Pre-settlement Landscape Vegetation Modeling and Mapping for the Southwestern Golden Horseshoe, including Hamilton, Halton, Peel, Toronto and York Regions and the Credit Valley Watershed: Frequently Asked Questions

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Pre-settlement landscape vegetation modeling and mapping in southern Ontario

What did pre-settlement vegetation look like, and how do we know this?

Prior to European settlement and the extensive land clearing, logging, development and agriculture that accompanied this process, southern Ontario was predominately covered by forested vegetation, which covered as much as 80 to 90% of the landscape in some areas. Throughout this forest matrix, there were openings, some of which were caused by natural or human-induced disturbances, and dominated by other types of vegetation, such as prairiesavannah, meadows, and marshes.

Most of the pre-settlement forests in southern Ontario were diverse, mature and in late-seral stages dominated by shade tolerant species. Forests dominated by early successional species, such as poplar and birch, were part of the landscape, but were less prominent, representing approximately 5% of the natural cover, and limited to disturbed areas or canopy gaps. The most common disturbances affecting pre-settlement forests were tree-falls caused by winds and decay. Fire, beaver activity, First Nations settlements and trails, as well as early-European settlements were less prominent disturbances (Larson et al, 1999; Riley and Mohr 1994; Puric-Mladenovic 2000, 2003).

An understanding of southern Ontario's pre-settlement vegetation can be derived from historical reports, books, land surveyors' records and notebooks, personal diaries (e.g. Jameson, 1838; Strickland, 1853) and historical maps. By mapping the pre-settlement landscape vegetation, we can enhance our understanding of southern Ontario's historic vegetation by adding spatially explicit information about its distribution and composition.

Why should we map pre-settlement vegetation?

In order to properly understand and manage the landscape of southern Ontario, an understanding of the past is vital. Pre-settlement vegetation mapping provides a critical historical reference condition for assessing natural vegetation biodiversity, but more importantly, provides evidence to make informed conservation, management and planning decisions.

Has pre-settlement landscape vegetation mapping been generated previously in Ontario?

Over the past few decades, a number of studies and mapping initiatives in Ontario have used pre-settlement surveyors' records (Puric-Mladenovic, 2003). Earlier mapping attempts were based on interpretation, and involved tracing species or species associations on soil and topography maps, and as such had limited predictive ability and could not be validated. More recently, statistically based modeling and mapping techniques have used pre-settlement surveyors' records to produce diverse spatial layers reflecting landscape condition, vegetation types, species distributions and disturbances. Statistically derived pre-settlement models and maps have been generated for Algonquin Park (Figure 2) and the Temagami Sustainable Forest License Area (Figure 3) (Puric-Mladenovic and Pinto, 2005), based on digital land surveyors' information collected from 1856 to 1958 (Pinto and Ferguson, 2008). Presettlement mapping was also completed for York Region (Figure 4) in 2003 (Puric-Mladenovic, 2003).

Are there any examples of how pre-settlement landscape vegetation maps are being used?

Since obtaining pre-settlement landscape vegetation mapping in 2003, the Region of York has used it to provide guidelines for conservation and land restoration activities in the area. The product was also used to identify properties with a species composition that reflected pre-settlement conditions to be acquired by the Ontario Natural Heritage Trust.

The southwestern Golden Horseshoe mapping may be used by ReLeaf Hamilton to conduct a gap analysis and determine biodiversity and other conservation objectives and targets to support Natural Heritage System design. In the southern Lake Simcoe Watershed, the product may be used to quantify wetland change and loss and inform wetland restoration efforts.



Figure 1. Early scenes from southern Ontario, including (above) men sawing down a tree in 1910, west of Guelph (Ontario Archives), and (below) a scene from Bathurst Street, Toronto in 1912 (City of Toronto Archives).



Figure 2. Pre-settlement vegetation mapping for Algonquin Provincial Park was completed in 2005 (Puric-Mladenovic and Pinto, 2005) based on land surveyors' information collected between 1856 and 1958 (Pinto and Ferguson 2008). The abrupt contrast in forest species composition between western and eastern Algonquin Park provides guidance for today's Parks Forest Management Plan.



Figure 3. Pre-settlement vegetation mapping for the Temagami Sustainable Forest License was completed in 2005 (Puric-Mladenovic and Pinto, 2005) based on land surveyors' information collected between 1856 and 1958 (Pinto and Ferguson 2008).



Figure 4. Pre-settlement vegetation mapping for the Regional Municipality of York was initially completed in 2003 (Puric-Mladenovic, 2003). Updated mapping for the area is included in the pre-settlement landscape vegetation mapping product for the southwestern Golden Horseshoe.

