corridor, and synoptic surveys. These supporting documents provide a more detailed assessment of the Deer Creek Watershed and are located at *http://dnr.maryland.gov/watersheds/surf/proj/wras.html.* More information about the WRAS process is available at *http://dnr.maryland.gov/watersheds/WRAS/.*

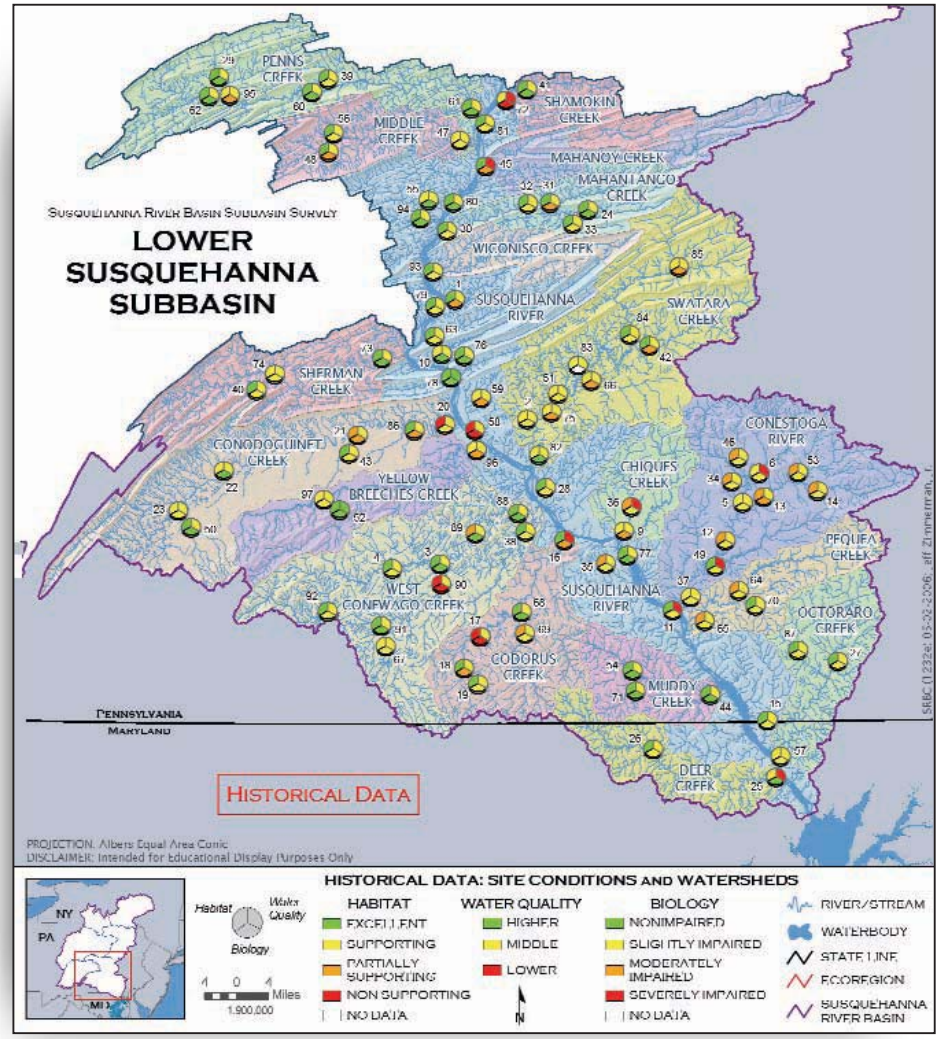
SUSQUEHANNA RIVER MAINSTEM

The Susquehanna River Mainstem sites were analyzed separately from other Lower Susquehanna Subbasin sites due to their large drainage size and different nature. SUSQ 77.0 served as a reference site for the Susquehanna River Mainstem sites. All the sites on the mainstem Susquehanna River had fairly similar biological conditions except for SUSQ 122.0, which was rated slightly impaired. Ironically, this was the only site to receive a "higher" water quality rating. This was most likely due to dilution or a one-time sample that was not representative of usual conditions. SUSQ 122.0 was located downstream of Sunbury, Pa., which is where the West Branch Susquehanna River and the North Branch Susquehanna River join to form the main stem. The next two sites downstream, SUSQ 106.0 and SUSQ 94.0, received "lower" water quality ratings mostly due to elevated specific conductivity. This elevated conductivity may be due to the influence of the AMD-impacted streams that flow into the Susquehanna from the east. The site farther downstream, SUSQ 77.0, was downstream of the high quality streams, such as Powell, Clark, Stony, and Sherman Creeks. Slightly elevated total nitrogen and sodium were the reason for the "middle" water quality rating. SUSQ 44.5 also was rated as "middle" quality with slightly elevated total nitrogen, sodium, and temperature. This site was an Interstate Streams Monitoring site and had received nonimpaired and slightly impaired ratings throughout the past couple years, although no sample was collected in 2003 (Hoffman and Sitlinger, 2005).

COMPARISON of 1996 and 2005 DATA

A comparison of historical Lower Susquehanna Subbasin data from 1996 and the current survey data from 2005 indicated overall similarity with some slight changes in biological and water quality conditions. Biological conditions seemed to be slightly better in 2005, while water quality appeared to improve in some parameters but degrade in others. The results for water quality, biological, and habitat conditions in the 1996 Lower Susquehanna Subbasin Survey are depicted in Figure 5. Two sites, CEDR 0.1 and CHIQ 20.0, were added to the survey in 2005 and are in blue print in the Appendix, since these sites were not included in the historical data. The methods have changed slightly