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# SHINGLE GULLY ICE CAVES MANAGEMENT PLAN: BALANCING RECREATIONAL USE AND SENSTIVE ECOSYSTEM PROTECTION

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***ABSTRACT*:** *This study outlines a resource management plan for an area known as the Shingle Gully Ice Caves located in Sam's Point Dwarf Pitch Pine Preserve in the Shawangunk Mountains of New York State. The key issues faced in protecting this sensitive ice cave ecosystem are addressed. These ice caves are deep crevices in the quartz conglomerate that contain snow and ice throughout much of the summer. The cool temperatures maintained within these crevices provide habitat for several rare species, and a distinctive flora and fauna common to a boreal climate. These factors make the Ice Caves an ecologically sensitive area with several critical management issues. The major problems stem from recreational use that leads to the development of social trails, vegetation trampling, soil erosion, and wildlife disturbance. The purpose of the Shingle Gully Ice Caves Management Plan was to establish a clear and manageable set of objectives for protecting the resource to the fullest extent possible while still allowing visitation. These objectives were developed as a result of research carried out by the author in the Spring of 2006 and will be implemented in the future by the land managers and volunteers from Sam's Point Dwarf Pitch Pine Preserve and The Nature Conservancy.*

***Keywords:*** *Resource management plan, Shingle Gully Ice Caves, Recreational use*

## INTRODUCTION

### The Shawangunk Mountains

The Shawangunk Mountains form a long, narrow ridge system, which extends south from Rosendale, New York through New Jersey at Port Jervis to the Susquehanna River in Pennsylvania. It was initially uplifted and folded about 450 million years ago during the Taconian Orogeny. This mountain building episode was the first of three events that eventually formed the Appalachian Mountains and the Shawangunks. It has since been shaped by the Pleistocene epoch glaciation. The ridgeline is referred to as the Kittatinny Ridge in New Jersey, and the Blue Mountains in Pennsylvania. The ridge comprises some 250,000 acres, approximately 150,000 of which lie in New York. It is a subsection of the High Allegheny Plateau ecoregion, a biological province with distinct natural communities. Nearly all of the ridge land is protected from development and subdivision in New Jersey and Pennsylvania; most of the unprotected land is in the Shawangunks of New York.

The northern Shawangunks comprise a thirty-mile section of the ridge, which extends from Ellenville to Rosendale and are widely recognized as one of the most important sites for biodiversity conservation in the northeastern United States. Much of the higher elevations are covered with unique pine-barrens communities that contain uncommon wetlands, such as the pitch pine-blueberry peat swamp and the perched bog. There are over 3,500 acres of pine-barren communities on the ridge. The slopes of the ridge support New York's largest known chestnut oak forest (28,000 acres). Interspersed through all of these areas are dozens of rare plant and animal species, such as mountain spleenwort (*Asplenium montanum*) and the timber rattlesnake (*Crotalus horridus*). These rare natural communities have led the New York Natural Heritage Program to grant the northern Shawangunks a biodiversity rank of B1, the highest possible within the program's ranking system. Furthermore, The Nature Conservancy designated the ridge as one of its original 75 "Last Great Places" for biodiversity conservation in the Western Hemisphere.

The northern Shawangunks are one of few remaining areas in close proximity to New York City where there are large, undisturbed forestlands, making the ridge a popular destination for many different types of outdoor recreation. Visitors come to picnic, walk on the historic network of carriage roads, mountain bike, hike, visit several dramatic waterfalls, or rock climb on the quartzite escarpment lining the eastern side of the ridge. It is estimated that approximately 500,000 people visit the ridge annually (Lougee, 2001).

**Sam's Point Dwarf Pine Ridge Preserve**

Sam's Point Dwarf Pine Ridge Preserve is located in the southwestern portion of the northern Shawangunks and comprises nearly 5,000 acres. The Open Space Institute (OSI) currently owns the Preserve and The Nature Conservancy (TNC) is authorized to manage the property. It is home to the rarest natural community in the northern Shawangunks, the globally unique dwarf pitch pine-barrens. This community is ranked G1 S1 by the New York Natural Heritage Program, which indicates the highest level of global and state rarity. The preserve is also home to four other rare natural communities, seven rare plants and three rare animals. The Sam's Point Preserve is perhaps the most intact and unfragmented of all the protected natural areas on the ridge, with only a few maintained hiking trails and carriage roads bisecting it (Lougee, 2001).

