WATER QUALITY

Analysis and Results

Between sub-basins

We examined water quality parameters to determine if they varied between sub-basins. Mean values of water quality parameters for each sub-basin are reported in Table 5 and 6. To assess the significance of differences in water quality parameters between sub-basins, we used one-way ANOVAs (Analysis of Variance). Significance was assessed at the a = 0.05 level. Results of the ANOVAs are reported in Table 7. We found significant differences between sub-basins for several water quality parameters.

Significant differences between sub-basins were further assessed by comparing each sub-basin to the entire watershed. We did this to determine if any of the sub-basins stood out as potential problem areas compared to what was typical of the watershed. To test if sub-basin means were different from the overall mean, we compared 95% confidence intervals. First, we calculated the overall mean and 95% confidence interval (denoted by two numbers in parenthesis following the mean) for each parameter using all the data for the entire watershed. If the sub-basin mean did not fall within the overall 95% confidence interval, there is significant difference at the a= 0.05 level (Table 5 and 6). These analyses give us a good picture of which sub-basins are outliers compared to what was typically observed for the whole watershed.

Table 5: Mean values of water quality, habitat, and land-use parameters for each sub-basin. These values were compared to the mean and 95% confidence intervals for the entire French Creek watershed. Bolded values are significantly lower than the overall mean at the a=0.05 significance level.

		Conneaut	Conneauttee	Cussewago	French Creek	Le Boeuf	Little Sugar	Muddy	South Branch FC	Sugar	West Branch FC	Woodcock
Percent Forest		**46.2**	49.5	49.9	56.3	**45.6**	51.3	56.4	54.8	71.0	57.0	49.9
Habitat/Riparian 1		77.5	83	78.5	79	**64**	**73**	98.5	83	99	**75**	87
Habitat/Riparian 2		74	79	**70**	83	**64**	83	88.5	80.5	103	**69**	98
Total Habitat/Riparian		159	**143**	**148.5**	156	**128**	**151**	187	160.5	193	**144**	188
DO (%)	Spring	**96.6**	99.9	98.2	100.3	**96.5**	99.3	**96.6**	100.1	99.8	**95.9**	99.2
	Base	**73.8**	**84.1**	**70.5**	113.2	**83.9**	96.8	110.8	98.2	112.5	96.6	113.6
	Summer	**64.9**	**80.7**	92.2	103.3	**77.9**	162.4	94.7	100.5	113.3	102.1	**90.9**
DO Concentration	Spring	**10.36**	11.23	10.83	11.07	**10.46**	10.75	**10.47**	10.98	11.04	10.59	10.83
	Base	**6.42**	**7.77**	**6.39**	9.91	**7.38**	9.03	9.61	8.65	10.54	8.66	9.95
	Summer	**6.04**	**7.46**	**8.29**	9.20	**7.29**	15.27	8.79	9.27	10.75	9.49	**8.02**
pH	Spring	**7.34**	7.39	7.38	**7.48**	7.41	7.40	7.38	**7.46**	**7.31**	7.38	7.38
	Base	**7.73**	**7.83**	**7.68**	8.25	**7.60**	8.04	**7.96**	**7.94**	8.21	**7.88**	8.12
	Summer	**7.47**	**7.77**	8.03	8.04	7.92	7.87	8.00	8.04	8.00	7.97	8.04

Table 6: Mean values of water quality and land-use parameters for each sub-basin. These values were compared to the mean and 95% confidence intervals for the entire French Creek watershed. Bolded values are significantly higher than the overall mean at the a=0.05 significance level.

