CAVE RESOURCE INVENTORIES: WHY ARE THEY IMPORTANT?

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Abstract

Cave resources are defined as all of the secondary attributes and features, both natural and man-made, that reside within the confines of the cave or cave system. Natural features include the biota, paleontology, mineralogy, speleothems, and sediments. Man-made features can be of archeological, historic, or cultural origin. In order to effectively manage, protect, and conserve caves, cave systems, karst areas/ecosystems, and cave resources in general, it is important to have basic knowledge of the physical extent, nature, and attributes of the system/area/resource. Resource inventories along with geographic data and photo documentation provide the baseline of information necessary to understand cave and karst resources and ecosystems. Resource inventories can be conducted graphically or as a dedicated list. The Hoffman Institute uses both types of inventory data to generate resource inventory maps of general features, hydrologic features, and archeological/cultural features. Project areas where resources inventories have been conducted include Coldwater Cave, Iowa; caves of Isla de Mona in Puerto Rico; and caves in the south-central Kentucky area. Synthesis of this information into maps, databases, and Geographic Information Systems provides the framework from which to make sound and intelligent resource management decisions. Such baseline data and information is also a starting point for scientific research.

Introduction

In order to effectively manage, protect, and conserve caves, cave systems, karst areas/ecosystems, and cave resources in general, it is important to have basic knowledge of the physical extent, nature, and attributes of the system. Geographic data, resource inventories, and photodocumentation provide the baseline of information necessary to understand cave and karst resources and ecosystems. Synthesis of this information into maps, databases, and Geographic Information Systems provides the framework from which to make sound and intelligent resource management decisions. Such baseline data and information is also a starting point for scientific research.

Geographic Data

With respect to caves, cave systems, and karst areas in general, there are two basic types of geographic data: surface geographic data and cave survey data. Surface geographic data consists of the location and cataloging of physical features on the land surface. This includes locations of karst features (cave entrances, springs and spring seeps, swallets sinkholes, karst windows, sinking streams), surface water and drainages (lakes, ponds, rivers, and streams), surface rock outcrops, and any other features that are related to the caves and karst area.

Surface geographic information can be found on topographic maps, geologic maps, and aerial photographs. Reference to surface features can also be found in reports and written accounts about the area. However, in order to have the most complete data, it is necessary to do field reconnaissance to identify and locate features not shown on existing maps.

Once all of the surface geographic information is collected it should be cataloged and referenced to explicit location references (surface benchmarks, latitude and longitude, UTM coordinates) and plotted on a base map (which should include surface topography). The base map is the first layer of geographic information to which all other information layers will be referenced.

Geographic information also includes cave survey data which defines the horizontal and vertical extent of a cave or cave system. The way to obtain cave survey data is to actually map the cave. The objective of cave surveying is to collect distance, bearing, and vertical data that will later be made into a cave map.

Another important component of the survey data is passage dimensions. These data are recorded in terms of where the survey station lies with respect to the left and right walls and to the ceiling and floor of the cave passage.

The final component of the cave survey data is a detailed sketch, done to scale, of cave passages and features along the survey line. Because caves are three-dimensional entities, sketches need to be done in plan view, profile, and in cross section. Passage features and attributes are shown symbolically on the sketch. Features and attributes that should be noted on the sketch include: domes, skylights, pits, ledges, slopes, changes in ceiling height, composition of the material covering or making up the floor, speleothems, coatings, and water (flowing, ponded, sumped, and seeps). Other important things to note include wind (or changes in air movement), directions of water flow, passage terminations, biology, bones, and archeological/historic/cultural features.

More often than not, caves in an area of interest have not been mapped. In that case it will be necessary to instigate cave mapping work. Sometimes even if the caves have been mapped, the data or the maps may not be to modern survey standards. For some very old surveys, a map may exist but the data that produced it does not. In either case, re-survey is in order.

As cave survey data are collected, the distance, azimuth, vertical readings, and passage dimensions are input to a cave data reduction and plotting program. The data is converted to XYZ coordinates and plotted by the software. The result is a preliminary line plot showing the horizontal and vertical extent of the cave and its passages. Referencing the cave data to surface coordinates shows how the cave passages relate to surface features. Some reduction and plotting software can use the passage dimensions along with the XYZ coordinates to make volumetric plots of the cave passages. These programs also make it possible to rotate cave and volumetric plots in three dimensions. This is a valuable aid for envisioning the layout of a cave system and for detecting geologic and/or hydrologic patterns which are not obvious otherwise.

