

Building a conservation geology ethic along the Great Arc

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ABSTRACT

The Niagara Escarpment and its adjacent cuesta formation form an approximate 650-mile-long corridor that traces the outer edge of the ancient Michigan Basin. While this geomorphologic feature straddles numerous political divides, it ties together the entire Great Lakes system, as no single lake is more than 50 mi (80 km) away from the escarpment's majestic cliff faces. This "Great Arc" creates and influences a terrestrial environment like no other feature of similar size in the world. This international-scale corridor contains a variety of geologic and biotic resources along its extent that expresses its uniqueness—and generates intrigue—like no other geologic feature in the Midwest.

This paper provides the reader with an overview of the Niagara Escarpment resource under the context of the Great Arc and discusses past and current education and protection efforts by both government and non-government entities as components of a broader "conservation geology" concept. The discussion surveys the potential for developing a formal conservation geology program (a Geopark) that spans the Great Arc, combining existing efforts into a more cohesive program for conservation awareness and action.

INTRODUCTION

Formation and description of the Niagara Escarpment

The Niagara Escarpment is comprised of dolomitic rock that was originally deposited as sediment on an ancient salt water sea floor about 420 million years ago. Its cliff faces represent the outer edge of the circular Michigan Basin. The present-day cliffs of the escarpment were formed by millions of years of weathering and erosion, and further enhanced by the actions of glaciers during the last several ice ages. In Wisconsin, the Niagara Escarpment spans over 230 mi (370 km) and reaches from Waukesha County in the

south, to the tip of the Door Peninsula in the north. Internationally, the Niagara Escarpment is an approximate 650-mile-long sickle-shaped geomorphologic landform that spans the Great Lakes region in both the United States and Canada (fig. 1).

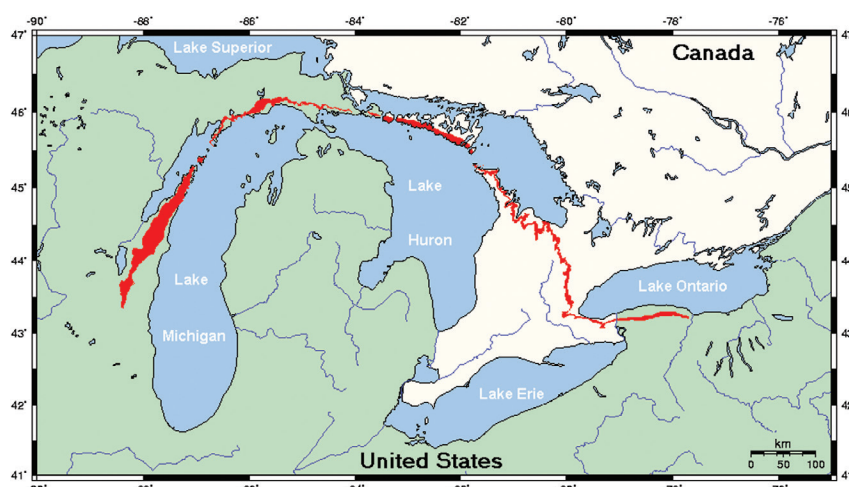


Figure 1. Location of the Niagara Escarpment.

Source: <http://commons.wikimedia.org>

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Unique aspects of the Niagara Escarpment

The Niagara Escarpment's exposed cliff faces are the most widely known feature of this corridor's landscape. Unique in and of themselves, the craggy walls tower hundreds of feet above the adjacent landscape in some places. Many native and present-day cultures have been impressed by the escarpment's scenery and vistas and have held them in high regard.

Repeated glaciation and the fluctuating waters of the Great Lakes system have shaped the escarpment's landscape into a variety of large waterfall-scoured gorges, glacial re-entrant valleys (valleys cut through the escarpment by flowing ice), ancient beach ridges, low hills, steep slopes, and broad benches. These varied features create a unique natural setting and a productive agricultural environment. Glaciers and other erosional forces carved out distinctive formations and features including waterfalls, sea-stacks, sea caves, talus slopes, crevice caves, canyons, natural arches, glacial scrapes, scours, and potholes (fig. 2). Over time, water has dissolved the landscape behind its brow into a variable karst terrain. Furthermore, the highly fractured bedrock is covered with relatively thin soils, thereby greatly influencing the corridor's surface water and groundwater.

“...the escarpment's cliff faces and rock formations harbor truly unique and extreme environments.”

From a habitat perspective, the escarpment's cliff faces and rock formations harbor truly unique and extreme environments. The corridor is home to such rare and unique habitats such as algific talus slopes (creating cool, humid microclimates), moist cliff faces, dry cliff faces, alvars (grasslands on thinly soiled limestone plains) and savanna (fig. 2). The cliff faces are home to gnarled and twisted ancient cedar trees which cling to the rock and, in some cases, are over 1,500 years old. The escarpment landscape is often forested, providing habitat and migratory corridors for birds, while its caves contain major bat hibernacula. In Wisconsin over 241 rare and endangered species, both plant and animals,

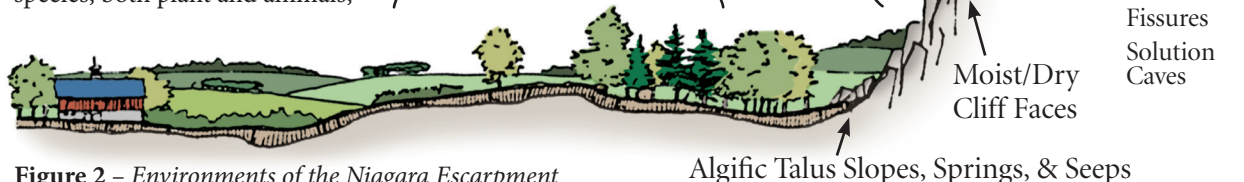


Figure 2 – Environments of the Niagara Escarpment

have been documented to exist in the corridor's unique environs (Anderson and others, 2002).

