Ecological Restoration of the Witchhazel/Seminary Ravine: Baseline Data and Future Plans

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Introduction

Walking around Lake Forest campus, it is impossible not to notice the picturesque ravines. These ravines literally shape the campus; they are the boundaries that separate middle campus from south and north. They are the borders that give definition to the shape and layout of the school. They are the context in which the school lies.

The ravines are a very unique ecosystem. They are a part of a system of almost 50 ravines along the shore of Lake Michigan in northern Illinois; there is no other such system existing on earth. These ravines were formed by glaciers around 13,000 years ago, and today represent the only natural drainage system in Illinois that feeds into Lake Michigan in Illinois.

The Lake Michigan Ravines have a unique ecology; they represent remnants of what may have been here during previous cooler climates. Their shaded slopes allow the microclimate to remain colder and block much of the wind, imitating past climates; these species usually only occur farther north live in these ravines.

The ravine that shapes the Lake Forest Campus is called the Witchhazel/Seminary Ravine. In the context of other Lake Michigan ravines, this one is not in optimal condition. It is the fourth most ravine in danger for erosion out of all the Lake Michigan ravines. Many courses of action can be taken to help protect and restore the Witchhazel/Seminary Ravine so that it can remain a source of beauty and culture for the campus.

The goal of this thesis is to provide a long-term plan for how to restore the Witchhazel/Seminary ravine. Taking the background of this ravine and the land management uses into account, I aim to provide the best ways to prevent erosion and promote healthy plant and animal communities.

As a key part of any restoration, it is important to get baseline data first. Over the course of the year that I work on this project, I will gather data on the ravines to come up with the most specialized and effective plan possible.

Ravine restoration is a long-term, ongoing project; there is no quick and easy fix. The practical component will consist mostly of data collection, which is a necessary first step before going into full restoration work. By laying out a plan for the long-term restoration of the ravine, I aim to ensure its beauty and culture as a part of the Lake Forest College campus for years to come.

Chapter One: Background

1. Lake Michigan Ravine Formation

The ravine systems that drain into Lake Michigan on Chicago's north shore are truly unique; there is no other ecosystem like them anywhere in the world today. These wild remnants have diverse and rare ecological properties. In combination with their ecology, the ravine formation history makes these ravines different from any other ecosystem in the world. These ravine systems help to create the dynamic landscape of the Chicago area.

These ravines were formed through processes of erosion. Around 13,000 years ago, the Lake Michigan Lobe of the Wisconsinan Glacial Episode retreated, carving out Lake Michigan and leaving deposits of soil and rocks along its way. Some of the clay till left by the glacier formed moraines, creating a divide in watersheds. Water that converges east of the moraine that runs along Greenbay Road in Lake Forest flows into Lake Michigan, whereas water that hits west of this moraine eventually flows into the Mississippi River.

Around 10,000 years ago, the water level in Lake Michigan was lowered significantly; approximately 200 feet below current sea level. When this occurred, streams from the water that converged east of the moraine began flowing rapidly into Lake Michigan, carving out the ravines along the way over a period of several hundred years.

Early ravine formation starts as a steep downward incline, and as the ravines get deeper, water finds more
ways into the ravine through layers in the soil, until the water drains into Lake Michigan through gaps in the bluff. The morainal complex where the Lake Michigan ravines are located, the Lake Border Upland, derives its name from the dramatic bluff near the shore of Lake Michigan. Layers of dirt become unstable with all of the water moving through them and eventually collapse, creating dramatic slumps. Water flowing down the slopes of the ravines then smooths out these slumps, lowering the overall steepness of the slopes and further widening the ravine. These erosive processes are not consistent year round; they occur more significantly and rapidly in the spring; the wet conditions of this season encourage slumping.

These processes continue, eventually resulting in wider and deeper ravines over time. The speed of water entering the ravines slows, and with it, the slumping and steepening of slopes as well. The sediment that finds its way into the streams gets washed out to Lake Michigan, causing permanent loss of soil. Concurrently with the erosion, stones are also deposited along the stream banks. These stones help keep the streams from widening deeply, slowing the erosive processes. With erosion slowed, vegetation is able to develop along the slopes, which protects the ravines from widening further and becoming river flood plains.

Currently, approximately 88 square miles of land in Illinois drain into Lake Michigan; Lake County comprises 50 of those square miles. There are about 1.6 square miles of ravines in Lake County. These 1.6 square miles constitute the drainage route that the water in Lake County takes to Lake Michigan. Keeping the watershed safe, stable, and healthy requires ecologically and geologically sound ravines.

