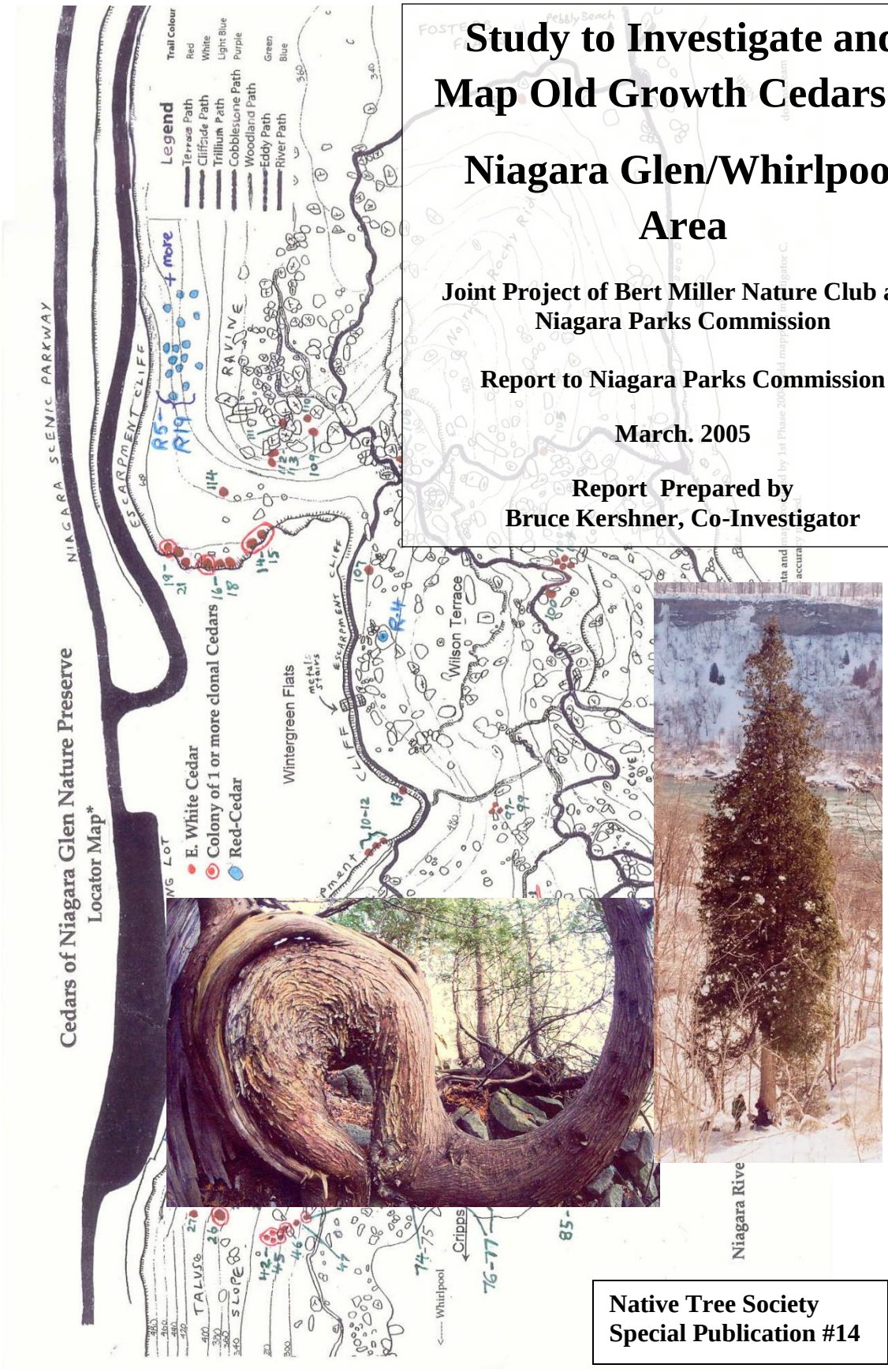
Study to Investigate and Map Old Growth Cedars of Niagara Glen/Whirlpool Area

Joint Project of Bert Miller Nature Club and Niagara Parks Commission

Report to Niagara Parks Commission

March. 2005

Report Prepared by
Bruce Kershner, Co-Investigator



Native Tree Society
Special Publication #14

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Native Tree Society
Special Publication Series:
Report #14

http://www.nativetreesociety.org
http://www.ents-bbs.org

Mission Statement:

The Native Tree Society (NTS) is a cyberspace interest groups devoted to the documentation and celebration of trees and forests of the eastern North America and around the world, through art, poetry, music, mythology, science, medicine, wood crafts, and collecting research data for a variety of purposes. Our discussion forum is for people who view trees and forests not just as a crop to be harvested, but also as something of value in their own right. Membership in the Native Tree Society and its regional chapters is free and open to anyone with an interest in trees living anywhere in the world.

Current Officers:

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Membership and Website Submissions:

Official membership in the NTS is FREE. Simply sign up for membership in our bulletins board at http://www.ents-bbs.org Submissions to the website or magazine in terms of information, art, etc. should be made directly to Ed Frank at: edfrank@nativetreesociety.org *The Special Publication Series of the Native Tree Society* is provided as a free download in Adobe© PDF format through the NTS website and the NTS BBS. The editorial staff of *the Native Tree Society Special Publication Series* are solely responsible for its content.

Forward/Introduction

This report is one of a series written by Bruce Kershner that the Native Tree Society (NTS) are publishing or republishing as part of its Special Report series. They were given to fellow NTS member Dale Luthringer prior to Bruce's untimely death in 2007 with the goal of them eventually being published and made available to other tree researchers.

This report: "Study to Investigate and Map Old Growth Cedars of Niagara Glen/Whirlpool Area" was prepared as part of a joint project of the Bert Miller Nature Club http://www.bertmillernatureclub.org and the Niagara Parks Commission. The report indicates it was submitted to the Niagara Parks Commission http://www.niagaraparks.com/ in March 2005, by Bruce Kershner, Co-Investigator for the project. The Bert Miller Nature Club kindly gave the Native Tree Society permission to publish the document.

I am unsure if the report was ever presented to the Bert Miller Nature Club or to the Niagara Parks Commission. In any case the document is not available for downloading elsewhere. The report was essentially complete with text, an excel spreadsheet listing of trees documented in the study, location maps of the cedar locations, graphs, and a series of photographs that had been scanned from pages onto which several photographs had been pasted onto each sheet with hand notations for captions.

The text included herein is complete and as written by Bruce Kershner aside from corrections of minor typographical errors . The text itself has been reformatted into a two column. The individual photographs have been separated and corrected as well as possible from the scanned copies provided.

This report focuses on the cedars present in the Niagara Glens Nature Preserve adjacent to the Niagara River Whirlpool Area on the western (Canadian) side of the Niagara River.

The description of the area on the Niagara Parks website http://www.niagaraparks.com/nature-trails/niagara-glen-whirlpool.html reads in part: "*Niagara Glen & Whirlpool- The Niagara Glen is a unique spot of beauty deep in the Great Gorge that has been a designated Nature Reserve since 1992. Stairways lead to 4 km (2.5 mi) of paths that wind through a pristine pocket of Carolinian Forest, past boulders left behind as the Falls eroded through the area thousands of years ago.*

The Niagara Glen overlooks the Niagara River Whirlpool, a unique natural phenomenon that you must see to believe! Thousands of years ago, as the Niagara River slowly eroded its way through the Niagara Escarpment, creating the Great Gorge, a right-angle turn in the river's path

forced the rushing water into a deep counter-clockwise spin."

Bruce Kershner first reported old cedars at Niagara Glen in a 2003 report:

> Old Growth Forest Survey of Niagara Peninsula, Project of Bert Miller Nature Club, First Phase Report to Trillium Foundation, October 2003

This document is available for download as a pdf file on the Bert Miller Nature website (42 MB) at:

http://www.bertmillernatureclub.org/assets/docs/library/OLD%20GROWTH%20FOREST%20SURVEY%20OCTOBER%202003.pdf

There are several mentions of old growth forests in Niagara Glen:

1) The largest Old-Growth Forest within the city limits of any city in eastern North America. This is Niagara Glen (60 acres) plus the Niagara Gorge ancient cedar zone (10 acres) that lies within the City of Niagara Falls, Ontario, with a combined total of 70 acres. (Phase 2 discoveries increased this acreage to 395.4 acres.)

2) Original discovery of ultra-ancient cedars in the Niagara Gorge. Although the gorge has been studied over 200 years by hundreds of scientists, until now, no one had realized that it had cedars that attained ages over 500 years, possibly to 700 years.

3) Discovery of possibly the tallest broadleaf ("hardwood") forest in the Province of Ontario: Niagara Glen's Old-Growth Forest. Its tallest Tulip Tree (Canada's tallest) has a champion height of 134 feet. The Glen also has Canada's tallest Sassafras and Chinkapin Oak.

The site is described in more detail on pages 19-21 of that report. Hw writes: "Northern white cedar (20-32 inch diameter) up to 500 years old, possibly older ! They grow in fantastic shapes on boulders and cliffs in the glen."

This report also describes other old growth cedar populations elsewhere within the Niagara Gorge. He writes, page 23:

"The old growth northern white cedars of the Niagara Gorge can safely be called a nationally significant discovery. Hundreds of ultra-ancient cedars populate Canada's side of the Niagara Gorge."

These include:

- 691 ancient cedars (preliminary count) populate Ontario's side of the 7-mile long Niagara Gorge
    - 464 ancient cedar trunks grow out ofthe talus (boulder) slopes
    - 227 grow out ofthe vertical cliff faces

Maps and photos are included of both sites within the document.

The second phase of this research report was completed in 2004:

> Old Growth Forest Survey of Eastern Niagara Peninsula, Phase 2/ Final Report

This document was republished as part of the NTS Special Publication Series, #13, and is available for download as a pdf file here: http://www.ents-bbs.org/viewtopic.php?f=281&t=3806#p15917

This report contains some additional new information on the cedars of Niagara Glen, p. 69-71, collected during the second phase of this larger project. The information on the Niagara Gorge white cedars are also updated on p. 77-78. Other smaller patches of old growth forest containing old cedars are also described in these two documents from elsewhere in the eastern Niagara Plateau region.

Douglas Larson and P. Kelly (1991) reported many ancient white cedars up to 1653 years old found along the Niagara Escarpment. A misconception by many casual is that the Niagara Escarpment where the oldest trees were found refers to the Niagara Gorge, when in fact, these trees were found growing on Flowerpot Island in Lake Huron.

> Larson, D.W., and P.E. Kelly. 1991. The extent of old-growth *Thuja occidentalis* on cliffs of the Niagara Escarpment. *Canadian Journal of Botany* 69:1628-1636.

Wikipedia describes the Niagara Escarpment http://en.wikipedia.org/wiki/Niagara_Escarpment in general terms:

> The Niagara Escarpment is a long escarpment, or cuesta, in the United States and Canada that runs predominantly east/west from New York State, through Ontario, Michigan, Wisconsin and Illinois. It is composed of the Lockport geological formation of Silurian age, and is similar to the Onondaga geological formation, which runs parallel to it and just to the south, through western New York and southern Ontario. The escarpment is most famous as the cliff over which the Niagara River plunges at Niagara Falls, for which it is named.

Niagara Escarpment marked in red

Within Niagara Gorge itself Kershner (1994) reported ring counts of 360 years from white cedars and extrapolated ages of up to 650 years. Trees have yet to be found that approach the ages documented from Flowerpot Island, Ontario but there is potential that some trees within the gorge may be substantially older than have been documented so far.

As would be expected, there have been a number of reports discussing the old cedars within the popular press. A listing of some of these articles will be included in a future volume of these NTS Special Report documents.

Edward Frank, editor

General Background

This document is one of a series of Special Reports being published by the Native Tree Society consisting of reports of old growth sites written by Bruce Kershner just prior to his untimely death from esophageal cancer in February 2007. Bruce S. Kershner (April 17, 1950 - February 16, 2007) was an environmentalist, author, and forest ecologist He served as a University of Buffalo adjunct faculty member. He earned a Master of Science Degree in Botany-ecology from University of Connecticut. He was widely acclaimed as an authority on old growth forests, documenting hundreds of ancient trees and forests in eastern North America, where previously no one thought they had existed. He is an author of a dozen books on natural history, including: The Sierra Club Guide to the Ancient Forests of the Northeast by Bruce Kershner and Robert T. Leverett (May 1, 2004); National Wildlife Federation Field Guide to Trees of North America by Bruce Kershner, Craig Tufts, Daniel Mathews and Gil Nelson (May 9, 2008); and Secret Places: Scenic Treasures of Western New York and Southern Ontario by Bruce Kershner (Aug 1994).

Bruce Kershner won numerous awards for his environmental activism. These included 'Environmentalist of the Year' in 1987 and 1988 from the Sierra Club (Niagara Group) and the Adirondack Mountain Club, and 'Environmentalist of the Year in New York State' in 1996 from Environmental Advocates of New York. Robert Leverett, a co-author and colleague of Bruce described him as a "a buzz-saw and indefatigable. His role often was one of calling attention to forests in danger, leading the charge to get them protected, and in being an inspiration to others."

These documents were given to his friend and colleague Dale Luthringer prior to his death with the goal of seeing them eventually published. The Native Tree Society has received permission from his widow to do so. The text and tables were reformatted to better fit the NTS Special Report format, but the content presented is as written by Bruce Kershner and has not been otherwise edited or altered.

Additional information relating to these reports and updates on the current state of affairs at the described sites have been compiled and are presented as separate articles within each individual report. A final document includes biographical information, miscellaneous smaller reports written by Bruce Kershner, listings and excerpts from articles talking about Bruce and his work, tributes and eulogies written upon his passing, and other materials in a similar vein.

Disclaimer

Bruce Kershner has argued in these documents that based upon extensive experience by the researchers, through using a series of physical characteristics that the ages of individual trees could be estimated to within 10 to 15% of their true ages. It is the position of the Native Tree Society that tree age estimates based only on physical characteristics cannot be made to this degree

of accuracy. Based upon physical characteristics alone, the age of an individual tree may be greatly underestimated or over-estimated even by an experienced researcher. Where permitted, in order to obtain accurate tree age information, dendrochronological methods, including taking cores from select standing trees and counting the rings present in fallen trees, should be used to provide baseline chronological data and to serve as a calibration for the apparent ages as indicated by physical characteristics.

Physical characteristics are commonly used by dendrochronologists to determine which trees in a stand or area are likely the oldest and to help select which trees to sample. Listings of characteristics found in old trees very similar to the one written by Kershner have been produced by the dendrochronology community. Dr. Neil Pederson recently published the article "External Characteristics of Old Trees in the Eastern Deciduous Forest (Volume 30 (4), 2010 Natural Areas Journal, pp. 296-307)." A similar article "Identification of Old Ponderosa Pine Trees in the Front Range(18 USDA Forest Service Gen. Tech. Rep. RMRS-GTR-110. 2003)," deals with the characteristics of this conifer. Physical characteristics are a valuable tool for old growth researchers, but for determining the age of as specific tree, an accurate age can only be determined through coring and similar dendrochronological techniques.

The above qualifications should not be misapplied to Kershner's old-growth designations. Old growth forest is essentially and anthropogenic designation with no distinct ecological boundary. As such there have been hundreds of old growth definitions that have been applied different situations and by different individuals. Kershner has provided one such definition. He has explicitly defined an old tree and one of a certain age or one which has certain physical characteristic he characterizes as an indication of old age. He further has explicitly defined an old growth forest as one which has certain specific criteria, including old trees, and is lacking in other characteristics. Therefore by definition, if a forested site has these characteristics it is an old growth forest. He has used this definition to many old growth forest sites in the northeastern United States and Canada. In contrast, such as in the Niagara Gorge for example, he has also used these criteria to exclude potential sites as old growth. Other researchers can argue the merits of the criteria used for this definition, but it appears to have been fairly and equitably applied by Kershner in these reports.

