

## Biomass production and other ecological processes in rehabilitated riparian zones: 18 years of results from Southern Ontario, Canada

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### 1. ABSTRACT

A long history of agricultural activities in southern Ontario, Canada, has led to the loss of forested riparian zones, with a subsequent increase in stream eutrophication, bank erosion and a loss of wildlife habitat. Such changes, however, may be temporary and can most likely be reversed upon reforestation of these zones, the inherent productivity of which is quite high as a result of a positive combination of soil and climatic factors. This paper will document, as a result of rehabilitation efforts, changes over a 18-year period in some components of the biophysical environment of Washington Creek, a (formerly) degraded first-order agricultural stream in southern Ontario.

Initial rehabilitation efforts dating from 1985 included the creation of a treed buffer strip and streambank stabilization plantings using hybrid poplar (*Populus* spp.), silver maple (*Acer saccharinum* L.) and alder (*Alnus* spp.). In 1990 and 1991, additional plantings of other hardwood tree species (*Fraxinus* spp., *Quercus* spp., *Juglans* spp.) also occurred in conjunction with plantings of several shrub species including multi-floral rosevine (*Rosa multiflora* Thunb.) and red-osier dogwood (*Cornus sericea* subsp. *sericea* L.). Both block and row (along the stream) plantings were utilized due to land availability and restrictions from landowners. Planting spacing varied from 1 m by 1 m to 3 m by 3 m although average planting density was approximately 2500 trees ha<sup>-1</sup>.

Radiation loadings (Photosynthetic Photon Flux Density (PPFD)) to stream water surfaces were significantly ( $p < 0.05$ ) lower as a result of reforestation: in 1989, PPFD was reduced by 27% and by 97% in 2001. Reduced streambank erosion resulted in a significantly lower ( $p < 0.05$ ) sediment depth in 2001 (4.3 cm) compared to that which existed in 1988 (11.2 cm). Litterfall in the rehabilitated site was significantly lower ( $p < 0.05$ ) than litterfall from a natural riparian zone containing trees ~ 150 years in age, within the same watershed. However, nutrient fluxes (N,P) were not significantly different ( $p < 0.05$ ) between the rehabilitated and mature riparian zones. The diversity of bird, fish and plant species has slowly increased over the last 18 years in the rehabilitated zone compared to a non-rehabilitated, channelized stream section downstream, reflecting the obvious structural and functional changes that have come about with reforestation.

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Certain groups of trees and blocks were thinned 50% in 1989 to allow for successful underplanting of trees and shrubs as noted above; this concurrently allowed for estimation of NPP. Certain clones of *Populus* were accumulating biomass at more than four oven-dry tonnes ha<sup>-1</sup> y<sup>-1</sup> (2 tonnes C ha<sup>-1</sup> y<sup>-1</sup>; ~ 8 tonnes CO<sub>2</sub> ha<sup>-1</sup> y<sup>-1</sup>) by age 5 and certain clones of *A. glutinosa* and *A. incana* still exhibit net primary productivities in excess of 5 tonnes ha<sup>-1</sup> y<sup>-1</sup> by age 19.

The Kyoto Agreement, to which Canada is signatory, requires a reduction of greenhouse gas emissions to 6% below 1990 levels by 2012. Carbon offset programs developed in riparian areas, in conjunction with environmental benefits associated with the reforestation of riparian zones (e.g. reduced nitrate loadings to streams from adjacent farmfields), should foster the development of ecologically-sound integrated riparian management systems. This represents one way in which Canada can address its Kyoto commitment.