One of the primary reasons for collecting cave survey data is to produce cave maps (Figure 1). The cave plot, passage dimensions, and sketches are the necessary components of making a good map. The cartographer integrates these data into a map of the cave in plan and profile. Cross sections are added to the plan view making for a more complete three-dimensional representation of the cave. The availability of high powered PCs and easy-to-use drawing programs make computer cartography possible to a wider range of cave map makers. Today, most all cave cartography is done digitally.

A cave map, in any stage of completion, serves as an underground base map from which all future work can be referenced. An integrated cave map–surface map makes for a powerful tool for cave management and from which to conduct work for resource inventories, restoration, rescue planning,

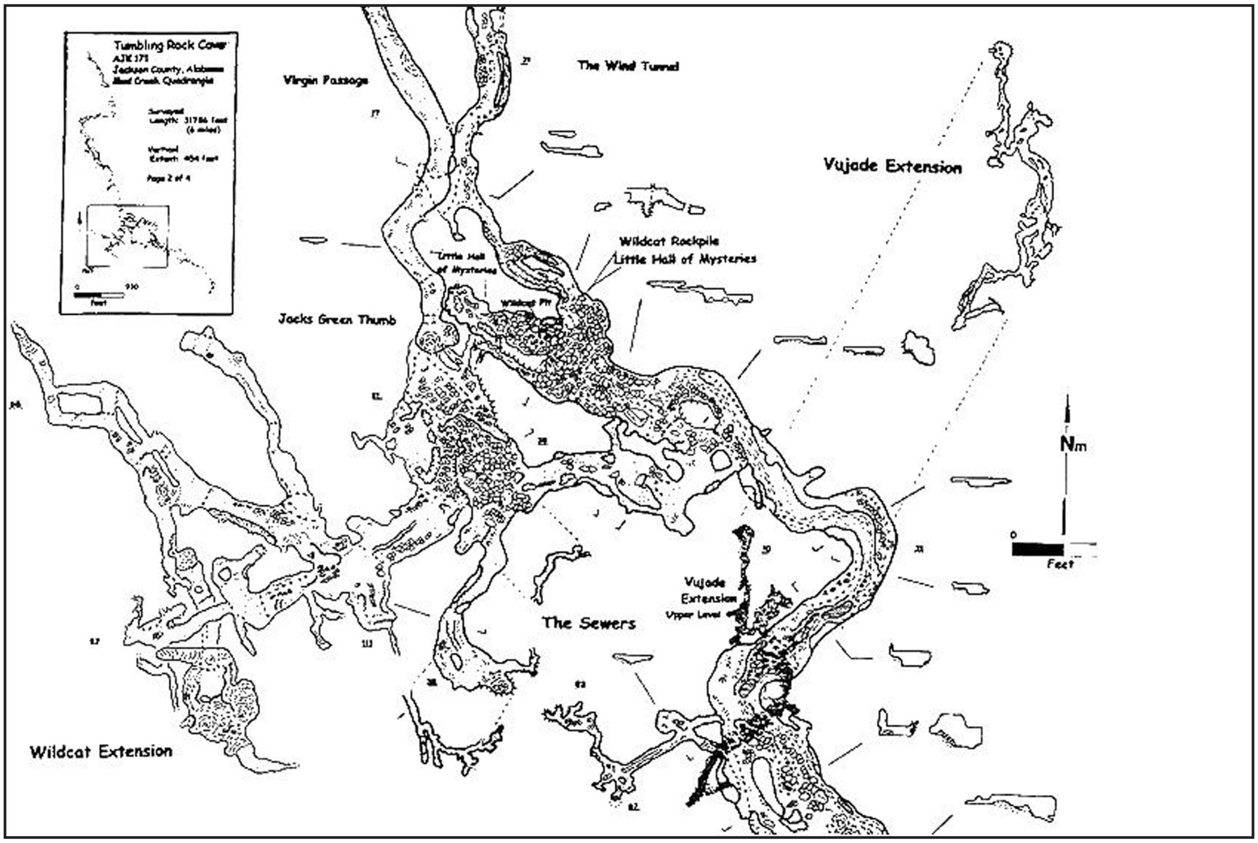


Figure 1. A portion of a map of Tumbling Rock Cave, Alabama,

impact surveys, and ultimately, research.

