LAND USE ASSESSMENT OF LONG'S PARK CREEK WATERSHED

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INTRODUCTION

The Little Conestoga Creek Watershed, covering 65.5 mi^2 in the south central Pennsylvania county of Lancaster is a key part of the drainage basin of the Conestoga River. This watershed lies in the Susquehanna River Watershed, which is the largest tributary of the Chesapeake Bay. This estuary is the largest in the United States and has been plagued with environmental problems for decades. Since the 1980s many restoration efforts have been made to reduce some of the effects of pollution in the Chesapeake Bay Watershed. In order for large-scale restoration projects to be successful, efforts must begin at headwater sites such as the Little Conestoga Creek and its tributaries.

Long's Park Creek (LPC) is one of the tributaries that is a possible candidate for a small-scale restoration project. This 2.05 mi^2 watershed contains highly impacted urban areas, a stretch of woodlands, a number of highways and a small farm. Because of this varied setting, the creek exemplifies many of the issues of Lancaster County streams. Each of these land types affects the health of the stream differently. The urban development along LPC distinguishes it from other tributaries of the Little Conestoga Creek, which flow mainly through suburban developments and agricultural lands. Changes in land use in LPC Watershed are reflected in both the stream channel geometry and the chemistry of the water and sediment. Through a study of these aspects one can gain a better understanding of the condition of this stream and the possibility for restoring equilibrium.

METHODS

Field Work

Nineteen sites along LPC were chosen to survey in order to provide examples of both impacted and more natural reaches of the stream and thereby determine the affects of urbanization on channel morphology. At each site, the cross-section was performed using an automatic level and a stadia rod. A separate group of sites was chosen as water and sediment testing locations, again for their representation of differing levels of development. On site, the water was tested for temperature, dissolved oxygen, pH, and total dissolved solids, and in the lab, the water samples were tested for nitrate and phosphate levels. A sediment sample was collected at the same locations to determine heavy metal concentrations. In order to provide a background with which LPC data could be compared, sixteen USGS sites were also sampled (Lopar and Davis, 1998).

Lab Work

All the water samples were tested for both nitrate and phosphate levels using a Spectronic 20D spectrometer. The sediment samples were tested for concentrations of cadmium, magnesium, lead, barium, zinc and iron in an Inductively Coupled Plasma Atomic Emissions Spectrometer (ICP-AES). The samples were put through EPA acid digestion process 3050 and then run through the ICP-AES. All of the sampled sites were entered into an ArcView GIS Database, along with the location of all out fall pipes along LPC. Building cover for 1947, 1971, and 2000 was calculated on the database by digitizing buildings from aerial photographs for those years.

RESULTS

The physical characteristics of LPC proved to be highly variable. Three cross-sections were chosen to represent the characteristics of differing land-uses. Cross-section “A” was taken in a wooded area near the confluence of LPC and the Little Conestoga Creek, and cross-section “G” was taken approximately 15 meters upstream. Both show a healthy riparian zone and a well-developed floodplain. “A” is a good example of a more natural stream. “G” is located just downstream of an artificially straightened stretch of the stream, which was altered to protect a sewage line from erosion. Upstream of cross-section “G”, where cross-section “Q” was taken, development is more prevalent. “Q” has a characteristic V shape.

All geochemical and nutrient data for LPC can be found on Table 1 and their corresponding locations are in Figure 1. On 6/19/01 nitrate levels varied from 5.0 mg/L to 9.2 mg/L. On 7/3/01 levels ranged from 1.9 mg/L to 6.2 mg/L. Additional sites tested on 7/3 were also relatively low. Phosphate levels on 6/19 averaged 0.34 mg/L; on 7/3 they averaged 0.27 mg/L. The average of the additional sites was 0.26 mg/L.

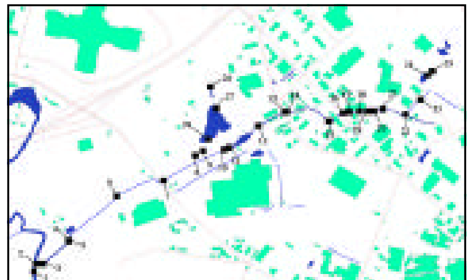

Fig. 2 Sample sites along Long’s Park Creek

Plotting amounts of cadmium, zinc, and lead in stream sediment samples collected on 7/3/01 against a ratio with respect to a mean value of metal concentration found in uncontaminated soils (data from Bowen, 1979), the trends of metals throughout the watershed can be seen. Cadmium concentrations stay relatively constant throughout the watershed except for sites 18 and 23. Lead and zinc, however, show a distinct change upstream of site 10, where concentrations surpass the mean. Also there is a distinct drop below the mean, for lead, upstream of site 22. The zinc concentration drops below the mean upstream of site 23.