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Joint Project of Bert Miller Nature Club and Niagara Parks Commission

Report to Niagara Parks Commission

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Report Prepared by
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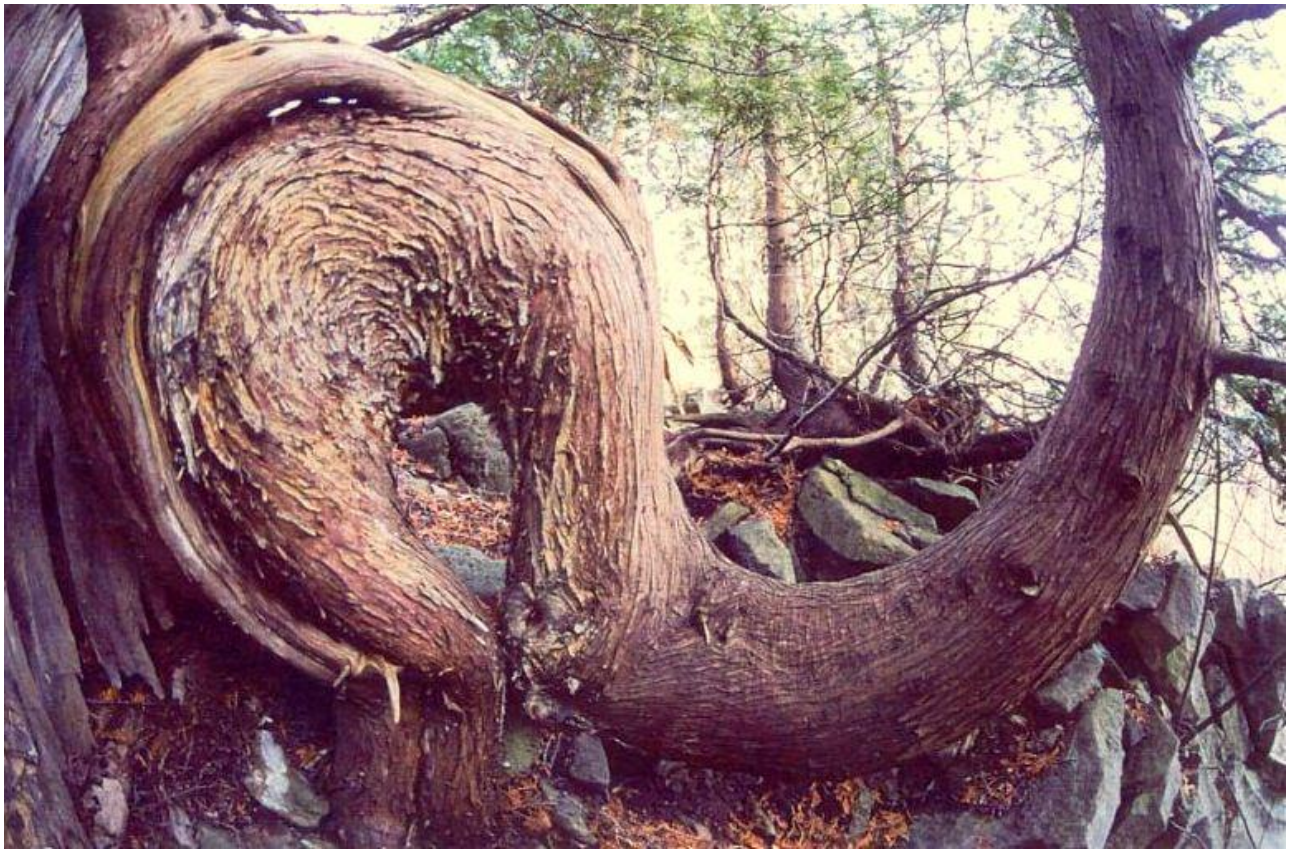


Study to Investigate and Map Old Growth Cedars of Niagara Glen/Whirlpool Area - Project Report -

Joint Project of Bert Miller Nature Club and Niagara Parks Commission
March 2005

Goals and Objectives

The goal of this project is to assess the extent of the population, and map the location of, the Eastern White Cedars that grow in the Niagara Glen/Whirlpool area, as well as to get an idea of their age, physical size, and other notable features. This is the first formal, funded study of old-growth cedars of the Niagara Gorge (Canada or U.S.), to the best of this investigator's knowledge. In particular, it is the first time that increment bore samples have been obtained to accurately measure ages of old growth cedars anywhere in Niagara Gorge. This small, preliminary project, therefore, can accurately be called ground-breaking.

Methods

This project was separated into two specific phases, each conducted by a different investigator.

Phase 1 - The first investigator, Carrie Turunen, conducted the field mapping of the cedars on Nov. 18, 19, 23, and 30, 2004.

According to the investigator, these items were used in the Glen for the mapping effort:

- Global Positioning System (GPS) device (Lowrance Global Map 100)
- centimeter tape measure
- camera
- notepad

During the 4 days of field mapping, the investigator was assisted by a volunteer who was familiar with the Glen, and physically capable of climbing up difficult terrain to measure trees. All parts of the Glen were explored for cedars, which was made easier because the deciduous leaves had fallen.

When a cedar or cedar colony was encountered, the investigator recorded the following data in the note pad:

1. the tree(s)' appearance, how many trunks, what substrate it was growing out of, and its location by trails, landmarks, and estimated distance from those landmarks (large boulders, cliffs, metal stairs).
2. latitude and longitude for about half of the mapped sites was measured using the GPS unit
3. circumferences of 30 trees, as measured by the volunteer with the tape measure
4. 13 different cedars were photographed. The volunteer and the Phase 2 investigator supplemented these with photos of 7 more different cedars (Appendix).

The field mapping data from the note pad was then typed into the computer. Using an 8.5 x 11" trail map of Niagara Glen, a grid line system was drawn. Using data from the notes, 83 dots were placed on the map to match the locations where each cedar or cedar colony site was estimated to be. Each dot was numbered to correspond with each cedar or cedar colony recorded in the notes. The numbers used the grid system coordinates so that each site could be easily located on the map.

The field notes, map and photos were provided to the Phase 2 investigator in December, 2004.

There was a several month interval between the two phases. Primary reasons were winter inaccessibility and hazardousness of the gorge, and inability to find snow-covered cedars and trails. Many of the cedars are challenging to find and reach under the best conditions. Winter conditions also make tree coring nearly impossible because of the risk that the borer will freeze into the tree; inability to extract and handle delicate wood cores without removing gloves, and also stiffening of fingers due to cold. Coring trees requires standing still for an hour at each tree.

Phase 2 - Forest ecologist Bruce Kershner conducted the field work (extracting tree cores) and lab measurements (measuring tree ages) for Phase 2, as well as analysis of these data and all Phase 1 mapping and other data. This investigator's last task was to compile and present it in this report.

Field Research

When the winter season seemed to be entering a mild period, the investigator scheduled field trips to the Glen on two different days in February, but each had to be cancelled because of sudden return of harsh weather. On March 4, 2005, this investigator was able to conduct a successful field trip, accompanied by 3 volunteers who have previously assisted with tree coring. One of the volunteers was the same person who assisted the first investigator; he was invaluable in guiding the group to the trees that were to be cored.

Tree Coring Using an Increment Borer - an accurate way to measure the age of a living tree is to bore 0.7 cm hole into the center of the trunk (ideally at about 1.3 m above its base), using an increment borer (in this case, a 20-inch long Suunto tempered steel borer). The device is a long hollow screw auger, turned by hand. When the researcher thinks the center has been reached, a long, narrow metal prong with teeth at the end is slipped into the hollow auger. It grabs and extracts the 0.5 cm diameter rod or wood core (ideally) so that it can be slowly pulled out. The core is then slipped into a plastic tube or straw, sealed at both ends, and labeled. Counting of its annual rings for age measurement was performed in the lab.

The investigator aimed to core 3 cedars with different features and habitats. Guided by the volunteer who assisted the Phase 1 investigator, we were able to core 3 cedars notable enough to have been given names: 1) Medusa Cedar - large diameter (24 inch at base); grows on top of boulder under deep forest; has bizarre tree base shape and roots; 2) Elephant Trunk Cedar - extremely bizarre shape; part of a large, complex, bizarre clonal colony near edge of forest overlooking river; grows on bedrock ledge; 3) Sitting Arm Cedar - double-trunk, straight and tall; grows on steep talus slope in the open; named for one peculiar branch.

One core was taken from the Elephant Trunk Cedar. For the Medusa Cedar and Sitting Arm Cedar, the first cores hit hollow spots, so a second (successful) core had to be taken from each. The tree coring process (alone) for the 3 trees took 3 hrs. 15 min.

The age of a fourth cedar was measured on-site. It broke off from the cliff overlooking Devils Hole Rapids. This investigator climbed down the river bank and counted its exposed rings to the center of the small trunk.

Measurement of Tree Height The heights of several cedars were measured using a very accurate, state-of-the-art method with a Bausch and Lomb Laser-Range Finder, a Clinometer and a trigonometry calculator. Measuring tree height with this method requires two people. The highest branch has to be found by stepping quite a distance away from the tree. The Laser-Range Finder is focused on the distant summit branch and registers a distance. The same branch tip is measured through the Clinometer lens, which provides the angle in degrees. Using the calculator and a simple trigonometry ("twigonometry ") formula, the two numbers yield the tree's height in feet.

During the rest of the field trip, which required traversing the entire length of the Preserve in deep snow, additional photos were taken. Notably, several significant errors in the Phase 1 map of cedar locations were noted. Also noted were very large Hop Hornbeams growing on top of boulders that were never previously noticed before. Seeing them during winter revealed them when they were camouflaged during other seasons. They had extensive gnarly, snake-like root systems that clambered down the boulders, much like the cedars do. This investigator thinks that ages of 350 years for these usually small trees would not be surprising.

Lab Analysis

Procedure to Measure Tree Cores to Determine Age of Cedars After the field trip, the tree cores were placed onto a board with grooves that were designed to be the right size to firmly hold them. Wood glue was used to permanently fix them to the board. They were then carefully sanded with fine-grain sandpaper. This reveals the annual rings, especially the minute rings, so that they can be accurately counted. A bright light was used with a strong hand lens and a long narrow metal pointer to carefully count the annual rings. This process was repeated at least 5 times for each core. Some annual rings were observed that were so narrow that they fitted *between* rings that were too narrow to see with unaided eye.

The less complete cores for two of the cedars were not used for any further measurement of the trees' ages. The 3 successful tree cores, one for each cedar, were used to count the number of annual rings.

The number of rings counted equals the age in years for that portion of the tree that was cored. However, the true age of the tree is at the tree's base, so a standard number of years are added to the number of annual rings (based on extensive past research). For nearly all trees, 10 years is added, but for a few very slow-growing tree species (such as cedars in this habitat), 15 years are added. (Coring at the tree base is not possible since the boring device would hit the ground, and the tree is more likely to be hollow there anyway.)

When the inner part of the core is missing because the tree is hollow, or if the borer missed the center of the tree, there are methods to extrapolate the age to account for the missing rings. This applies to the cores obtained for this study. For old growth trees, especially Eastern White Cedars, the extrapolation is rather reliable because there are usually only minor variations in the width of the annual rings to account for, when considering the missing portion. The exact methods are too lengthy to explain in this report.

Minor extrapolation was needed to reach as close an approximation of the age of the 3 cedars as possible.

Analysis of Phase 1 Map and Statistical Data About Cedars

The Phase 1 data was carefully reviewed and compared with the map of the cedar locations that was produced by the Phase 1 investigator. The aim was to verify the accuracy of the map, as is expected in all scientific procedures. This investigator's aim was also to create a clear, "user-friendly" map for the report. Along with being as accurate as possible, such a map would make it easier for future researchers to locate the cedars, which are usually in difficult to find or challenging to reach locations.

A careful analysis of the Phase 1 descriptive data about the cedars was also required to ensure as accurate a map as possible. The obvious aim was to separately number each individual cedar with its location on the map. Phase 1 did not determine the actual number of individual cedars, since many cedars grow as clonal colonies with multiple separate trunks. The Phase 1 map identified 83 sites that are either individual cedars or various combinations of cedar colonies and individuals cedars (the total number of distinct cedars, after the Phase 2 research, was concluded to be 116).

To determine the total number of cedar "organisms" in the field, more time than the 4-day Phase 1 mapping effort would have been needed. Since it is a challenging task in the field, analyzing the Phase 1 data (in the office) was even more challenging.
Besides producing an accurate map and determining the total population of cedars, the other major aims of analyzing the Phase 1 data were to:

1) devise quantitative comparisons by dividing the cedars into different categories by
   a) growth form: total number of -
      i) individual, single-trunk cedars
      ii) individual cedars with multiple trunks connected at the same base
      iii) cedar clone organisms with multiple, separate trunks
      iv) cedar clusters (genetically unrelated but growing close together).
   b) substrate on which they grow: soil, bedrock, single large boulder, cliff face, or talus slope.
   c) location in preserve.
2) determine which cedars should be cored, with that decision partly based on their locations and features

When the map was carefully compared with the Phase 1 field notes, and the Phase 1 data were exhaustively analyzed, an unexpected conclusion had to be reached before any of the above aims could be accomplished. Much of the data turned out to be incomprehensible as well as inaccurate. More than a third of the cedar locations on the map were inaccurately placed, with

some of them either far from their true location, non-existent, mapped but not described, or described but not mapped.

While the data were being analyzed, corrections of the inaccuracies had to be continually added to the Phase 1 field notes simply, and solely, to achieve the project aims described above. The field notes and the corrections are provided in the Appendix.

As a result of the unexpected problem, the data analysis took several times longer (8 days) than it would have otherwise.

Results and Analysis

Measurement of Tree Ages

Increment borings, or tree cores, that were extracted from 3 old growth cedars were analyzed in the lab which provided a close approximation of their age. In addition, one field count of annual rings was performed on the trunk of a cedar that had just been broken off a cliff.

These ages are supplemented by 4 other age measurements of cedar logs in the Glen, and

The tree ages are as follows:

Medusa Cedar = approx. **316 years** old

- trunk was cored where diameter was 14" about 2 feet above its base.
- actual # of annual rings = 280 with 36 yrs. added to account for slightly missing the center, and for distance to the base.
- individual single-trunk tree grows on a boulder in the ravine below (north of) Whispering Falls Cliff (Wintergreen Flats). Has striking bizarre growth form.

Elephant Trunk Cedar = approx. **175 years** old

- trunk was cored where diameter was 5.75" about 5 in. from its base.
- actual # of annual rings = 153 with 22 yrs. added to account for slightly missing the center, and for distance to the base.
- - tree grows on edge of bedrock ledge along Blue Trail overlooking Cripps Eddy. Has astonishing bizarre growth form like an elephant's trunk. Part of an amazing clonal colony with a total of 17 separate trunks.
- It is important to note that the hollow 18-inch diameter stump (part of the same clone) abutting this cedar would have an extrapolated age (conservatively) of 200 to 250 years when it died.

This investigator has experience in judging how long it takes a cedar in this region to weather and become hollow. The stump has been there without question for at least 150 years, since that trunk died. That would mean that this cedar organism is at least the combined age of the Elephant Trunk Cedar and the former tree (now stump) which means about 400 years old. If however, the stump has been there even longer, then an age of the organism approaches 500 years old. Some of the other trunks of this clone are older than the Elephant Trunk Cedar. With overlapping ages, on a continual basis, a 17-trunk clone like this could very well be as old as 750 years old, maybe even 1000 years. Instead of one continual age, this amazing organism has a longevity more like a relay race, handed over from one trunk to another.

Sitting Arm Cedar = approx. **218 years** old

- trunk was cored where diameter was 10.6 in. above its base.
- actual # of annual rings = 159 with 49 yrs. added to account for missing the center, and for distance to the base.
- tree grows at lower end of talus slope and uphill from the Whirlpool Trail along the west side of Cripps Eddy. Has two fused, straight trunks, with a peculiar, hooked arm-like branch which a small child could sit on.

Spring Trail Cliff Cedar = approx. **110 years** old

- 15 ft. long broke off from the cliff (for unknown reasons) overlooking Devils Hole Rapids; annual rings were exposed and measured during the field trip
- 105 years were counted to the center of a 4-in. diameter. Looking up at the cliff, it was estimated that about 18 inch length of trunk was still left in the cliff. With that knowledge, this small cedar's age was estimated at 110 years old.

Previous age measurements in the Glen:

- 14 in. diameter log = 283 years (to the center)
- 17.5 in. diameter stump = 260 years (extrapolated, 30 rings per inch)
- 30 in. diameter log = 330 years (to the center)
- 22 in. diameter log = 360 years (to the center), counted almost at ground level

Previous age measurements of other Niagara Gorge cedars

- During the 2002-2005 Eastern Niagara Peninsula Old Growth Forest Survey, sponsored by Bert Miller Nature Club, an age of 436 years was obtained for a cedar whose rings were exposed by rockfall damage on the talus slope 0.4 km upstream of Niagara Glen's southern boundary. Furthermore, ages of 185 - 360 years for 5 cedars (8 to 20 inch diameter) were obtained from cedar stumps in the Old Growth Walnut Grove ravine at the north end of the top of Niagara Gorge.

Population Count and Other Statistical Information Related to the Cedars

After sorting through the confusing Phase 1 data, the **preliminary total of Eastern White Cedars in Niagara Glen is 116**. This means there are 116 genetically separate cedars, as far as this data allows one to determine. In addition, at least 19 Eastern Red-Cedars grow in the Glen. Future investigation is highly recommended to verify this and refine the analysis.

The accompanying **Map of Cedars of Niagara Glen** clearly shows where all the different categories of cedars are located (based on best analysis and correcting of the Phase 1 data). The **Grid Reference Map for Locating Cedars** enables one to find where cedars are on both maps and when looking to find them in the Glen.

<u>Types of Growth Forms</u>

The 116 Eastern White Cedars (called "cedars" hereon, except when needed to distinguish them from Red-Cedars) can be divided into 4 different growth forms (also shown in the accompanying graph). Unfortunately, mixtures of any of these can and do occur, which makes the identification process a bit challenging.

1. *individual single-trunk cedars* (total = 31)
2. *individual cedars with multiple trunks* all attached at the same base. A total of 19 of this form grow in the Preserve. They have a combined total of approx. 80 trunks.
3. *clonal cedar* with a complex of multiple, separate trunks and crowns, but all connected underground, and by above-ground roots, and horizontal trunk "connectors." All trunks are genetically the same, even if it looks like a "grove" of trees. A total of 42 clonal cedars grow in the Preserve. They have a combined total of 136 trunks. Because many cedar clones are joined with other clones or cedar clusters to form colonies, there are only 24 physically separated clonal cedars.
4. *cedar clusters* - genetically distinct individual cedars which grow close together in the same fashion that the trunks of a clonal cedar do. They are actually the same as (1) individual single-trunk cedars except for the close distance of their trunks. There are 7 cedar clusters, which contain 23 White Cedars and 1 cedar cluster containing 15 Red Cedars.

Geographical Comparison A quick look at the map shows that nearly all the cedar clones grow in the southern end of the Glen. A total of 18 grow along or close to the river on bedrock or rocky soil. Another 12 grow on the talus slope above and west of Cripps Eddy. Six grow on cliff faces on the north edge of Wintergreen Flats or over Devils Hole Rapids , and one colony of 4 clones grows on soil among boulders below the escarpment just north of Feather in the Glen Shop.