Cave Resource Inventories

Cave resources are defined as all of the secondary attributes and features, both natural and man-made, which reside within the confines of the cave or cave system. Natural features include the biota, paleontology, mineralogy, speleothems, and sediments. Man-made features can be of archeological, historic, or cultural origin.

The first step in managing, protecting, and studying caves resources is to know what and where they are. Resource inventories are descriptive lists of the cave resources referenced to survey stations. Most resource inventories are done in conjunction with the cave survey and collect only very basic information on the resources such as location or simple descriptions. Basic training and the use of field guides can supply enough expertise for data collectors to provide more descriptive surveys.

Resource inventories are generally done during the survey. Detailed sketches and notations from the survey notes can provide a generalized list of the cave resources. A resource inventory team can follow up on the generalized list and provide more detailed descriptions of the resources and the general cave conditions. Resource inventories can also be conducted as narrative descriptions or lists (Figure 2). Inventories can also be done on pre-printed checklist sheets which show a list of possible resources (Figure 3). The person inventorying simply checks the list. In either case, the data should always be referenced to survey stations.

Once the general inventories are done, it falls to the specialist with expertise and training in a particular field (biologists, paleontologists, or archeologists) to conduct detailed inventories and identifications. As resource inventory data is collected, the descriptive information needs to be entered into a database. Data in this format can then be searched and queried quickly and efficiently. Some cave data reduction and plotting programs have database functions that allow resource information tied to survey stations to be entered into a database. Plots or screen views can be produced which show the resource data displayed next to the survey station. Dedicated GIS programs are ideal