		Conneaut	Conneauttee	Cussewago	French Creek	Le Boeuf	Little Sugar	Muddy	South Branch FC	Sugar	West Branch FC	Woodcock
Percent Agriculture		37.6	**45.1**	38.6	39.8	**44.7**	**44.7**	37.2	39.4	27.2	36.4	38.6
N, nitrate + nitrite (mg/L)	Spring	0.22	**0.68**	0.41	**0.58**	0.34	**0.79**	**0.62**	**0.61**	0.38	0.26	0.52
	Base	0.18	**1.63**	0.20	0.40	0.23	0.46	0.23	0.68	0.37	0.56	0.20
	Summer	0.17	**2.97**	0.36	0.34	0.69	0.53	0.05	**0.76**	**0.75**	**0.84**	0.12
P, total (mg/L)	Spring	0.15	0.08	0.10	0.14	0.12	**0.20**	0.11	0.10	0.14	**0.19**	**0.28**
	Base	0.08	**0.18**	0.11	0.04	0.08	0.08	0.07	0.09	0.08	0.09	0.03
	Summer	**0.23**	**0.22**	0.04	0.06	**0.10**	**0.10**	0.09	**0.11**	0.05	0.04	0.08
N, kjeldahl (mg/L)	Spring	0.9	0.8	1.2	1.0	1.2	1.2	1.2	1.1	1.3	1.0	0.8
	Base	**1.4**	1.0	1.1	0.9	0.9	0.8	1.0	0.9	0.7	**1.4**	0.8
	Summer	**1.8**	1.2	1.4	1.0	0.8	1.3	0.7	1.1	0.7	**3.0**	1.0
TDS (mg/L)	Spring	**120**	**130**	88	**120**	**130**	110	91	**130**	66	**140**	110
	Base	**240**	**270**	180	200	210	190	175	**230**	140	**235**	140
	Summer	180	**260**	**220**	190	**230**	210	170	**225**	180	**225**	120
SS (mg/L)	Spring	37	12	11	43	12	66	**92**	30	23	33	**74**
	Base	6	6	6	5	5	6	5	5	5	7	5
	Summer	**71**	16	10	10	18	**44**	**27**	19	5	6	**36**
N, ammonia (mg/L)	Spring	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Base	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Summer	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
BOD (mg/L)	Spring	4	4	NA	4	4	4	4	4	4	4	4
	Base	4	4	4	4	4	4	4	**257**	4	4	4
	Summer	4	4	4	4	4	4	4	4	4	4	4
N, organic (mg/L)	Spring	0.65	0.00	0.80	0.50	0.70	0.40	**1.00**	0.60	**1.10**	0.75	0.30
	Base	**0.90**	-0.80	**1.10**	0.50	**0.70**	0.30	**0.70**	0.30	0.45	**0.75**	0.50
	Summer	**1.50**	-1.80	**1.00**	0.45	0.10	0.80	0.70	0.35	-0.10	**2.10**	0.90
Temperature (°C)	Spring	**12.09**	10.36	11.00	11.20	**11.54**	**11.82**	11.38	11.00	**11.69**	11.11	11.41
	Base	21.18	18.50	20.34	**23.07**	19.97	17.49	21.36	**21.55**	19.44	**22.07**	**21.90**
	Summer	18.76	19.12	**20.53**	**20.31**	18.51	18.31	18.94	19.25	17.85	18.84	**21.52**
Specific Cond. (mS/cm)	Spring	0.17	0.26	**0.14**	0.19	**0.21**	0.15	0.15	0.17	0.14	0.20	0.14
	Base	**0.36**	**0.41**	0.26	0.32	**0.34**	0.29	0.24	0.32	0.21	**0.38**	0.22
	Summer	0.24	**0.41**	0.24	0.29	**0.32**	0.25	0.24	0.29	0.22	**0.35**	0.18
Conductivity (mS/cm)	Spring	0.13	**0.18**	0.10	0.14	**0.15**	0.11	0.11	0.12	0.11	**0.15**	0.10
	Base	**0.33**	**0.37**	0.23	**0.30**	**0.33**	0.25	0.22	**0.30**	0.19	**0.34**	0.20
	Summer	0.21	**0.37**	0.22	0.26	**0.28**	0.22	0.21	0.26	0.19	**0.31**	0.16
Salinity (ppt)	Spring	0.08	**0.12**	0.07	0.09	**0.10**	0.07	0.07	0.08	0.07	**0.10**	0.07
	Base	**0.17**	**0.20**	0.12	0.15	**0.17**	0.14	0.11	0.15	0.10	**0.18**	0.11
	Summer	0.11	**0.20**	**0.11**	0.14	0.15	0.12	0.11	0.14	0.10	**0.17**	0.08

Table 7: Results of the ANOVAs comparing sub-basin means of water quality parameters for each sampling event. Significant (p-value <0.05) results are in bold type.

	Spring Rain		Base Flow		Summer Rain	
	F- value	**p-value**	**F- value**	**p-value**	**F- value**	**p-value**
N, nitrate + nitrite (mg/L)	**8.32**	**.000**	**3.36**	**.001**	**23.63**	**.000**
Phosphorus, total (mg/L)	1.01	.447	**2.70**	**.005**	**8.82**	**.000**
N, kjeldahl (mg/L)	1.23	.278	**2.62**	**.006**	**3.41**	**.013**
TDS (mg/L)	**5.35**	**.000**	**7.49**	**.000**	1.79	.140
SS (mg/L)	**2.13**	**.025**	1.33	.223	**4.29**	**.004**
N, ammonia (mg/L)	0.30	.984	**2.31**	**.015**	.658	.747
BOD (mg/L)	NA	NA	1.28	.323	.049	.999
N, organic (mg/L)	1.63	.104	**2.65**	**.006**	**5.38**	**.001**
Temperature (°C)	1.29	.268	**4.04**	**.000**	**4.16**	**.005**
Conductivity (mS/cm)	**3.62**	**.002**	**9.37**	**.000**	**3.72**	**.008**
Salinity (ppt)	**3.50**	**.002**	**8.50**	**.000**	**4.41**	**.004**
DO (%)	0.89	.549	**3.91**	**.000**	**3.71**	**.009**
DO (mg/L)	0.69	.752	**4.04**	**.000**	**4.19**	**.005**
pH	0.79	.634	**4.79**	**.000**	1.64	.177