The Niagara Escarpment corridor has been used by mankind since Paleo-Indian times over 12,000 years ago (10,000–9,200 B.C.). Evidence of settlement and use of the landscape by later Woodland period (A.D. 300–1,000) cultures is well documented. Numerous archeological finds, including ancient petroforms, petroglyphs, and effigy mounds, are present throughout the corridor. Furthermore, written and oral histories of native tribes describe the escarpment as a significant and revered feature of the ancient landscape, and sacred sites abound. As settlement by French explorers occurred, the Niagara Escarpment's resources were used for hunting, trapping, agriculture, forestry, and mineral extraction. These uses were repeated by the numerous eastern European immigrant cultures during the 1700s and 1800s and exist through the present day. They continue to be the mainstay of the rural economy within the Great Arc corridor. Over the last 50 years, additional advancements in conservation activities have boosted the tourism/geotourism portion of the economy along the Great Arc. Urban and rural development interests have also greatly benefited from the natural beauty and aesthetic qualities of the Niagara Escarpment.

The combination of the escarpment's unique natural systems, along with its important role in culture and heritage, is what led to portions of Ontario's escarpment corridor being designated as a United Nations Educational, Scientific, and Cultural Organization (UNESCO) Biosphere Reserve in 1990. This noteworthy designation makes the Ontario portion of the Niagara Escarpment part of a global network of 631 biosphere sites (UNESCO, 2014).

Source: Adapted from Kasprzak, C.M., and Walter, M.A., 2001.

The 'Great Arc' context

In recent years, the idea of the Great Arc has emerged as a tool for building cross-boundary conservation and sustainable development activities in Ontario and adjoining states in the U.S. The Great Arc refers to the entire Niagara Escarpment landform, from central New York, north through Ontario and south along the west side of Lake Michigan. The Great Arc is a special landscape of considerable natural, cultural, economic, aesthetic, recreational, touristic, and symbolic importance in Canada and the U.S. At its core, the Great Arc is a corridor for migratory birds and wildlife and also for people who hike and move along it through the seasons (Nelson and others, 2005).

In 2002 the Great Arc Initiative was launched and has involved many individuals and groups, although in recent years, no significant activity has occurred. The Initiative is loosely organized and participation levels of its partners vary based on time availability and level of interest. To generally describe the makeup of the effort, the following groups, entities, and individuals are noted as having some significant past level of involvement in the Great Arc Initiative:

1. University of Waterloo, Ontario
2. University of Toledo, Ohio
3. Ontario's Niagara Escarpment Commission
4. Niagara Escarpment Resource Network (NERN)
5. Western New York Land Conservancy
6. Michigan Karst Conservancy
7. Nature Conservancy of Michigan
8. U.S. Forest Service (Hiawatha, MI Unit)
9. Parks Research Forum of Ontario

Five separate conferences and symposiums were held in Wisconsin, Ontario, and the Upper Peninsula of Michigan between 2001 and 2006 in an effort to draw interest and attention to the development of the Great Arc concept. While no significant activity occurred with this group between 2007 and 2014, a surge of recent activities in Wisconsin regarding awareness of the Niagara Escarpment prompted the rekindling of this effort through the development of an international symposium in Tobermory, Ontario, in 2015. The Bruce Peninsula-based Sources of Knowledge (SOK) organization collaborated with seven Wisconsin experts to speak to various commonalities and differences of communities situated on the escarpment. Subjects

such as geology, karst, biology, sustainability, tourism, economic development, and Geoparks have prompted additional dialogue and interest to formalize this effort with the goal of developing programs for information exchange and the development of a cross-border Geopark.

A DEFINITION FOR CONSERVATION GEOLOGY

Global examples

Conservation geology takes cues from the more well-known and widely adopted concept of conservation biology. The term *conservation biology* was introduced as the title of a conference held at the University of California, San Diego in 1978, and was defined as “the scientific study of the nature and status of Earth’s biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of extinction” (Wikipedia contributors, 2010). Much like conservation biology, conservation geology is an interdisciplinary subject drawing on sciences, economics, and the practice of natural resource management—with the obvious emphasis on geology.

Geology encompasses scientific studies of evolution, history, structure, and composition of the earth. This field has explored the formation and evolution of the earth’s history over the past billion years. Until recently, the field of geology emphasized exploration of earth resources for human need with limited focus on conservation (Suratman, 2008).

Conservation geology provides a means of protecting a geological formation or phenomenon that has special scientific value, representing different stages of the earth’s geological history and its transformation through various geological processes (Suratman, 2008). The new field of conservation geology requires the input of all traditional fields of geology. A successful research and development program for advancement of this field requires expertise from disciplines outside of geology such as planning, law, tourism and management. Geologists should lead the development efforts and harness multidisciplinary networking to ensure that conservation geology contributes to the aspiration of achieving sustainable development (Komoo, 2008).

An outstanding example of conservation geology can be found in the Langkawi Geopark in Malaysia. This site is made up of 99 tropical islands which provide

a rich example of geodiversity. Many of the islands have scientific value as well as national and regional significance. This particular site is mostly protected within the Malaysian holistic nature conservation concept of a Geoforest Park, wherein rock conservation is equally treated as biological conservation and other nature conservation components (Leman and others, 2008).

Other examples of conservation geology are known by different names. In the United Kingdom, formal policies and regulations for consideration of geologic sites are not in place; however, the notion of Regionally Important Geological and Geomorphological Sites (RIGS) are included in a non-statutory manner. RIGS are designated and protected sites of regional and local importance for geodiversity (geology and geomorphology) and are noted for their value to Earth science, and to Earth heritage in general. RIGS may include cultural, educational, historical, and aesthetic resources (RSNC, 1999).

