ROYAL BOTANICAL GARDENS

Managing Botanic Gardens using GIS

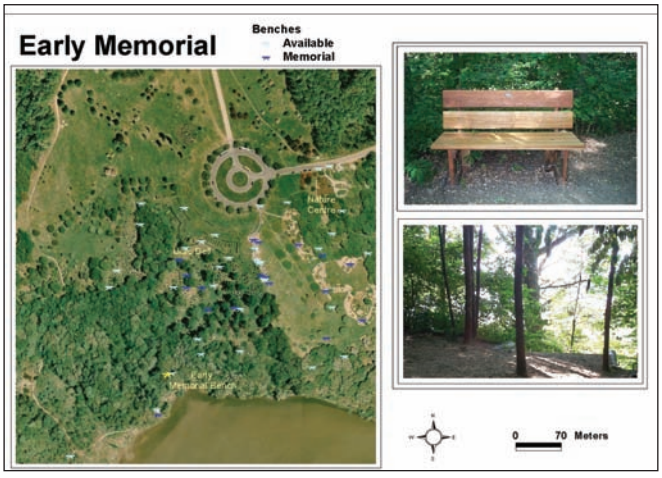
Royal Botanical Gardens (RBG) is a living museum, a rare Carolinian forest, the world's largest lilac collection, a garden of curative secrets, a wilderness, a wetland, and a centre for plant research. Established in 1929, and later granted a Royal Charter by King George V, the Gardens has blossomed into one of North America's largest, and one of the world's most admired, botanical gardens. The Gardens is located in Burlington/Hamilton, Ontario, at the western end of Lake Ontario. There are 120 hectares of collections and gardens, and the remaining property is designated as natural and sanctuary lands. Today, RBG is using GIS to manage more than 1,100 hectares (2,700 acres) of ecologically rich land.

Regionally and nationally significant habitats and species are found on RBG property, which is bound by the Niagara Escarpment, a UNESCO World Biosphere Reserve. These include various rare and threatened species, critical habitat links, Carolinian forests, oak savannah, limestone escarpment woodlands, and the 325 hectare Cootes Paradise Marsh – site of Project Paradise, the largest freshwater marsh restoration project of its kind in North America.

Historically, RBG concentrated management and documentation on its cultivated areas (about 10 percent of the property), while the extensive natural lands have received little attention including inadequate mapping; sporadic and inconsistent data collection; and the absence of a system for managing information. The Cootes Paradise restoration effort, which began in 1992, highlighted the long-established need for monitoring and predictive information modeling for all of RBG's holdings. The marsh restoration project alone involves collecting and managing data on water quality, bathymetry, sediments, and fish-bird-wildlife and aquatic vegetation populations, all of which are interrelated. The natural lands add an exponential number of other factors, and more dimensions of interrelation.

A study conducted at the beginning of the project identified GIS as the management tool of choice for the restoration effort. It recognized that efficient organization and maintenance of historical and accumulating environmental data is essential if informed decisions are to be made with respect to the long-term management of the marsh. The study also noted that RBG could apply this technology to its other endeavours. As a result, RBG began using ArcView GIS in 1997 and worked with several local institutions including Mohawk College and McMaster University to assess their GIS needs.

A 1998 feasibility study and pilot project was successful in illustrating how GIS could be used by the various departments at RBG to manage any type of spatially referenced information, whether it be the location of a single plant, the site of visitor facilities, the routing of a proposed trail, or the management of information about these features themselves. The following year, RBG received funding from the Richard Ivey Foundation to commence implementation of the GIS program. Today, with the help of additional grants and donations, GIS is used in all areas of RBG activity including base mapping, ecological mapping, vegetation monitoring, trail mapping, the creation of a memorial database, and the redesign of the Morrison Woodland Garden.



RBG maintains a database of memorialized trees, rocks, and benches dedicated by donors, and GIS has been used to map the existing memorials and potential new sites.

In 2000, RBG acquired new, high-resolution orthophotos at 12-centimetre resolution, which are a great improvement over the low (one metre) resolution orthophotos used in the past. The new orthophotos are used in conjunction with data collected during field visits by RBG staff, using Trimble XRS-Pro GPS units. With this information they are able to generate accurate maps of the entire RBG property. The maps include all kinds of information, from trails, roads, buildings, signs, memorial rocks, benches, trees, shrubs, and planting beds, to utilities, turf areas, paths, and garbage cans. RBG staff in all departments use the maps to make informed planning and maintenance decisions on issues such as redevelopment, staffing levels, and numbers of plants needed.

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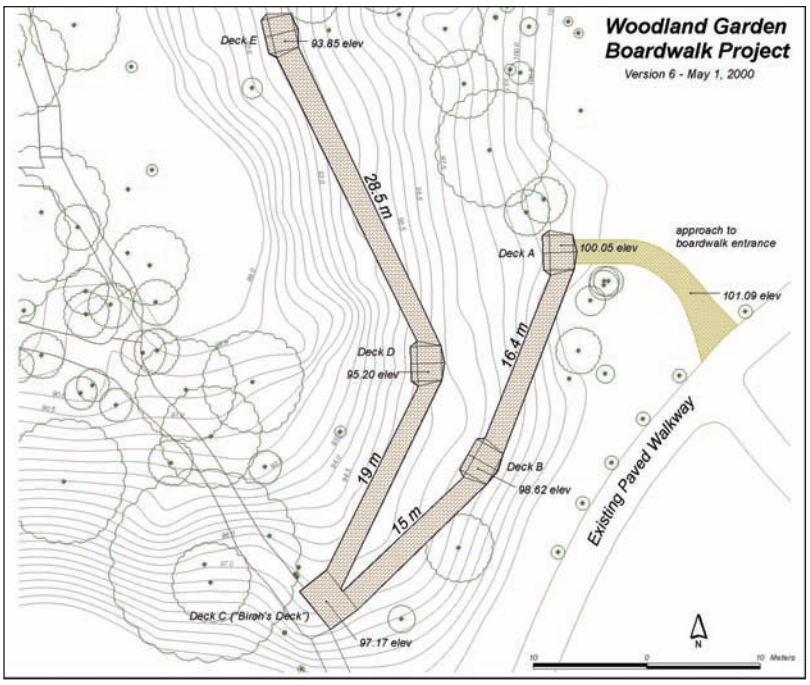
Margaret Walton, GIS Coordinator, RBG

