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Is nitrogen loading in wastewater more important than phosphorus? A historic review of the relationship between algae and macrophyte biomass and wastewater nutrient loading in the Bow River

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The role of nutrient loading on biomass growth in wastewater-impacted rivers is important in understanding how to most effectively optimize wastewater treatment to avoid excessive biomass growth in the receiving water body. Nutrient loading is also affected by the nature of the effluent mixing in the river. This paper relates ammonium (NH4), nitrate (NO_3) and total phosphorus (TP) from a wastewater treatment plant (WWTP) to epilithic algae and macrophyte biomass for determination of impacts of the WWTP on the Bow River ecosystem in Calgary, Alberta.

Annual macrophyte biomass data and WWTP effluent nutrient data was analyzed for the years from 1981 – 2011. Locally Weighted Scatterplot Smoothing (LOWESS) was used to remove the influence of the river discharge from the biomass. The LOWESS method indicates that macrophytes do not grow beyond a maximum annual discharge of $300 m^3 s^{-1}$. Algae biomass was most significantly correlated to daily mean discharge on sampling date and the LOWESS method indicates that they do not grow well beyond a daily mean discharge of $100 m^3 s^{-1}$. Correlation analysis suggests that biomass in the Bow River is nitrogen limited. Epilithic algae are significantly correlated ($p <= 0.05$) with dilution corrected NH4 concentration. Spearman rank correlation showed a significant correlation ($p <= 0.05$) between macrophyte biomass and dilution corrected TP effluent concentration as well as dilution corrected NH4 concentration. Macrophyte correlated highest and for more sampling sites with NH4 concentration. No significant correlation was found for macrophyte biomass and dilution corrected NO_3 effluent concentration. Left and right bank stations show a significant difference in macrophyte biomass as well as varying strength of response to nutrient loading. This should be taken into account when developing and parameterizing water quality models for that reach.