The Master Plan for the Sam's Point Dwarf Pine Ridge Preserve was written by J. Lougee in 2001. The purpose was to create a process for protecting the unique natural resources of the preserve with appropriate and managed public use as its focus. The Sam's Point Master Plan provides guidance for protecting the property's biodiversity, as well as its educational, scenic, cultural and recreational value with goals focused on the protection of natural and cultural resources. Balancing ecological management with visitor management at the preserve is essential in achieving the goals of the Master Plan. Unmanaged recreational use is a leading threat to the fragile areas. The visitor management program in the Master Plan was designed using the National Park Service's Visitor Experience Resource Protection (VERP) framework. The implementation of this framework combined with an education and outreach plan should lead to responsible visitation and stewardship activities at the preserve (Lougee, 2001).

**Shingle Gully Ice Caves**

One of the critical management areas at the Sam's Point Dwarf Pine Ridge Preserve is an area known as the Shingle Gully Ice Caves, Greater Ice Caves, or Ellenville Ice Caves. This area is currently accessed by permit only. The Ice Caves are deep 100-foot crevices in the quartz conglomerate that contain snow and ice through much of the summer. Due to the cool temperatures that are maintained within these crevices, the area contains flora and fauna common to a northern or boreal climate. The Ice Caves also contain several rare and unique species. These factors make the Shingle Gully Ice Caves an ecologically sensitive area with several management issues particularly in regards to recreational use. The purpose of this study was to apply VERP management practices from the Sam's Point Master Plan to identify specific management issues for the Ice Caves sub-region and to develop a comprehensive set of goals to protect the resource while allowing recreational visitors. The final Shingle Gully Ice Caves Management Plan could then be used as a foundation for better management and future planning.

# BACKGROUND

**Geology**

The ice caves of the Shawangunk Mountains are deep fissures in quartz conglomerate bedrock that contain ice most of the year. Some ice persists well into the summer, especially where conglomerate slabs bridge over the upper part of the gaps and blocks the sun. The conglomerate ice caves are quite different geologically from limestone caverns. Throughout the ridge a hard quartz conglomerate, known as Shawangunk Conglomerate, overlies the less competent Martinsburg Shale (Kiviat, 1991). There are several locations where these ice caves exist but the highest concentration is at Sam's Point Preserve. The largest of these caves is in the Shingle Gully Region. These ice caves were produced when conglomerate masses separated along joint cracks leaving deep, canyon-like gaps that range from a few feet to more than a hundred feet across (Fagan, 1998). The gravity slide is the largest block landslide in the East and possibly the U.S. At the north end of the area is a stream offset at an angle of about 200 degrees. This may be the only place an offset stream can be seen in the U.S. east of the San Andreas Fault (Kiviat, 1991).

The Grand Canyon, the largest crevice within the Shingle Gully Ice Caves has cliffs that are around 100 feet with both high and low angle walls. There are also freestanding blocks that separated from the adjacent cliff walls. This area is between 1,700 and 1,800 feet in elevation, varies in width, and is over a quarter of a mile long. Talus chokes the bottom of this crevice and may be up to 100 feet deep. The talus at this site is deep and layered but is not extensive in area. The Grand Canyon Cliffs have variable aspects facing north and south due to the opposing nature of the canyon walls (Lougee, 2000).