2. Ravine Ecology
The Lake Michigan Ravines are unique not only by their method of formation, but also in their ecology. The steep slopes of the ravines keep in moisture, creating a humid microclimate, while their proximity to Lake Michigan and forest shade provide cool temperatures. The ravines remain more humid and cooler than the surrounding landscape due to their shady V-shaped slopes that keep the moist air from escaping while allowing the heat to rise. From their unique microclimates, the ravines are able to maintain a different species composition than the surrounding ecosystems. Furthermore, these ravines can host species that usually live in more northern ranges.

The ability of the ravines to mimic more northern climates makes them particularly necessary to study. Many of the species that grow in these ravines are considered relicts, meaning they probably were more common in this region when temperatures were cooler but are now restricted to the ravine microclimates. This has two implications; first, that we can learn about the historical ecology of the region, and second, that as the climate warms, ravines may become a refuge for current species.

The climates of the ravines create mesophytic forest conditions, meaning they have a moderate amount of water held in the soil. Historically, the forest type of these ravines is characterized as maple–basswood, with the majority of trees being either Acer saccharum (sugar maple) or Tilia americana (American basswood). The forest composition is consistent with the mesophytic conditions of the ravines. The maple-basswood ecosystem of the ravines differs from the oak-hickory forest classification of the tableland surrounding them.

The plants in a ravine are very important in slowing erosion because their root systems not only absorb water but also hold together unstable layers of the soil that are hard to penetrate. Leaves and vegetative structures also catch and slow down water runoff. Through transpiration, plants also absorb water from the soil. Tree roots are less effective at preventing erosion than herbaceous plants, which have more extensive and intersecting root systems.

As previously noted, the dominant trees of ravines are usually sugar maple and American basswood. Additionally, oaks and ashes also grow in the tree canopy layer. Other trees that are known to grow among the upper canopy layer include black locust (Robinia pseudoacacia) and Norway maple (Acer platanoides); both of these trees are invasive but have found their way into the ravines. Some of the relict species that normally grow in this layer include paper birch (Betula papyrifera), white pine (Pinus strobus), and rarely American beech (Fagus grandifolia). The ravines also have a layer of understory trees and shrubs. The most common of these is witch-hazel (Hamamelis virginiana). Also to be found in this layer are black cherry (Prunus serotina) and musclewood (Carpinus caroliniana). One of the most problematic invasive plants, common buckthorn (Rhamnus cathartica), dominates this shady layer.

The herbaceous layer varies greatly with season. Many species of spring wildflowers bloom early in the spring to capitalize on the extra sunlight before the leaves on the trees mature and create more shade. Some of these striking flowers include bloodroot (Sanguinaria canadensis), great white trillium (Trillium grandiflorum), jack-in-the-pulpit (Arisaema triphyllum) and wood anemone (Anemone quinquefolia). Also included in this layer are a diverse range of grasses, sedges, and forbs. Some relict herbaceous species include star-flower (Trientalis borealis) and small henbane (Equisetum scirpoideum). One notable invasive Kentucky blue stem (Poa pratensis), is most commonly used as lawn grass, but has made its way into the ravine. Other
The ravines are also home to some species listed in Illinois as "state endangered species" under the Endangered Species Protection Act in 1972. These include the American dog-violet (Viola conspersa), purple-flowering raspberry (Rubus odoratus), a native bluegrass (Poa languida), northern bush honeysuckle (Dierwilla lonicera), limber honeysuckle (Lonicera dioica), longstalk sedge (Carex flacculata), and the Clinton’s sedge (Polygonatum tubescens), and common juniper (Juniperus communis), among others. The Witchhazel/Seminary Ravine is home to the American dog-violet and purple-flowering raspberry. The existence of these endangered species signifies the need to preserve and restore these ravines.

The soil within the ravines was carried here as the glaciers receded during the last Pleistocene glaciation. The soil is rich in calcium, and silt and 15% sand and gravel. Of the clay, illite, a common non-expanding clay-sized mineral, which forms in alkaline conditions, is the dominant material. The mixture of these types of soil give the earth in ravines a balance between movement of water through the soil and retention of water.

One of the main concerns in ravine environments is that they tend to become dense woodlands. Herbaceous roots are more efficient at preventing erosion; therefore a proper amount of light is necessary to reach the forest floor in order to maintain species diversity. For ravines, about 10% of ambient light reaching the forest floor is the ideal level. Most of the Lake Michigan ravines that lack active management have much lower levels than this.