Comparison of Substrates Which the Cedars Grow On

Analysis of the field data shows that there are 5 substrates that the cedars grow on. They appear to be relatively evenly distributed over 4 of the 5 substrates.

Substrate	No.of Cedars
Single Large Boulder	34
Cliff Face	28
Talus Slope	26 (incl. all 17 Red-Cedars)
Soil	24
Bedrock	5

The accompanying graph also shows this comparison. In addition, it shows how many clonal cedars grow on each type of substrate. Interestingly, White Cedars do not seem to show preference and can grow on the most challenging (steep), sterile or fertile sites. In other areas outside the Niagara Gorge, they can also grow well in wetlands.

Substrate	No.of Cedar Clones
Single Large Boulder	3
Cliff Face	5
Talus Slope	7
Soil	8
Bedrock	2

Measurement of Tree Heights

During the 2002-2005 Eastern Niagara Peninsula Old Growth Forest Survey, extensive measurements of many broadleaf tree species heights were obtained when it was realized that the Glen's forest is probably the tallest broadleaf forest in Ontario. The heights of the cedar trees however, were not particularly notable, so measurements were not taken then.

The heights of several cedars were measured for this study:

- Leaning Rock Cedar : 66.5 feet
- Fosters Flats Cedar : 50 feet
- Sitting Arm Cedar : 46 feet

Concluding Statement

The old growth cedars of Niagara Glen and the entire Niagara Gorge are a remarkable ecological treasure that requires more research. It is amazing that organisms that reach 500 years old have survived here despite the environmental destruction that has surrounded them. It is just as amazing that we only learned that they were still here within the last 6 years.

This is the first formal, funded research project to study the old growth cedars of the Niagara Gorge. The amount of knowledge gained from this study may be small in quantity but it is ground breaking nevertheless. Only 3 cedars were cored to determine their age. They were the first ever to be cored. They only give a hint of what the maximum ages are within the Glen. Nothing is formally known about the rest of the Niagara Gorge's cedars.

This investigator recommends that the Niagara Parks Commission will continue its generosity and vision in supporting more research of the old growth cedars and old growth forests in the Niagara Gorge (and its other parks).

Appendix 1: Inventory and Description of the Cedars of Niagara Glen

Appendix 2: Cedars of Niagara Glen Nature Preserve Locator Map

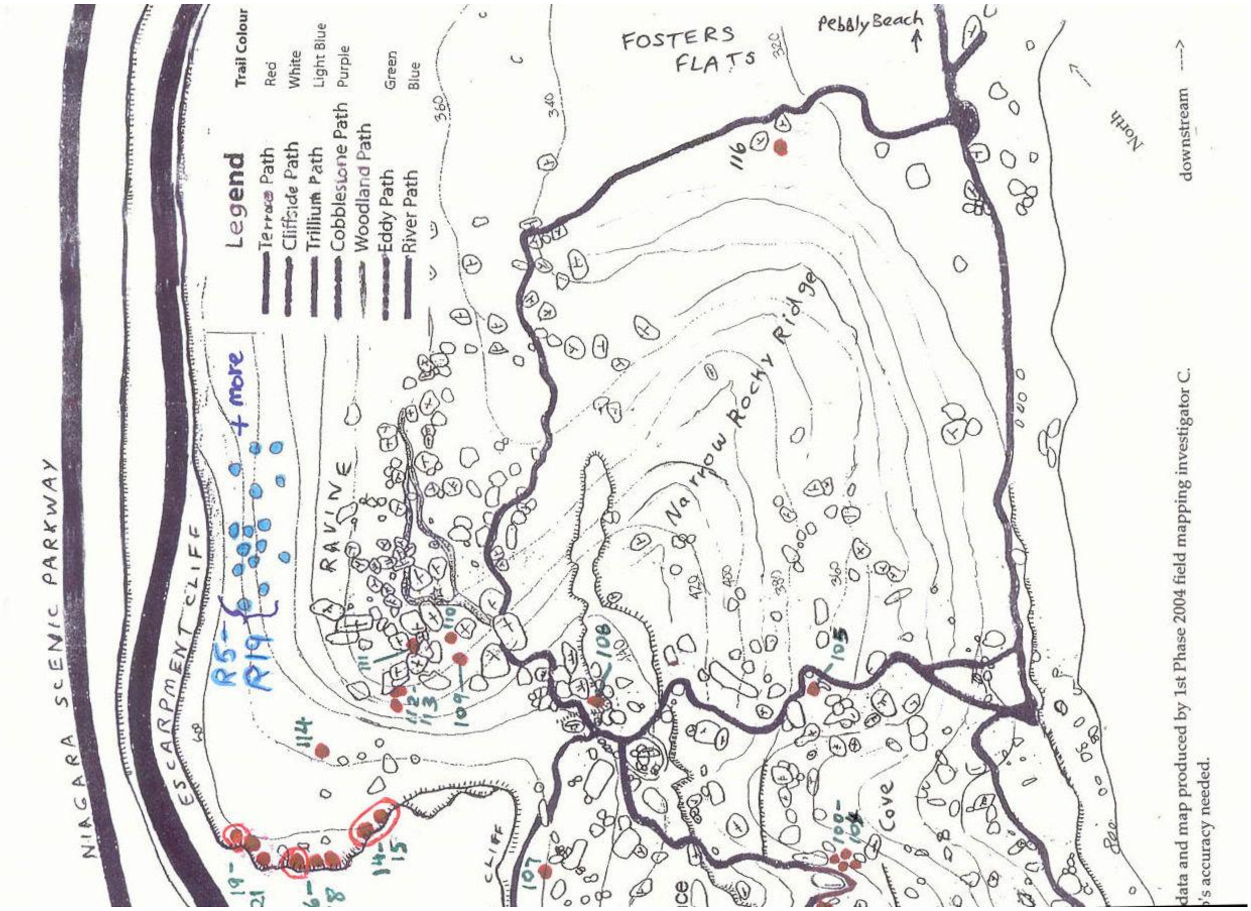
Appendix 3: Niagara Glen Reference Map Grid fro Locating Cedars

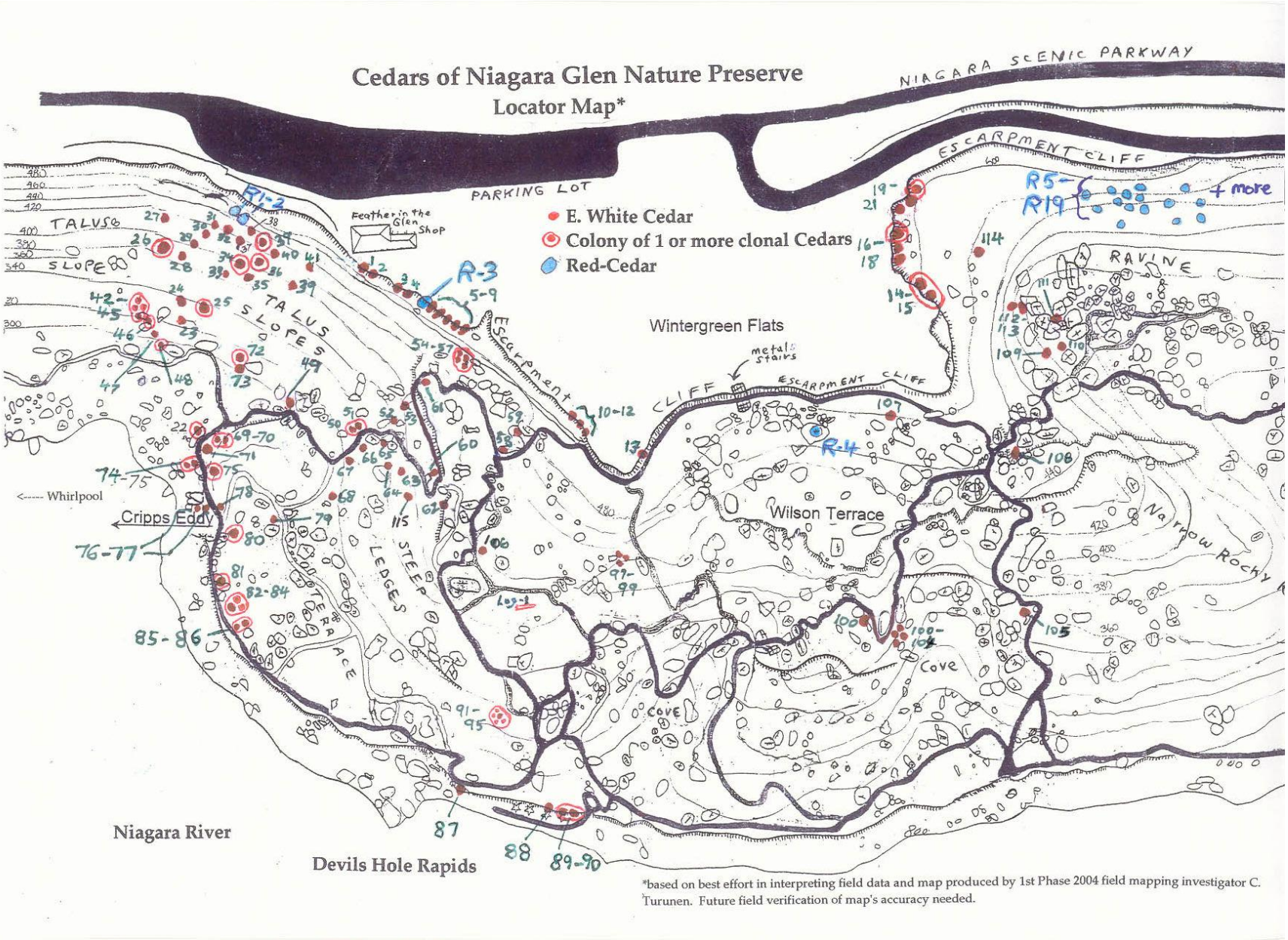
Appendix 4: Cedars of Niagara Glen Nature Preserve Locator Map
from Phase 1 with annotations

Appendix 5: Graph of Niagara Glen Cedars – Type of Growth Forms

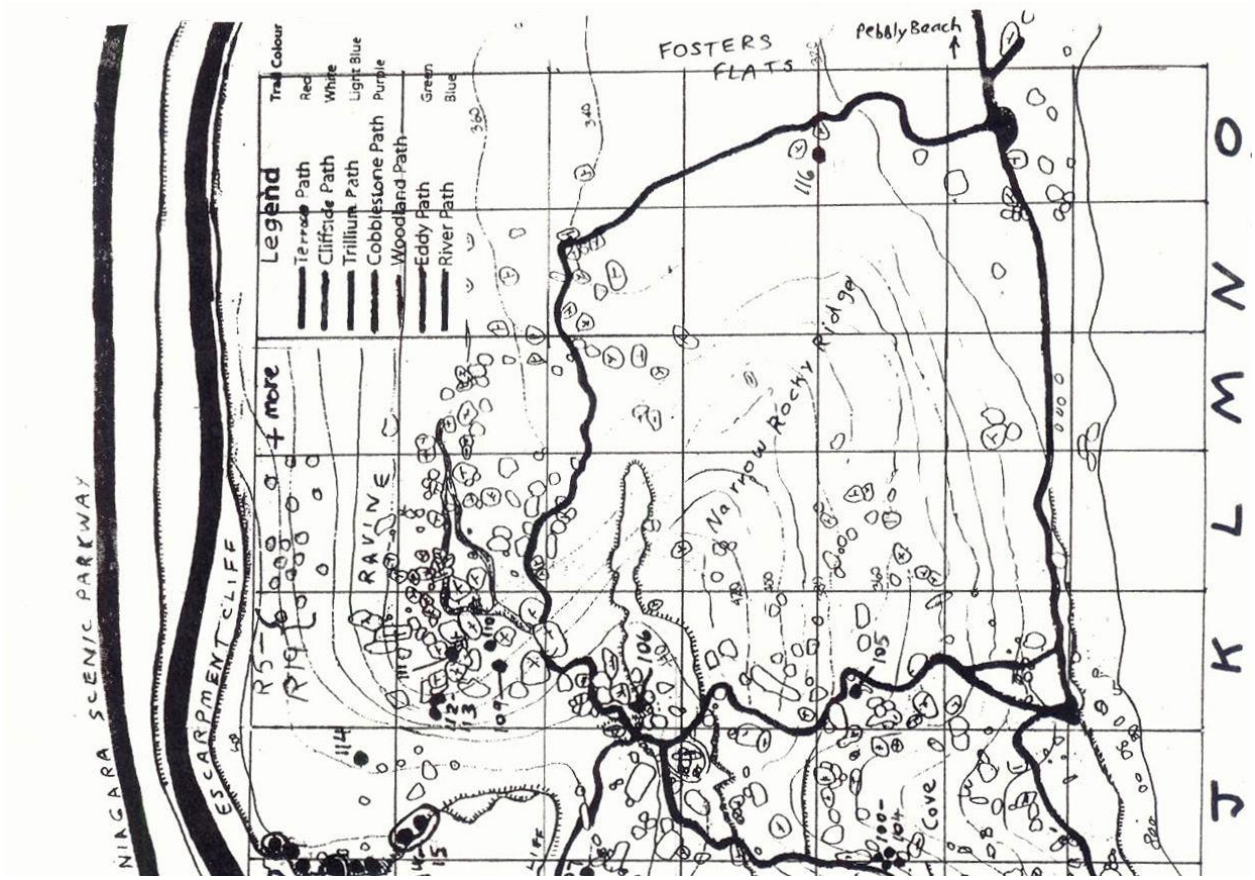
Appendix 6: Graph – Comparisons of Substrates Where Niagara Glen Cedars Grow

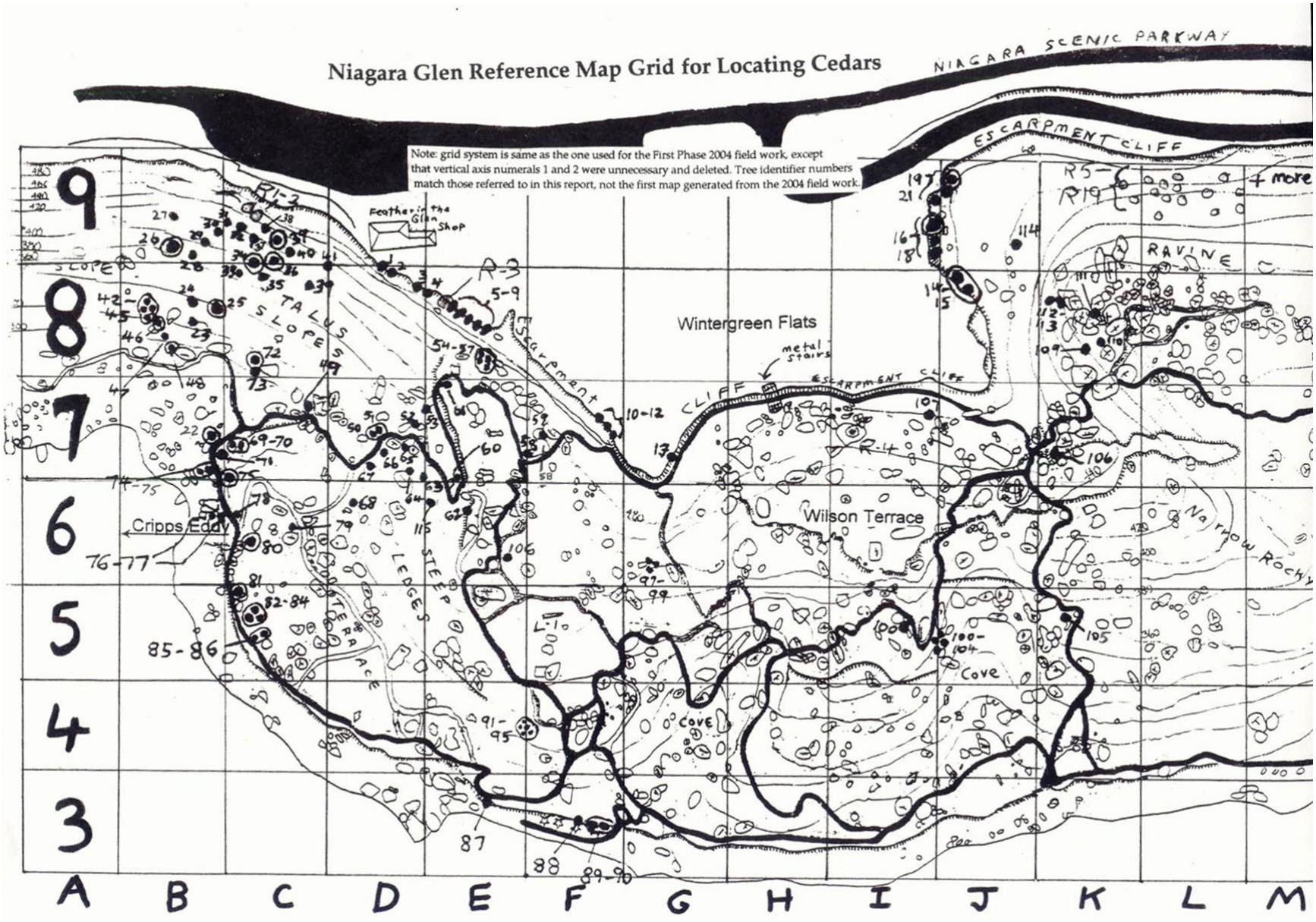
Appendix 7: Photographs of Cedars of the Niagara Glen


NIAGARA SCENIC PARKWAY
ESCARPMENT CLIFF
Legend
Trail Colour
Terrace Path Red
Cliffside Path White
Trillium Path Light Blue
Cobblestone Path Purple
Woodland Path
Eddy Path Green
River Path Blue
R5-R19
+ more
RAVINE
FOSTERS FLATS
Pebbly Beach
Narrow Rocky Ridge
Cove
CLIFF
North
downstream --->
data and map produced by 1st Phase 2004 field mapping investigator C.
's accuracy needed.