What applications are there for pre-settlement landscape mapping?

Pre-settlement landscape vegetation mapping can be used for many purposes, including any one of the following applications (Puric-Mladenovic and Aslam 2009):

- a) Supporting gap-analysis to define conservation features and set ecological targets for natural heritage system planning.
- b) Directing forest management and silvicultural practices to achieve presettlement species composition or vegetation structure conditions (Figure 5).
- c) Determining restoration potential by identifying species targets for restoration or afforestation efforts.

- d) Guiding seed source and gene conservation by identifying remnant vegetation patches of specific species.
- e) Supporting wildlife habitat protection by identifying underrepresented habitat types in today's landscapes.
- f) Supporting species at risk recovery planning through identifying underrepresented habitat and areas with suitable conditions to support habitat restoration.
- g) Creating public awareness of southern Ontario's ecological history.



Figure 5. Pre-settlement vegetation assemblages (e.g. mixed maple forest) superimposed on existing forest plantations in York Region. Long-term management of these plantations might be directed towards silviculturally-based thinning prescriptions that restore the presettlement vegetation cover. Similarly, pre-settlement vegetation assemblages with hemlock species components are superimposed on existing natural forest stands to identify potential seed sources for hemlock—a species that is much less common in today's forests. Alternatively, knowledge of hemlock-dominated pre-settlement vegetation cover in these forest stands might lead managers to consider redirecting silvicultural or thinning prescriptions to encourage hemlock regeneration, although this may require additional efforts to prevent deer browsing.

The southwestern Golden Horseshoe pre-settlement landscape vegetation mapping product

What is the pre-settlement landscape vegetation mapping product for the southwestern Golden Horseshoe?

The pre-settlement landscape vegetation mapping product for the southwestern Golden Horseshoe consists of a number of wall-to-wall maps portraying the distribution and composition of dominant vegetation and landscape characteristics as they were prior to major land clearing activities carried out by European settlers in southern Ontario approximately 200 years ago (Figure 6, Figure 7, Figure 8, Figure 9, and Figure 10). This mapping product contains spatial information about the pre-settlement landscape and its vegetation that can be used to support decision making related to many land management, planning and conservation activities.

What is the spatial extent of the southwestern Golden Horseshoe pre-settlement landscape vegetation mapping product?

Pre-settlement vegetation modeling and mapping was initially carried out for York Region in 2003 (Puric-Mladenovic, 2003). Building on the methodology from this work, the newly available pre-settlement mapping covers the southwestern Golden Horseshoe, including 28 townships, 5 municipalities (York, Toronto, Peel, Halton and Hamilton), and the entire Credit Valley watershed (Figure 6).

How was the southwestern Ontario pre-settlement landscape vegetation mapping product created?

The pre-settlement vegetation mapping product was created through statistical modeling that enabled model extrapolation and mapping across the entire study area. Pre-settlement land surveyors' records for the southwestern Golden Horseshoe from approximately two centuries ago were the main source of data used to support the product's creation. Other information was also used to support the modeling and validation process, including readily available vegetation data and spatial environmental information.



Figure 6. The pre-settlement vegetation mapping for the southwestern Golden Horseshoe covers York, Toronto, Peel, Halton and Hamilton Regions, as well as the entire Credit Valley watershed.



Figure 7. The pre-settlement vegetation mapping for the southwestern Golden Horseshoe maps the distribution of 21 species assemblages (also known as vegetation type) grids. This map shows the probability of pre-settlement distribution of upland American beech-basswood forest. Red indicates areas where American beech-basswood forests were more likely to have occurred, while green indicates areas where this forest type was less likely.



Figure 8. The pre-settlement vegetation mapping for the southwestern Golden Horseshoe maps the distribution of 21 species assemblages (also known as vegetation type) grids. This map shows the probability of pre-settlement distribution of upland maple-oak forest. Red indicates areas where maple-oak forests were more likely to have occurred, while green indicates areas where this forest type was less likely.



Figure 9. Probability of pre-settlement upland sites across the southwestern Golden Horseshoe. Upland sites are shown in darker shades of red while darker shades of blue represent areas where upland vegetation was not likely to have occurred.



Figure 10. Probability of pre-settlement wetland areas across the southwestern Golden Horseshoe. Darker shades of purple represent areas where wetlands were most likely to have occurred, while lighter shades of yellow represent areas where they were not likely to have occurred.

What are land surveyors' records?