Besides being a microclimate for the ecology of the region, the ravines also contain their own microclimates within their edges. The different sides of the ravine slopes have different microclimates and species compositions. North-facing slopes are cooler and moister, and also receive less direct sunlight. More shade-tolerant and northern relict species grow on the North-facing slopes. South-facing slopes, on the other hand, receive more direct sunlight making them warmer and drier. They are home to more of the prairie plants and less shade tolerant plants.

Another microclimate of the ravines is the bottom riverbed, which can be called "seeps." They get this name from the calcium-rich groundwater that keeps the ground wet year round. A plant that is indicative of a seep area is skunk cabbage (Claytonia virginica). It grows along the boundary of these seep microclimates.

The Lake Michigan ravines are not only important for their unique climates but also for ravine water flow. Since the reversal of the Chicago River, the Lake Michigan ravines are the only natural drainage system into Lake Michigan in Illinois. Keeping these systems healthy is vital to the watershed processes of this area. Additionally, because of the development along these ravines, increased erosion endangers buildings and structures built close to the edge of the ravines. Although they are in danger, the ravines are still relatively unspoiled wild ecosystems that are vital to the culture, hydrology, and ecology of the area.

### 3. Cultural Significance and the Witchhazel Seminary Ravine

The North Shore of the Chicago Area has attracted an affluent society. The combination of ravines, lakes and prairies create a multidimensional landscape that is desirable to live in. Due to the glacial clay and till deposits, the soil is very fertile. In Lake Forest, IL, a major attraction was the railroad that ran parallel to the lakeshore. The central location and the meeting of many waterways made the Chicago area a center for communication and trade. Part of the attraction to the ravines was the idea of the sublime; something awe inspiring and slightly frightening.

Though not as dramatic as a mountain, the ravines attracted admirers of the sublime and were influential landscapes that brought the wealthy settlers.

One of the things that first struck me when driving through Lake Forest is how much the grid system falls apart when one nears the lake; this is not accidental. When Almerin Hotchkiss, a landscape architect, planned the roads in the 1,200 acres surrounding current day Lake Forest College, he built them to go with the natural geography of the land. Between the roads along the ravines, he built parks that later became Lake Forest College's campus. Rather than filling in portions of the ravine, which would have been the standard, he built bridges through them and made the roads hug the curves of the ravines and moraines.

The Witchhazel/Seminary Ravine is the contextual layout in which the college was built. Based on Hotchkiss's design, the open parks were ideal to build a campus. By his design, some significant land alterations occurred. A swamp that was once located where Reid Chapel now resides was filled in. Additionally, one of the fingers of the ravine extended through the center of middle campus, where the library is currently located. This finger was also filled in.

In part from filling in of these natural drainage systems and rerouting the water, the Witchhazel/Seminary Ravine is not in optimal condition. Compared to the other 46 Lake Michigan Ravines, it is the fourth most vulnerable to dangerous erosion. The Lake Michigan Watershed Ecosystem Partnership (LMWEP) identified the Witchhazel/Seminary Ravine as a high priority for restoration necessity. Of the top four ravines, it is the largest and most difficult to restore. It is not only considered large among these top four ravines, it is also among the largest of all the Lake Michigan ravines.

### 4. Ravine Threats

It has already been established that the ravines are important to the culture and ecology of the area, but they will not remain important if they become too damaged. The factors that threaten the ravine health and safety are accelerating erosive processes. The amount of non-permeable surfaces and flat expanses of turf grass in ravine watersheds accelerate and amplify runoff reaching the ravines. Developments in close proximity to the edges of the ravines also add to this problem. Developments inside of the ravines are problematic, especially when these structures are not properly maintained. Direct storm water outlets which discharge into ravines, cause rapid erosion. Invasive species threaten native vegetation while overgrowth of trees has lowered the light permeability of these ecosystems. Proximity to private property also poses a problem for ravines.

Erosion can damage ravine slopes in multiple ways. The typical erosion is the simple dislodging of material down the slopes. Bank incision is specific to the riverbanks, where erosion causes steepness. Incision often causes almost 90-degree drops that can be several feet long at the river. Slumping, another erosive process, occurs when large amounts of material move down slopes that are too steep and soil that is too moist. Slumps are drastic losses of ravine bed material. Erosion is often characterized as happening either vertically, laterally, or both.

