Cost-effectiveness of wetlands as a nature-based solution to buffer phosphorous in Canadian landscapes

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The tradeoff between environmental services of wetlands and alternative land uses is well-documented, but this literature is not well-integrated. We review four decades of Canadian literature on the role of wetlands in reducing the runoff of nutrients.

While there were 47 studies focusing on the role of wetlands to reduce phosphorous emissions from different types of land use, 19 studies focused on the costs of wetlands protection and restoration. Only five studies focus on both the costs and effectiveness of wetlands for P removal in Canadian landscapes. A database is created containing a set of common variables to examine the key drivers behind differences in study outcomes.

The methods of calculating and reporting costs across studies vary. The three most common types of costs are: (1) one-off capital expenditure, (2) recurring opportunity costs of displaced land uses, (3) total costs without clear specification of the composition and (4) other costs (i.e., nuisance costs). We annualize one off costs using the relevant useful life of wetlands and add them to the recurring opportunity costs and other costs to produce a measure total costs per year per hectare. We also calculate costs per kg of phosphorous retained as a measure of cost-effectiveness.

Our preliminary results indicate that total costs per hectare per year vary by latitude, province, wetland type, size, type of landscape and source of pollution, and by total phosphorous reduction. Total costs tend to decrease with latitude, increase with wetland area and with total phosphorous reduction. However, phosphorous reduction cost effectiveness seems not to be statistically significantly dependent on latitude, phosphorous emission reduction level, or wetland type. Wetland size had a positive, statistically significant impact on the cost per kg of phosphorous reduction indicating that smaller wetlands are more cost-effective means of phosphorous emission reduction.

There were several comparability challenges for costs and phosphorous reductions across studies including unclear definitions of cost functions and baseline scenarios. We describe those challenges and propose a standardized method for reporting costs and phosphorous emission reductions that would make future meta-analyses more effective.