Land-use

There is approximately 721,000 acres of land in the Pennsylvania portion of the French Creek watershed. Agriculture encompasses 38.0% of the land use while 55.8 % is forested land (Figures 2 and 4). The average percent agriculture for the entire watershed was 38.6% (35.7,41.6). Sub-basins with significantly higher than average percent agriculture were Le Boeuf (44.7%), Little Sugar (44.7%), and Conneauttee (45.1%). Sugar Creek had significantly lower than average percent agriculture (27.2%). The mean percentage of forested land for the entire watershed is 51.3% (47.1, 55.5). Only Sugar Creek was significantly higher than the watershed average, with 71% forested land. Those with significantly lower percent forested land were Le Boeuf (45.6%) and Conneaut (46.2%).

Habitat/Riparian Assessment

No significant differences were found between sub-basins for habitat/riparian score 1, which focuses on in-stream habitat (p-value = 0.07), habitat/riparian score 2 which focuses on riparian habitat (p-value = 0.15), or total habitat/riparian score (p-value = 0.08).

The overall mean for habitat/riparian score 1 was 79.6 (75.7,83.6). Habitat score 1 was significantly lower than the watershed mean in Le Boeuf and Little Sugar sub-basins. High areas of sediment deposition, for example, in Little Sugar Creek contributes to the low scores here. Habitat/riparian score 1 was significantly higher than the mean in Sugar Creek, Muddy Creek and Woodcock Creek sub-basins.

The overall mean for habitat/riparian score 2 was 79.6 (75.2,84.1). Habitat score 2 was significantly lower than the watershed mean in Conneaut, Cussewago, Le Boeuf and West Branch French Creek sub-basins. Thin riparian vegetative zones in Watson Creek and Rock Creek in the Conneaut sub-basin and Rundeltown Run and near the mouth of the Cussewago in the Cussewago sub-basin particularly contribute to low scores. Trout Run in Le Boeuf sub-basin had particularly low scores, showing problems with all aspects of the assessed habitat. Habitat/riparian score 2 was significantly higher than the mean in Sugar Creek, Muddy Creek and Woodcock Creek sub-basins.

The overall mean total habitat/riparian score was 159.3 (151.6,167.0). Total score was significantly lower than the overall mean for Le Boeuf, Conneauttee, West Branch

French Creek, Cussewago, and Little Sugar Creek sub-basins. Muddy Creek, Sugar Creek and Woodcock Creek sub-basins had higher than average total habitat/riparian scores.

Salinity

The mean salinity for the spring rain event was 0.09 ppt (0.08,0.09), and the maximum salinity measured was 0.16ppt. The means for base flow and summer rain were both 0.14 ppt (0.13,0.15). The maximum salinity measurement was during the base flow (0.42 ppt) at Darrows Brook in Conneauttee sub-basin. Other points above 0.20ppt during the base flow were 2 sites in Conneaut sub-basin (Conneaut Outlet confluence with Mc Michaels Run and Watson Run), 2 sites in Conneauttee sub-basin (Darrows Brook and Conneauttee Creek confluence with Darrows Brook), and Trout Run in Le Boeuf sub-basin.

Temperature

Although some differences in temperature were observed during the spring rain event, biologically speaking, there is no reason for concern. However, when temperatures rise above optimal or tolerable levels for fish and/or mussels during the summer, there is reason for concern. The mean temperature for all sub-basins during the spring flow was 11.16 °C (10.9, 11.4). The mean temperature for the base flow was 20.9°C (20.4, 21.5). The mean temperature during the summer rain event was 19.8°C (19.4, 20.2). During base flow, French creek main-stem mean temperature (23.1°C) was significantly higher than the watershed mean, as were mean temperatures for South Branch (21.6°C), West Branch French Creek (22.1°C) and Woodcock Creek (21.9°C). Two sites were dry during the base flow sampling period, Navy Run in Muddy Creek sub-basin and an unnamed tributary to Hubbel Run in the main-stem sub-basin. Forty-six sites had above average base flow temperatures (Table 8, Figure 5).