Gullies are deep erosive "valleys" that run along the ravine beds. Gullies can become so eroded that they lead to side branches of ravines. They are often caused by runoff from a direct source, such as a pipe or a pathway on the ravine tableland. The steeper the slope and the more water in a ravine, the worse the erosion becomes. Runoff that causes erosion also causes this positive feedback loop. The eroded material that gets washed into the streams is discharged into Lake Michigan.
The same processes that created the ravines are also endangering them. The erosion that took thousands of years to create the ravines has accelerated greatly due to development around the ravines. Non-permeable surfaces like driveways, parking lots, and roofs accelerate water runoff that erodes the ravines. As the only drainage systems in their watersheds, the excess runoff that should be absorbed by the ground goes directly into the ravines to make its way to Lake Michigan. Water also reaches the ravines more quickly after rainfall because of non-permeable surfaces.

Another factor that increases water runoff is the increase of turf grass. Diverse native plant communities have extensive and deep penetrating root systems that absorb water before it reaches the ravines. Lawns are monocultures, and their root systems are not extensive, therefore they do not absorb or slow water that drains into the ravines. They also have a more uniform topography, aiding in the acceleration of water runoff.

Another issue for the ravines is urban development in and around their edges. Many cities on the north shore have laws limiting how close one can build near the ravines. For example, in Lake Forest, nothing can be built within 20 feet of the edge of a ravine. This development disturbs the natural vegetation and ground surface. Also, the increased water flow around or off of structures can lead to deep gully erosion. In some cases, there are falling or damaged structures inside of the ravines, like old bridges and retaining walls; when left un repaired, they can contribute to greater erosion. When storm pipes drain into the ravines, they dramatically increase the velocity and quantity of water entering and eroding the slopes and stream banks. Gullies commonly form around these storm pipes.

Development near the ravines also poses another issue: the human movement of plants and animals that are not native. Anyone who has a basic working knowledge of plant identification can see the common buckthorn (Rhamnus cathartica) growing along the edges of the ravines that line the roads in Lake Forest. Invasive species, like common buckthorn, can take advantage of competitors that have not coevolved with them. The most aggressive of these can take over ecosystems and outcompete the native plants that are normally there.

One of the problems in ravines is that they are often so overgrown that enough light does not reach the ground; invasive plants contribute to this issue. Common buckthorn grows leaves earlier and drops them later than most plants native to the area, so it creates shade that is not normally there in the spring and late fall. Herbaceous plants that took advantage of the margins of these seasons are adversely affected by the lack of light. In ravines, the natural vegetation is one of the best methods of preventing erosion. Invasive species that remove native vegetation from these systems contribute to the speed of erosion.

The native vegetation in ravines is not only threatened by mistakenly introduced invasive species that have made their way out of residential gardens and into the natural ravines but also by intentionally introduced species. In the ravines at Fort Sheridan, as is true of many of the ravines that line private property, the owners will throw horticultural seed mixes into the ravines to produce pretty flowers. Most of the ravines are owned privately, and this landscaping of ravines with plants that do not improve the biological integrity of the slopes limits the ability of native plant communities to prevent erosion.

5. State of The Witchhazel/Seminary Ravine

The Alliance for The Great Lake’s LMWEP conducted a study on the state of the Lake Michigan ravines. This study was done under a process they deemed the Strategic Subwatershed Identification Process (SSIP). They identified a number of factors that contribute to erosion and quantified them in 47 of the Lake Michigan Ravines. These factors included, number of stormwater outlets, length of eroding beds and banks, and failing structures, among many other factors. The SSIP did not measure biological properties, like species richness, though they plan to do so in the future and are currently working on establishing a biological monitoring protocol.

The Witchhazel/Seminary Ravine got a score of 95.54 out of 100 for erosion risk. Only three other ravines had higher scores than this. The SSIP labeled it as a strategic subwatershed, meaning that it is a high priority ravine for restoration. One of the worst problems for the Witchhazel/Seminary Ravine is the high number of stormwater outlets, which totals 79. It also had 19 log jams, 8 failing structures, and 17 exposed pipes. All of these indicators can cause serious slumping and rapid erosion. The other key areas in which the Witchhazel/Seminary Ravine ranked highly were the measures of already occurring erosion. The ravine on average is about 115 feet from buildings and about 155 feet from roads. There are 4.2 acres of buildings within 50 feet of the ravine, and 6.84 acres of roads within 100 feet of the ravine. The urban developments cause excess water to reach the ravine more quickly. Not measured in this study was the proximity of parking lots to ravine edges. On middle campus, the parking lots are located directly on the edges of the ravines. The ravines get more runoff from these parking lots, which results in more erosion, and any fast erosion could cause the parking lots to collapse, leading to a dangerous situation. The Witchhazel/Seminary Ravine is already undergoing active erosion, and action needs to be taken soon.

