4.2	3
85	MFRSH 1.6	06-02-2009	11:30:00									0.065								1
86	MUDR 0.3	04-07-2009	10:50:00		1137		2915		2533		1.13			256						5
87	MUDR 4.5	06-03-2009	14:00:00		985	362	1783	38.4	5271	0.92				352		608	22			8
88	MUNC 1.1	06-01-2009	16:00:00								1.06									2
89	MUNC 18.8	06-01-2009	12:30:00	16.2																1
90	PADY 0.1	06-17-2009	07:40:00	8.2																1
92	PINE 14.2	06-03-2009	11:30:00	17.8																1
94	PINE 57.5	06-02-2009	11:00:00	15.6																1
95	ROAR 0.9	06-03-2009	08:10:00	0	2516		1708	35.7	5604					306		534	38		3.5	9
96	SINN 0.2	06-10-2009	11:15:00	10.4															4.79	2
97	SINN 11.9	06-10-2009	09:30:00	9.8																1
98	SLAB 0.2	06-18-2009	17:30:00							3.17	3.23		27.7							3
99	SMIL 0.1	06-04-2009	10:25:00	7.8																1
100	SPRG 0.2	06-18-2009	14:00:00							3.03	3.21									2
101	SPRG 14.8	06-18-2009	16:05:00							3.04	3.18									2
102	SURV 0.3	04-23-2009	11:15:00	0	2427				3041					322						4
104	TANG 0.2	06-22-2009	13:15:00	4.8																1
105	TML 0.1	05-01-2009	14:51:00	0	2710		1870		2180								36		3.3	6
106	TROT 0.1	06-02-2009	09:00:00	1.6																1
107	WBPC 3.5	06-02-2009	09:30:00	10.6																1
111	WBSR 23.0	07-07-2009	10:20:00												52					1
115	WBSR 64.0	07-06-2009	14:05:00	12																1
116	WBSR 69.0	07-06-2009	12:15:00	11.8																1
117	WBSR 75.0	07-01-2009	15:40:00	8.6																1
118	WBSR 83.0	07-01-2009	13:20:00	9																1
119	WBSR 91.0	07-01-2009	11:30:00	8.6																1
120	WBSR 97.0	07-01-2009	09:40:00	9.2																1
121	WBSR 103.8	06-30-2009	17:00:00	9.2																1
122	WBSR 110.0	06-29-2009	11:00:00	10.6																1
123	WBSR 131.0	06-29-2009	12:45:00	10																1
124	WBSR 142.0	06-29-2009	13:45:00	13																1
132	WBSR 208.0	06-30-2009	16:45:00										20.6							1
133	WBSR 214.0	07-01-2009	08:20:00										25.4							1
134	WBSR 224.0	07-01-2009	11:45:00										25.9							1
135	WBSR 235.0	07-01-2009	14:47:00	8.6	2803		2557			0.68			25.8							5
137	WEST 2.0	06-09-2009	12:10:00	13.4																1
138	WILS 0.5	06-02-2009	13:00:00	17.2	1208				2034											3
139	WTDR 3.7	06-04-2009	11:00:00	9.4																1
140	YGWO 0.5	06-17-2009	11:30:00	10.8																1
141	YGWO 4.5	06-17-2009	09:55:00	10																1
	# Exceeds			78	23	3	15	3	20	19	19	2	5	6	2	2	9	1	15	

* Aluminum >750 ug/l for all waters and >200 ug/l for waters with pH < 5.2.