The concept was introduced by the Nature Conservancy Council in their publication, *Earth Science Conservation in Great Britain – A Strategy* (1990). RIGS are locally designated with a scheme that relies almost entirely on volunteer efforts (DEFRA, 2006). In some cases, local action plans have also been prepared which aim to set local objectives to deliver and promote geological conservation based on knowledge of a broader existing network of nationally important geological Sites of Special Scientific Interest (SSSIs).

There are a number of similarities between geotourism, geoheritage, and conservation geology. While individual approaches may vary, four common themes exist across the range of definition:

1. **Education and awareness:** Encompasses activities that are critical to an individual's understanding of the geologic processes, and the resulting implications as they relate to human activity on the affected landscape. Knowledge can be powerful in terms of building conservation values and an improved land ethic. Education and Awareness can be delivered in a variety of ways to target diverse audiences at all age levels. From a tourism perspective, such information provides a context or a setting to help visitors understand what they are seeing on the landscape.
2. **Planning and regulation:** A key component to the long-term protection of any geologic resource. Most conservation-based plans and regulations are based on the concept of “community good” and the overall protection of the public's health, safety, and welfare with respect to the environment and its functions and values. They typically restrict certain uses, or the intensity of uses, for private landowners. Many plans and regulations have been successfully implemented along the Great Arc over the decades, often as a result of the increase in awareness by elected officials and regulatory agencies.
3. **Land conservation and stewardship:** Consists of both short- and long-term actions taken across the landscape to directly enhance, maintain or protect features or systems of the natural environment. In addition to outright land purchases by government and non-government entities, voluntary transferrals of property rights (conservation easements sold, donated, or partially donated by the landowner) are becoming an increasingly popular tool for protection. Along the Great Arc corridor, this includes agency-driven agricultural protection and land management programs, and the stewardship actions of individual property owners.
4. **Recreation and geotourism:** Public access to the land is critical to furthering the notion of conservation geology. Using lands for both active and passive recreation activities helps to bolster local and regional economies with businesses linked to the needs of tourists. In addition, when private businesses become involved in conservation activities, they help to promote a broader awareness of conservation geology. A system of publicly owned lands linked by various trails and paths has begun to form along the corridor.

While each of these components can exist independently, the inter-relationships are evident. Collaboration and communication at all levels will be required to integrate the four themes of conservation geology into an effective program that spans the Great Arc.

A CROSS-SECTION OF CONSERVATION GEOLOGY ALONG THE GREAT ARC

The application and practice of conservation geology exists throughout the Great Arc corridor in many different forms. Using the context of the definition and framework elements in the previous section, this discussion focuses on describing several of the most established and relevant activities occurring in the Great Arc which advance the creation of a conservation geology ethic.

Some of the earliest efforts began in Ontario over 50 years ago, while other efforts are much more recent. Nonetheless, they all comprise an important foundation for a coordinated international-scale conservation geology program for the Niagara Escarpment. These 'stand-alone' initiatives are inextricably linked to the underlying resource and therefore to one another.

ONTARIO'S NIAGARA ESCARPMENT

Education and awareness

One of the major grassroots entities in Ontario involved in education and awareness (as well as direct activism) is the Coalition on the Niagara Escarpment, or CONE. CONE is a nonprofit alliance of environmental groups, conservation organizations, and concerned citizens and businesses founded in 1978 and dedicated to the protection of Ontario's Niagara Escarpment. The group's origins began in the public discontent of a nonmetallic mining company's 1962 blast through the face of the Niagara Escarpment in Milton, Ontario (CONE, 2010).

During the mid- to late 1960s, CONE organized, consulted, and leveraged support for the eventual development of the draft Niagara Escarpment Plan. The creation of the Niagara Escarpment Commission (NEC) occurred in 1973 and, as a regulatory entity, it assumed development control within a defined corridor in 1975. In 1978, CONE formalized and succeeded in opening NEC meetings to the public, and it further monitored and participated in the two plus years of public hearings associated with the development of the NEC's Niagara Escarpment Plan. In 1985, CONE received formal recognition by NEC with an appointment to the land use decision-making body so as to provide a single voice representing concerned conservation organizations. Since that time, CONE has continually monitored the NEC's meetings and has actively participated in the NEC's 5-Year Plan Review processes (CONE, 2010).

CONE's organization consists of a seven-member volunteer board representing 27 separate organizations. Their role in planning is to assist in identifying sensitive areas and help incorporate environmental issues into management plans, thereby avoiding damage to endangered species of plants and animals living on the Niagara Escarpment. CONE also adopts formal positions on issues and publishes policy statements in four main focus areas: aggregates (mining), aboriginal peoples, wind turbines, and water. For example, in 2002 CONE released its water policy paper, a technical assessment of the need to change and upgrade the water science of the Niagara Escarpment Plan. Over the years, CONE has played an instrumental provincial leadership role in influencing and improving government decisions on water, aggregate, land use, transportation, economic, and other sustainability issues along Ontario's Niagara Escarpment corridor (CONE, 2010).

CONE's efforts have gone far beyond its formal role in the provincial government's Niagara Escarpment Commission. CONE created an Escarpment Enterprise Club, which highlights private corporations and their leaders who are doing the "right things" environmentally and finds ways to partner with them to show positive examples of the way to move forward and protect the Niagara Escarpment. In 2001, CONE created a sister organization called the Niagara Escarpment Foundation, a registered charity established to undertake research and education initiatives. They also lead research initiatives to learn more about the escarpment and best practices for protecting it, undertake educational programs to foster public appreciation for the escarpment and the issues that impact its integrity, and build awareness through their road signage program announcing that the Niagara Escarpment's countryside is part of this exclusive UNESCO Biosphere Reserve designation (CONE, 2010).

Planning and regulation

The Niagara Escarpment Plan, administered by the Niagara Escarpment Commission (NEC), serves as the primary mechanism for planning and regulation of the escarpment corridor in Ontario. This official plan guides provincial objectives for resource protection and land use control within the Niagara Escarpment corridor. Often noted as Canada's first "green plan," this visionary environmental land-use document was approved by the Ontario government in 1973 through adopting the Niagara Escarpment Planning and Development Act (NEC, 2010).