According to the Pennsylvania Code Title 25 Chapter 93, French Creek is designated as a warm water fishery, and temperature limits during the base flow event (early September) should not exceed 28.9°C. Although several sites had temperatures in the upper 20's, only one site had temperatures above 28.9°C during the base flow-sampling, site 60 at the mouth of Mill Run. To maintain cold-water fisheries, as some of the tributaries to French Creek are designated, 17.8°C is the maximum temperature level.

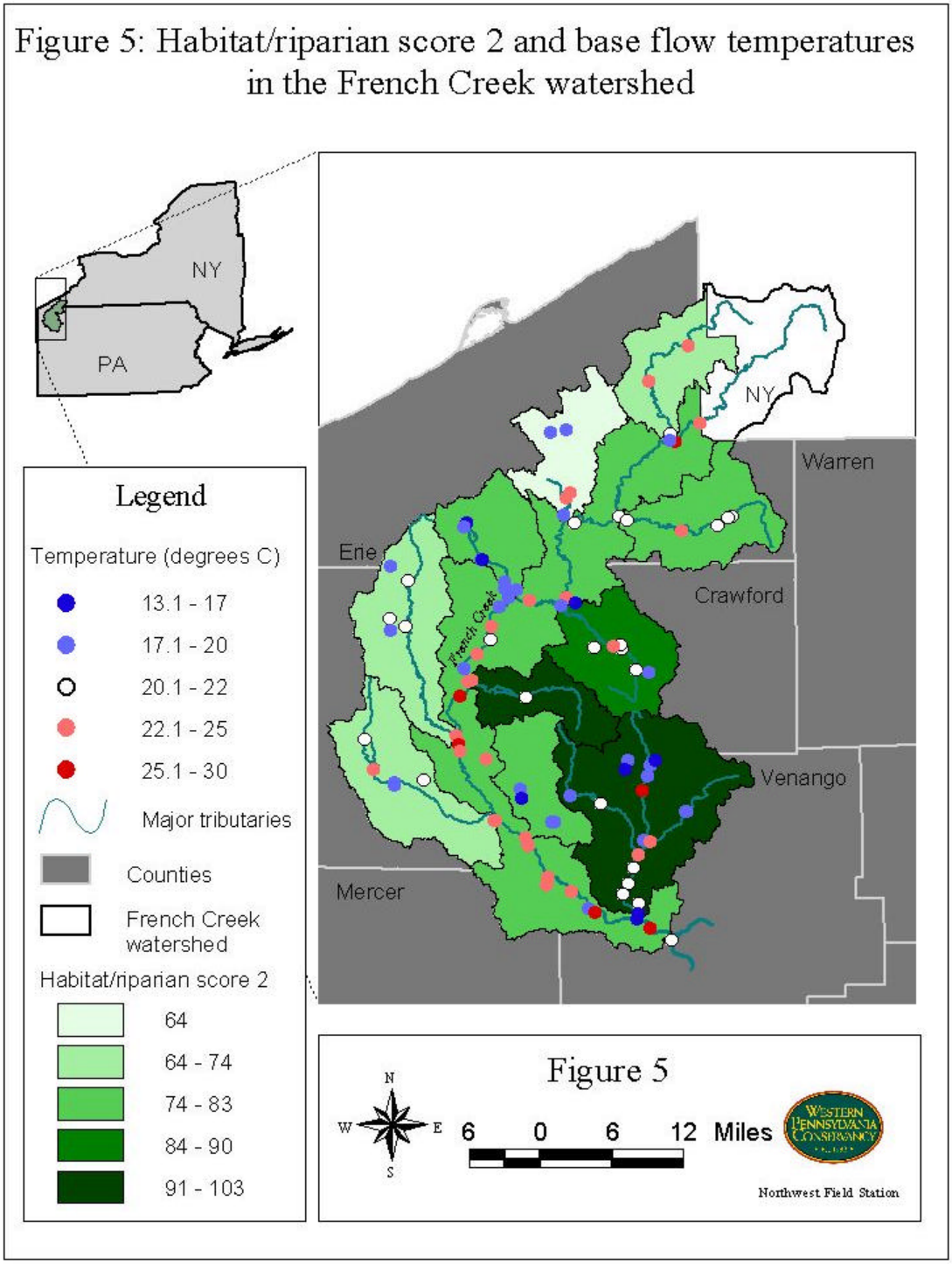

Table 8: Sites with significantly higher than average base flow temperatures (> 21.5 °C).