**Flora and Fauna**

The ice caves support regionally unique boreal biota as a result of cold air draining from the depths of the crevices. These communities are home to plants more commonly seen in sub-alpine forests and alpine meadows above 4,000 feet, such as those found on the highest Adirondack summits. A Cliff Community Survey was completed in 2000 on five cliff sites including the Grand Canyon. A total of 72 plant species were recorded growing in the cliff communities and 51 species were observed on the cliff faces, many of which also occurred in the talus. All five survey sites harbored rare or unusual species (Lougee, 2000). Where enough soil has accumulated on the talus blocks that choke these crevices, there is a delicate carpet of bryophytes (mosses and lichens) and boreal plants, such as creeping snowberry (*Gaultheria hispidula*), goldthread (*Coptis trifolia*), shining clubmoss (*Lycopodium lucidulum*), bunchberry (*Cornus canadensis*), and starflower (*Trientalis borealis*). An alpine lichen called crustose or map lichen (*Rhizocarpum geographicum*) also occurs within this community type. Common trees associated with the ice caves talus communities have boreal and alpine affinities as well. These include black spruce (*Picea mariana*) and mountain ash (*Sorbus Americana*) (Lougee, 2000 and 2001; Kiviat, 1991).

The Shingle Gully Ice Caves provide important habitat for wildlife at the preserve. Small mammals such as the star-nosed mole (*Condylura cristata*), the long-tailed shrew (*Sorex dispar*) and a variety of bats, including the brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*) and the eastern pipistrelle bat (*Pipistrellus subflavus*) have been known to use these habitats. However, little is known about the extent that these bat species utilize the caves for hibernation. Shingle Gully is also a historical location of the extirpated eastern woodrat (*Neotoma floridana*), and it has been suggested the ice caves talus communities