As a regulatory agency, the NEC conducts itself according to the management principles of the Government of Ontario, but its decisions are made independently and impartially. The commission has 17 members appointed by Order-in-Council (a type of legislative process). Nine members, including the chair, represent the public-at-large, and eight members represent counties and regions within the escarpment area. The NEC meets monthly to make decisions on development permit applications; consider recommendations on Plan amendments; comment on official plans, development proposals, consent applications, environmental assessments; and review Niagara Escarpment Plan policy issues (NEC, 2010).

The Niagara Escarpment Plan consists of a series of maps indicating six separate districts (fig. 3). Similar to a typical zoning ordinance, each district is accompanied by its own set of rules regarding allowable land uses and development controls. The districts range in intensity from strongly protected escarpment natural areas to

intensely developed urban areas with a separate district designation existing for mineral extraction activities (aggregate). Map amendments and boundary changes to these districts are permitted on occasion, but follow a strict set of application and review standards. Similarly, a set of development standards (Regulation 828-90)

“The districts range in intensity from strongly protected escarpment natural areas to intensely developed urban areas...”

apply to all development projects within the corridor’s districts that allow such uses. An established process for the application and filing of development permits was created to accurately assess proposed projects and their conformance with policies and regulations. Separate and distinct policy documents have also been developed to cover topics such as “significant woodlands” and “visual assessment guidelines” (NEC, 2010).

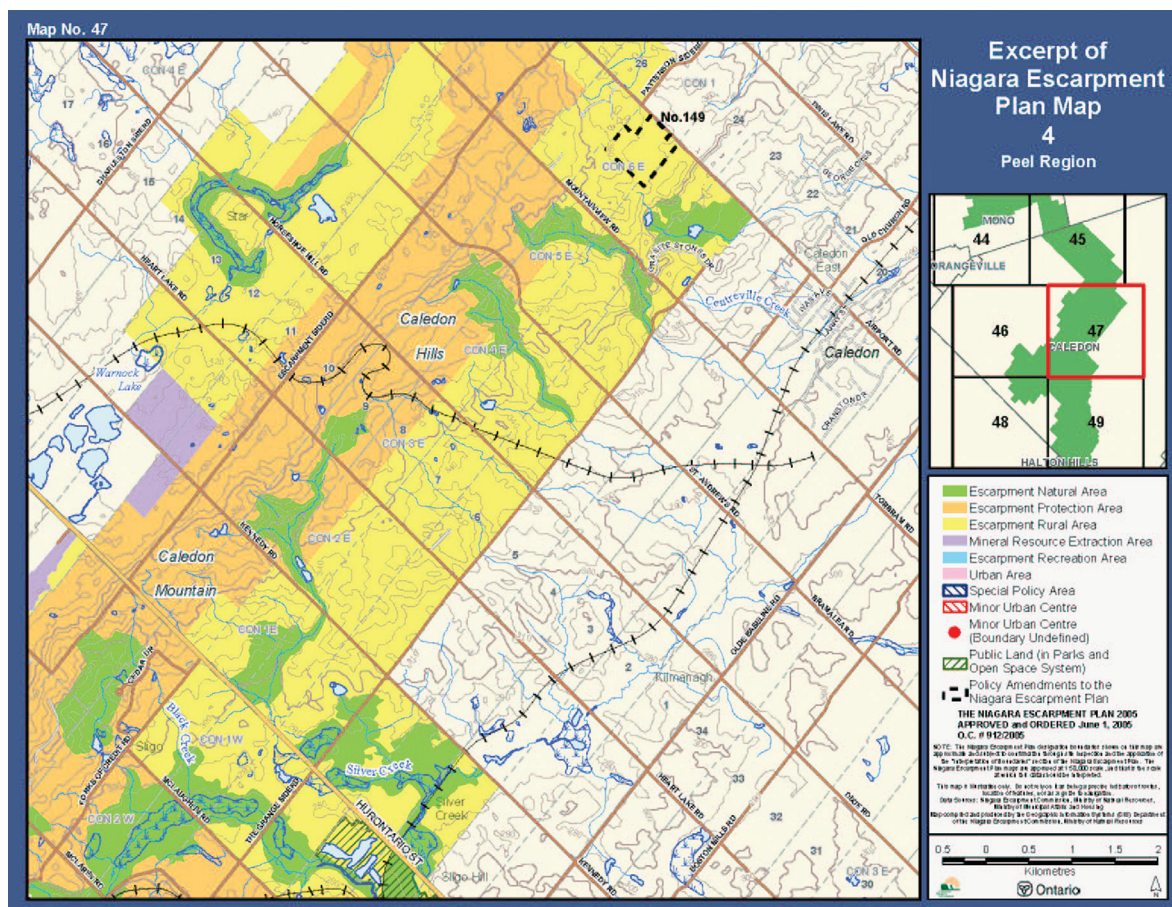


Figure 3. Niagara Escarpment plan map.

Source: Niagara Escarpment Commission, 2010.

Land conservation and stewardship

Numerous non-government organizations and provincial ministries (agencies) exist to monitor and protect the resources of the Niagara Escarpment. None, however, have been more effective than the use of land trusts to directly preserve, protect, and enhance the Niagara Escarpment corridor permanently.

According to the Ontario Land Trust (2010), of the five existing registered land trusts along Ontario's portion of the Niagara Escarpment corridor, none has been more successful than the Escarpment Biosphere Conservancy (EBC). The Escarpment Biosphere Conservancy was formed in 1998 and is now one of the most prominent and active organizations involved in the protection of private lands throughout the corridor. Land protection efforts are funded through a variety of means, including traditional landowner donations and the use of tax incentives, member donations, and charitable foundations.