*based on best effort in interpreting field data and map produced by 1st Phase 2004 field mapping investigator C. Turunen. Future field verification of map's accuracy needed.


Legend
Trail Colour
Red
White
Light Blue
Purple
Green
Blue
Terrace Path
Cliffside Path
Trillium Path
Cobblestone Path
Woodland Path
Eddy Path
River Path
FOSTERS FLATS
Pebbly Beach
RAVINE
Narrow Rocky Ridge
ESCARPMENT CLIFF
NIAGARA SCENIC PARKWAY
Cove
J K L M N O


Niagara Glen Reference Map Grid for Locating Cedars
NIAGARA SCENIC PARKWAY
Note: grid system is same as the one used for the First Phase 2004 field work, except that vertical axis numerals 1 and 2 were unnecessary and deleted. Tree identifier numbers match those referred to in this report, not the first map generated from the 2004 field work.
ESCARPMENT CLIFF
RAVINE
Wintergreen Flats
Wilson Terrace
Cripps Eddy
Feather in the Glen Shop
metal stairs
TALUS SLOPE
STEEP LEDGES
TERRACE
Cove
Narrow Rocky
9
8
7
6
5
4
3
A
B
C
D
E
F
G
H
I
J
K
L
M

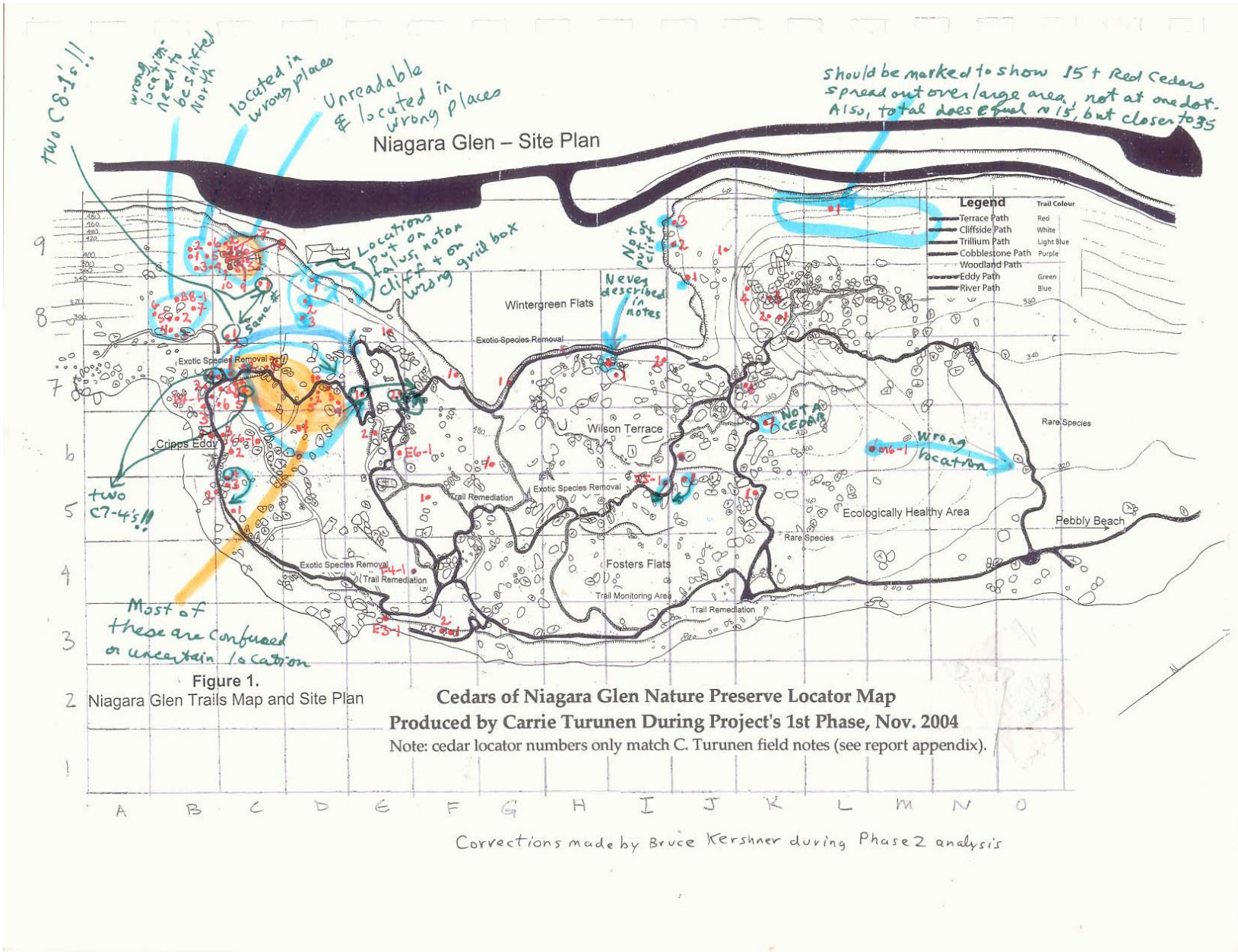
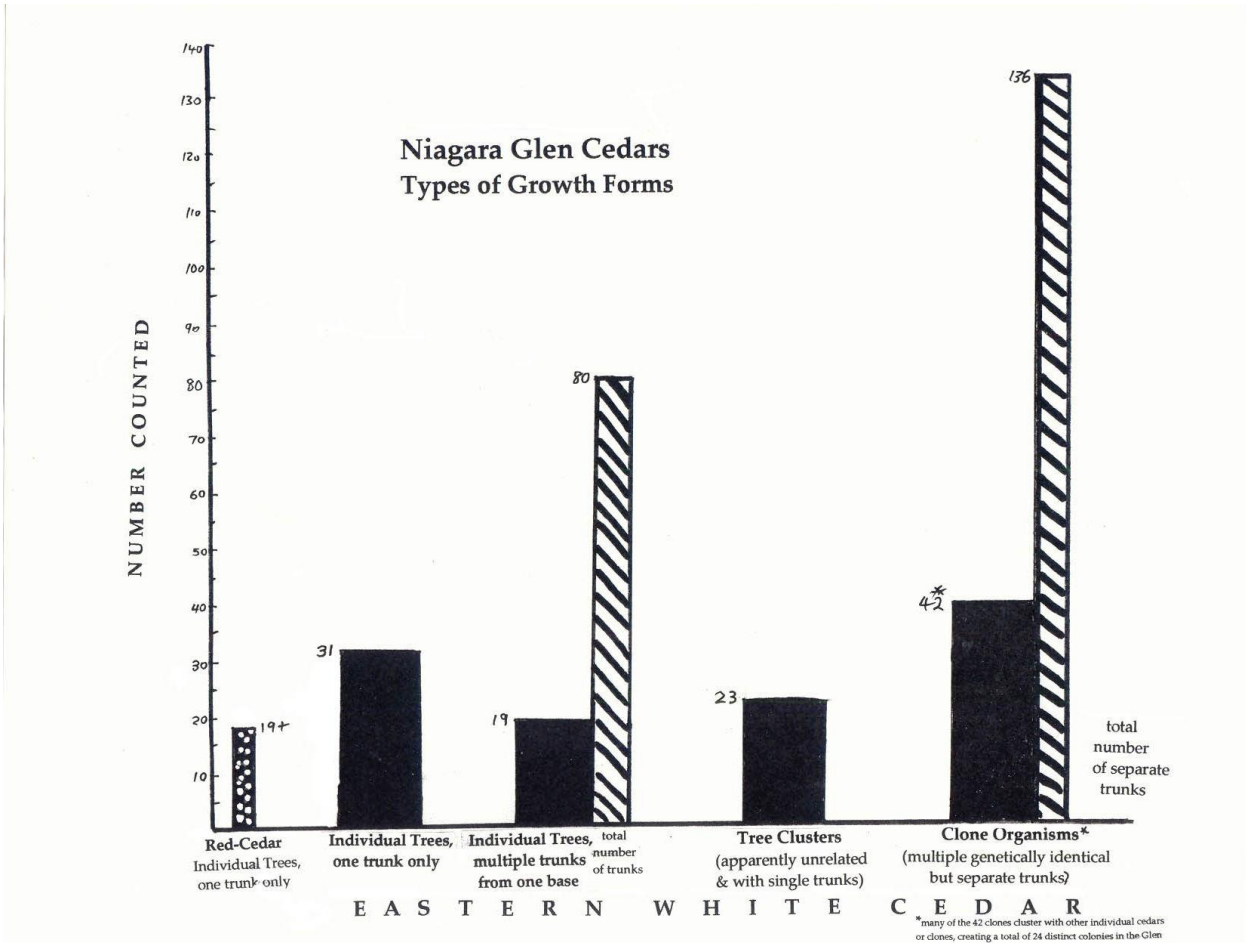
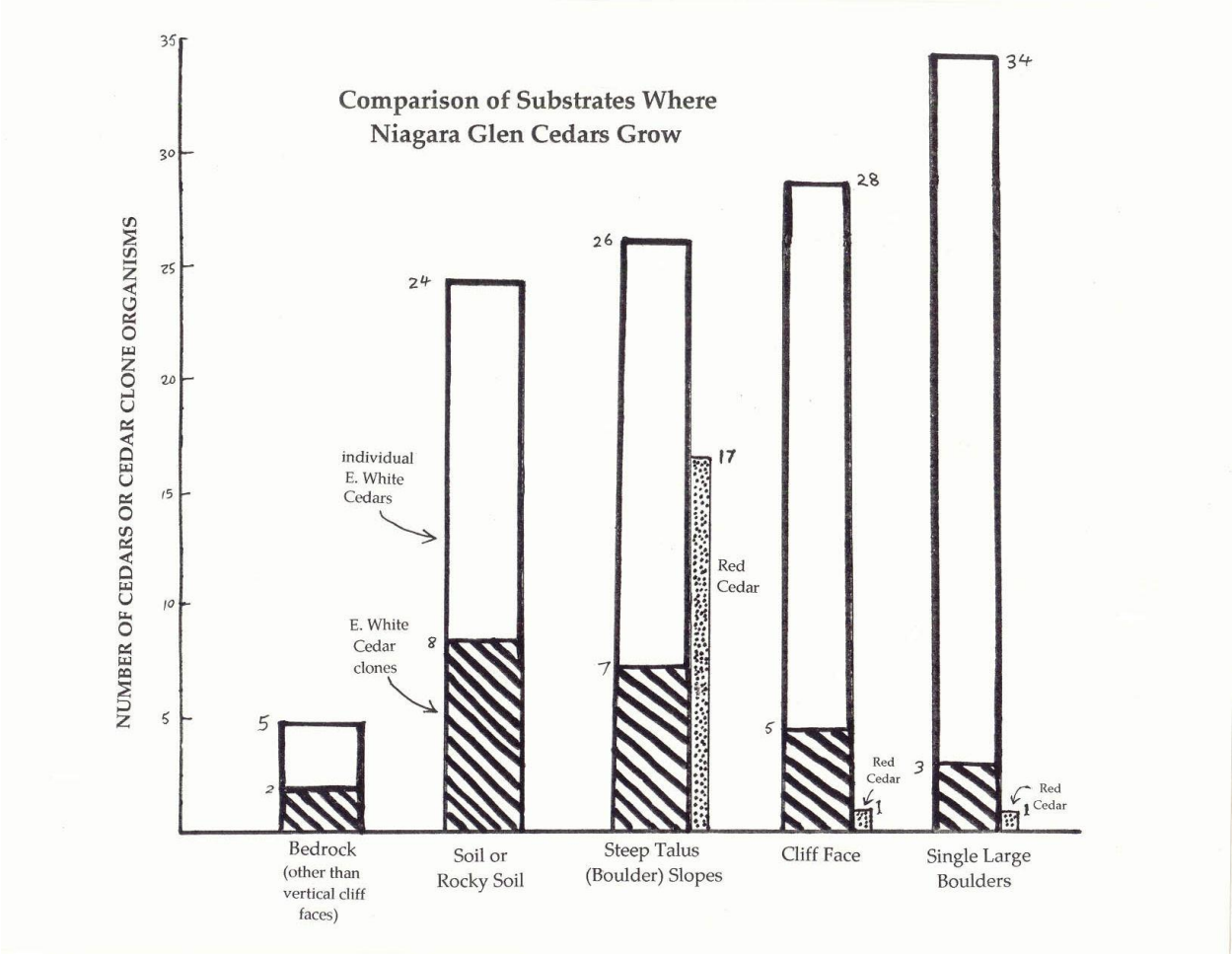


Figure 1.
Niagara Glen Trails Map and Site Plan

Cedars of Niagara Glen Nature Preserve Locator Map
Produced by Carrie Turunen During Project's 1st Phase, Nov. 2004
Note: cedar locator numbers only match C. Turunen field notes (see report appendix).

Corrections made by Bruce Kershner during Phase 2 analysis


Niagara Glen Cedars
Types of Growth Forms
NUMBER COUNTED
140
130
120
110
100
90
80
70
60
50
40
30
20
10
194
31
19
80
23
42*
136
total number of separate trunks
Red-Cedar
Individual Trees, one trunk only
Individual Trees, one trunk only
Individual Trees, multiple trunks from one base
total number of trunks
Tree Clusters
(apparently unrelated & with single trunks)
Clone Organisms*
(multiple genetically identical but separate trunks)
EASTERN WHITE CEDAR
*many of the 42 clones cluster with other individual cedars or clones, creating a total of 24 distinct colonies in the Glen


Comparison of Substrates Where
Niagara Glen Cedars Grow
NUMBER OF CEDARS OR CEDAR CLONE ORGANISMS
35
30
25
20
15
10
5
individual
E. White
Cedars
E. White
Cedar
clones
Red
Cedar
Red
Cedar
Red
Cedar
5
2
24
8
26
7
17
28
5
1
34
3
1
Bedrock
(other than
vertical cliff
faces)
Soil or
Rocky Soil
Steep Talus
(Boulder) Slopes
Cliff Face
Single Large
Boulders

Inventory and Description of the Cedars of Niagara Glen

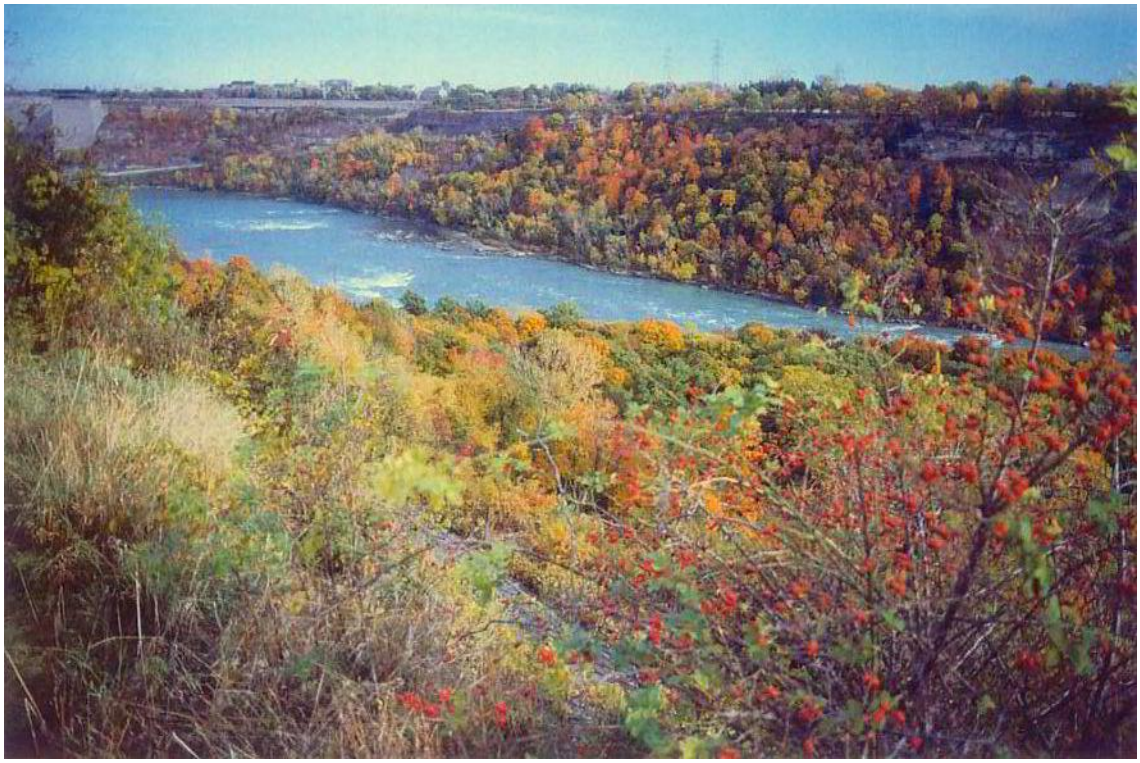
Map #	Descriptive Name	Grid Location & Coordinates & General Location	Growth Form *	# of trunks	Trunk Circum. (cm)	Substrate where it grows	Tree or Trunk Shape
1 & 2	Feather in the Glen Cliff Cedars	D8-N N 43° 07 707; W 79° 03 475	**cluster** of 2 unrelated trees	1 for each		cliff face	curve out from cliff, then upward
3 & 4	Northeast Feather in the Glen Cliff Cedars	D8-NE N 43° 07 750; W 79° 03 563	**cluster** of 2 unrelated trees	1 for each		cliff face	curve out from cliff, then upward
5.-.9	Dead-end Trail Cliff Cedar Cluster	D8-central N 43° 07 750; W 79° 03 563	**cluster** of 5 unrelated white cedars	1 for each		cliff face	grow horiz-ontal from cliff, then up
R-3	Dead-end Trail Cliff ***Red Cedar***	this is the 6th member of the same cluster above (#5-9)		1		cliff face	
10 to 12	White Trail Cliff Cedar Cluster	F7-E	**cluster** of 3 unrelated trees	1 for each		cliff face	
13	White Trail Solitary Cliff Cedar	G7-S	single-trunk individual	1		cliff face	U-shaped
14 to 15	East Whispering Falls Cliff Twin Cedar Clones	J8-NW	2 adjoining clones	2 + 3		cliff face	
16 to 18	Middle Whispering Falls Cliff Cedar Cluster with Clone	J8-SW	2 individuals & 1 clone	1 each 2	25 to 101 cm	cliff face	grow horiz-ontal from cliff, then up
19 to 21	West Whispering Falls Cliff Cedar Cluster with Clone	J8-NW	2 individuals & 1 clone	1 each 2	1 large, 3 small	cliff face	grow horiz-ontal from cliff, then up
22	Big Hemlock Cedar Clone	B7-E	1 clone	5		boulder	
23	Downslope-of-Sitting-Arm Cedar	B8-central	single-trunk individual	1	30	talus slope	straight
24	Sitting Arm Cedar	B8-central	multi-trunk individual	2	219	talus slope	straight; ~ 65 ft. tall
25	North-of-Sitting-Arm Talus Cedar Clone	B8-E N 43° 07 750; W 79° 03 563	small clone	appr. 5		talus slope	