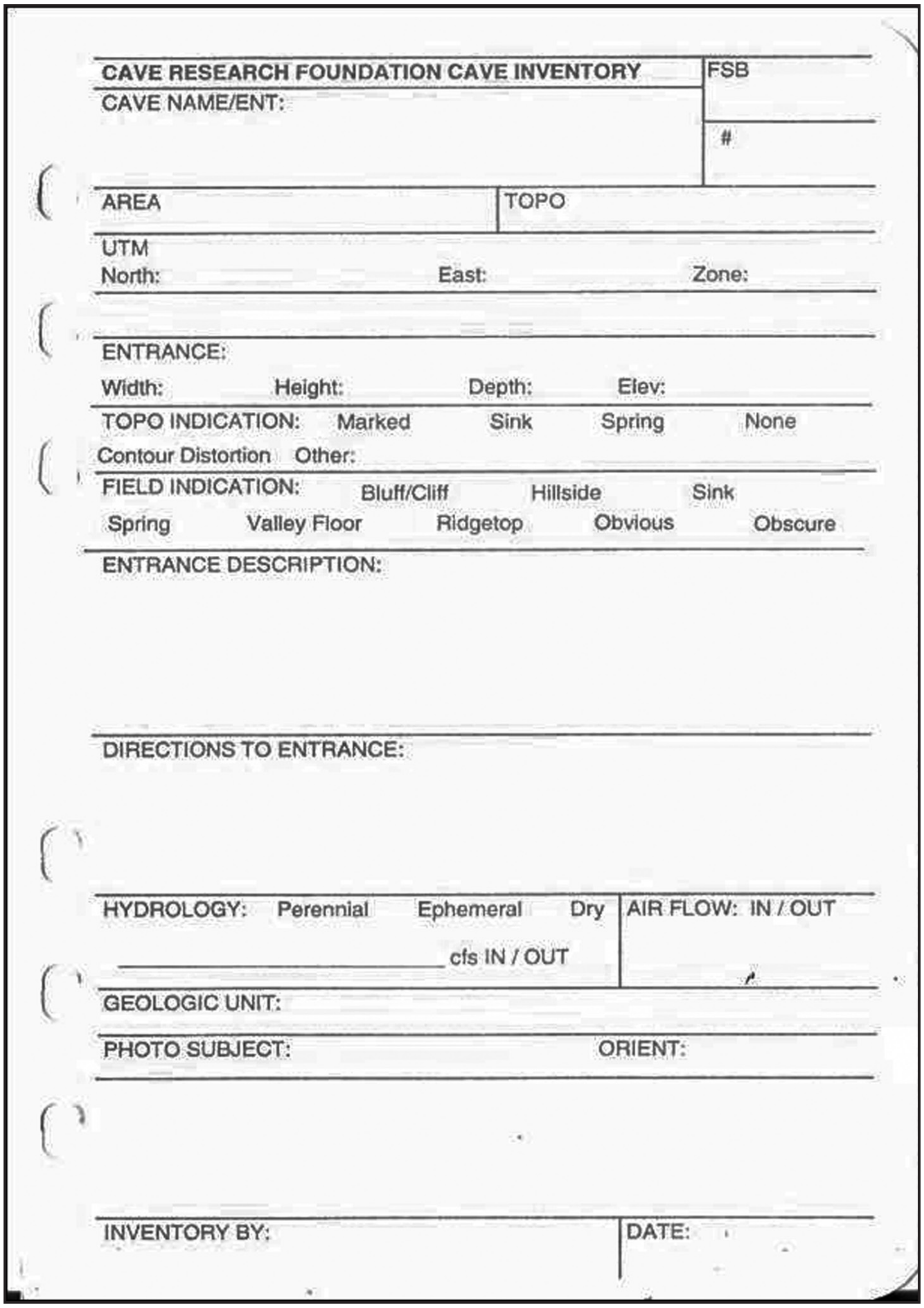

CAVE RESEARCH FOUNDATION CAVE INVENTORY | FSB
CAVE NAME/ENT: | #
AREA | TOPO
UTM
North: East: Zone:
ENTRANCE:
Width: Height: Depth: Elev:
TOPO INDICATION: Marked Sink Spring None
Contour Distortion Other:
FIELD INDICATION: Bluff/Cliff Hillside Sink
Spring Valley Floor Ridgetop Obvious Obscure
ENTRANCE DESCRIPTION:
DIRECTIONS TO ENTRANCE:
HYDROLOGY: Perennial Ephemeral Dry | AIR FLOW: IN / OUT
cfs IN / OUT
GEOLOGIC UNIT:
PHOTO SUBJECT: ORIENT:
INVENTORY BY: | DATE:

Figure 2. Cave inventory form.

for combining cave plots and maps with attribute tables that contain inventory data.

Photo documentation

Photo documentation is an often overlooked but extremely important component of baseline data, especially if photographs are referenced to survey stations. A picture is indeed worth a thousand words, so photography serves as a superior component in resource inventories. A camera comes in extremely handy during surface reconnaissance in cataloging cave entrances (especially in areas where there are many cave entrances) and other karst features. In-cave photography provides excellent visual information on the nature, size, shape, and contents of cave passages and also serves to document the data collection process or new discoveries.