WQ site Number	Sub-basin	Site Name/Description	Temperature ° C
WQ60	French Creek	Mill Run (mouth)	29.15
WQ104	French Creek	FC us Franklin	26.81

WQ50	French Creek	FC us Cussewago Creek	26.17
WQ2	French Creek	Hubbel Run (mouth)	25.72
WQ87	Sugar Creek	West Branch Sugar Creek (mouth)	25.22
WQ80	French Creek	FC ds Utica	25.16
WQ45	French Creek	FC us Wolf Run	25.06
WQ62	French Creek	FC us Conneaut Outlet	24.97
WQ64	Conneaut	Conneaut Outlet ds Conneaut Lake	24.50
WQ78	French Creek	FC us Mill Creek and Utica	24.49
WQ75	French Creek	FC ds Cochranton	24.47
WQ76	French Creek	FC us North Deer Creek	24.44
WQ59	French Creek	Mill Run ds Tamarack Lake	24.32
WQ69	French Creek	FC us Little Sugar Creek	24.31
WQ95	Sugar Creek	Lake Creek (mouth)	23.86
WQ1	French Creek	FC on NY Border, us Hubbel Run	23.61
WQ58	French Creek	FC us Mill Run	23.42
WQ31	French Creek	FC us Cambridge Springs	23.24
WQ57	Cussewago Creek	Cussewago Creek (mouth)	23.20
WQ19	Le Boeuf	Le Boeuf Creek ds Lake Le Boeuf	23.17
WQ61	French Creek	FC ds Meadville	23.12
WQ12	South Branch FC	South Branch FC us Union City	23.07
WQ17	Le Boeuf	Le Boeuf Creek us Lake Le Boeuf	23.04
WQ47	French Creek	FC us Woodcock Creek	23.02
WQ43	French Creek	FC ds Venango	23.00
WQ49	Woodcock Creek	Woodcock Creek (mouth)	22.96
WQ91	Sugar Creek	East Branch Sugar Creek 2	22.85
WQ28	Muddy Creek	Muddy Creek us Mackey Run	22.82
WQ68	Conneaut	Conneaut Outlet (mouth)	22.82
WQ5	West Branch FC	West Branch FC us Alder Run	22.77
WQ101	Sugar Creek	Sugar Creek us Lick Run	22.75
WQ21	French Creek	FC us Muddy Creek	22.59
WQ42	French Creek	FC us Venango	22.49
WQ77	French Creek	North Deer Creek (mouth)	22.29
WQ4	West Branch FC	West Branch FC near NY Border	22.22
WQ74	Little Sugar Creek	Little Sugar Creek (mouth)	22.12
WQ26	Muddy Creek	Muddy Creek us Federal Run	21.96
WQ6	West Branch FC	West Branch FC us Wattsburg	21.92
WQ56	Cussewago Creek	Carr Run (mouth)	21.92
WQ29	Muddy Creek	Mackey Run	21.79
WQ44	French Creek	Gravel Run (mouth)	21.74
WQ63	Conneaut	Inlet Run us Conneaut Lake	21.72
WQ99	Sugar Creek	Sugar Creek us Warden Run	21.64
WQ32	French Creek	FC us Conneauttee Creek	21.63
WQ9	South Branch FC	South Branch FC us Slaughter Run	21.57
WQ10	South Branch FC	Slaughter Run	21.55

Dissolved Oxygen

In nearly all unpolluted streams and rivers, DO concentrations stay above 80% saturation (Hauer and Hill 1996). Although some sites in the spring rain event fell short of the watershed mean DO concentration of 98.0 % (96.8, 99.3), no sites had DO concentrations below 80% saturation. However, during the summer base flow event, 22 sites fell below that level. There were significant differences in base flow DO between sub-basins (p-value =0.00). The mean DO concentration for the base flow event was 98.0 % (92.1,103.9). The mean DO concentration in Cussewago sub-basin was only 70.0% (32.7,95.7), with 6 sites below 72%. A low DO of 12.4% was measured in West Branch Cussewago Creek (site 52), and 27.1 at Cussewago Creek (site 51). Mean DO in Conneaut sub-basin was 73.8% (34.3,92.8) with lows of 20.9% at the confluence of Conneaut Outlet and Mc Michael Run (site 65) and 38.8% at Mc Michael Run (site 66). Although the overall mean for Le Boeuf Creek was over 80%, levels were still significantly less than the overall FC watershed mean. Sites such as the confluence of Le Boeuf Creek and East Branch Le Boeuf Creek (site 15, 35.0%) and the mouth of Le Boeuf Creek (site 20, 69.7%) brought down the overall mean. Similarly, Conneauttee Creek had a mean of 84.1%, but had a few sites with very low DO saturation; Darrows Creek (site 36, 20.0%) and Shenango Creek (site34, 65.4%). Although the mean DO level in the main stem of French Creek was not significantly different from the whole watershed, there were a few sites that had quite low DO levels, particularly Torry Run (site 38, 25.1%), Wolf Run (site 46, 69.9%), and Mill Run (site 59, 75.5%). Sites 93 and 94 on Lake Creek in the Sugar Creek sub-basin should also be noted, with dissolved oxygen saturation at 20.5 and 21.9%, respectively. Table 9 lists sites with significantly lower base flow dissolved oxygen (below 80% saturation and/or below 7.0 mg/L). Figure 6 illustrates base flow dissolved oxygen levels.