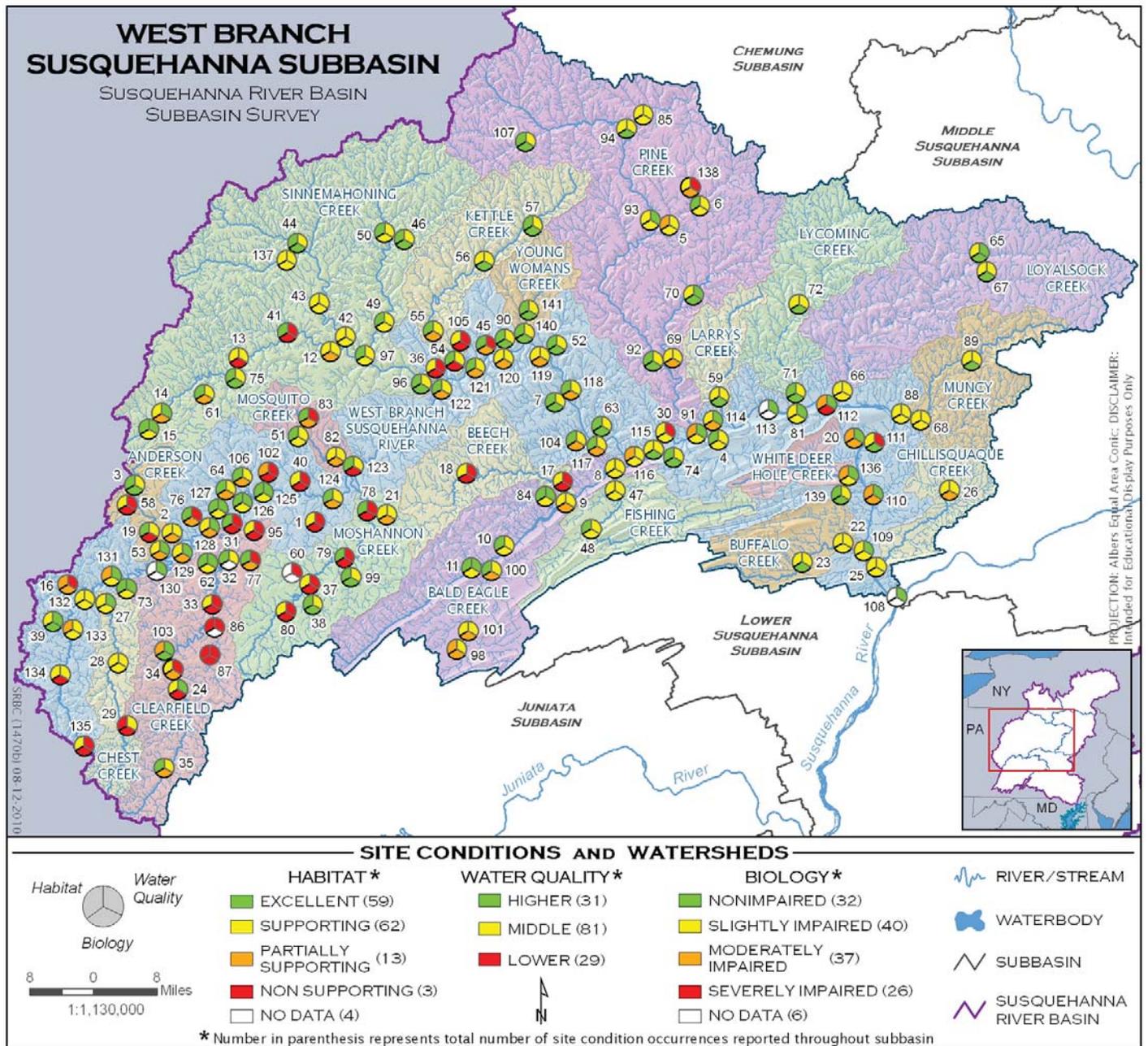


Figure 3. Water Quality, Biological, and Habitat Conditions in the West Branch Susquehanna Subbasin in 2009

HISTORICAL DATA COMPARISON

A comparison of the current 2009 data to historical data indicates that overall conditions in the West Branch Susquehanna Subbasin have improved over the years from the first time SRBC sampled in 1983. In particular, the AMD conditions appear to have improved, which may have been due to natural processes, but also was most likely facilitated by the numerous remediation efforts happening in many of the watersheds. The historical data comparison includes assessment of overall condition categories, water quality values exceeding levels of concern, and metric values able to detect AMD conditions.

Biological, water quality, and habitat conditions from the subbasin survey in 2002 (LeFevre, 2003) are depicted in Figure 4. The distribution of conditions was similar to that in 2009 (Figure 3) with the red colors (severely impaired, “lower”, and nonsupporting conditions) located in the abandoned mine land areas in the western portion of the subbasin and the green colors (nonimpaired, “higher”, and excellent) located in the northern and eastern portions of the subbasin. The watersheds that were higher quality and reference watersheds in 2002 continued to be higher quality in 2009. Some individual watersheds showed improvement, such as Babb Creek, Cush Creek, and Sinnemahoning Creek, and many sites on the West Branch Susquehanna River mainstem showed marked improvement from 2002 to 2009.