Several unique and nontraditional fundraising methods have been developed using a variety of partnership arrangements. Examples include: (1) "Avalon Funds," which are offered to members as a new way to donate using secured endowment bonds which are backed by life insurance policies; and (2) partnering with Ag Energy, a farmers' co-op, which allows the EBC to offer competitive special usage rates that include a \$75 average annual donation, plus one-half of that on income tax savings (EBC, 2010).

As of 2015, the EBC has successfully protected 145 reserves covering over 11,000 acres. Within these reserves lie over 18 km (11 mi) of Great Lakes shoreline and the habitats of 72 rare and endangered species (EBC, 2015). The EBC's ability to reach out to prospective landowners with their suite of conservation tools and products have increased protection, awareness, and tourist revenue generation for the Niagara Escarpment in Ontario.

Recreation and geotourism

While the Niagara Escarpment is used for many recreational activities in Ontario, including downhill skiing and rock-climbing, no activity is more prevalent than hiking or walking the Bruce Trail, Canada's oldest and longest marked footpath (fig. 4).



Source: The Bruce Trail Conservancy, 2014.

Figure 4. Bruce Trail map.

In 1960 the idea of a public footpath spanning the entire Niagara Escarpment was born by naturalist Raymond Lowes. He expressed his vision of a footpath at a meeting of the Federation of Ontario Naturalists and the subsequent first meeting of the Bruce Trail Committee (now four members strong) was held. The committee recognized that gaining access to the Niagara Escarpment was the critical first step in building the Bruce Trail, as a majority of its corridor lay on privately

held lands. Understanding that building relationships was essential, then Trail Director Philip Gosling visited major towns along the proposed trail route to solicit help and a team of volunteers went door-to-door to discuss the vision for the trail with residents (BTC, 2015).

The Bruce Trail Conservancy (BTC), as it is now known, is a charitable organization committed to establishing a conservation corridor containing a public footpath along the Niagara Escarpment, to protect its natural ecosystems and to promote environmentally responsible public access.

A formal Board of Directors governs the BTC and volunteers from the nine separate Bruce Trail Clubs are responsible for maintaining, stewarding, and promoting the trail. The BTC is now supported by more than 1,000 volunteers and 8,500 members (BTC, 2015).

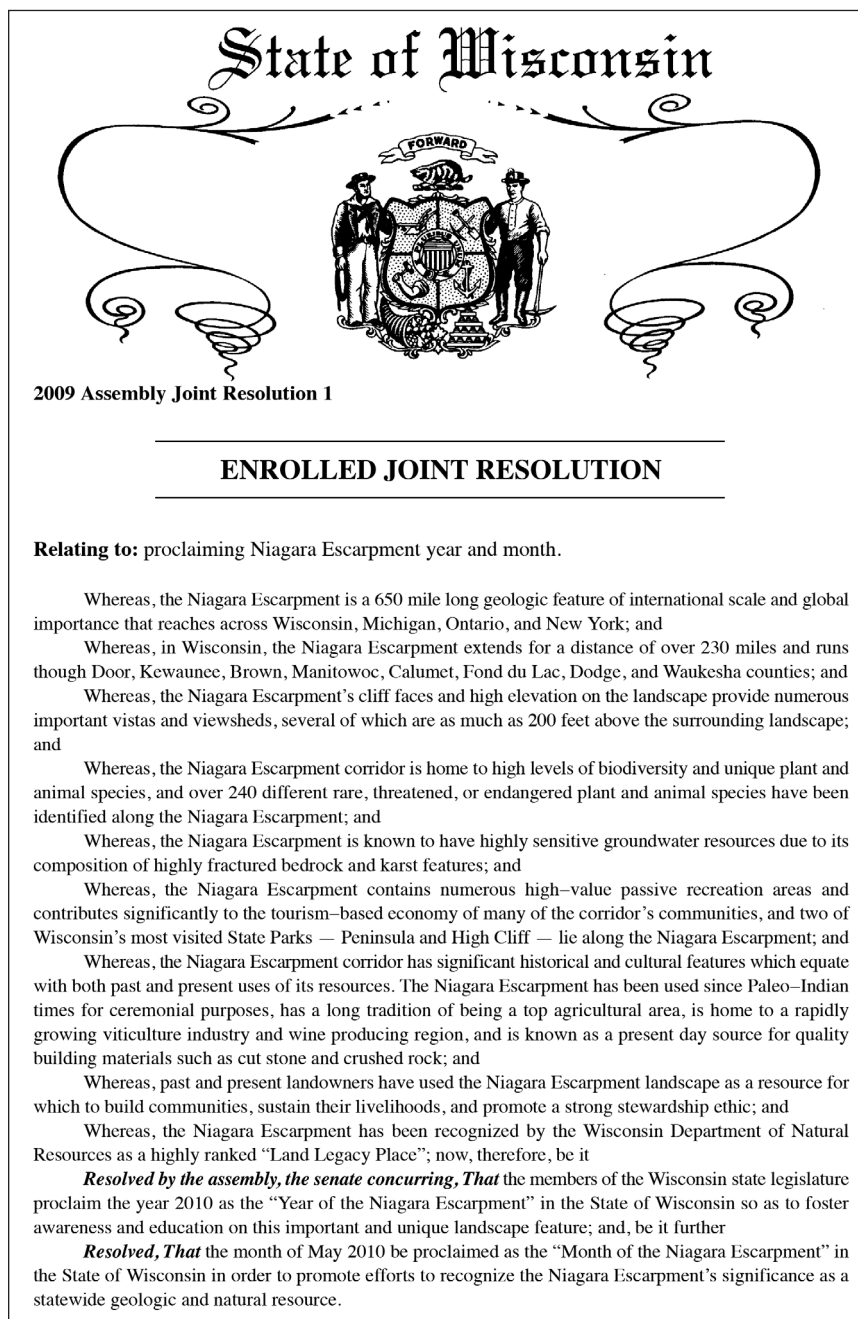
The economic impacts of the Bruce Trail's existence have been documented over the years. A 1997 study determined that direct recreational expenditures associated with visitors to the Bruce Trail contributed more than 4.4 million dollars (CAN) annually to the local economy. Multipliers which illustrate the indirect broader effect to regional economies raise this figure to as much as 10 million dollars (CAN) annually (Schutt, 1997). The trail's overall importance as a tourist attraction and economic generator has helped foster the idea that providing public access to the escarpment also supports and solidifies conservation values.