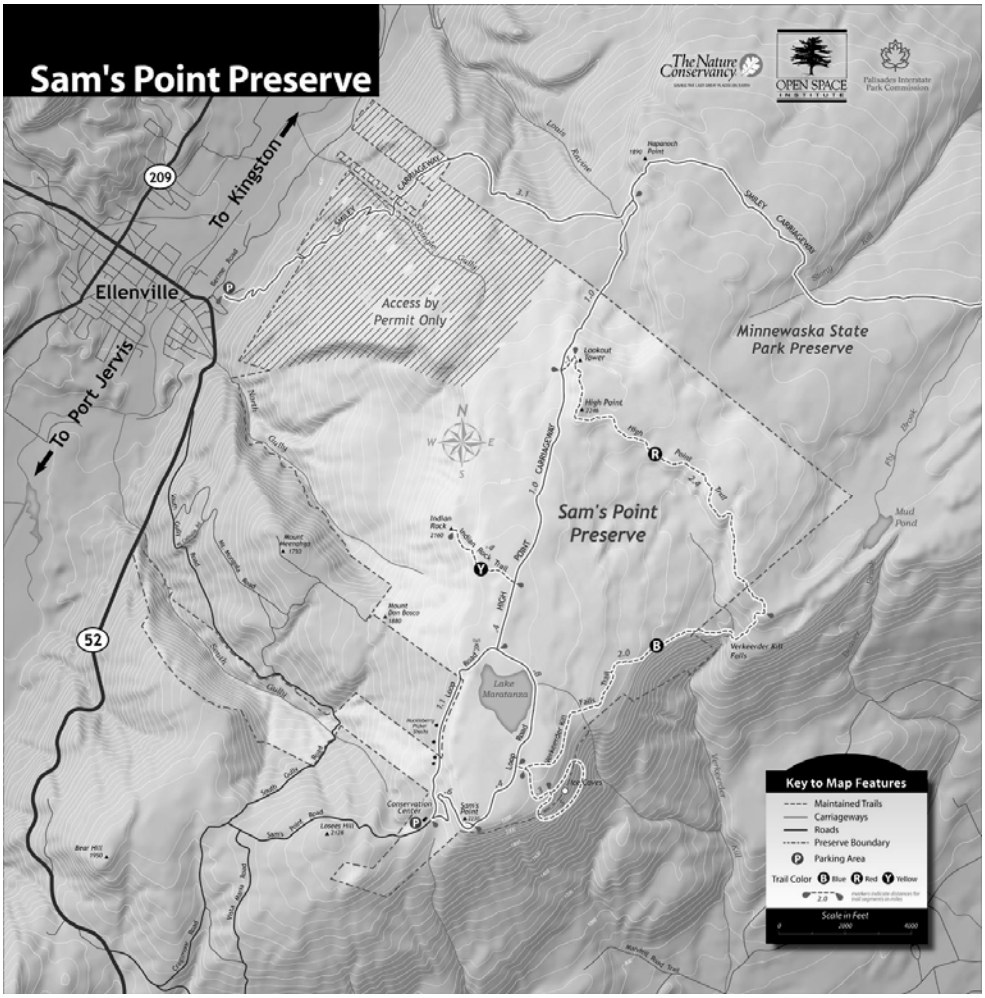


Figure 1. Sam's Point Preserve. Shingle Gully Ice Caves are located in the Access by Permit Only zone.

are possible habitats for the rock vole (*Microtus chrotorrhinus*) (Lougee, 2001; Kiviat, 1991). Locally rare faunas including peregrine falcons, common ravens, and black vultures have all recently returned to the Shawangunks (Lougee, 2000). Many dwell in areas next to or on cliff walls. Nesting ravens were documented in field reports from the Mohonk Preserve throughout the 1990's. In a recent trip, nesting ravens were sighted in the Grand Canyon. The caves probably support "northern" invertebrate species, but there is no information on this subject (Kiviat, 1991). Additional field reports from 1953 to 1996 were provided by the Daniel Smiley Research Center at Mohonk Preserve and are on file for more detailed flora and fauna findings during that period. A current detailed inventory and analysis is needed in order to better understand the flora and fauna present and to determine the influence of visitation.

**Cultural and Historical Significance**

The Shawangunk Mountain landscape has a long history of human intervention but little is known about the Shingle Gully Ice Caves region. There have been no professionally conducted archaeological surveys or excavations within Sam's Point Preserve's limits, with the exception of one highly localized survey effort. However, excavations and surveys conducted within portions of the Shawangunks adjoining the preserve suggest that the relatively inaccessible ridge tops of the preserve contain a repository of archaeological information that cannot be found in other settings (Lougee, 2001).

Archaeological sites within this environment typically take the form of rockshelters. This type of site can be found in several contexts including rock/ledge overhangs along the bases of cliffs, within caves, or among rock masses that have become detached from "parent" cliffs. Such sites were used as temporary shelter by small mobile bands of pre-Columbian hunter-gatherers because they offered safety and protection from the elements. Activities usually involved sleeping, food preparation, cooking, and maintenance of equipment. Groups tended to visit rockshelters repeatedly through time, accumulating cultural debris. Based on existing research, several areas within the preserve are now considered potentially sensitive for rockshelter sites, including overhangs in the vicinity of the Shingle Gully Caves. To understand fully Native American presence within this region more professional archaeological surveys are needed (Lougee, 2001). Available evidence indicates that current preserve lands were not intensively utilized by Euro-Americans during the early American colonial period. Only a handful of eighteenth and nineteenth century Euro-Americans were able to establish livelihoods in the Shawangunks. Local industries included wintergreen distilling, quarrying, mining, shingle making, barrelhoop making, charcoal making, trapping and huckleberry picking (Lougee, 2001).

The huckleberry pickers were a group of working-class men and women who began to inhabit the Shawangunk Ridge seasonally in the middle of the nineteenth century. At some point, the berry pickers began to establish seasonal and/or semi-permanent camps within what is now the Preserve and the adjacent lands. One of their settlements was along the Smiley Road. This is a roadway constructed at the beginning of the 20th century providing a direct route from Ellenville to the hotels at Lake Minnewaska. The Smiley Road is currently used as a trail for visitors and for access to the Shingle Gully Ice Caves (Lougee, 2001). Considering the ice caves area has high numbers of berry bushes, the berry pickers probably harvested around the ice caves but this is not supported by historical research.