Approximately two centuries ago (1793 to 1838 in the study area), prior to the first major waves of European settlement in Ontario, extensive land surveying was carried out to support settlement and provide information on land and timber resources. At this time, surveyors traveled along concession lines marking lot corners and recording information about natural features, vegetation cover and forest composition (Figure 11). These records are unique and contain extremely valuable information about southern Ontario's landscape just prior to dramatic changes and reductions in natural vegetation cover. The surveyors' records are archived at the Provincial Office of the Surveyor General in Peterborough, Ontario.



Figure 11. Examples of pages from surveyors notebooks; each page contains numerous data records.

Apart from the surveyors' records, what other data sources were used to create the pre-settlement vegetation mapping product?

In addition to the surveyors' records, readily available vegetation data and spatial environmental data were used to support pre-settlement vegetation modeling, validation, prediction and mapping. Environmental information used to support model development included surficial geology, county soils mapping, digital elevation models (DEM) and various DEM derivatives, historical shoreline mapping, and historical climate averages for 1900-1931. Various vegetation datasets, such as OMNR Forest Resource Inventory (FRI) paper and digital mapping, OMNR and Conservation Authority Ecological Land Classification

(ELC) mapping, and other historical maps and field inventories, supported model validation.

Who were the project partners participating in southwestern Golden Horseshoe pre-settlement landscape vegetation mapping?

Partner support was critical in generating the pre-settlement landscape vegetation mapping product. Project partners included the municipalities of Hamilton, Halton, Peel and York, Credit Valley Conservation, the University of Toronto, the Crown Land Surveyor's Office, and the Natural Heritage Information Center at the Ontario Ministry of Natural Resources (OMNR).

Will pre-settlement landscape vegetation mapping be extended to other areas of southern Ontario and who can I contact to get more information about pre-settlement vegetation mapping?

With the exception of a few townships, early surveyors' records exist for much of southern Ontario. However, despite the fact that some records are missing, the abundance of historical surveyor data makes it possible to fill these gaps with modeling and extrapolation.

To discuss expanding the scope and / or geographic area of pre-settlement vegetation mapping coverage, or if you have any questions about pre-settlement vegetation, the methodology or analysis that was used to produce the pre-

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Using the southwestern Golden Horseshoe presettlement vegetation mapping product (Version 1)

What sort of mapping is available in the pre-settlement landscape vegetation mapping product?

The pre-settlement landscape vegetation mapping product, Version 1, contains 21 probability grids showing different forest assemblages, and 2 probability grids that show the distribution of upland and wetland areas (see Figure 7, Figure 8, Figure 9, and Figure 10 for examples).

What is a "species assemblage"?

Species assemblages are statistically derived vegetation clusters that correspond to dominant pre-settlement vegetation. "Tamarack-eastern white cedar" for example, is a vegetation cluster that represents a stand dominated by these two species on the pre-settlement landscape. Note that the species order in the vegetation clusters does not imply relative species dominance or abundance (i.e. "maple-beech" does not mean that maple was more prominent than beech within the cluster).

How can a probability grid help me determine the spatial locations of the vegetation clusters on the pre-settlement landscape?

⁵ The continuous probability grids (values from 0 to 1) can be converted to maps of species presence or absence based on a threshold probability indicative of species presence.

Probability threshold values above which the different species assemblages are likely to be present have not yet been statistically defined. It is suggested that species presence/absence maps are derived by reclassifying the provided probability maps into two classes (i.e. create a binary map) based on the "natural breaks method" that is available in GIS software. Note that when creating species assemblage presence-absence maps, using a 0.5 probability as a breakpoint is not recommended.

How can I find the specific maps and information that I'm interested in within the product?

Within the pre-settlement mapping product, open "table.doc" within the "Maps_Report" folder to find a table that lists the available vegetation clusters and their composition. "SpecGridNames.xls" is a key for the codes contained in this table. In "table.doc", identify the grid name of interest (e.g. Vg1_1), and then locate the grid file in the "Species_Assemblages" folder, where all 21 vegetation cluster grids are stored by name. Wetland and Upland grids are stored in the "Wetland_Upland" folder. Please see Figure 12 for a map of the product file structure.



Figure 12. The file structure for the southwestern Golden Horseshoe pre-settlement vegetation mapping product.

How should this product be referenced?

This product should be referenced as:

Puric-Mladenovic, D. 2011. Pre-settlement Vegetation Mapping for the Greater Toronto Area, including the Regions of Hamilton, Halton, Peel and York and the Credit Valley Watershed. Ontario Ministry of Natural Resources. Southern Science and Information Section. Peterborough Ontario. January 2011.

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