In addition, RBG field botanists work from these high-quality photos and use the Ecological Land Classification (ELC) manual to describe and map the different plant community types that occur in the nature sanctuaries. This information includes species lists, forest stand descriptions, and signs of disturbance. Besides the ELC data that is collected, special note is made of issues of particular land management concern including relative habitat quality, sensitive terrain, and recreational use. All of the information collected is stored as layers in the GIS database. This allows detailed analysis of the information and ultimately leads to the development of a management plan for the nature sanctuaries.

For the rehabilitation of Cootes Paradise, vegetation is monitored using a GPS and GIS. Different

types of emergent vegetation are located on site using the GPS unit and the location data is imported into ArcView, where the vegetation areas can be displayed and analyzed for size, growth, and alien vegetation. In order to obtain an overall impression of vegetation change in the marsh, historic vegetation maps, for several years between 1934 and 1993, were digitized from paper maps and compared with the accurate vegetation data collected with GPS in the field. Using ArcView, data from successive years can be overlaid to determine the growth or loss of vegetation, as a whole and by individual species. Data from individual years can be analyzed in detail by species to develop plans for further work and determine where restoration work should be concentrated.



Using GIS, the Morrison Woodland Garden was redeveloped to add a wheelchair accessible boardwalk and a series of viewing decks.

Members and visitors are able to access the natural sanctuaries at RBG using over 30 kilometres of hiking trails. Accurate trail maps have been produced using GPS and GIS. To create these maps, staff walked the trails throughout the property with a Trimble GPS unit, and the data was imported into ArcView and combined with base layers including drainage, roads, and tree line. These maps are being used as the basis for new, full colour trail guides to RBG property, due to be published shortly. The guides will be available at RBG Centre and the Nature Interpretive Centre.

RBG also maintains a database of memorialized trees, rocks, and benches dedicated by donors. GIS has been used to map the existing memorials and potential new sites. Using ArcView, staff can show new donors the locations of existing and potential memorials, including a photo and a view from each location. This system assists RBG staff in helping donors narrow their choices before going out to visit the actual locations on the property.

"One of the biggest GIS projects at RBG to date was the redevelopment of the Morrison Woodland Garden to add a wheelchair accessible boardwalk with a series of viewing decks," said Margaret Walton, GIS Coordinator, Royal Botanical Gardens. "The garden's terrain, a steep valley 'bowl' with a stream, provided a beautiful natural context but also created unique design considerations and problems. We worked with our on-staff landscape architect on the project, which began in 1999 and took two and a half years to complete, from design to the re-opening of the garden."

The redesign began with the creation of a digital elevation model (DEM) of the terrain. The GIS department took approximately 300 spot elevation readings in the field using traditional survey equipment and collected horizontal locations using GPS. The elevations, and parameters for extents and intervals, were input into ArcView 3D Analyst to create the DEM and calculate slope and aspect. Contour lines were then generated based on the defined intervals and extents. Existing features of the area such as trees, benches, walkways, and bridges were added by digitizing hard copy maps.

Once the contour model was in place, work began on the design of the boardwalks and platforms. The challenge was to maintain a boardwalk gradient of less than 9 percent slope, with a vertical drop of almost 22 feet in 260 horizontal feet. The structures were tentatively placed using the contour model in ArcView and then adjusted in the field using survey methods. The final step involved developing a conceptual drawing in ArcView. The drawing integrated base mapping data with survey information and the contours derived from the DEM. Finally, the landscape architect's plans for the decks were incorporated to create a new map of the garden.

"Many of our projects would have been much more time-consuming, and some may not have been possible, without the incorporation of GIS," continued Ms. Walton. "Prior to the implementation of GIS, RBG staff relied on hard copy maps that often did not show the most up-to-date information. Today, our mapping database is updated frequently and we can create maps on demand to provide members and visitors with current, reliable information."

GIS is now an integral and essential component of many daily operations at RBG and the staff are very pleased with the results they have achieved with GIS to date. They continue to find new application areas for GIS at the Gardens and plan to expand their use of the technology. They hope to launch several Internet projects including a virtual tour of the horticulture and natural areas, and a live online mapping application developed with ArcIMS, to showcase the maps they have created. More science related projects including the analysis of turtle nesting and fish populations, bird breeding surveys, vegetation rehabilitation projects, and rare species analysis are also planned.

According to Ms. Walton, they intend to migrate to ArcGIS and would like to begin using ArcPad to help with field data collection and real-time updates. She is confident that the Gardens will build on their success with GIS and that it will continue to help them manage their collections and make informed planning decisions for their land.

RBG – www.rbg.ca