Re-sampling of multiple sites on different dates revealed consistently proportional relations in concentration of metals at each site. When overlapping sites were compared for two different dates (6/27/01 and 7/3/01), trend lines for cadmium, zinc and lead all had a slope of 1±0.2. This shows that the data remained relatively consistent between the two sample dates.

DISCUSSION

The shape of Cross-section “Q” is most likely caused by developing the land along the stream banks, straightening the stream, and reinforcing it with riprap to protect the

Tabel 1. Water sampling results for Long's Park Creek sites on 6/19 and 7/3*

Site	T°C 6/19	T°C 7/3	pH 6/19	pH 7/3	TDS 6/19	TDS 7/3	DO 6/19	DO 7/3	Nit 6/19	Nit 7/3	Phos 6/19	Phos 7/3
1	21.3	19	7.8	8	380	244	6.50	9.28	8.5	5.7	0.45	0.17
2	21.6	19	7.6	8.1	369	334	7.74	8.75	9.2	6.2	0.35	0.26
3	21.0	18	7.7	8.3	395	390	7.41	9.51	5.4	2.4	0.57	0.12
4	21.3	19	7.7	8.4	393	392	7.43	9.39	5.0	2.9	0.11	0.04
5	16.1	16	6.7	7.2	461	453	NT	5.95	5.9	3.2	0.44	0.16
6	NT	20	NT	8.4	NT	395	NT	9.02	NT	2.5	NT	0.05
7	19.5	18	7.5	8.2	417	415	6.44	8.52	6.8	3.1	0.13	0.15
8	NT	20	NT	8	NT	422	NT	7.71	NT	3.3	NT	0.29
9	NT	20	NT	8	NT	424	NT	7.8	NT	3.4	NT	0.24
10	NT	19	NT	7.9	NT	391	NT	8.75	NT	2.9	NT	0.2
11	NT	20	NT	8	NT	389	NT	11.1	NT	3.5	NT	0.22
12	NT	18	NT	8.1	NT	426	NT	8.58	NT	3.2	NT	0.08
13	NT	18	NT	7.9	NT	428	NT	9.1	NT	3.1	NT	0.25
14	17.5	18	7.6	8	426	430	7.33	9.12	5.5	3.3	0.33	0.21
15	NT	17	NT	8.1	NT	426	NT	8.62	NT	2.9	NT	0.13
16	NT	16	NT	8.1	NT	427	NT	9.08	NT	3.3	NT	0.18
22	NT	21	NT	7.6	NT	419	NT	5.86	NT	2.6	NT	0.27
24	NT	29	NT	7.9	NT	356	NT	8.98	NT	1.9	NT	0.61
25	NT	28	NT	7.7	NT	362	NT	15	NT	1.9	NT	0.7
26	23.1	24	7.1	8	385	385	5.46	9.41	5.3	1.7	0.37	0.01
27	25.8	27	8.3	9.2	294	300	10.22	14.6	8.1	1.9	0.33	0.78
28	NT	26	NT	9.1	NT	286	NT	13.5	NT	1.9	NT	0.66

*(TDS-Total Dissolved Solids (ppm), DO- Dissolved Oxygen (mg/L), Nit-Nitrates (mg/L), Phos-Phosphates (mg/L), NT-Not Tested

surrounding areas from erosion. These actions increase runoff and therefore discharge, increasing sediment load, which leads to incising and steepening of banks. Cross-sections "G" and "A" are located in a less anthropogenically impacted area. These cross sections exhibit a more natural shape. Cross-section "G" shows a traditional meander profile, with the deposition bank on the left and the cut-bank on the right. Cross-section "A" shows a traditional pool profile. The dramatic difference between the channel geomorphology of the urban area and that of the forested area is an example of how land use practices have affected the physical properties of the stream.

When viewed against the backdrop of the rest of the Little Conestoga Creek Watershed, the nitrate and phosphate levels of LPC are lower than average. All of the nutrient concentrations fall below the safe limit of 10 mg/L of nitrates for drinking water (Commonwealth of Pennsylvania, 1994). Table 1 shows both nitrate and phosphate data for the 22 samples collected from LPC and the 16 USGS sites that were re-sampled. LPC nutrient levels were lower than the USGS sites because the land use around LPC is primarily commercial. Over 80% of the land in the Little Conestoga Creek Basin is used for agriculture, and most of the USGS sites are located on streams that flow through farmland. As suspected, the runoff from fertilized fields is a major contributor of nutrients.