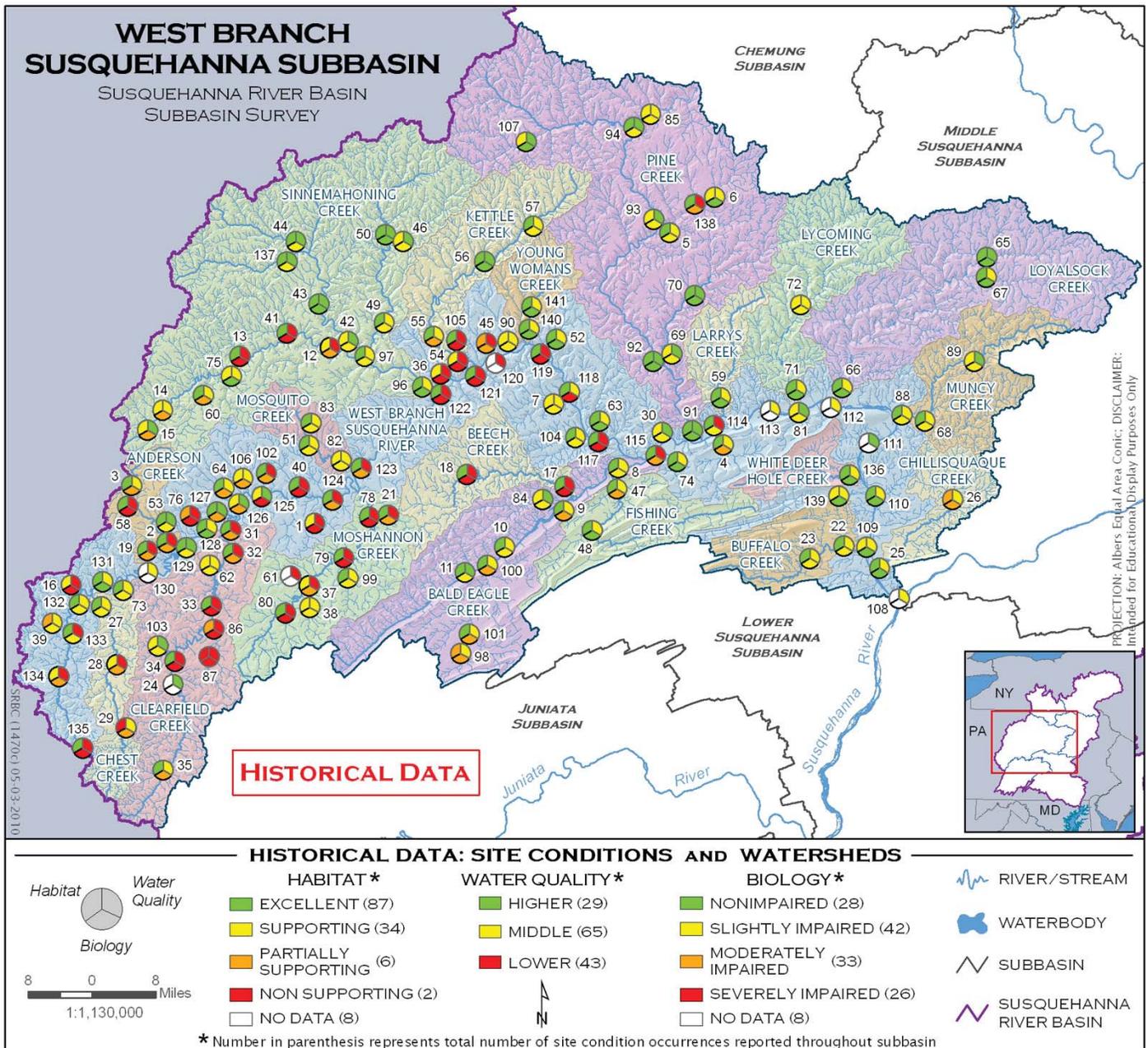


Figure 4. Water Quality, Biological, and Habitat Conditions in the West Branch Susquehanna Subbasin in 2002

Figures 5–8 show the percentage of biological condition categories in the different subbasin surveys in 1983, 1994, 2002, and 2009 for the sites that were sampled in all four surveys. These pie charts indicate that biological condition has improved from 1983 to 2009. The percentage of severely impaired stream sites has decreased from 38 percent in 1983 and 1994 to 18 and 15 percent in 2002 and 2009, respectively. The percentage of moderately and severely impaired sites has decreased from 52 percent and 54 percent in 1983 and 1994, respectively, to 43 percent and 45 percent in 2002 and 2009, respectively.