Beginning in the mid-nineteenth century shingle making was also an important local industry. The place name "Shingle Gully," given to a ravine adjacent to the Shingle Gully Ice Caves suggests that local residents were engaged in this livelihood. Shingle makers were often hermits or farmers who worked on a seasonal basis. Shingles made from white pine or hemlock were probably sold commercially to dealers in the Rondout Valley (Harris, 2003). The shingle weavers probably lived and worked near the ice caves but this is not supported by research either. During the middle and late nineteenth century the Preserve was a popular tourist destination. Thomas Botsford built two resorts at Sam's Point. In this period there was an extensive trail network that went through the Shingle Gully Ice Caves. Historical watercolor paintings of tourists visiting the caves document this use.

## RECREATIONAL USE AND MANAGEMENT

Visitation to the Shingle Gully Ice Caves is not well understood. There is currently no on-site method for recording the number of visitors accessing the site, what trails they are using, or what activities they engage in while at the caves. Visitors are currently required to obtain a permit from the Nature Conservancy. For 2005, only 28 permits were

granted. However, the annual number of visitors is probably far greater because some visitors are not aware that a permit is needed or choose not to obtain one. Visitors use historic trails, and social paths or unofficial trails. Management of these trails is badly needed to prevent further resource degradation. There are several trails along the cave bottoms that cut through fragile and unique plant communities. A path along the canyon's northern wall is severely eroded and braided. Visitors also walk along the canyon floor (the talus) and have worn a path into the fragile soils and caused degradation of the flora covering the boulders (Lougee, 2000 and 2001). Understanding visitation is important because it is integral in determining which areas require management and what tactics should be employed.

**Overview of the VERP Framework**

The VERP framework consists of nine elements that enable the development of a public use management plan. VERP is a modification of the Limits of Acceptable Change (LAC) system that was developed by the U.S. Forest Service in the 1980s. LAC was a turning point in recreation management as it shifted the emphasis from how much use an area could tolerate to maintaining desired resource conditions. VERP is very similar to LAC and other related planning processes; the primary difference in VERP is that it is driven by goals defined by park purpose, while LAC tends to be more issue driven. VERP is also designed to address recreational public use issues in many National and State Parks (Hof and Lime, 1997).

An important part of the VERP framework is defining management zones. These zones determine how recreation is managed when applied to geographical areas within the preserve. The zones are based on the goals of Sam's Point Preserve Master Plan and coincide with priority conservation areas. The management zones fix the limits of recreational use for an area, in some cases prohibiting it entirely. Each zone has a unique set of guidelines, restrictions, and desired levels of resource protection that helps to identify the threshold of acceptable public use. Once the zones are determined, a monitoring program is set up to ensure that each zone's standards are maintained. When the management standards are not upheld specific actions will be taken in order to correct the problem. Other elements of the VERP framework include involving the public and developing a mission statement.

***The VERP elements***

(1) Assemble an Interdisciplinary Project Team
(2) Develop a Public Involvement Strategy
(3) Develop Statements of Preserve Purpose, Significance, and Interpretive Themes
(4) Analyze Preserve Resources and the Existing Visitor Use
(5) Describe a Potential Range of Visitor Experiences and Resource Conditions
(6) Allocate the Potential Zones to Specific Locations in the Preserve
(7) Select Indicators and Standards for Each Zone; Develop a Monitoring Plan
(8/9) Monitor Resources and Social Indicators

The first three elements are addressed in the Sam's Point Preserve Master Plan. The Sam's Point Advisory Council served as the project team for this framework and discussed the public involvement strategy at the outset of the Master Plan. The VERP framework is detailed in the Master Plan as it applies to the entire Sam's Point Preserve. Only information pertaining to the Shingle Gully Ice Caves will be addressed in this paper, using elements four through eight. All the information about the VERP Framework came from the Sam's Point Master Plan prepared by J. Lougee in 2001.

**Shingle Gully Ice Caves VERP Elements**

***Element 4: analyze preserve resources and the existing visitor use***

The purpose of element four is to assess potential conflicts between visitor use and resource protection. This is accomplished through identifying sensitive resource areas of the preserve in the context of traditional use patterns, desired visitor experiences, and existing trails and facilities. The following sensitive resource areas apply to several regions within the Preserve including the Shingle Gully Ice Caves.

