Post-Flood Monitoring of Aquatic Vegetation in the Bow River, Alberta, Canada

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Introduction

Flooding is a significant catalyst for change in aquatic ecosystems and depending on the magnitude of the flood, systems can take many years to regain pre-flood conditions. Recovery of ecosystems from such events is not well understood as river characteristics differ drastically between basins. In June of 2005, the Bow River experienced a flood of such a magnitude as to scour much of the aquatic vegetation and redistribute the sediment nutrient stores.

The City of Calgary is committed to maintaining a high level of water quality and ecosystem health as the Bow River leaves the city. The flood scoured the vegetation which had been causing problems downstream providing the city with an opportunity to prevent growth rather than reducing it. In order to facilitate this process, an analysis of the state of the river and the patterns of re-growth were required for the flood affected system.

Objectives

- To determine the state of vegetation re-growth in the Bow River following the flood of 2005.
- To provide the City of Calgary with a baseline against which the effects of wastewater treatment processes could be measured.

Methodology

Six sampling sites were monitored (Fig. 1) along the Bow River from just upstream of Bonnybrook Waste Water Treatment Plant (WWTP) to the downgradient edge of the City of Calgary. This reach contains both WWTPs which service the City and allows for the comparison of the pre-WWTP state of the river and the river condition as it leaves the City of Calgary.

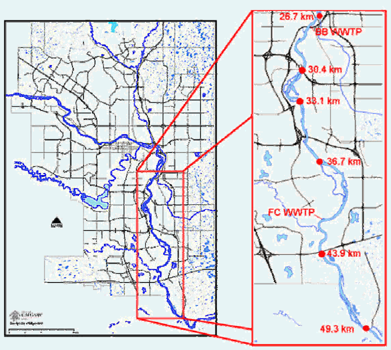

Fig. 1. Study area and sampling site locations

- Periphyton sampling was conducted using Alberta Environment (AENV) sampling procedures and analyzed for chlorophyll-a concentration biomass (ash-free dry weight).
- Macrophyte sampling using a net and frame was accomplished following the AENV sampling procedures. Rooted plants were analyzed for dry weight and ash-free dry weight in the laboratory.
- Nutrient concentration was determined from macrophyte and periphyton samples collected throughout the growing season.

Fig. 2. Sampling periphyton and macrophytes

Results and Discussion

Periphyton Biomass

2006 Season vs Historic

The algal chlorophyll-a concentrations found in the Bow River during the 2006 growth season are higher than the average chlorophyll-a between 1990 and 1996 (A. Sosiak, pers. comm). Figure 3 compares these concentrations to identify the changes in benthic algae density following the 2005 flood. In addition to the increased concentrations in 2006, a downstream increasing trend is observed indicating a relationship with the nutrient loading from the WWTP effluent.

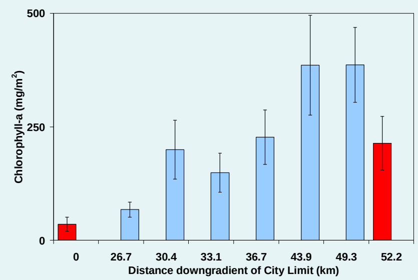

Fig. 3. Seasonal averages of periphyton chlorophyll-a concentrations (mg/m^2) with 95% confidence intervals indicated.

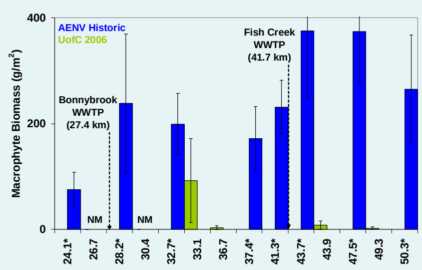

Fig 4: Seasonal averages of macrophyte biomass (dry weight, g/m^2) with 95% confidence intervals. (*AENV sites)

Macrophyte Biomass

2006 Season vs Historical

Macrophyte populations observed in the 2006 growth season were compared with biomass densities observed historically (1996, 2001). Not all sites had macrophyte growth of sufficient density so as to allow random sampling and these sites are indicated (NM) on Figure 4.
Macrophyte density was significantly lower at most sites sampled in 2006 than the historical densities observed by AENV.

Aquatic Vegetation and Dissolved Oxygen

In addition to these changes in the aquatic vegetation communities, the dissolved oxygen was observed to fluctuate at pre-flood levels despite the decreased macrophyte population (Figure 5).
The effects of the increase in periphyton on DO revealed weaknesses in the water quality model which was being used by the City of Calgary for planning wastewater treatment processes. These weaknesses will be addressed with future research into the dominant processes in the model.

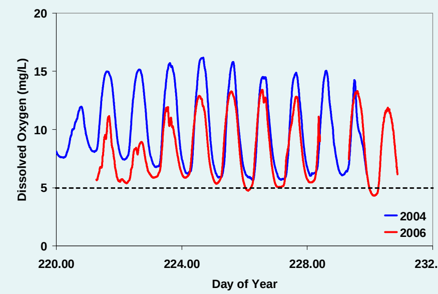

Fig. 5. DO levels observed at 49.3km downstream during 2004 and 2006 (M. Iwanyshyn, pers. comm., 2006)

Nutrient Limitation

Levels of nitrogen and phosphorus measured in the macrophyte and periphyton samples were compared to that found in the water column. The N:P ratio observed in the water column (>115) indicates severe phosphorus limitation. The average ratios for the periphyton (13.2) and macrophytes (19.7) revealed that the vegetation was dominated by the water column phosphorus limitation.

Conclusions

Periphyton appears to have flourished in the conditions following the severe flood event of 2005 while macrophyte growth is less dense and regenerating at a much slower rate than the benthic algae. The increase in periphyton appears to be in sufficient quantities to maintain the DO fluctuations to levels observed in pre-flood years.

The nutrient ratio analysis conducted in this project has indicated phosphorus limitation in the system.

Acknowledgments and Sponsors

Thanks are due to A. Sosiak (AENV), V. Cooper, A. Pawlak, N. Sinclair-Foreman and R. Willson.