Figure 5. *State of Wisconsin Joint Assembly Resolution proclaiming 2010 as the "Year of the Niagara Escarpment."*

WISCONSIN'S NIAGARA ESCARPMENT

Education and awareness

The education and awareness efforts surrounding Wisconsin's Niagara Escarpment began in 1998. The Niagara Escarpment Resource Network (NERN) has been the leading organization behind enhancing the public's knowledge of the Niagara Escarpment through its many coordinated, partnership-style efforts.



The Network's creation dates back to a conference that was held to inform people of the unique attributes of the Niagara Escarpment. Over 100 attendees provided the feedback and the motivation to create an informal organization that fostered education, awareness, research, planning, and ultimately conservation efforts at the community level, which would begin to protect the critical resources of the Niagara Escarpment in Wisconsin. The group started as a series of regular meetings amongst three key stakeholders who were eventually chosen by the group to co-lead the effort: the East Central Wisconsin Regional Planning Commission, the Bay-Lake Regional Planning Commission, and the Wisconsin Department of Natural Resources.

NERN's activities began to gain attention from local legislators, and in early 2009 the Network's crowning achievement was made: the formal recognition by the state legislature of the Niagara Escarpment as a unique and highly valued landscape within northeastern Wisconsin. Joint Assembly Resolution AJR-1 (fig. 5), sponsored by Rep. Al Ott (R-3rd Assembly District), officially designated 2010 the "Year of the Niagara Escarpment." This accomplishment motivated many of NERN's partners to celebrate by developing and dedicating numerous events, tours, educational programs, and promotional projects to further elevate the public's knowledge of this truly remarkable landscape.

The momentum built over the last few years fostered an opportunity to advance the efforts of the informal organization and a decision was made to join forces with an existing

Planning and regulation

Wisconsin has no equivalent to Ontario's Niagara Escarpment Plan either in scope or as a basis for state land use management and regulation. Rather, long-term plans for the Niagara Escarpment are fragmented and dispersed throughout numerous connected and disconnected documents, which were developed at all levels of government throughout the state. WDNR State Natural Area (SNA) plans, trail plans, recreation plans, and wildlife plans acknowledge the existence of the broad Niagara Escarpment corridor and recognize its uniqueness; however, they do little to form official policy that is implemented consistently. Most recently, the WDNR's *Land Legacy Report* has done the most to acknowledge and support the recognition of Wisconsin's Niagara Escarpment as one of the most special and valued landscapes in all of Wisconsin. The purpose of the *Wisconsin Land Legacy Report* is to identify the places believed to be most important to meet the state's conservation and recreation needs over the next 50 years. This report specifically identified the Niagara Escarpment corridor as being one of Wisconsin's top three specific sites/areas for future conservation efforts (WDNR, 2006).

Regional plans have been developed by both of the Regional Planning Commissions (RPCs) that cover portions of the escarpment's landscape; however, they too are not in-depth enough to provide sufficient guidance to the local units of government.

"Wisconsin has no equivalent to Ontario's Niagara Escarpment Plan..."

nonprofit conservation organization, the Lakeshore Natural Resource Partnership (LNRP). In early 2010 the Niagara Escarpment Resource Network officially became a dedicated program area of LNRP, joining the ranks of other successful efforts which focus on the health of the entire Lakeshore Basin—of which the Niagara Escarpment essentially forms the basin's western boundary.

As its name suggests, the Network exists mainly to link people with information in hopes that it will effect positive change in both individual stewardship and community-level conservation of this unique landscape's natural and cultural resources. NERN now serves to build a stronger foundation for conservation by continuing its awareness campaign and developing projects and plans which focus on maintaining or improving the corridor's ecology and economy.

The Niagara Escarpment Greenway Plan, an ongoing planning initiative (slated for completion in 2016), is being prepared under the guidance of the Niagara Escarpment Resource Network and will serve as an initial step for identifying policy issues and program opportunities which are more closely tied to community values, as well as opportunities for trail development and geotourism. Long-term, this plan could foster a more comprehensive approach to regulatory consistency issues along the numerous governments responsible for the management of this feature.

County and community level "smart growth" comprehensive land use plans do a fair job of recognizing the Niagara Escarpment; however, community values associated with the escarpment are difficult to measure, and political pressures easily restrict the ability of

communities to increase regulation and protection along its cliff faces and environs. Some communities, however, have had a great degree of success in improving the levels of protection for this resource.

From a regulation standpoint, most of the existing land-use provisions that apply to the Niagara Escarpment occur at a county or community level and are very dependent upon the communities' knowledge of and support for protection of the escarpment and its associated features (with the exception of the broad provisions offered through the federal Endangered Species Act, state authorized shoreland zoning, or state/county implemented farmland preservation programs). Few,

if any, regional or statewide regulations exist that are specific to the Niagara Escarpment in Wisconsin.

In 2009, the escarpment's groundwater resources were the subject of a state Senate Bill (SB 632) that was proposed but never adopted. The rules were developed in response to historic well contamination issues stemming from both human wastewater treatment systems and the management of livestock manure within the corridor. They would have applied only to areas where carbonate bedrock is within 50 feet of the surface (fig. 6) and attempted to instill additional precautionary rules that would protect the aquifers sensitive resources. Justification for the proposed legislation was derived in part from the work of the Northeast Wisconsin Karst Task Force that convened for several years to discuss knowledge of human impacts and gaps in that knowledge base, best management methods for agriculture, and prioritized implementation of available technologies to better deal with karst environments.