26	Snaking Cedars Talus Colony	B9-S N 43° 07 750; W 79° 03 563	1 large clone	12	largest is 57	talus slope	
27	Bristlecone Cedar (named for its white, barkless trunk)	B9-central N 43° 07 750; W 79° 03 563	single-trunk individual	1	103	talus slope	~ 45 ft. tall straight
28	Leaning East Talus Cedar	B9-S N 43° 07 750; W 79° 03 563	single-trunk individual	1	113	talus slope	tall, straight leaning east
29	Reverse-S Cedar	B9-SE N 43° 07 750; W 79° 03 563	single-trunk individual	1	109	talus slope	
30	Three-Pronged Talus Cedar	B9-E N 43° 07 750; W 79° 03 563	multi-trunk individual	3		talus slope	
31	Three-Trunked Talus Cedar	B9-W N 43° 07 750; W 79° 03 563	multi-trunk individual	3	109	talus slope	
32	Five-Trunk Fungal Talus Cedar (large fungus on North side)	B9-W N 43° 07 750; W 79° 03 563	multi-trunk individual	5	153	talus slope	SE-facing branches &
33	Snaking Branch Talus Cedar	B8-NW N 43° 07 750; W 79° 03 563	single-trunk individual	1	124	talus slope	straight, leaning
34	Radiating Trunks Talus Cedar Clone	C8-NW N 43° 07 750; W 79° 03 563	1 large clone	5		talus slope	main trunk is flattened with other trunks radiating from it.
35	Twisting Talus Cedar	C8-N N 43° 07 750; W 79° 03 563	single-trunk individual	1	107	talus slope	part twisting, part straight
36	Three-Trunked Talus Cedar Clone	C9-SW N 43° 07 750; W 79° 03 563	1 clone	3		talus slope	
37	Forked and Curled Talus Cedar	C9-SW N 43° 07 750; W 79° 03 563	multi-trunk individual	2	95	talus slope	Forked & curled shapes; 1 trunk is living, 1 isdead, pointing downslope
38	Live Trunk-Dead Trunk Talus Cedar	C9-center N 43° 07 750; W 79° 03 563	multi-trunk individual	2		talus slope	
39	Four-Trunked Talus Cedar Clone	C8-NE N 43° 07 750; W 79° 03 563	1 clone	4		talus slope	
R 1-2	Twin Talus Red Cedars	B9-W	2 single-trunk individuals	1 each	89 & 105	talus slope	Straight trunks; branches face southeast
40	U-shaped Talus Cedar	C8-NE N 43° 07 750; W 79° 03 563	single-trunk individual	1		soil	grows on talus slope but in a pocket of rocky soil
41	2-Trunked Leaning Talus Cedar	C8-NE N 43° 07 750; W 79° 03 563	multi-trunk individual	2	62 + 32	talus slope	
42 to **45**	Cripps Eddy Mid-Talus Cedar Colony	B8-W N 43° 07 750; W 79° 03 563	complex cluster of 4 clonal organisms	4	47 + 71	soil + bedrock	conclusion is tentative
46	Cripps Eddy Chassis Cedar Colony	B8-W N 43° 07 750; W 79° 03 563	1 large clone	7	7.6	bedrock	

47	Cripps Eddy Chassis Tall Cedar	B8-W N 43° 07 750; W 79° 03 563	single-trunk individual	1		talus slope	above 70 yr. old car chassis that was dumped over the cliff
48	Cripps Eddy Trail Cedar Clone	B8-W	1 young clone	many		talus slope	shrubby, short young cedars
49	Green Trail Stairs Bedrock Cedar	C7-E	multi-trunk individual	3		bedrock	small straight trunks
50 to **51**	Cripps Eddy Green Trail Talus Cedar Clone	C7-NE	1 clone	4+	42	talus slope	
52	Bench Cedar	D7-E N 43° 07 713; W 79° 03 565	single-trunk individual	1		boulder	tru nk grows horizontally across a gap in the steep sloe: "bench"
53	U-Shape Cedar	E7-W	single-trunk individual			boulder	U-shaped
54 to **57**	Dead-end Trail Ground Cedar Clone	E8-S	complex clone & cluster of 3 individuals	3 1 each		soil	4 separate cedars, with complex tangle of branches, crowns, trunks
58	Green & White Trail Jct. Cedar	F7-W	single-trunk individual	1		bedrock	has 3 crowns
59	Creeping Cedar	F7-W N 43° 07 754; W 79° 03 534	single-trunk individual	1		boulder	astonishing unexplainable bizarre growth over both sides of boulder
60	Sliding Rock Cedar	E7-SW N 43° 07 713; W 79° 03 565	single-trunk individual	1	86	boulder	
61	Black Stairs Cedar	E7-NW	single-trunk individual	1		bedrock	very straight trunk
62	Whirlpool View Cliff Cedar	E6-center N 43° 07 754; W 79° 03 534	single-trunk individual	1		cliff edge	bizarre shaped trunk
63	South Sliding Rock Bedrock Cedar	D7-SE N 43° 07 713; W 79° 03 565	single-trunk individual	1		Bedrock	small scraggly , U-shaped
64	South Sliding Rock Soil Cedar	D7-SE N 43° 07 713; W 79° 03 565	single-trunk individual	1		Soil	small bushy cedar
65	East Green Trail U-Shaped Cedar	D7-E	multi-trunk individual	3	124	boulder	
66	North Green Trail U-Shaped Cedar	D7-E	multi-trunk individual	3	78	boulder	
67	Green Trail Rock Steps Cedar	D7-S	multi-trunk individual	3		Bedrock	
68	White Ash Boulder Cedar	D6-NW	multi-trunk individual	2		boulder	has 4 crowns; large white ash nearby
69 to **70**	Green Trail 10-Trunk Cedar Clones	C7-W N 43° 07 754; W 79° 03 534	2 clones	8 & 2	56 114	boulder?	location uncertain due to data problems

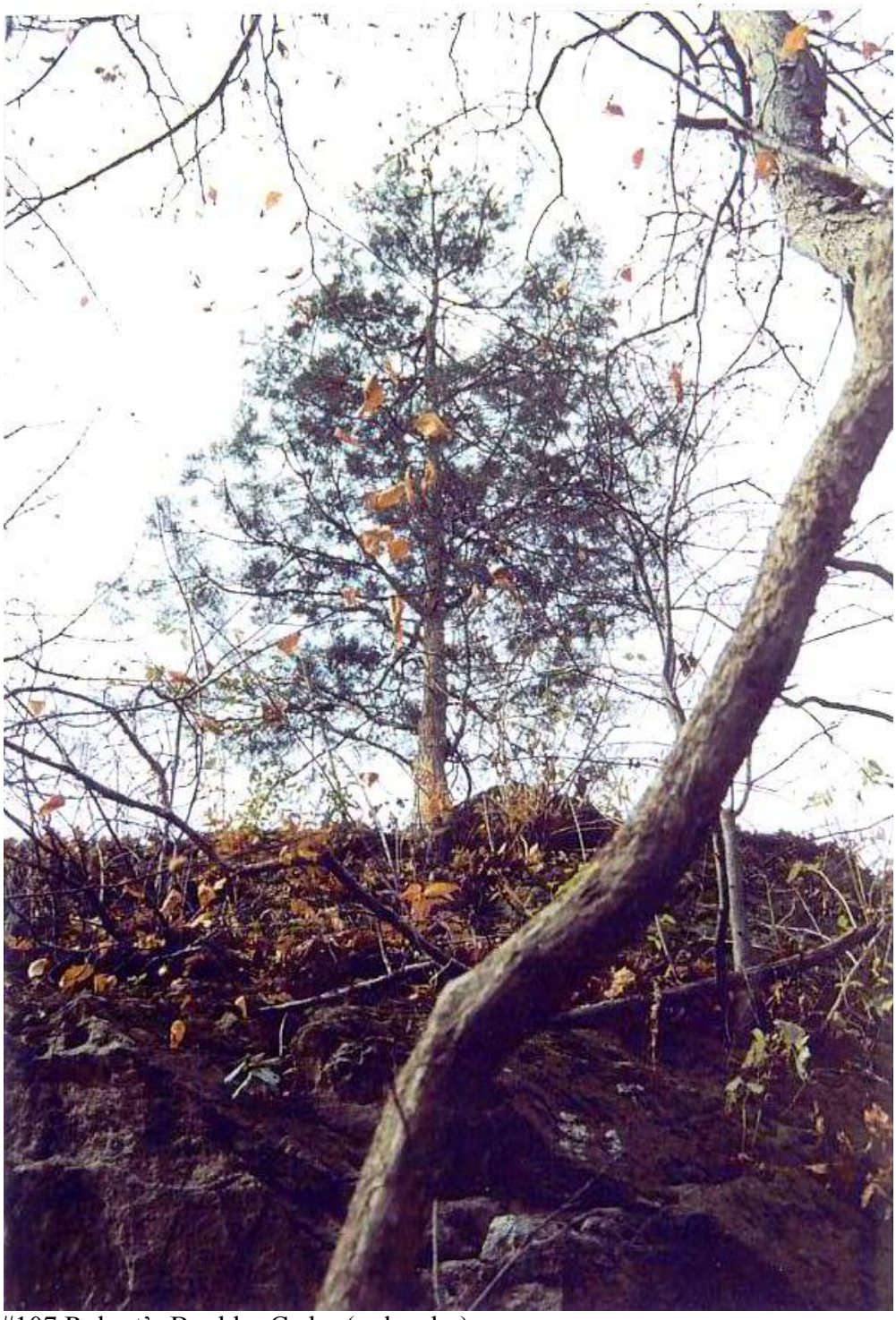
71	Green Trail Hemlock Cedar	B7-SE N 43° 07 713; W 79° 03 565	single-trunk individual	1		boulder	
72	Cripps Eddy Green Trail Talus Cedar Clone	C8-SW	1 clone	4	42	talus slope	
73	Cripps Eddy Green Trail Talus Cedar	C8-SW	multi-trunk individual	2	44	talus slope	
74 & 75	Creeping Twisted Cedar Clones	B7-SE	2 clones	each with 3		soil	low creeping, in a twisted mass
76 & 77	Cripps Eddy Tulip Tree Twin Cedars	B6-E	2 single-trunk individuals	1 each		soil	small, shrubby, on each side of path
78	Yellow-Blue Trail Jct. Cedar	C6-W		1		soil	straight
79	Bent Butternut Cedar	C6-center N 43° 07 637; W 79° 03 550	multi-trunk individual	2		boulder	has 4 crowns; next to large butternut on boulder
80	Twisted Mass Cedar Clone	C6-E	1 clone	1		soil	its 3 crowns cover ground in twisted mass
81	Elephant Trunk Clone (named for remarkable resemblance)	C5-NW	1 huge clone	17	largest 91	bedrock & soil	The 14 cm diam. "Elephant Trunk" was cored; age = 175 yrs
82 to **84**	Crawling Cedars Clone/Cluster	C5-NW	3 clones	3; 4; & 5		boulder	grow in twisted, contorted bizarre style
85 & 86	Elephant Tusk Clone (one trunk resembles a tusk)	C5-W	2 complex clones	6 & 7	largest 108	rocky soil	bizarre U-shapes, leaning, other odd forms
87	Giant Rock View Cedar	E3-center	multi-trunk individual	4		rocky soil	also has 4 crowns, twisted roots & trunks
88	Bubbling Spring Cliff Cedar	F3-center	multi-trunk individual	2	<25	cliff face	grow horizontally from cliff, then skyward, directly above spring
89 & 90	Spring Trail Cliff Trail Cedar Clone	F3-W N 43° 07 691; W 79° 03 399	2 clones	each with 2	~ 25	cliff face	A 4-inch diameter trunk measured at 110 years old.
91 to **95**	Southeast Red Trail Cedar Clone/Cluster	F4-W N 43° 07 770; W 79° 03 415	2 clones and 3 individuals with one	Each has 2	clone trunks, trunk	cliff face each	
96	Cripps Eddy Hemlock Grove Cedar Clone	C7-SW	multi-trunk individual	2	largest 39		A 30 cm. Is growing into Hemlock. Located in a Hemlock Grove.
97 to **99**	Looping Cedars Cluster	G6-SW N 43° 07 745; W 79° 03 497	cluster of 3 single-trunk individuals	1 each		bedrock	cedar loops around the rock, the other 2-crowned cedar grows across & over the rock
100	Leaning Rock Cedar (near that famous landmark)	IF-E N 43° 07 732; W 79° 03 418	single-trunk individual	1	163	soil	Straight, and leaning to south.I Measured at 66.5 feet tall.

101 to **104**	Leaning Rock North Cedar Cluster	IF-E N 43° 07 732; W 79° 03 418	cluster of 4 single-trunk individuals	4	bedrock	Grows from north side of Leaning Rock. 3 vertically and 1 horiz-ontally from it.
105	Rock Snake Cedar	K5-NW N 43° 07 852; W 79° 03 356	multi-trunk individual	3	bedrock	3 trunks lean & snake around the rock.
106	Red Trail "Up" Cedar (word "UP" painted on boulder)	E6-SE	single-trunk individual		boulder	grows horizontally, then upwards
107	Cliffside Trail Boulder Cedar	I7-NE N 43° 07 750; W 79° 03 563	multi-trunk individual	2	boulder	curves out and then upwards from boulder; east of metal
R 1-2	Robert's Red Cedar	I7-W	single-trunk individual	1	boulder	straight, growing out of top of 20 foot tall boulder
108	Red Trail Staircase Cedar	K7-SW	single-trunk individual	1	bedrock	U-shaped, just below northern Red Trail steps leading north
109	Whispering Falls Ravine Boulder Cedar	K8-center	single-trunk individual	1	boulder	small, straight trunk
110	Medusa Cedar	K8-center	large single-trunk individual	1	boulder	was cored; age = 316 yrs Roots and trunk have very bizarre growth around the boulder
111	Whispering Falls Soil Boulder Cedar	K8-center N 43° 07 893; W 79° 03 415	single-trunk individual	1	boulder	small, straight trunk
112 to **113**	Upper Whispering Falls Ravine Cedar Cluster	K8-NW	2 single-trunk individual	1 each	soil	One has 2 crowns, the other has 3 crowns.
114	Resurrection Log Cedar	J8-SE	single-trunk individual	1	bedrock	Below escarpment cliff, at head of ravine. Dead cedar trunk has regrowth curving out of the log.
115						
116	Fosters Flats Boulder Cedar	O5-W N 43° 07 959; W 79° 03 267	single-trunk individual	1	boulder	appr. 50 ft. tall; northernmost cedar in the Preserve. Straight trunk, leaning to north.
Log-1	Robert Ritchie's White Cedar Log	F5-NW		82 inches		age estimated at 330 to 350 years