According to the Pennsylvania Code Title 25 Chapter 93 warm water fishery designation, minimum daily average of dissolved oxygen concentrations should be at least 5.0 mg/L. Although several sites had dissolved oxygen below 5.0 mg/L at the time of sampling, we were unable to measure DO throughout the day to calculate the average daily rate.

The mean DO saturation during the summer rain event was 98.7% (91.6,105.9). Only 4 sites fell below 80% saturation; two sites on the main stem of French Creek; site 31 at Cambridge Springs (66.4%) and site 32 at Conneauttee Creek (66.4%), one site at the mouth of Conneaut Outlet (site 68, 64.9%) in Conneaut sub-basin, and the mouth of Le Boeuf Creek (site 20,77.9%). The mean DO saturation during the spring rain event was 98.0% (96.8,99.3), and no sites fell below 86% saturation.

Biological oxygen demand (BOD)

Only two readings for BOD were above the mean for all sites; site 13, the mouth of South Branch French Creek (513mg/L) and site 61, French Creek below Meadville (13mg/L). Both readings were taken during the base flow event.

Figure 6: Percent forested land and base flow dissolved oxygen percentages in the French Creek watershed

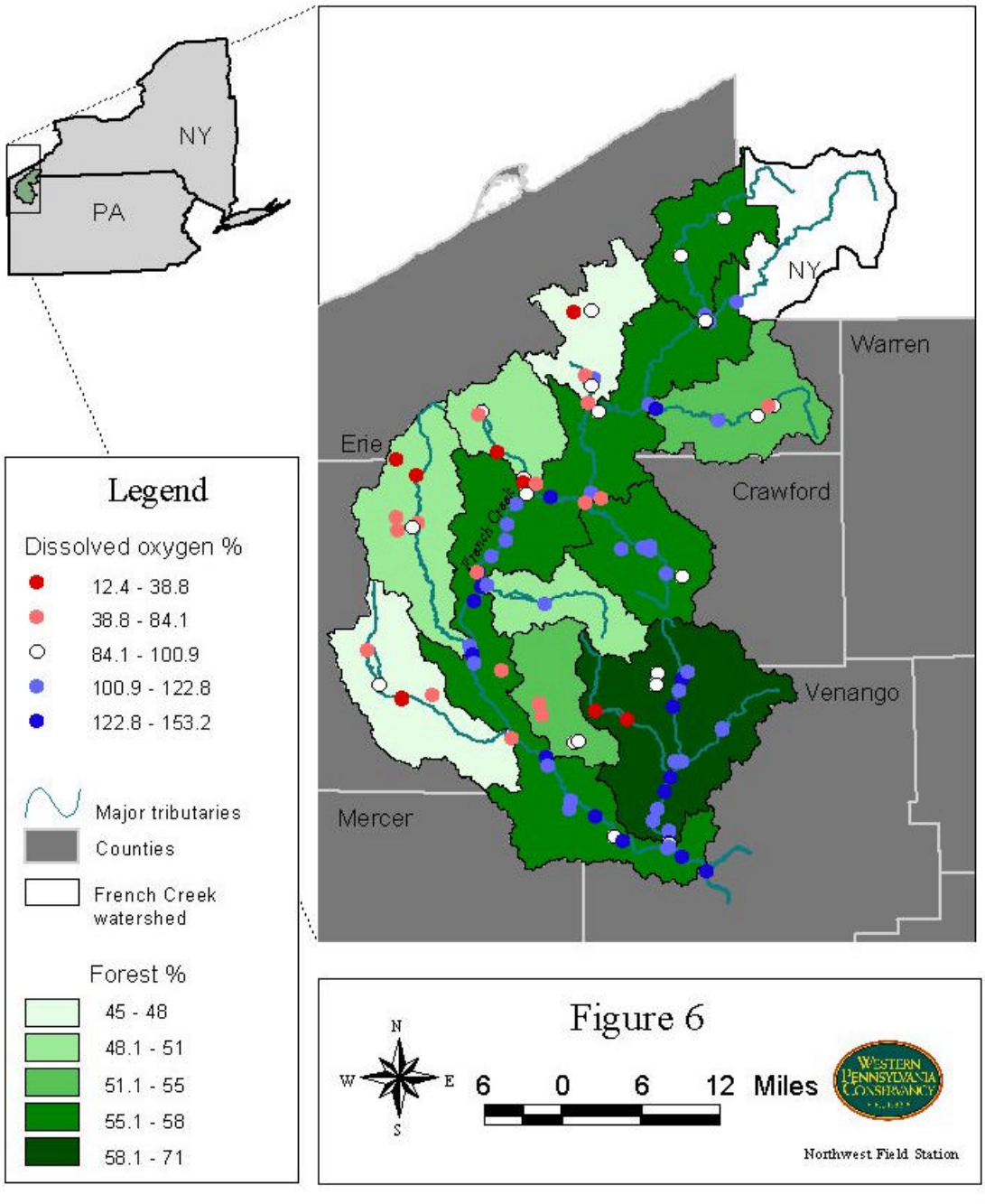

Table 9: Sites with significantly lower base flow dissolved oxygen (below 80% saturation and/or below 7.0 mg/L).

WQ Site Number	Sub-basin	Site Name/Description	DO %	DO (mg/L)
52	Cussewago Creek	West Branch Cussewago Creek	12.4	1.15
36	Conneauttee Creek	Darrows Creek (mouth)	20.0	2.08
94	Sugar Creek	Lake Creek ds Sugar Lake	20.5	1.85
65	Conneaut	Conneaut Outlet us Mc Michael Run	20.9	1.94
93	Sugar Creek	Lake Creek us Sugar Lake	21.9	2.01
38	French Creek	Torry Run	25.1	2.34
51	Cussewago Creek	Cussewago Creek us West Branch CC	27.1	2.44
15	Le Boeuf	Le Boeuf Creek us East Branch Le Boeuf	35.0	3.18
66	Conneaut	McMichael Run	38.8	3.66
34	Conneauttee Creek	Shenango Creek	65.4	6.12
63	Conneaut	Inlet Run us Conneaut Lake	69.5	6.11
20	Le Boeuf	Le Boeuf Creek (mouth)	69.7	6.65
46	French Creek	Wolf Run (mouth)	69.9	6.49
55	Cussewago Creek	Rundelltown Creek	70.2	6.39
54	Cussewago Creek	Carr Run us Rundelltown Creek	70.5	6.28