throughout the years, and the methods for the 1996 survey can be found in Traver (1997). Specifically, the number of macroinvertebrates subsampled changed from 100 to 200, the habitat assessment form changed to assigning each parameter 20 points instead of weighting the parameters with different point ranges, and the water quality assessment analysis has changed. In the 1997 report, Traver assessed water quality using Principal Components Analysis and cluster analysis and did not assign rating categories for site conditions. For comparison purposes, the 1996 data were analyzed using current methodology to acquire water quality site condition ratings. In addition, the reference categories have changed due to advances in Geographic Information Systems technology and calculation of drainage size. MNTN 3.0 was the only site in Ecoregion 66, so this site was grouped with 67cd.

Figure 5. *Water Quality, Biological, and Habitat Conditions in 1996 Sample Sites in the Lower Susquehanna Subbasin*



Another difference between the data sets was flow, which varied from site to site for different years.

In 1996, 28 percent of the biological conditions were nonimpaired, 50 percent were slightly impaired, 18 percent were moderately impaired, and four percent were severely impaired (Figure 6). A summary of the biological conditions in 2005 showed a larger percentage rated as nonimpaired (43 percent), 33 percent slightly impaired, 22 percent moderately impaired, and two percent severely impaired (Figure 7). Of the sites that were sampled in 1996 and 2005, 59 percent maintained the same site condition rating, 28 percent improved, and 13 percent degraded. The improvements and degradations were only by one category step, except for CODO 22.4, WCON 35.5, and YLBR 3.4, which improved, and ELKN 0.1 and MISP 0.5, which degraded by more than one step in biological condition from 1996 to 2005. CODO 22.4 showed the most significant improvement from severely impaired to nonimpaired biological condition.

The 1996 water chemistry data were analyzed using current methods and levels of concern, and two percent of the sites were considered "higher," 90 percent were "middle" quality, and eight percent were considered "lower" quality. In 2005, six percent were "higher" water quality, 77 percent were "middle" quality, and 17 percent were considered "lower" quality. A site-to-site comparison indicated that 83 percent of the sites had the same water quality site condition category in 2005 as in 1996, seven percent improved, and ten percent degraded. The only site to change by more than one step was MNTN 3.0, which degraded from "higher" to "lower."