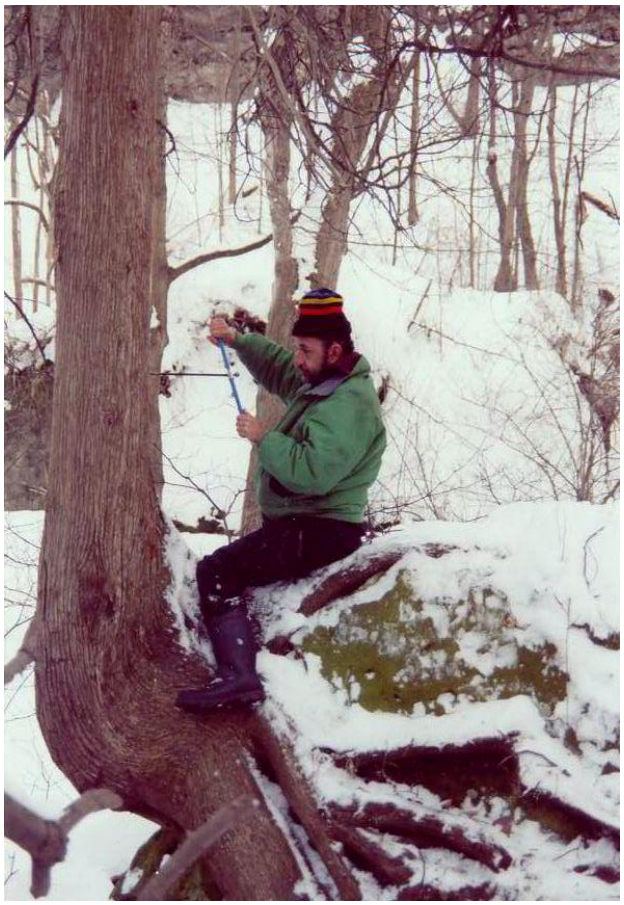


Niagara Glen looking north – photo by C. Milazzo

Niagara Glen looking south – photo by C. Milazzo

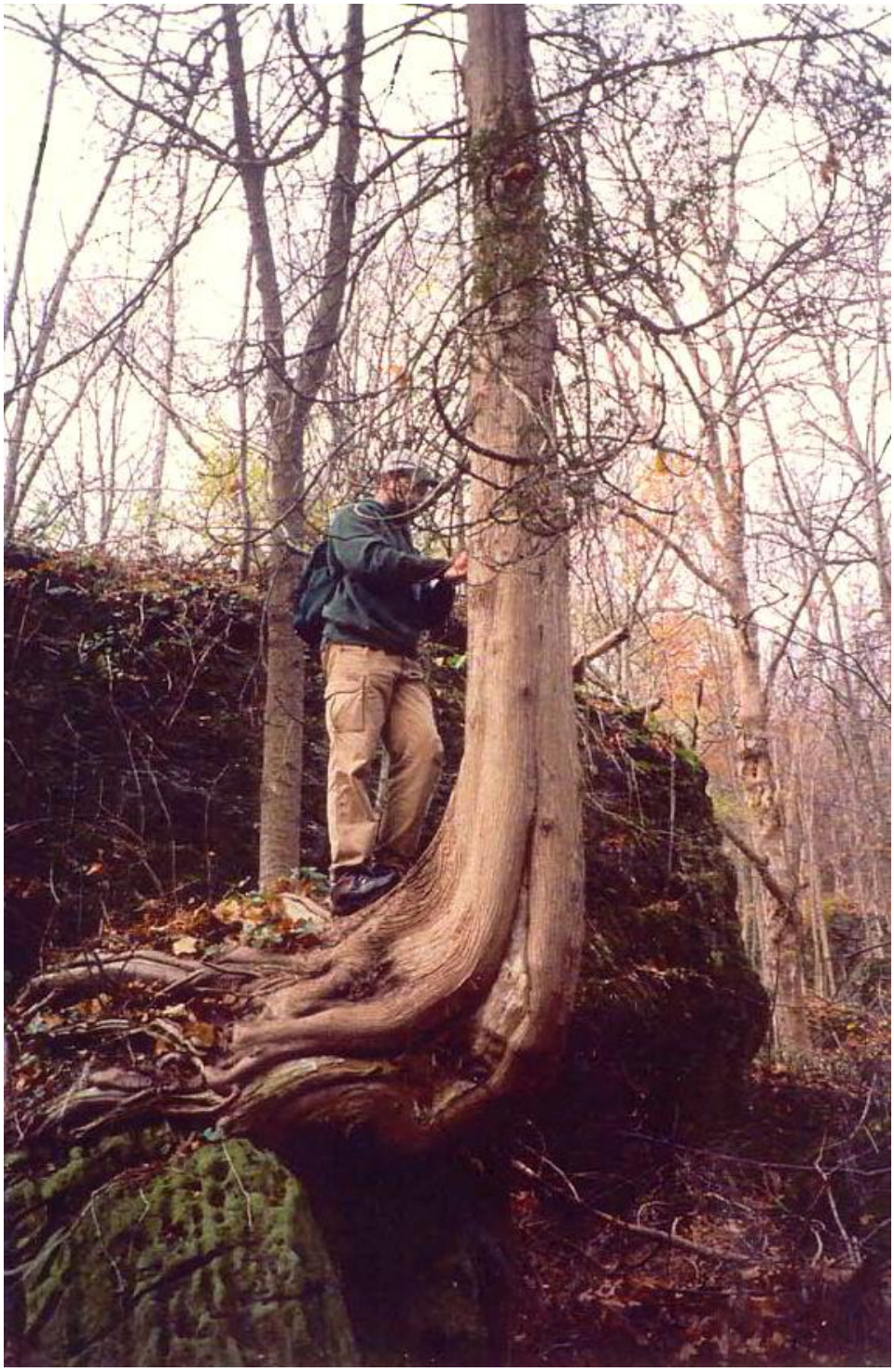


#107 Robert's Boulder Cedar (red cedar)

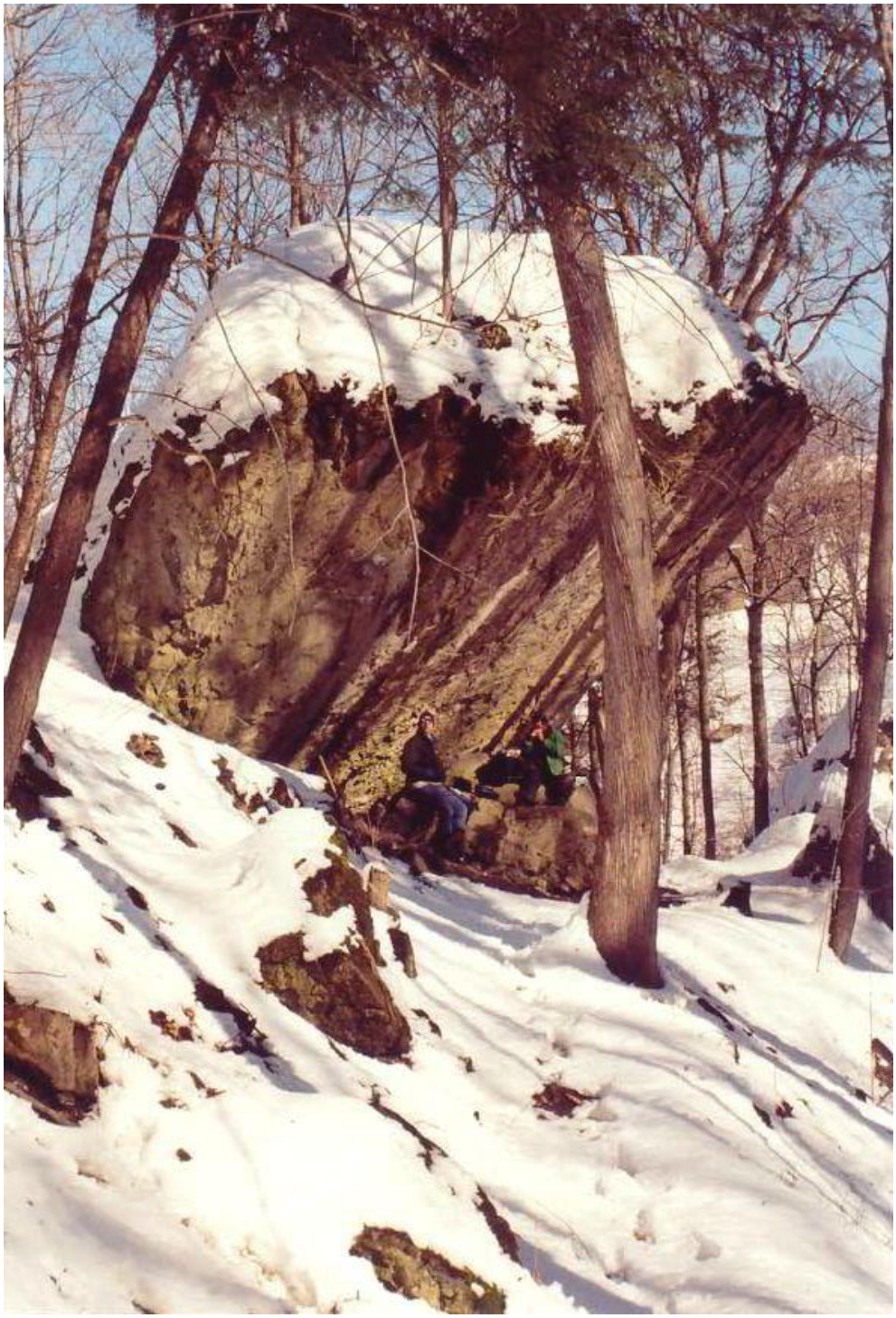


#110 Investigator Bruce Kershner coring the 316 year old Medusa Cedar with increment borer.

#110 Medusa Cedar – photo by C. Milazo

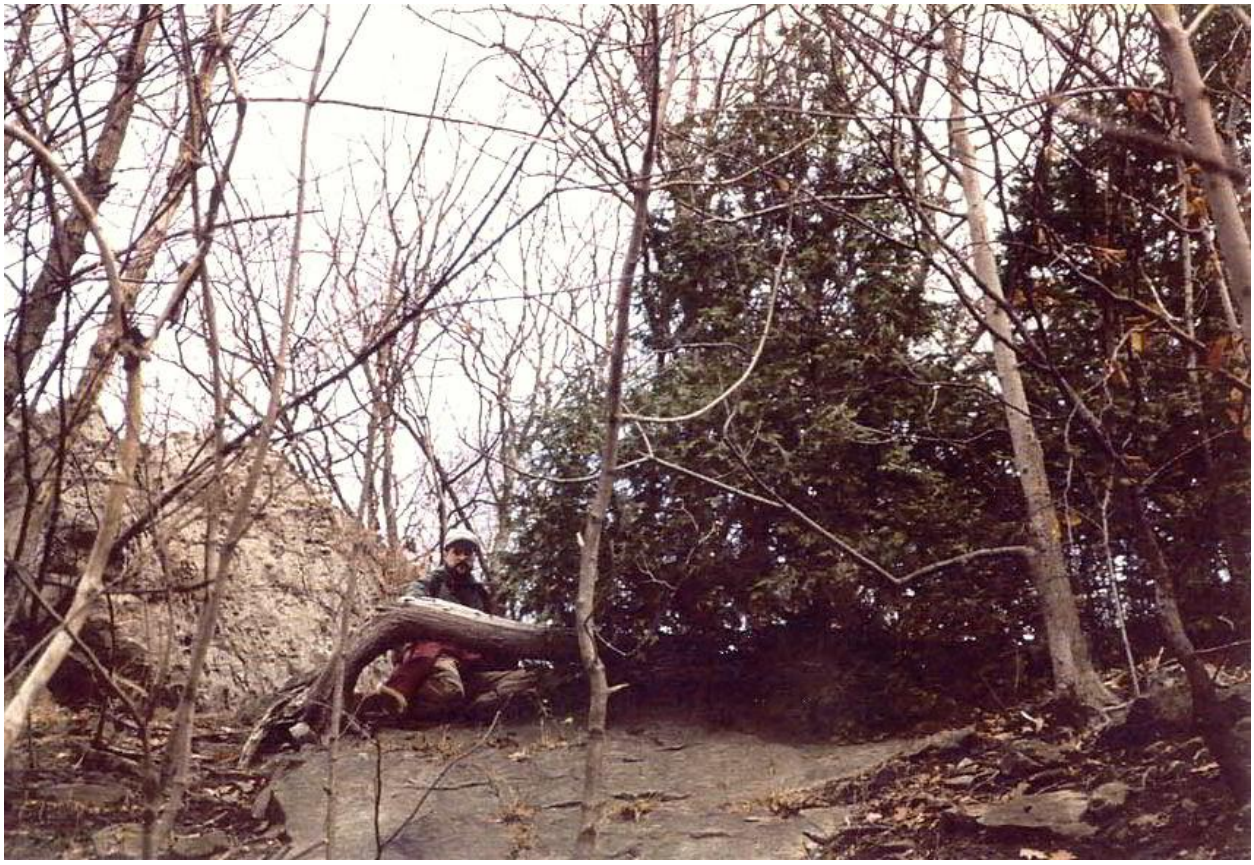


#110 Medusa Cedar



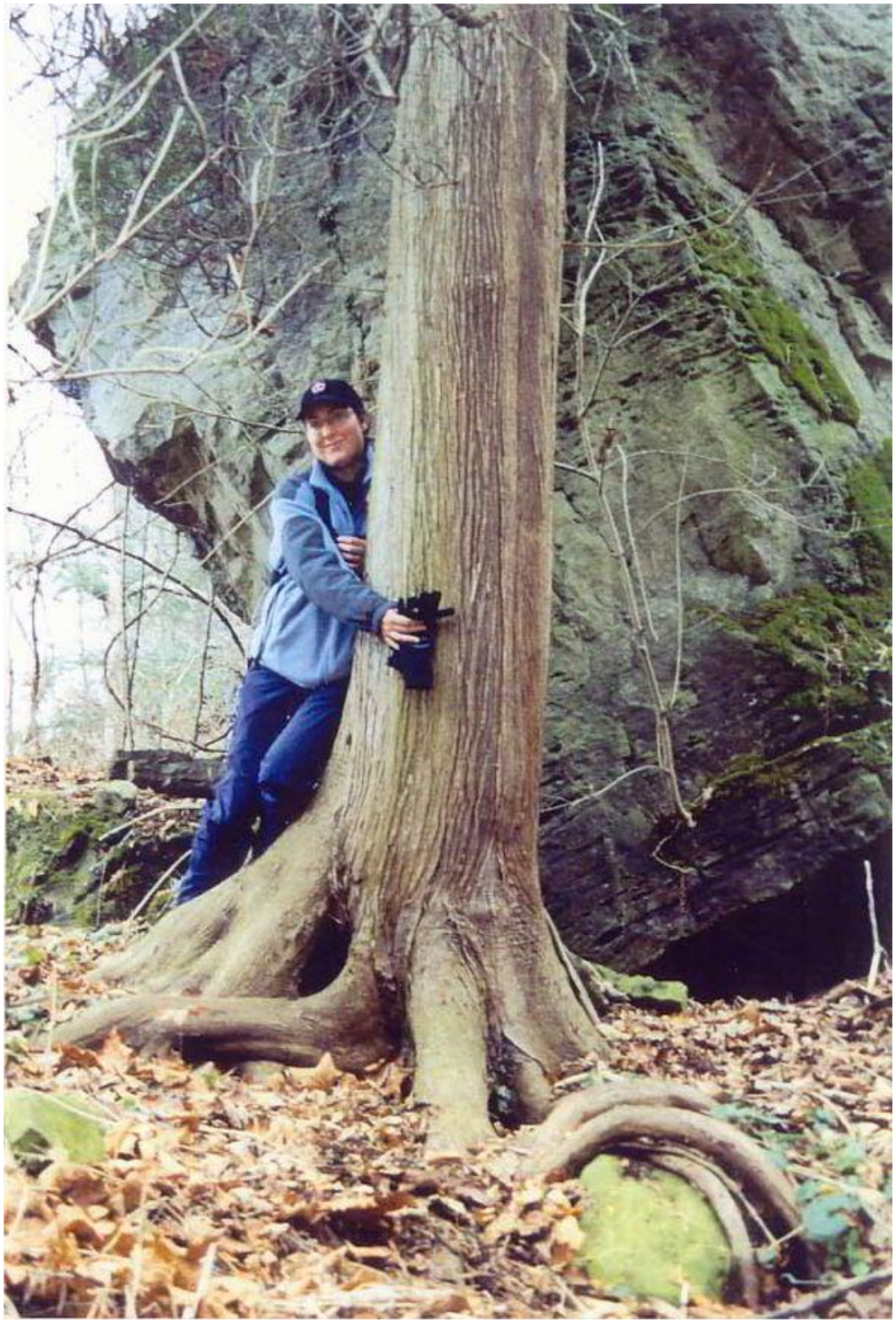
#100 Leaning Rock Cedar (66 feet tall)

#16 – 18 Whispering Falls Cedar Cluster/Clone



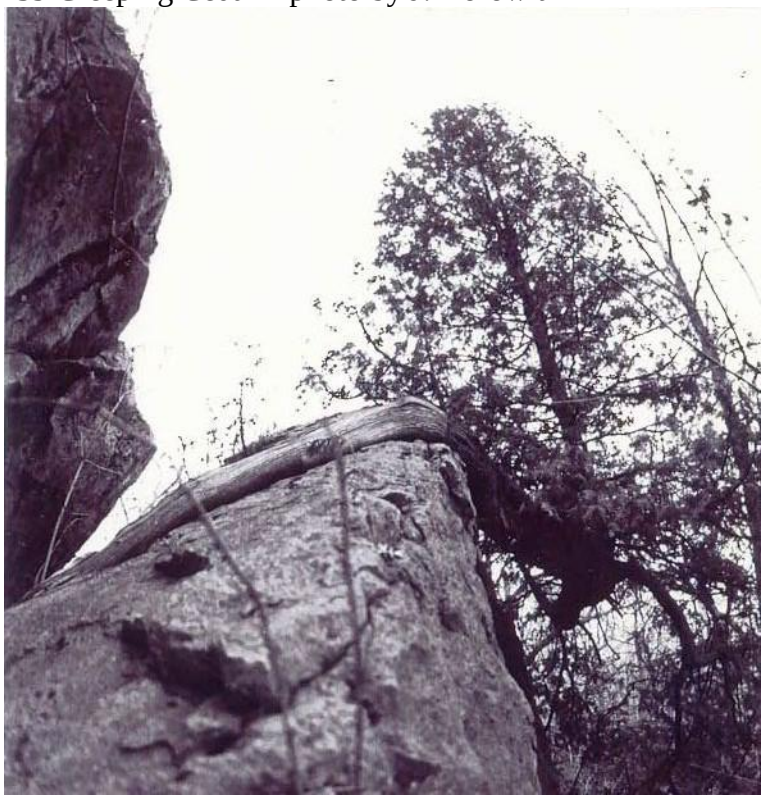
Sitting Cedar (map location unclear)