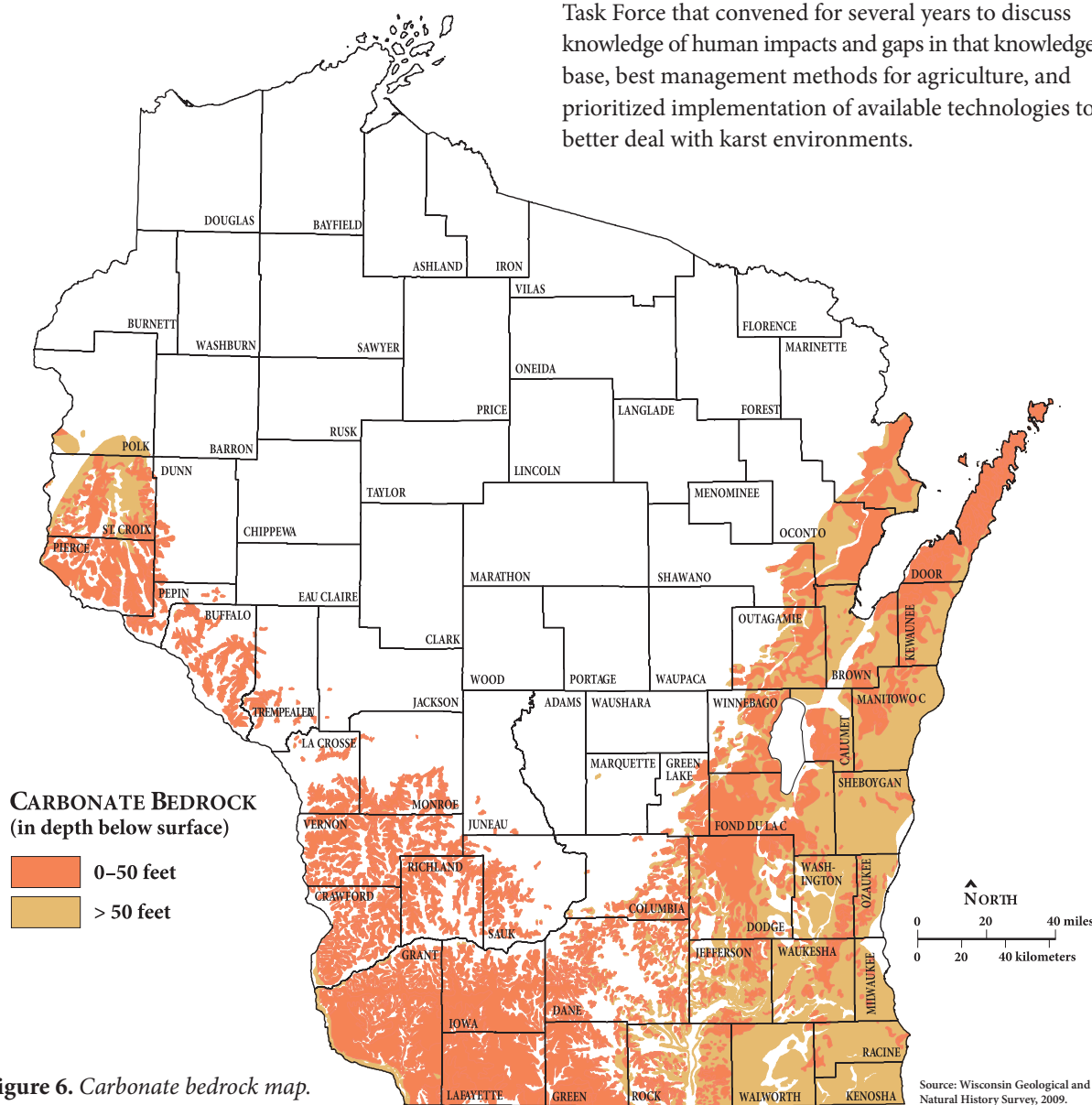


Figure 6. Carbonate bedrock map.

Land conservation and stewardship

Like Ontario, many public and private conservation and stewardship activities are taking place in Wisconsin's Niagara Escarpment corridor. Effective efforts in land protection have been implemented by entities such as the Glacial Lakes Conservancy, Door County Land Trust, and the North Eastern Wisconsin Land Trust. Other efforts for conservation and stewardship focus on the underground, as the escarpment's fragile Niagaran aquifer is the source for much of the drinking water in eastern Wisconsin.

Leading the way in on-the-ground actions to improve groundwater conservation and stewardship efforts is the local implementation of the national Groundwater Guardians program. Groundwater Guardians is sponsored by the Groundwater Foundation in Lincoln, Nebraska, and connects and recognizes communities that take action to protect and educate the public about groundwater (Wisconsin Ground Water Association, 2010). Much of the program's work is overseen by local chapters such as the Calumet County Groundwater Guardians. Calumet County's chapter has implemented programs in partnership with local governments and other conservation organizations to increase awareness of the groundwater resource and to demonstrate how homeowners can adopt best practices for groundwater conservation and protection. The group promotes groundwater education through well testing programs, water conservation through rain barrels and rain gardens, and pollution prevention awareness through agricultural and medical "clean sweep" programs.

Many additional land stewardship activities occur throughout the corridor, ranging from private woodland management to strategic land acquisitions designed to strengthen wildlife corridors. While funding for such protection and management is becoming sparse, in 2011, the Wisconsin State Legislature added the Niagara Escarpment to the Warren Knowles–Gaylord Nelson Stewardship Program's list of priorities for project funding consideration.