53	Cussewago Creek	Cussewago Creek us Carr Run	71.3	6.47
71	Little Sugar Creek	Mud Run	74.3	7.36
59	French Creek	Mill Run ds Tamarack Lake	75.5	6.32
70	Little Sugar Creek	Little Sugar Creek us Mud Run	76.5	7.31
22	Muddy Creek	Kelly Run (mouth)	76.8	7.42
68	Conneaut	Conneaut Outlet (mouth)	78.1	6.72
67	Conneaut	Watson Run	79.4	7.12

pH

The mean pH was 7.4 (7.35,7.44) for the spring rain event, 8.1 (8.0,8.2) for base flow, and 8.0 (7.9,8.0) for the summer rain event. It doesn't appear that pH is a problem for most sites in the French Creek watershed. The minimum for all sites during the spring was 6.87, the base flow was 7.19, and the summer rain was 7.47. The maximums were 7.73, 9.38, and 8.21 for the spring, base, and summer events respectively.

Rain Sampling

Nutrient concentrations from the three sites where rain was collected during the spring rain event are illustrated in Figure 7. During the spring rain, the concentrations of organic nitrogen and kjeldahl nitrogen were high at the northernmost site (Lake Pleasant) and the mid-watershed site at Meadville. Levels of kjeldahl nitrogen were high at the southernmost site (Franklin). Concentrations of organic nitrogen and nitrogen (nitrate + nitrite) were about half that of kjeldahl nitrogen at Franklin.

Main-stem habitat evaluation

Figure 8 is a map of the large (>100 m length) flow regimes along the main-stem of French Creek. These flow regimes were used to evaluate potential study sites for future fish and mussel study.

Results from the riparian assessment on the main-stem sites show that the upper section (defined as French Creek above Cambridge Springs) had a mean riparian score of 58.5% (54.4, 62.6), the middle section (defined as French Creek between Cambridge Springs and Meadville) had a mean riparian score of 59.4% (54.0,64.8), and the lower section (defined as French Creek below Meadville) had a mean riparian score of 57.1% (54.2,60.0). The one-way ANOVA showed no significant difference between the 3 stream sections (F-value =0.92, p-value=0.40). The overall mean for all sites on French Creek was 58.1% (56.0, 60.3).