Table 4 shows the number of sites with water quality values exceeding levels of concern for sites sampled in both 2009 and 2002. This table indicates that alkalinity was the parameter that was exceeded at the highest number of sites for both years. In fact, the number of sites exceeding alkalinity increased slightly from 2002 to 2009, whereas all other parameters had a decrease or similar number of sites exceeding levels of concern. The decrease in the number of sites exceeding levels of concern from 2002 to 2009 may indicate improvement, or may be the result of dilution during higher flow conditions. All the sites had higher flows at the time of sampling in 2009 than in 2002, except for seven tributary and six mainstem river sites.

Table 4. Number of Sites with Water Quality Values Exceeding Levels of Concern for Sites Sampled in 2002 and 2009

Parameter	2002	2009
Acidity	40	9
Alkalinity	64	78
Aluminum T	25	23
Calcium T	9	0
DO	0	1
Hardness T	24	3
Iron T	18	15
Magnesium T	18	3
Manganese T	32	20
Nitrate-N	30	19
Nitrogen T	28	19
pH	20	15
Phosphorus T	1	0
Phos T Ortho	1	2
Sodium T	7	5
Sp. Cond	17	0
Sulfate-IC	23	6
Temp	4	0
TSS	3	2

Alkalinity was exceeded at many sites in 2009 that did not have any parameters exceeding levels of concern in 2002, such as on Driftwood Branch Sinnemahoning, headwaters of First Fork Sinnemahoning, headwaters of Kettle Creek, Larrys Creek, headwaters of Muncy Creek, and headwaters of Pine Creek. These headwater sites that had low alkalinity values at elevated flows may indicate influence of acidic atmospheric deposition.

Alkalinity was the parameter that exceeded levels of concern at the highest number of sites — 55 percent of the sites throughout the West Branch Susquehanna Subbasin.

AMD impairment was extensive in this watershed and many tributaries and the mainstem river have been mostly void of healthy macroinvertebrate populations and fish for decades. Numerous efforts have been made to remediate AMD conditions in this watershed, and assessment of the historical data from SRBC’s subbasin surveys conducted since 1994 indicates that conditions are improving. Due to different data collection and recording in 1983, the data from that survey were not used for the assessment of changing AMD conditions.

Insects of the order Ephemeroptera are commonly known as Upwinged Flies or Mayflies. Mayflies are one of the most sensitive orders to AMD conditions.

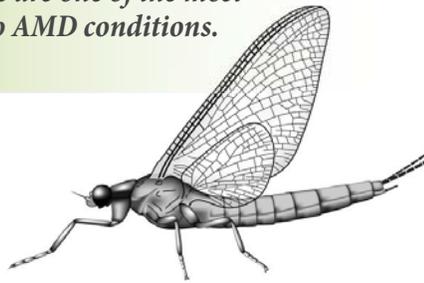


Image Credit: R.W. Holzenthal

The percent Ephemeroptera metric was used to assess improvement, since Ephemeroptera (mayflies) are one of the most sensitive orders to AMD conditions. As AMD streams improve, mayflies are once again able to inhabit them. Also, percent Ephemeroptera is a metric that most likely remained correct throughout the years as taxonomists and taxonomies changed. Approximately 46 percent of AMD-impacted sites (including the mainstem sites) improved in percent Ephemeroptera from 1994 to 2009. This increase in mayflies in AMD-impacted areas indicates improvement in conditions conducive to their survival, such as lower acidity and less metal precipitate embedding the substrate.