Table 7 shows a comparison of the total number of sites to exceed levels of concern for the sites that were sampled in both 1996 and 2005. The amount of sites to exceed levels of concern for each parameter was relatively similar except for total nitrate-n, total nitrogen, total phosphorus, and total sodium. The number of sites to exceed levels of concern for total nitrate-n and total nitrogen decreased; however, the number of sites for total phosphorus and total sodium increased from 1996 to 2005. A decrease in total nitrate-n and total nitrogen over the years may be due to localized implementation of Best Management Practices (BMPs) such as manure storage, manure digesters, contour plowing, etc. and updates in wastewater treatment systems and infrastructure. The increase in total phosphorus and sodium may be due to additional development increasing the amount of erosion from disturbed land, erosion from stream banks due to increased runoff, and more sodium from pavement runoff. The highest total nitrogen values in 1996 and 2005 were 12.3 mg/l and 11.37 mg/l, respectively, and they were both from the same site, LCHQ 0.4, on Little Chiques Creek. The same was true for total nitrate-n with values of 12 mg/l and 11.2 mg/l, respectively. CCLC 12.2 had the highest total phosphorus, total sodium, total chloride, and total orthophosphate in 1996. In 2005, this site had similar values for these parameters, but the highest values were found at MIDL 0.7 for total phosphorus, MILL 0.3 for total sodium and total chloride, and EMAH 0.2 for total orthophosphate.

Figure 6. *Summary of the Biological Conditions in the Lower Subbasin in 1996*

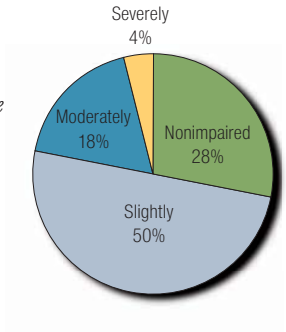
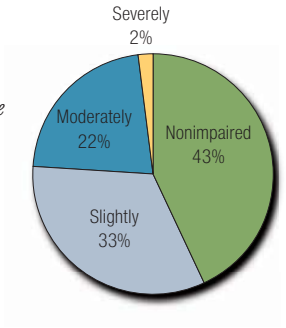


Figure 7. *Summary of the Biological Conditions in the Lower Subbasin in 2005*



Conclusions

Overall, conditions of streams sampled during the 2005 Lower Susquehanna Subbasin Survey were satisfactory; however, improvement was needed at many of the stations. Less than 50 percent of the sites sampled had nonimpaired biological conditions and less than 10 percent of the sites had "higher" water quality ratings. Only 30 percent of the habitat assessments were excellent, suggesting more effort is needed to physically protect streams. The largest cause of impairment appeared to be from nutrients, which may have originated from excess fertilization of agricultural fields and residential lawns, uncontrolled barnyard runoff, livestock directly accessing streams, increased loads from point sources, leaking septic tanks, outdated sewage treatment plants, or combined sewer overflows. Combined sewer overflows occur in some older towns where the infrastructure was developed to channel stormwater runoff from the streets into the wastewater treatment plants. When these systems receive too large an amount of water, such as during a large storm, they are unable to process and treat the waste, resulting in raw sewage discharge to the streams.

Another significant source of pollution appeared to be urbanization. Sodium levels were high in numerous streams, and habitat assessments indicated problems with channelized streams, eroded banks, and litter. In areas where most of the land is paved or developed, there is no place for precipitation to be

Table 7. *Number of Water Quality Values Exceeding Levels of Concern for the same sites in 1996 and 2005*

Year	Lab Alkalinity	Calcium T	Hardness T	Iron T	Magnesium T	Manganese T	Nitrate-N T	Nitrite-N T	Nitrogen TOT	Phos T Ortho	Phosphorus T	Sodium T	Sulfate T	Acidity	Specific Cond.	Water Temp.	Lab pH
1996	13	0	1	2	0	2	95	2	100	32	16	8	1	1	0	4	1
2005	10	1	2	3	1	2	70	4	82	34	29	21	1	1	3	12	0