Recreation and geotourism

Wisconsin has an extensive system of public lands along the Niagara Escarpment corridor. State-, county-, and locally owned parks within 1 mile of its cliff face account for over 37,290 acres of land that is accessible by the general public (Kasprzak and Walter, 2001). If one factors in the shoreline areas of the bay of Green Bay and Lake Winnebago, tens of thousands of additional

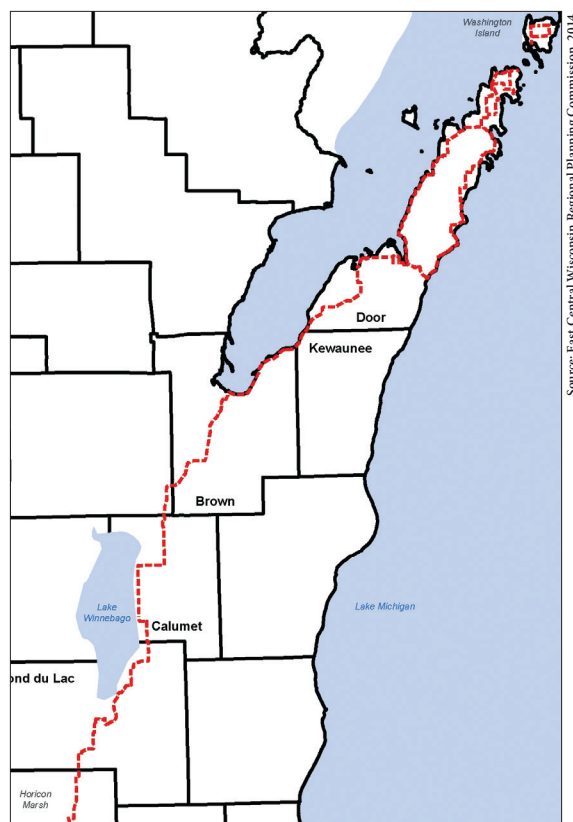


Figure 7. *The Great Arc bike route.*

acres are made available for recreational purposes. These public lands not only provide for outdoor opportunities, but "underground" ones as well, since numerous caves exist along the corridor.

Similar to the hiking trail planning efforts mentioned above, the Great Arc Bike Trail (fig. 7) was created to help generate awareness through geotourism. This route was developed under the auspices of the NERN as part of the "Year of the Niagara Escarpment" celebration. A 204-mile-long route connects the escarpment from the Horicon Marsh in the south to Washington Island in the north. It is hoped that improved bicycle access to the escarpment will lead to increased awareness and revenue.

Another geotourism program recognizes the corridor's uniqueness and suitability for growing cold climate grape varietals. In 2012, the federal American Viticultural Area (AVA) formally created the "Wisconsin Ledge AVA" designation for a 2.4 million acre area. This area, the 12th largest wine region in the U.S., places Wisconsin's escarpment corridor on the national map for winery tour destinations and further promotes the connections between the natural landscape and agricultural and tourism economies.

A GREAT ARC GEOPARK?

Many of the resources reviewed for this paper suggested the notion of a Geopark as a way to collectively implement the components of conservation geology. A significant opportunity exists to collaborate between the U.S. and Canada on the possible development of the first bi-national Geopark in North America.

A Geopark is defined by UNESCO as “a territory encompassing one or more sites of scientific importance, not only for geological reasons but also by virtue of its archaeological, ecological or cultural value.” The program aims to enhance the value of such sites while creating employment and promoting regional economic development in parallel with the protection of its ecological value. The program’s goal is to designate a network of up to 500 Geoparks worldwide.” (UNESCO, 2010). Today, UNESCO provides only ad hoc support to national Geopark initiatives which are coordinated through the Global Geoparks Network (GGN). The GGN helps to ensure that national geological heritage initiatives benefit fully from information exchange and cooperation through the network (UNESCO, 2015). When the program was first established in 1998, the following qualifications were developed in order to consider a site for designation as a Geopark. According to UNESCO’s website, a Geopark needs to:

1. Have a management plan designed to foster socio-economic development that is sustainable (most likely to be based on agri-tourism and geotourism);
2. Demonstrate methods for conserving and enhancing geological heritage and provide means for teaching geo-scientific disciplines and broader environmental issues;
3. Have joint proposals submitted by public authorities, local communities and private interests acting together, which demonstrate the best practices with respect to Earth heritage conservation and its integration into sustainable development strategies.

The Niagara Escarpment, or Great Arc, is a prime example of a geologic feature that could qualify for a Geopark designation. The themes discussed above fit naturally with the numerous legislative efforts and localized conservation programs that have taken shape across the escarpment corridor over the decades. All of these efforts have been raised to their current status by

the vision and hard work of concerned communities and their citizens who recognized that the Niagara Escarpment is a special place that is worthy of recognition and protection. Combining and integrating the many programs along the corridor, along with filling gaps in planning and management in some areas, could allow for the eventual creation of a Great Arc

“The Niagara Escarpment, or Great Arc, is a prime example of a geologic feature that could qualify for a Geopark designation.”

Geopark. A designation can be awarded to recognize “sites representing an interest for the earth sciences” (UNESCO, 2010). What better place than the Great Arc to implement such an idea?

Such an effort would require the cooperation and coordination of dozens of organizations and agencies along the corridor in order to create a cohesive Geopark program that fosters conservation awareness and action. Integrating the components of *conservation geology* into these programs, and subsequently a Geopark could help to broaden the public’s view of what the Niagara Escarpment is, particularly at an international scale.

And why not a Geopark for the Niagara Escarpment? The Niagara Escarpment corridor has long been known as a unique natural feature which contains rare geological, ecological and cultural landscapes. These natural and cultural features need to be placed in context within both the narrowly defined Niagara Escarpment and its broader surrounding landscape in order to establish a better definition for, and awareness of, the Niagara Escarpment as a true corridor system. The amount and variety of geoheritage sites which are recognized by the existing systems and programs may lend themselves well to efforts which seek formal recognition as a Geopark.

By applying national and trans-national planning concepts such as a Geopark, the individual resources of the Niagara Escarpment can be enhanced as a system that defines the current and future social and economic well-being of its owners and caretakers. Achieving the Geopark designation would certainly give people a reason to celebrate the Niagara Escarpment.

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