#116 Foster Flats Cedar



#111 Whispering Falls Ravine Soil Cedar

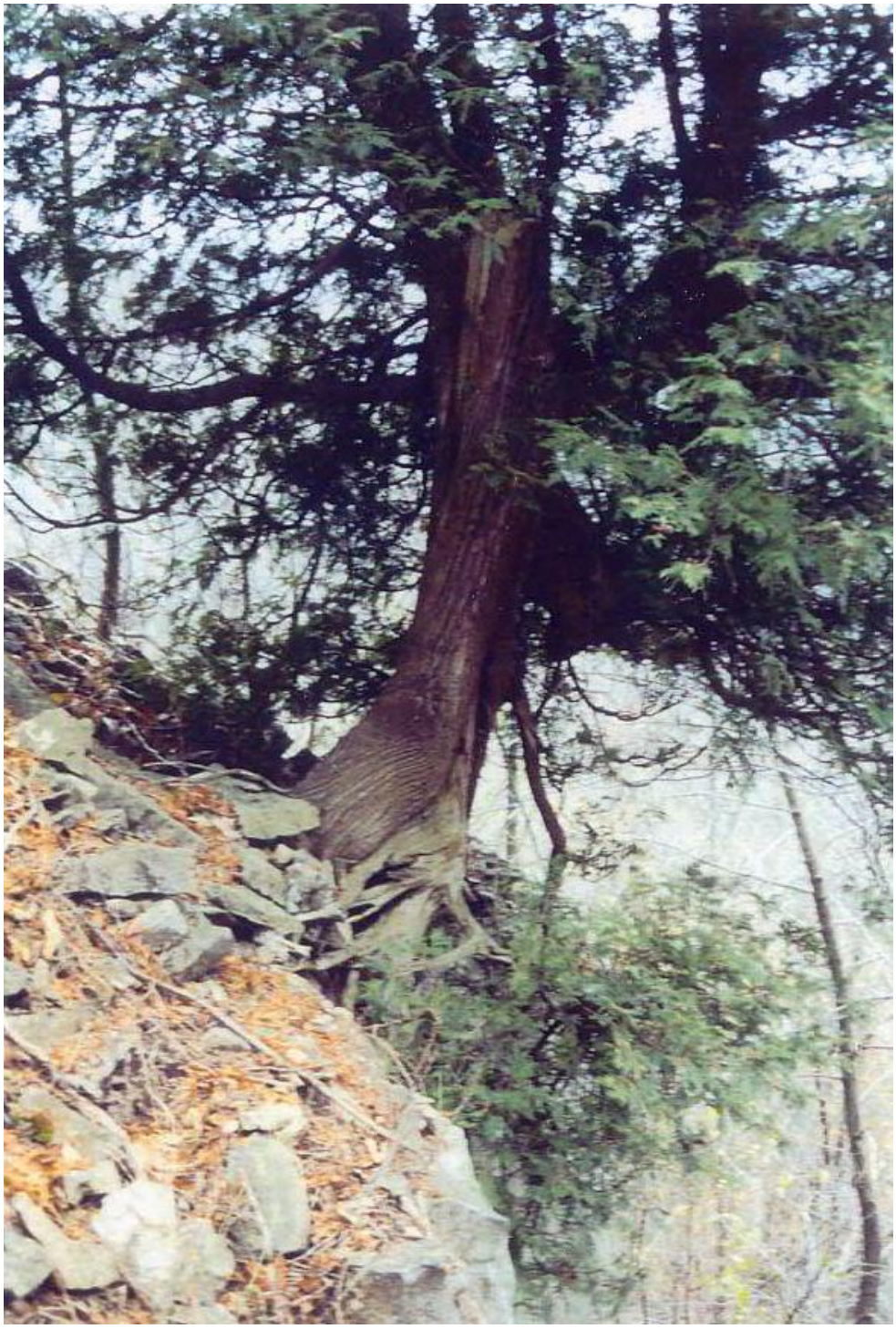
#59 Creeping Cedar – photo by J. Horowitz



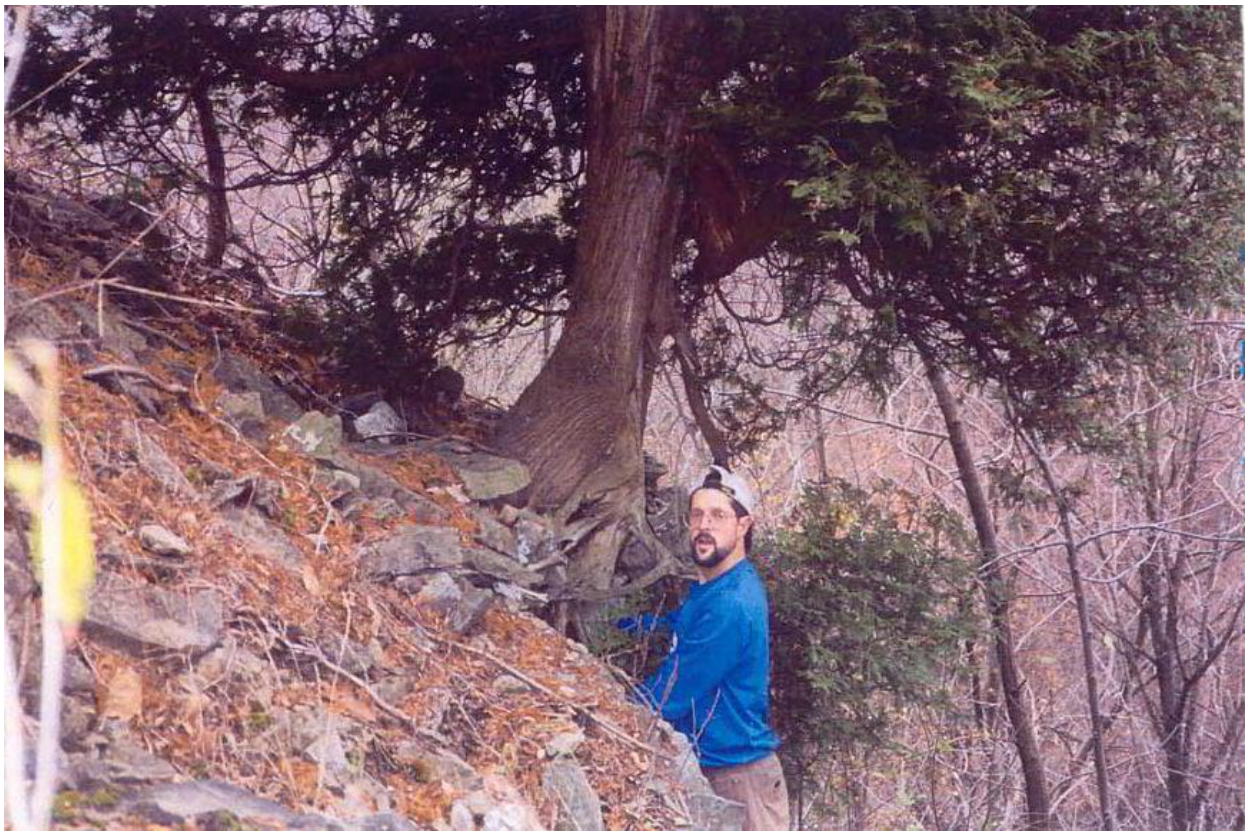
#50 Creeping Cedar – photo by C. Milazzo