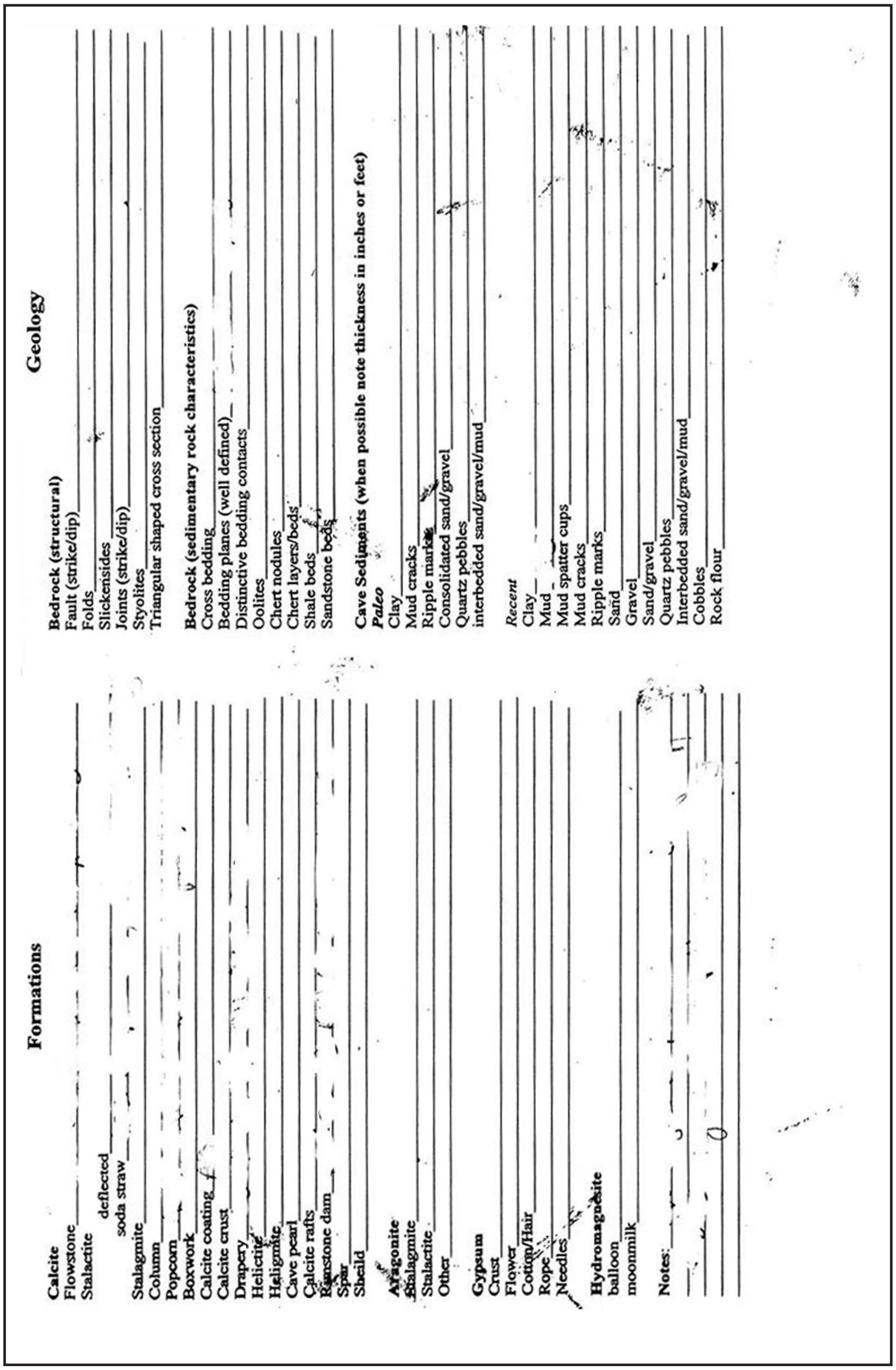
Photography is integral to photo monitoring programs in caves. For these programs, areas of the cave are photographed to document the condition of the passages and features at a point in time. The sites are visited on a regular basis and re-photographed. The pictures can then be compared to determine areas that are being degraded over time.

Good photographic records augment all of the geographic baseline data. A photographic archive is an important component for good interpretive and educational programs.

As with resource inventory data, scanned photographs or digital images can also be catalogued, archived into a database, and referenced to surface or underground locations.

Integrating the Baseline Data

In order for baseline data to be used efficiently


Formations

Calcite
Flowstone
Stalactite
deflected
soda straw
Stalagmite
Column
Popcorn
Boxwork
Calcite coating
Calcite crust
Drapery
Helictite
Heligmite
Cave pearl
Calcite rafts
Rimstone dam
Spar
Sheild

Aragonite
Stalagmite
Stalactite
Other

Gypsum
Crust
Flower
Cotton/Hair
Rope
Needles

Hydromagnesite
balloon
moonmilk

Notes:

Geology

Bedrock (structural)
Fault (strike/dip)
Folds
Slickensides
Joints (strike/dip)
Styolites
Triangular shaped cross section

Bedrock (sedimentary rock characteristics)
Cross bedding
Bedding planes (well defined)
Distinctive bedding contacts
Oolites
Chert nodules
Chert layers/beds
Shale beds
Sandstone beds

Cave Sediments (when possible note thickness in inches or feet)
Paleo
Clay
Mud cracks
Ripple marks
Consolidated sand/gravel
Quartz pebbles
interbedded sand/gravel/mud

Recent
Clay
Mud
Mud spatter cups
Mud cracks
Ripple marks
Sand
Gravel
Sand/gravel
Quartz pebbles
Interbedded sand/gravel/mud
Cobbles
Rock flour

Figure 3. Inventory check list sheet

and effectively, it should be integrated in a way that combines basic map information, database information, and the photographic catalog into a graphic, interrelational format that is basically a Geographical Information System (GIS). A GIS integrates database capabilities with the visual perspective of a map.