6. Previous Restoration Attempts

Restoration ecologists in the area have noticed the importance of ravine restoration to the local ecology and heritage. Several ecologists have successfully restored many of the ravines, making them healthier and stabler. One notable ecologist is Dr. Charles Shabica, an emeritus professor of Northeastern University. He has restored several ravines, adjacent bluffs and beaches.

One of these ravines was Ravine Park Ravine (RP Ravine) in Lake Bluff. The first steps to the restoration included intensive removal of invasive species. Shabica also employed many physical barriers to erosion. Common buckthorn, an important preventative method for erosion is restoring streambed armor. Shabica used limestone cobbles and boulders to line the streambed of the RP Ravine. They used geoweb to keep these boulders in place and graded some parts of the ravine streambed to a uniform slope. They also filled slumps with cobble and added soil with native plant seeds over the cobble. They restored the beach where the mouth of the ravine empties, also preventing erosion. They found a great improvement after seventeen years in the native vegetation, the health of the stream, and the reduction of sediment loss.

Also included in Shabica’s work was the restoration of Ravine 10 in Highland Park. Many similar processes were followed as the restoration of the RP Ravine because Highland Park has the most heavily urbanized ravines. An important consideration for Ravine 10 was the repair of broken or exposed pipes that had been damaged by erosion. A number of extensive erosion control mechanisms were installed in this ravine. Gabion baskets constructed of steel and filled with limestone cobbles were put in place in the streambed. Reno Mattresses, six by nine foot steel mesh baskets filled with limestone were placed in the base of the streambed as well. Additionally, A-Jacks, six arm jacks made of concrete, and Geoweb, a plastic textile that is shaped like a honeycomb that gets filled with cobble, were also installed.
The A-Jacks were unsuccessful, but the other erosion preventers worked in controlling loss of sediment. Shabica also helped to restore the Glencoe Ravine by creating water retention basins in the lower edges of the ravine to slow stream movement. They also planted native plants and selectively thinned trees. Shabica’s work relies heavily on engineering to control erosion. Other projects have focused more on the restoration of native vegetation.

The Chicago Botanic Gardens has been working with Openlands Lakeshore Preserve since 2008 to restore the ravines there. The area was formerly operated as part of Fort Sheridan, but after being decommissioned, Openlands acquired the land; this preserve is open to public access. There are three ravines on the site: Bartlett, Van Horne, and Schnenck. In 2008 and 2009, the Conservation Design Forum performed a Floristic Quality Assessment of Bartlett Ravine. In Bartlett Ravine, the goals of restoration are focused on vegetation. They have started out with invasive species control. They also selectively thinned trees, encouraging the growth of native grasses and sedges, and are planning to establish a burning regimen in the ravine. They have done a small amount of slope repair, but this was a secondary goal.

The restoration work began in 2009, so there are no results to report yet. Bartlett Ravine is relatively undisturbed as far as Lake Michigan ravines are concerned. It has a floristic quality inventory value of 32, which means that it is regionally significant. It does have a problem with invasive species, particularly *Robinia pseudoacacia* and *Allaria petiolata*. Hopefully with active restoration, the biological monitoring will see improvements ultimately resulting in effective erosion control.

Other methods have been employed to reroute water going into ravines. At the site of former Fort Sheridan, a swamp has been restored to absorb runoff before it reaches McCormick and Jane Ravines. McCormick Ravine is the best example of healthy ravine vegetation in this system of ravines. It is a host to many rare and native species and has high biodiversity. Part of this has been attributed to the existing natural tableland around healthy parts of the ravine. McCormick is threatened because of water coming from trails and from pipes. The restoration there, besides the swamp, only consists of occasional invasive species control. There are many recommendations for fixing broken pipes in the ravine as well as rerouting some of these pipes to empty directly into the bottom of the ravine.

It is clear from these previous projects that ravine restoration is multifaceted. Vegetative quality and composition needs to be taken into account. Invasive species control is an important part of improving biological communities. Tableland restoration is also effective in helping improve ravine hydrology. Engineering approaches can control streambed erosion. Additionally, broken structures and pipe placement need to be addressed. Rerouting water is also an effective erosion controller. To improve the health and prevent erosion of these ravines, all of these aspects must be taken into consideration.