#52 Bench Cedar

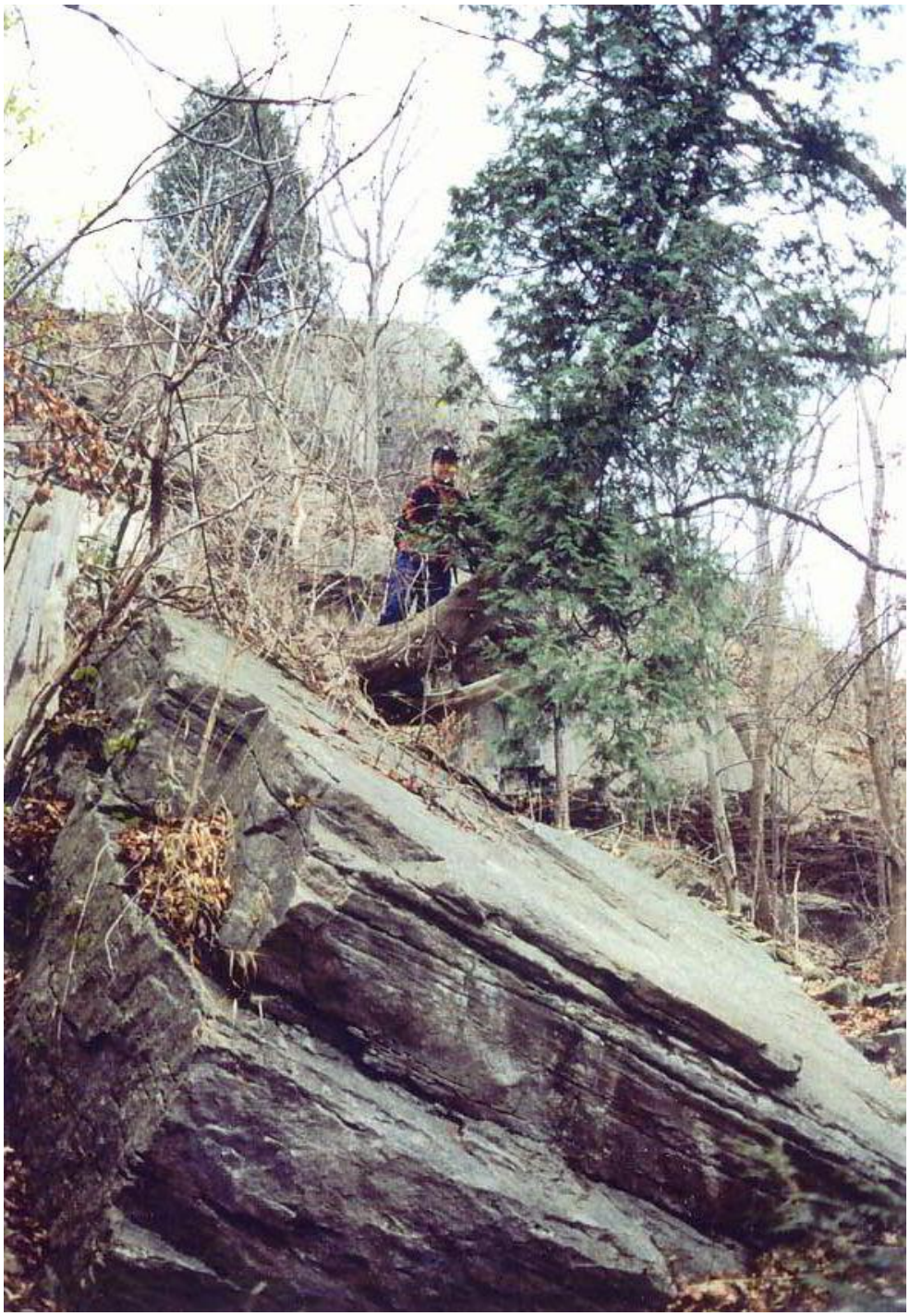
#62 Whirlpool View Cedar



#62 Whirlpool View Cedar

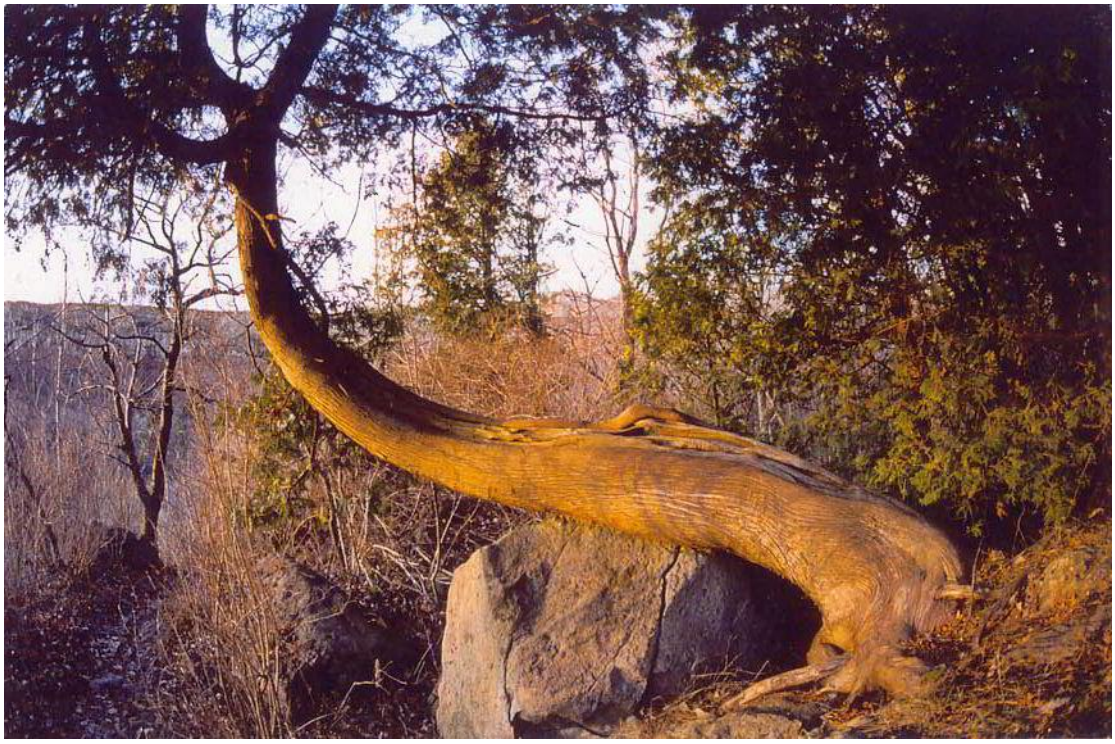


#62 Whirlpool View Cedar

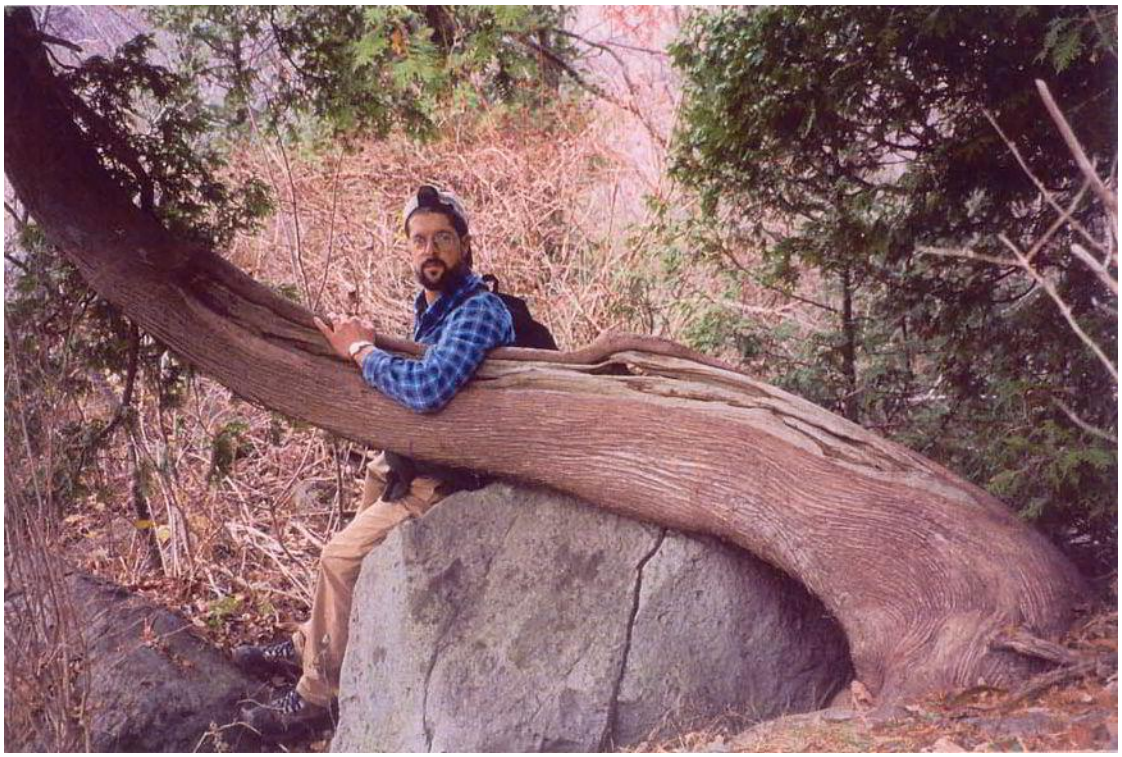


#60 Sliding Rock Cedar

#60 Sliding Rock Cedar



#85 – 86 Elephant Tusk Cedar – photo by C. Milazzo



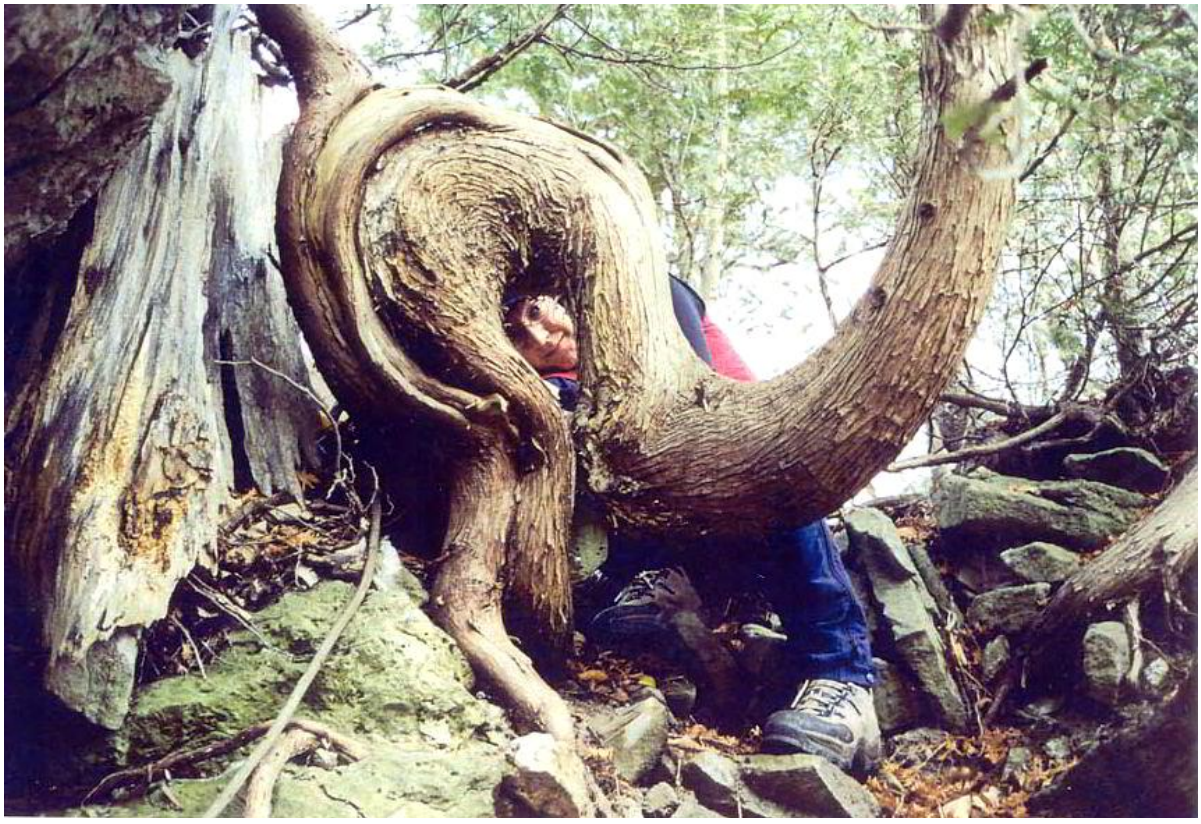
#85 – 86 Elephant Tusk Cedar

#85- 86 Clonal Cedars of Elephant Tusk Cedar Colony

#86 – 86 Another clonal cedar of Elephant Tusk Colony

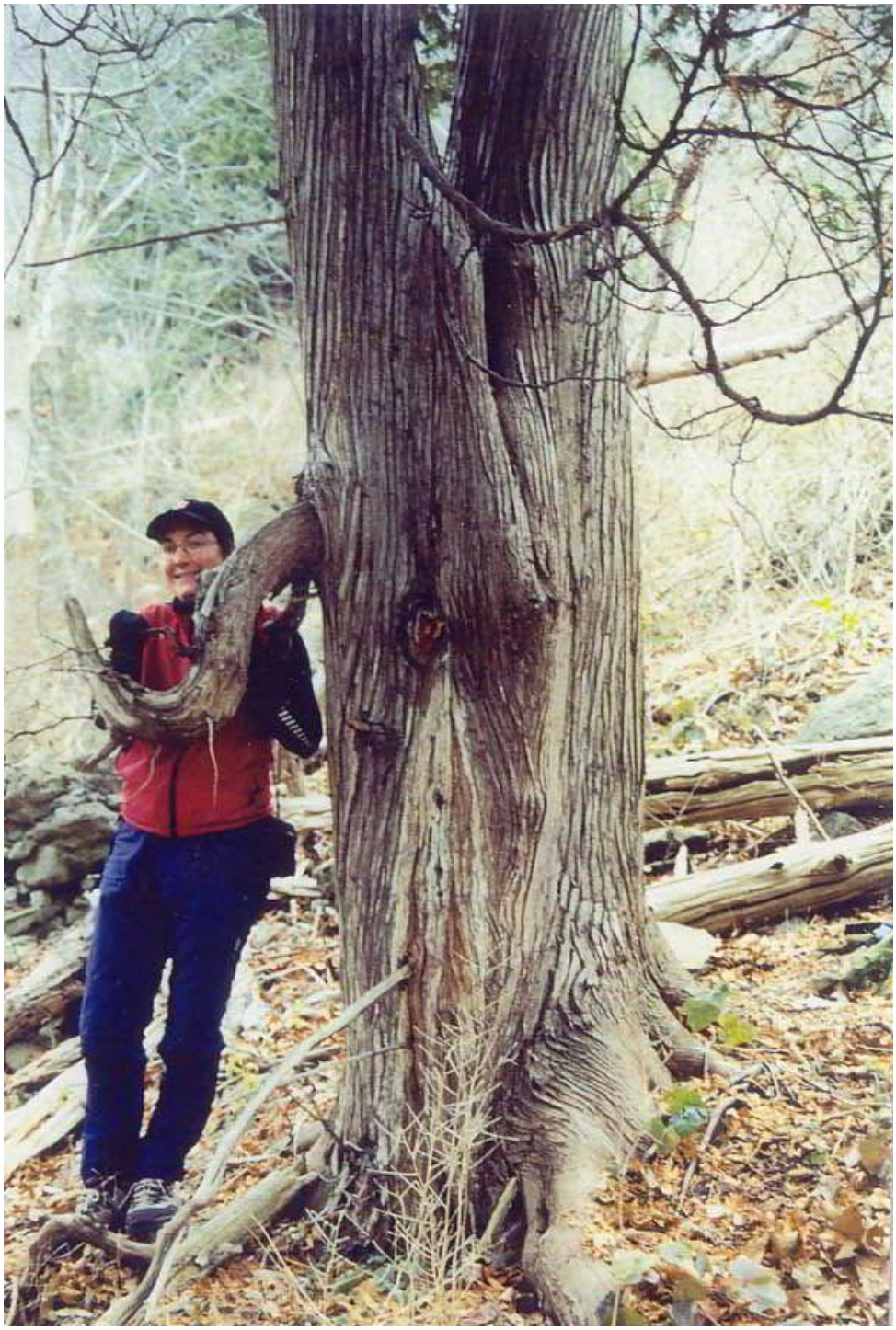
#89 – 96 Spring Trail Rock Face Colony

#81 Elephant Tusk Cedar 175 years old

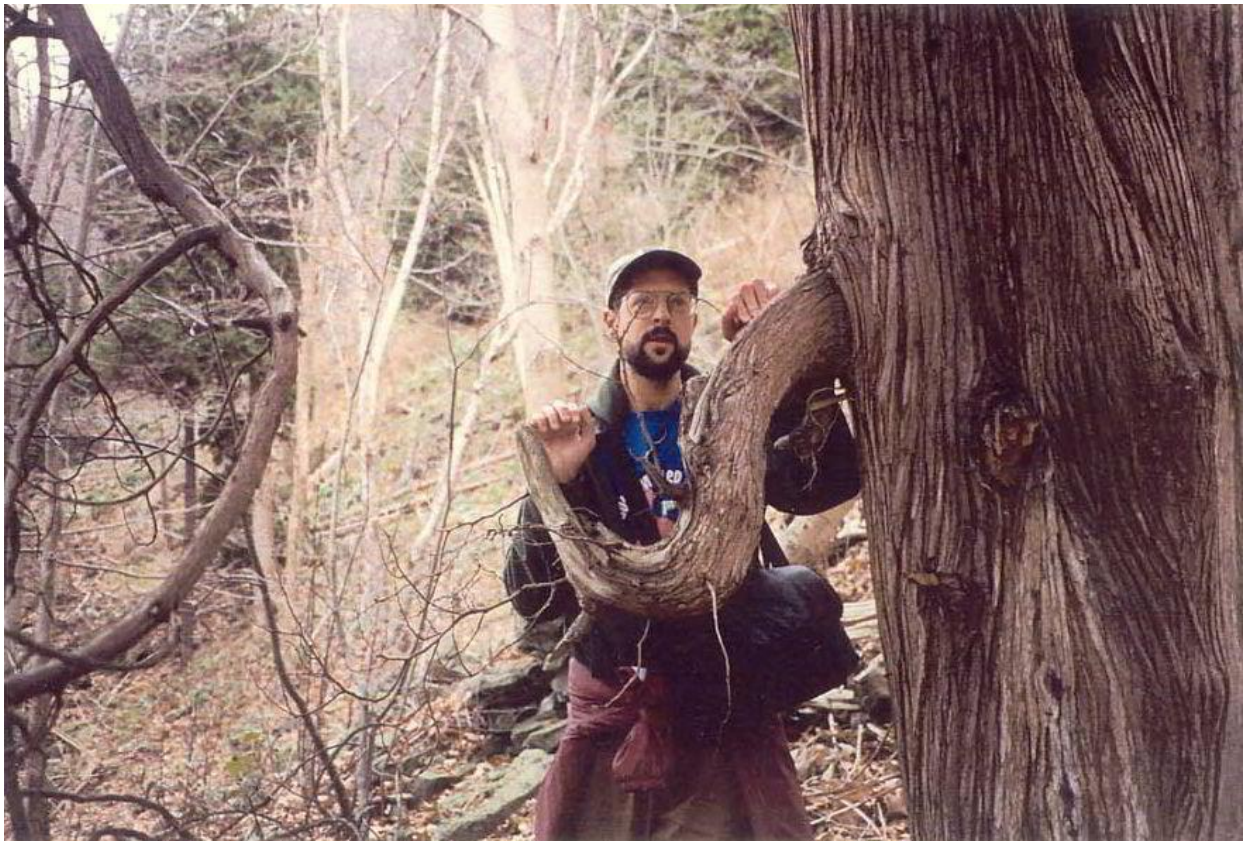


#81 Elephant Tusk Cedar 175 years old

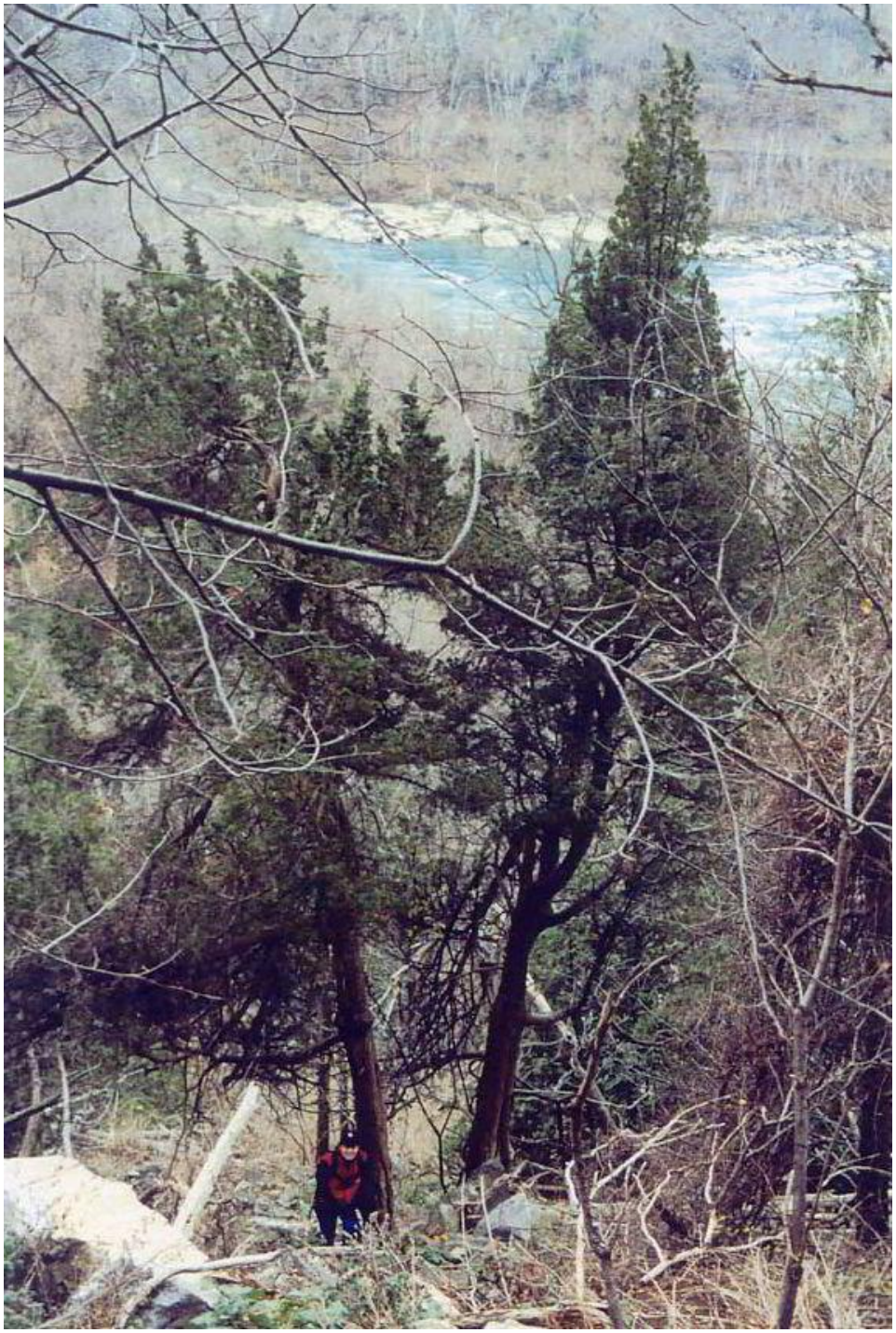
#24 Sitting Arm Cedar – 215 years old, approximately 67 feet tall



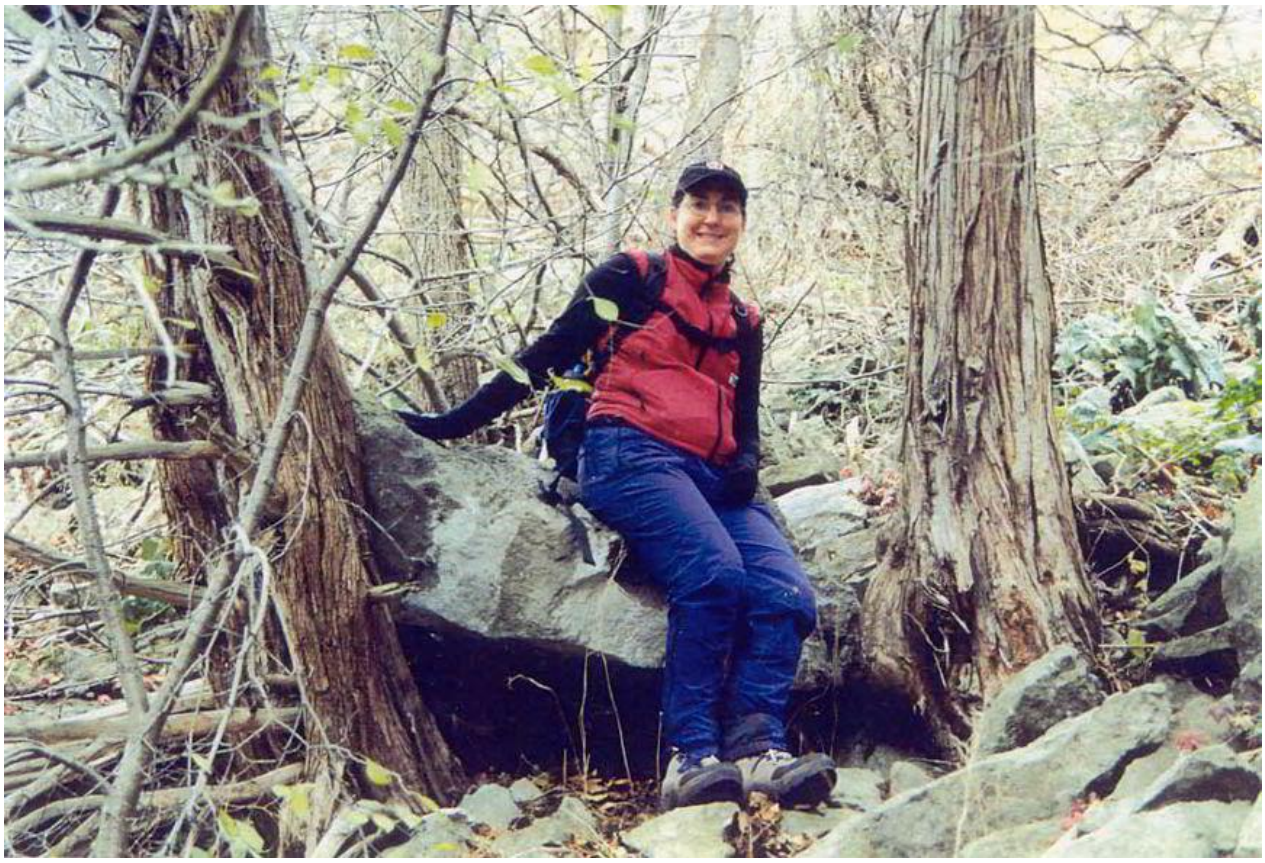
#24 Sitting Arm Cedar – 215 years old, approximately 67 feet tall



#24 Sitting Arm Cedar – 215 years old, approximately 67 feet tall



R1 – 2 Twin Talus Red Cedars – photo by j. Horowitz



R1 – 2 Twin Talus Red Cedars – photo by j. Horowitz

#28 Leaning East Talus Cedar

#27 Bristlecone Cedar

Ancient cedar wood on talus at south end of Niagara Glen overlooking Cripps Eddy