When compared to sediment samples from the USGS sites, the LPC is elevated in zinc, cadmium, and lead (Fig. 2). Between sites 10 and 11 there is a dam on the LPC. Upstream of this dam, concentrations of lead and zinc are higher than the rest of the stream. The dam may be acting as a trap for sediment laden with heavy metals, keeping them in the upper reaches of the stream. The upper sites, 24 and 25, lie in the Dillerville swamp, which is upstream of major industries. Site 26 is

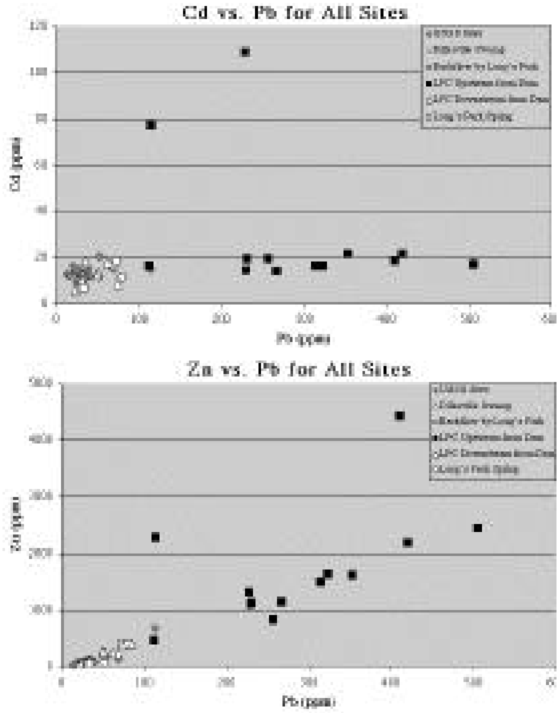

Fig. 2. Levels of Zn, Pb, and Cd in LPC sediments are much higher than those found in USGS sites.

Long's Park Pond and is therefore not subject to industry.

The most probable sources for zinc and lead are industries in the northern area of the city of Lancaster. In this area there are companies with a history of metal pollution (EPA Toxic Release Inventory, 2001), including the metal processing plant, Alcoa, a Superfund site. Additionally, the watershed is underlain by the Ledger Formation, a limestone-dolomite unit that contains some layers of zinc ore (Freedman, 1972). Runoff from road surfaces (motor oil, tire tracks, gasoline) or fly ash (Page *et al*., 1979) from smokestacks could also be sources of metal pollution.

Cadmium levels are relatively consistent throughout the Little Conestoga Creek watershed, with the exception of the two LPC sites, which are high due most likely to point source pollution. Still the Little Conestoga Watershed concentrations are very high (between 4 and 22 times the mean value of uncontaminated soils (data from Bowen, 1979)). The consistency of cadmium levels suggests a background source for the metal, perhaps in the bedrock or from long term discharge of fly ash. Further research is required to determine the exact source.

CONCLUSIONS

This study has attempted to indicate some the effects of urbanization on a stream. LPC is a unique section of the Little Conestoga Watershed and while development clearly has had many negative effects, the stream does have some positive characteristics as well. Negative aspects include radically altered physical characteristics such as the artificially steepened and straightened stream channel, and lack of a natural flood plain. All of these problems contribute to frequent flash floods and overall degradation. Positive characteristics include the lack of farmland, which has resulted in lower nutrient pollution, and a fairly healthy riparian zone in some stretches that helps reduce erosion and keeps temperatures lower.

The high metal concentrations are also a cause of concern. The concentrations of zinc and lead are up to ten times the uncontaminated mean (Bowen, 1979) and cadmium concentrations exceed one hundred times the uncontaminated mean (Bowen, 1979) in some areas. If the dam between sites 10 and 11 were removed, large amounts of suspended sediment would increase metal concentrations downstream. Organisms lower on the food chain, such as bottom feeders, could take greater concentrations of heavy metals into their tissues. In turn, higher organisms that eat the lower organisms would accumulate even higher concentrations of these toxic metals in the process of biomagnification.

Due to the time constraints of the project, the number of sampling locations had to be limited. For better results, many more sediment and water samples would have to be taken in a more systematic way and averaged together. Rather than collecting the sediment from the same part of the stream channel each time, the samples were selected on the basis of where the finest grains could be gathered. In the future, the tests should be conducted several times throughout the year in order to rule out seasonal variations. Finally, a more in depth look at the sediments trapped behind the dam in LPC could possibly provide a record of industrialization through metal concentration.

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