SUMMARY OF BIOLOGICAL CONDITIONS IN THE WEST BRANCH SUSQUEHANNA SUBBASIN

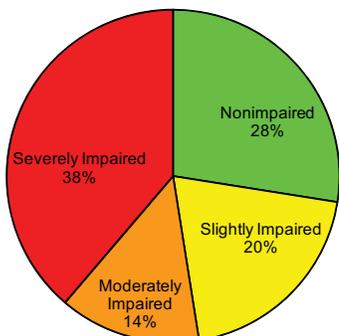


Figure 5. 1983 Biological Conditions

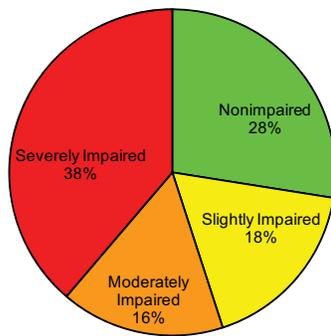


Figure 6. 1994 Biological Conditions

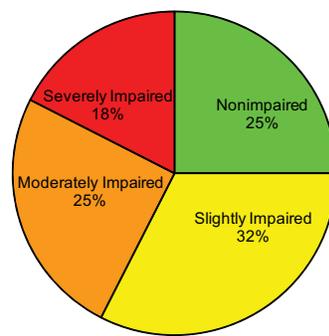


Figure 7. 2002 Biological Conditions

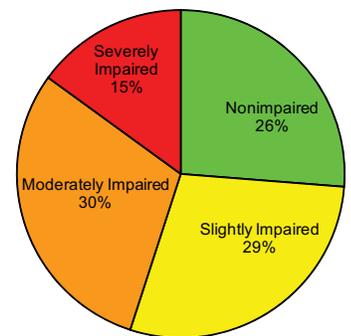


Figure 8. 2009 Biological Conditions

Figure 9 shows percent Ephemeroptera at the sites on the mainstem river (in river miles upstream from mouth) in 1994, 2002, and 2009. Arrows and letters “ND” indicate that no data were taken during that year. All other places without a bar line indicate that no mayflies were found at that site. The percentage of mayflies inhabiting the mainstem river improved mostly between the 2002 and 2009 surveys. The stretch of river from WBSR 172.3 (just upstream of Clearfield Creek in Clearfield) to WBSR 64 (just upstream of Jersey Shore) had large increases in percent mayflies in 2009. Many of the sites did not have mayflies in the 1994 and 2002 samples. The highest percentage of mayflies was found at the sites around McGees Mills. These sites had almost 70 percent Ephemeroptera. Some of the sites downstream of Jersey Shore had decreases in the percent Ephemeroptera metric in 2009. This may be due to sediment embedding the substrate and impacting macroinvertebrate habitat.