The advantage of a GIS is its ability to produce graphics on the screen or on paper and the ability for that data to be searched, queried, and ultimately analyzed. This capability makes for an important tool not only in cave and karst management but also in research and outreach.

Case Studies

The Hoffman Environmental Research Institute has used resource inventories in several diverse cases. Resource inventory information was extracted from survey notes for Coldwater Cave, Iowa, and Isla de Mona, Puerto Rico, and resource inventories were conducted for Munin and Garnett Caves in south central Kentucky. This information was compiled into different databases and presented to resource managers and shareholders in order to allow them to make informed decisions concerning their karst resources. The Compass database function was used for Coldwater Cave, and the ArcGIS attribute tables were used for the caves of Isla de Mona, Munin Cave, and Garnett Cave. These databases were used for research projects, outreach, and education.

The Hoffman Institute has been working to glean information from the cave surveys of Coldwater Cave in Winneshiek County, Iowa, to be used for a hydrologic feature inventory. The survey notes were searched for all references to dome locations and underground drainage divides, and once found, these locations were entered into an Excel spreadsheet and then imported into Compass' database function. Underground drainage divides and domes were integrated into a line plot. The line plot illustrated where water was entering Coldwater Cave by showing its many insurgence points (Figure 4). In this particular case, the inventory and database was useful not only in terms of research but also in terms of local land use. This information was used in karst hydrogeology studies of the Coldwater drainage basin, and was also used in educational presentations made to local residents and landowners.

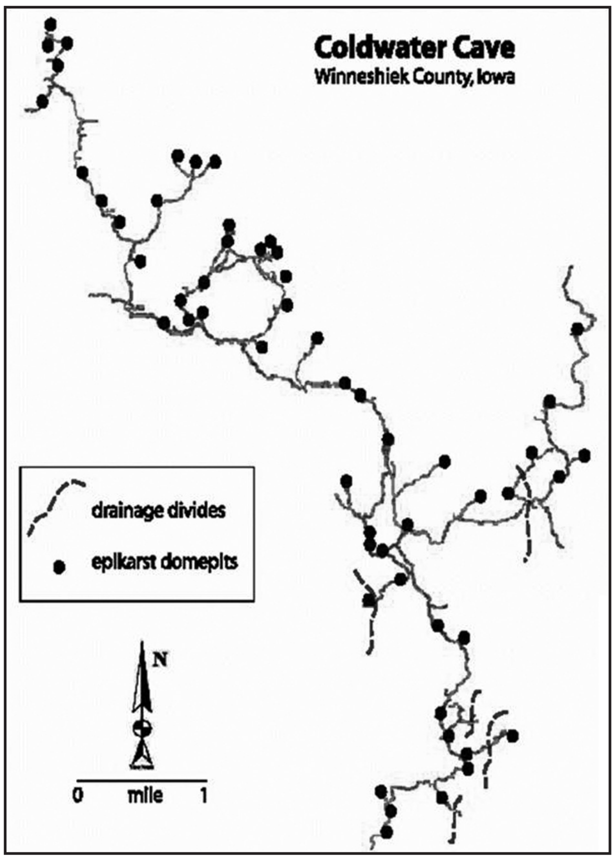


Figure 4. Line plot illustrating insurgence points.

The second case study involves the island of Isla de Mona, Puerto Rico. Isla de Mona is a natural reserve open to research and recreation. The Puerto Rico Department of Natural Resources issues public camping permits and hunting permits. The public often camps on the island during hunting season and the caves are open to these people if they can find them. Some cave entrances had paths leading to them with signs at the entrance. Many of these caves are located near major camping areas.

The Hoffman Institute in cooperation with the Isla de Mona Project and the Puerto Rico Deptment of Natural Resources is involved in an ongoing project to map and inventory the flank margin caves on Isla de Mona. Thorough surveys are conducted with detailed sketches and notations especially incorporating any historic artifacts or pictographs discovered (Figure 5). Because the caves are not closed to the public, these historic and cultural resources are highly susceptible to impact. Photographs were taken along with the survey to help document these artifacts and pictographs. The surveys and photographs are compiled into a database for resource managers in Puerto Rico.

