Defining Phosphorus Concentrations to Prevent Eutrophication of Canadian Agricultural Streams

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Inputs of nutrients (phosphorus, P, and nitrogen, N) to fresh waters can cause excessive aquatic plant growth, depletion of oxygen, and deleterious changes in abundance and diversity of aquatic invertebrates and fish. Efforts to safeguard or improve the quality of water resources in agriculturally-dominated ecosystems have traditionally focused on managing on-farm activities to reduce materials loss; however, another management measure for improving environmental quality is adoption of environmental performance standards (or "outcome-based standards"). As part of a "National Agri-Environmental Standards Initiative", the Government of Canada committed to the development of non-regulatory environmental performance standards that establish P concentrations to protect ecological condition of agricultural streams. Comparison of nutrients released to the Canadian environment showed that agriculture was the largest source of P to surface waters (compared to sewage, industry and aquaculture). Analysis of data from > 200 long-term water quality stations across Canada and detailed ecological study at approximately 70 sites further showed that land-use activities from agriculture increased nutrient concentrations in streams, resulting in increased sestonic and benthic algal abundance, loss of sensitive benthic macroinvertebrate taxa, and an increase in benthic diatom taxa indicative of eutrophication. Application of five different approaches for defining environmental performance standards using only chemistry data resulted in values for total P spanning a relatively narrow range of concentrations within a given ecoregion of Canada. Cross-calibration of these chemically-derived standards with information on biological condition resulted in recommendations for total P standards that would maintain high water quality and protect aquatic life from adverse effects of eutrophication. Recommended standards for total P (summer average) ranged from 0.01-0.03 mg/L for the east coast Atlantic Maritime region, to 0.02 mg/L for the Montane Cordillera of western Canada, to ~0.03 mg/L for the Mixedwood Plains of southern Ontario and Quebec, and finally to 0.10 mg/L for the interior Prairies. These recommended standards should result in good ecological condition with respect to benthic algal abundance, benthic diatom composition and benthic macroinvertebrate composition. Research is continuing to determine whether these total P standards are protective of downstream receiving waters and to evaluate interactions of P with other stressors (e.g., N, suspended sediments, pesticides), specifically their combined effects on aquatic food webs.