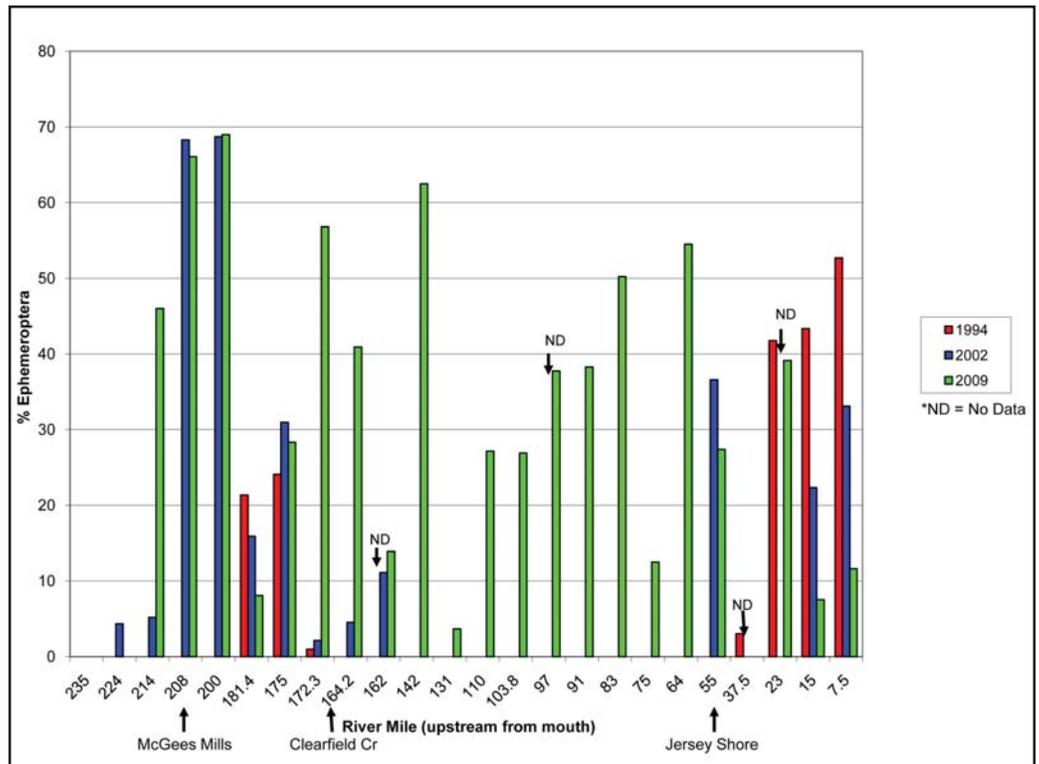


Figure 9. Percent Ephemeroptera at Mainstem Susquehanna River Sites during 1994, 2002, and 2009

Tributary watersheds that had increases of percent Ephemeroptera indicating improvements in AMD condition were Babb Creek, Chest Creek, Cush Creek, Kettle Creek, Mosquito Creek, Bennett Branch Sinnemahoning Creek, and Sinnemahoning Creek (Figure 10). Babb Creek had a large increase in mayflies in 2002 and a decrease in 2009, although the percentage of mayflies is larger than 20 percent (higher than 25 percent mayflies in the sample indicates healthy conditions). Remediation of Babb Creek began in 1990. In 2009, 14 miles of Babb Creek were removed from the 303(d) list of impaired waters. Chest Creek, Cush Creek, and Sinnemahoning Creek showed significant improvement throughout the years and all have percent Ephemeroptera values higher than 25 percent. Kettle Creek, Mosquito Creek, and Bennett Branch Sinnemahoning Creek appear to have started improving, but need additional restoration.

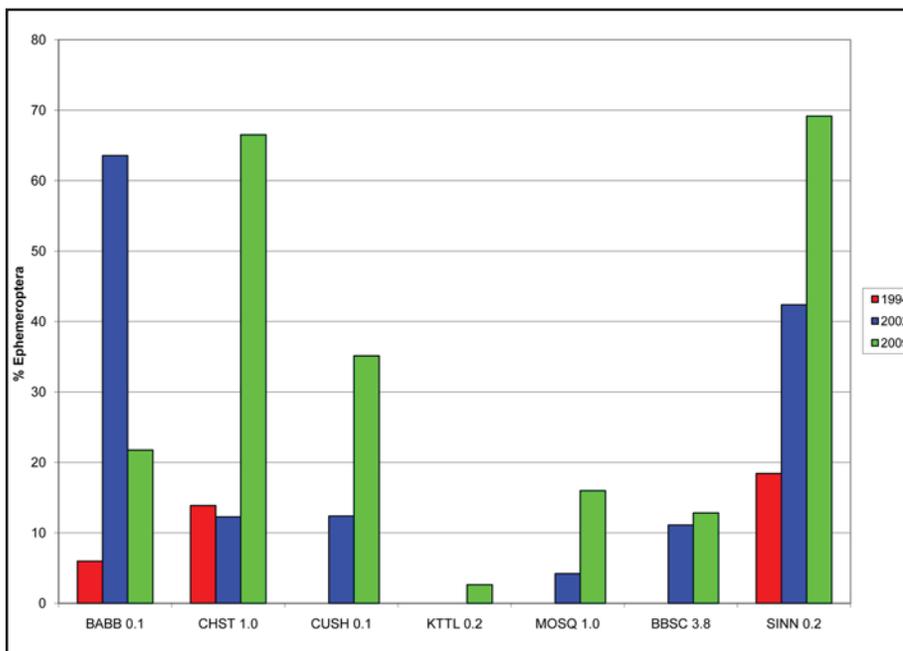


Figure 10. Sample Sites Showing Increased Percent Ephemeroptera Indicating Improved AMD Conditions



Photo Credit: NCSU