(1) Escarpments and Cliff Edges: Numerous escarpments comprise boundaries between pine-barrens communities, hardwood forests and open rock cliff edges, which are dominated by delicate lichen floras and scattered vascular plants. The vertical cliff faces are known to support rare plant populations and important wildlife habitats. The bases of escarpments are often locations of rock overhangs or rockshelters that once supported Native American or early Euro-American habitation. These areas are extremely delicate, are easily damaged by hiker trampling and are slow to recover from such impacts. The damage caused by this can be easily observed by the presence of devegetated soils, exposed bedrock which has not been weathered or

colonized by lichen species, and braided paths formed from hikers pursuing different vantage points along cliff edges. Even without established trails, hikers will continue to venture out onto the tops of escarpments making these special areas of concern for the visitor management program.

(2) Rare Plant Populations: The preserve contains seven rare plant species, all of which have locations in close proximity to hiking trails and pedestrian use areas. These populations are especially vulnerable to hikers who may trample them when wandering off trail to pick blueberries or "bushwhack."

(3) Crevice and Canyon Bottoms: Some of the most unique terrain of the preserve is the crevices that have formed through fracturing and subsequent shifting of the bedrock. Because of the cool air that circulates along the bottom of these crevices, they provide a habitat for boreal plant species disjunct from their typical mountain environs. Areas such as Shingle Gully and the Grand Canyon receive many visitors because of this unique habitat. These plants grow on very shallow soils forming a thin mantle over the underlying talus, which partially fills the crevices. Due to this and the limited amount of space along the crevice bottoms, the potential for vegetation trampling and soil erosion is high.

(4) Social Paths / Trail Braiding: This management concern applies to all of the communities and resources within the preserve. With the use of any trail system comes the potential for trail braiding along the periphery of the established trails. This happens when hikers and walkers cut corners, seek out viewpoints, or are unable to follow a poorly marked trail. In the area of Shingle Gully and the Grand Canyon, ambiguous trail delineation has led to significant trail braiding.

(5) Rare Animal Populations: The preserve is home to three rare animals. Other locally unique animals are also at risk of disturbance from visitor use. The scientific literature has shown how recreational activity can disturb nesting and mating habits, disrupt feeding activities and stress hibernating animals during the winter months.

(6) Commercial Ice Caves: Due to the historic use of the property, it is likely that the eastern ice caves will continue to be one of the primary interests of the visiting public. The eastern ice caves represent a globally unique natural community called ice caves talus similar to that of the Shingle Gully Caves but on a smaller scale. The former interpretive trail from the commercial Ice Caves Mountain era follows terrain not unlike the crevice and canyon bottoms mentioned above. These caves are therefore sensitive areas bound to absorb a large percentage of the public use of the preserve. Directing visitors to these ice caves as opposed to other ice cave sites has been a management strategy. This diverts visitors from the Shingle Gully Ice Caves and educates the public through signage on their uniqueness and proper stewardship (Lee, 2006).

***Elements 5 and 6: describe a range of visitor experiences and resource conditions; apply them to geographic locations within the preserve***

Element 5 describes the desired future conditions for the preserve. It outlines what resource, managerial conditions and visitor experience opportunities will exist at the preserve by developing management zones. These zones detail the type and extent of recreational use that will be permitted. Only passive recreational uses are permitted at the preserve including hiking, nature observation, cross-country skiing, and snowshoe hiking. Other forms of public use will be research, education, and stewardship activities. Each zone will allow varying levels of these uses.

It is envisioned that Sam's Point Preserve will be maintained as the "wilderness" component of the open space areas in the northern Shawangunks. In accordance with the Preserve's mission statement, protection of the natural resources is the primary goal for the Preserve, and limiting public access in some areas will be necessary to sustain this objective. The following management zones provide for both resource protection and compatible public use: the sensitive resource protection zone, primitive zone, backcountry zone, and developed zone. The zones largely follow the boundaries of natural communities and take into account the existing infrastructure on the preserve (facilities, trails, and roads). For simplification, VERP Elements 5 and 6 have been combined.