Discussion of Results

Temperature and dissolved oxygen are highly variable both spatially and temporally. Temperature is very important to aquatic organisms since many life history variables such as reproduction and growth are often regulated by temperature. Many stream organisms use temperature as a cue for emergence or spawning. Both temperature and dissolved oxygen fluctuate diurnally and between microhabitats. While mobile organisms can seek cool refuges, less mobile organisms such as freshwater mussels, cannot easily escape intolerable temperatures or levels of dissolved oxygen. For these reasons summer temperatures and dissolved oxygen should be studied in more detail.

Our study only provides a snapshot of these temporally varying parameters such as dissolved oxygen and temperature. Low DO levels observed at several sites warrant additional investigation, perhaps with permanent water quality monitoring stations.

Organic pollution, for instance, that linked with municipal sewage treatment discharge or industrial wastes, may drastically reduce DO concentrations as microbes consume oxygen. BOD is a measure of the microbial oxygen consumption, so attention should be made to the two sites with high BOD readings.

Use of salt to clear roads of ice can be a significant source of elevated concentrations of NaCl in stream water. Although we expected high salinity during spring runoff, this was not observed in our data. This is likely due to most road salts being washed downstream during snow melt prior to our spring sampling.

Recent studies have shown that the pH of acid rain in the French Creek watershed ranges between 4.33 and 4.39 (reported in French Creek Watershed Conservation Plan, WPC 2002). Although we did not observe acidic conditions in the streams, precipitation can also carry various chemical pollutants, including nitrogen and phosphorus. Rain samples showed a large amount of kjeldahl nitrogen and organic nitrogen added to the system from atmospheric sources, especially in the middle and northernmost portions of the watershed.

Sub-basins with high percentages of agriculture generally had high nutrient and sedimentation concentrations, and low habitat and/or riparian scores. These relationships will be discussed later in this report.

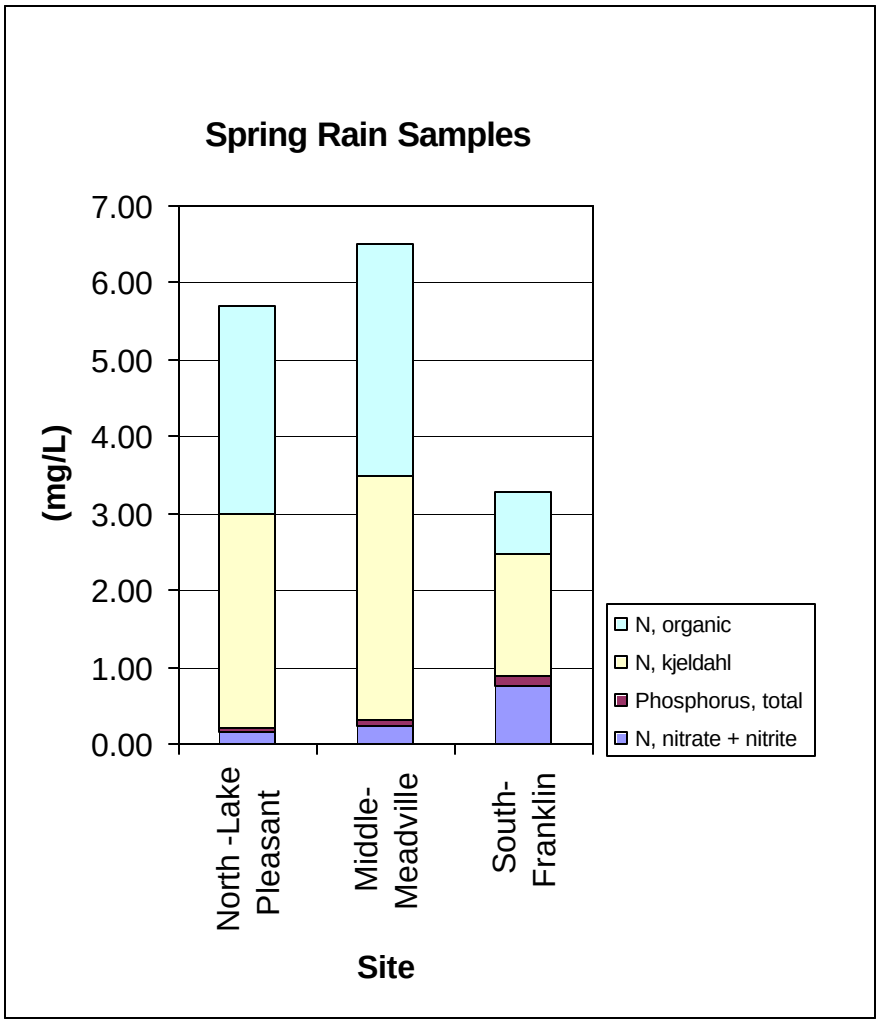

Figure 7: Nutrient concentrations from the three sites where rain was collected during the spring rain event.