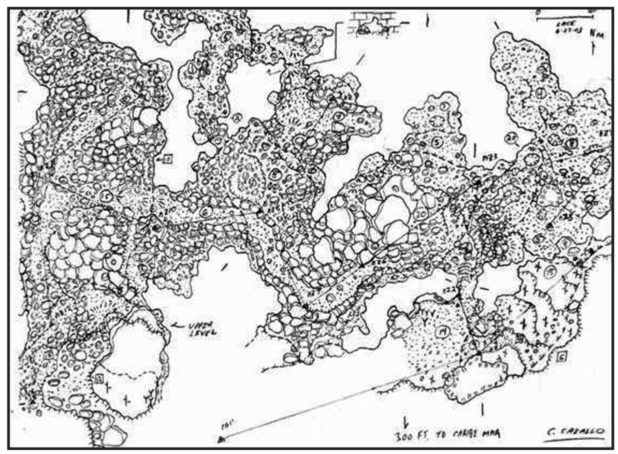


Figure 5. Sample detailed sketch.

The inventories gave resource managers a tool through which they could evaluate the usage and accessibility of caves on Isla de Mona. In order to help protect these valuable resources, the mowing of trails to caves was stopped and entrance signs were removed. Camping areas were changed to increase distance between campers and caves. Ideas for the future include creating an interpretive display to educate the public in the main cave near the main camping area.

In 2005 The Nature Conservancy invited the Hoffman Institute to map and inventory Munin and Garnett Caves located in Hart County, Kentucky. The Nature Conservancy wanted to have an inventory of what biological, historical, and hydrological resources were in their caves. The caves were mapped through detailed surveys and a checklist

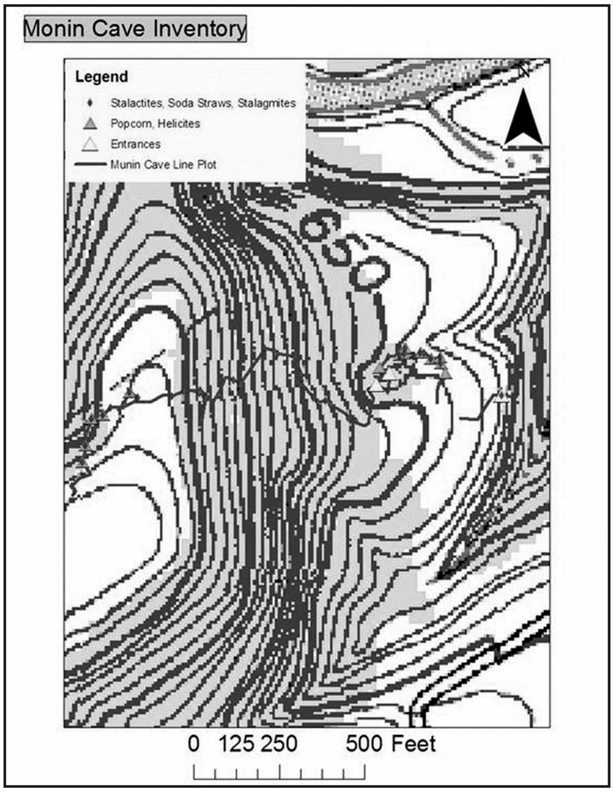


Figure 6. Final GIS layer.

inventory was used to denote important formations, historical signatures, and biological components. Photo documentation was conducted and referenced to survey stations to display each of these aspects. Finally, all this information was compiled into a GIS layer (Figure 6). The map and GIS layers representing the different inventories allowed The Nature Conservancy to develop a monitoring program and to acquire additional land if necessary to protect their resources.

Conclusion

Resource Inventories are important to resource managers because they allow for better protection of caves and karst. Monitoring programs can be developed to ensure better understanding and protection of these resources into the future. Increased knowledge of cave and karst resources allows for increased education and outreach to stakeholders and the general public. Finally, resource inventory databases will provide the baseline data for future scientific research. Ultimately it is research that will further the knowledge and understanding about cave and karst systems, resources and ecosystems.

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