For the purpose of this study, only the primitive zone will be described in detail because the Shingle Gully Ice Caves are located within this Zone. The primitive zone is described by detailing geographic location, resource and social conditions, and management activities.

***Description and application in the primitive zone***

(1) Geographic Location: This zone covers the northwestern corner of the preserve and includes the Shingle Gully Ice Caves and the Grand Canyon. Its southern boundary is where the

pitch pine-oak heath rocky summit community meets the chestnut oak forest.

(2) Resource Conditions: The Primitive Zone includes largely unmodified areas and is designed to protect rare and sensitive natural communities and rare species populations. These elements of the preserve's biological diversity will be left unharmed by visitors who will be required to use established paths and obtain a permit for access. The resource conditions of this zone will also be determined by natural processes, except where ecological management, restoration, and possible public control measures are needed.

(3) Social and Experiential Conditions: The Primitive Zone provides visitors with a wilderness like experience. Footpaths will receive little maintenance (to protect the resource), and route finding may be challenging. Map and compass skills are necessary for travel in this zone. Permits will be required for access to the Primitive Zone, which will help to protect sensitive resources and maintain a quality visitor experience. Encounters with other visitors will be few in this zone. Public uses will include education, interpretation, hiking, hunting, research, and stewardship. The dangers of travel in this zone include over-exertion, weather, poisonous snakes, cliff edges, and crevices.

(4) Management: Management of the Primitive Zone includes education, visitor management and enforcement, research, stewardship, ecological management and wildlife management.

***Element 7: select indicators and specify standards for each zone; develop a monitoring plan***

Table 1 shows indicators, standards, and monitoring frequency for the Primitive Management Zone using VERP criteria. Selecting indicators and specific standards for each zone is the crucial element because it marks where the VERP framework moves from being qualitative to being quantitative. It is intended that the set of indicators and standards will be supplemented as more baseline information is gathered for the preserve's natural and cultural resources. A combination of staff and volunteer labor will be needed to carry out this monitoring plan.

***Elements 8 and 9: monitor resources and social indicators***

When the standards listed in element seven are violated, action will need to be taken. Determining what management action will be taken should be done by carefully evaluating each situation. Restricting visitor use to prevent trail braiding may not be as effective as improving trail delineation. On cliff edges, the reverse may be true when very clear trail definition does not prevent vegetation trampling caused by hikers seeking out viewpoints. Monitoring for the VERP framework should also be incorporated into the preserve's education and outreach program. Many of the indicators described above will only require a thorough walking of the preserve to monitor; others will require more time and a modest amount of training to complete.

Table 1. Indicators, Standards, and Monitoring Frequency for VERP Primitive Management Zone

| **Indicator** | **Standard** | **Monitoring Frequency** |
|---|---|---|
| Trampling of rare plant populations | 10% of any rare plant population is trampled within a 5yr period | Update NY Natural Heritage Program rare plant forms biannually |
| Presence of priority invasive plant species | There are currently no known occurrences of exotic plant species w/in this zone | Annual walk-through to determine presence/absence and distribution |
| Impact to wildlife (ravens) | Nesting ravens are not observed in Shingle Gully | Annually |
| Trail width on the canyon/crevice floors | Not to exceed 18-24" | Biannually through photopoints |
| Vegetation disturbance on canyon/crevice floors | No further disturbance from 1999 photopoints | Biannually |
| Trail braiding of primitive paths | No more than 1 path w/in 50' from trail centerline | Every 5 years |
| The presence of "social" paths | Obvious unofficial trails forming | Annual walk-through observations |
| Number of non-permitted visitors | No more than 20% of annual visitors did not obtain a permit | Biannually |
| Encounters between visitor groups | A visitor group encounters no more than 1 other party in a day | Annually based on questionnaires to permitees |

## MANAGEMENT RECOMMENDATIONS

After analyzing the relevant elements of the VERP Framework in the Sam's Point Dwarf Pitch Pine Preserve Master Plan that applied to the Shingle Gully Ice Caves, it was decided that local experts and land managers should be consulted to find out their recommendations, based on their experience and background knowledge. Experienced trail experts, ecologists, land managers and hike leaders contributed their recommendations. These were compiled and analyzed. A meeting was then set up to determine future management actions. The result of this meeting was a clear set of objectives that built on the research in the Master Plan. These resource management objectives will be implemented over the next few years as funds and staff become available.

A significant issue addressed was how the Preserve can improve its knowledge of visitation at the Shingle Gully Ice Caves. Mohonk Preserve, located farther north on the Shawangunk Ridge, has been using a trail monitoring device that counts individuals as they pass a specific location. This technique is slightly problematic because it may count an individual more than once. There are four potential monitoring locations. Research needs to be done on costs and actual use of the monitoring device.

Improving the education of hike leaders will help improve general visitor stewardship. Informational materials should be created and disseminated to existing and future hike leaders. When anyone contacts the preserve for a permit they should complete a survey. Staff may want to consider having hike leaders view a presentation or take a short training session. Several hike leaders are knowledgeable about the Ice Caves and have offered to serve as onsite stewards during their guided hikes. A physical presence at the Ice Caves is necessary to enforce regulations and to improve visitor awareness. With minimal staff and other resources, informed hike leaders would serve this purpose best.

The permit system may not adequately count visitors, but it does serve as a method of education. Currently, a letter is sent to those individuals receiving permits. This letter should be reworded and made concise as well as educational. It should include information on how to hike responsibly in the area and why it is important to take care of the Shingle Gully Ice Caves.

Ravens nest in the Grand Canyon on a western cliff wall under a ledge. These ravens have been documented in field reports done by the Smiley Research Center at Mohonk Preserve since the early 1990's and they were seen and heard on a recent trip. Ravens are not very tolerant of people near their nesting sites so it was recommended that the Grand Canyon trail be closed during the nesting period.

Minimal signage should be placed to maintain the wilderness/backcountry appearance of the area. Signage should only be used where necessary to protect the resource. It was decided that signs would be helpful at two locations: the entrance to the Shingle Gully Cave and after entering Grand Canyon. The sign should only serve to educate those that do access the caves. These signs should be small and very simple. They should inform people about the sensitivity of the vegetation and appropriate trail use.

A monitoring system needs to be put in place in order to document the effects that visitation is having on the rare and unique vegetation in the Shingle Gully Ice Caves. A photo point monitoring system would help to monitor changes in the vegetation. In addition, specific locations could be identified and then monitored as indicators of the general health and changes in vegetation. Analysis of these sites would not have to be highly quantified as long as they provided the appropriate information. These sites should be monitored in late spring and early fall to determine how significant seasonal changes may be.

Social and braided trails are a high priority. Trails along the cave bottoms and along cliff edges are the most sensitive and important. The best management of unwanted trails surrounding the Shingle Gully Ice Caves would be to brush in unwanted trails for several feet with downed trees and underbrush. Since there are so many trails, there is a high possibility of the unfamiliar visitor getting lost or following a wrong trail. Hikers would be more inclined to use the cleared trails.

## SUMMARY

The resource management plan for Shingle Gully Ice Caves addresses the key issues faced in protecting a sensitive and unique ecosystem. The major problems stem from recreational use that leads to the development of social trails, vegetation trampling, soil erosion, and wildlife disturbance. This plan establishes a clear and manageable set of objectives that integrates input from experts and preserve staff as well as builds upon the work done by J. Lougee in the Sam's Point Dwarf Pitch Pine Preserve Master Plan. These objectives can be summarized as follows.

- Place trail counters to evaluate visitation volume
- Improve education of hike leaders
- Use hike leaders as on site stewards/monitors
- Make permit letter more effective and educational
- Close Grand Canyon during Raven nesting period
- Place discrete signage in sensitive caves
- Use photopoint monitoring and/or flora monitoring stations to assess vegetation changes and degradation
- Brush in trails where use should be discouraged

Implementing these objectives will address key issues in preserving this unique and complex ecosystem, while allowing visitors to continue to experience a special part of one of the "Last Great Places."

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