The Importance of Education in Karst Protection: the Virginia Experience

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Abstract

By the early 1990s, it became apparent that Virginia needed to protect its karst landscape. Twenty-seven Virginia counties depend heavily on karst aquifers for water supply. Industrial, agribusiness, and rural residential development were placing increasing stress on karst aquifers already impacted by traditional agricultural land use. The problem was convincing government agencies and local citizens of the need for karst groundwater protection. Education proved to be the solution. This paper examines the many ways education has furthered the cause of karst protection in Virginia. Educational materials from government agencies and the caving community have increased citizen awareness of Virginia's karst resources. The Cave Conservancy of the Virginias produced the widely distributed book *Living on Karst*, which explains basic karst science in layman terms and makes a strong case for karst protection. The Virginia-based Project Underground curriculum brought karst issues into primary and secondary school classrooms, as well as to environmental educators at museums, state parks, and soil and water conservation districts. The bench-scale karst groundwater model, produced by the University of Nebraska – Lincoln, is a visual tool that demonstrates surface water and groundwater interactions in karst. Numerous Virginia agencies and non-profit organizations now use this model. Numerous presentations and workshops have helped planning district commissions, local governments and state and federal agencies create new standards and ordinances protecting karst watersheds. Ten years ago most citizens in Virginia's limestone regions had never heard the word karst. Today, awareness of karst is widespread, and stakeholders are taking concrete steps toward karst protection.

Introduction

Caves have been a prominent part of Virginia culture since colonial times. Organized cave exploration began in the 1940s, and many old cave maps date from the 1950s. By 2003, over 4,000 caves in 27 counties were known to the caving community. Underlying about a quarter of the state, karst aquifers supply water for drinking, agriculture, and industry, and stream and river recharge. In the early days of Virginia caving, most of the karst landscape supported an agrarian economy with a low population that relied on springs and shallow wells for water supply. As the population grew and land use patterns changed, it became clear that many land use practices had negative impacts upon karst. Citizens, state and local officials, and agency staff alike lacked knowledge about the hydrologic importance and environmental sensitivity of karst water supplies.

By the early 1970s, members of the caving community recognized the need for karst protection and became advocates for such efforts, spearheaded by the Richmond (Virginia) Area Speleological Society (RASS). Lobbying by these dedicated cavers led to a significant state role in cave and karst protection. In 1975, a committee comprising cavers, agency staff, representatives from commercial caves, and a legislator began discussing potential roles for the state in cave conservation (Wilson, 1981). Though the initial committee disbanded, Richmond caver John Wilson worked with Delegate Bill Axselle to draft a resolution forming a temporary cave commission, which passed in 1978 (Wilson, 1981). This commission, composed dominantly of cavers and chaired by

Wilson, drafted the Virginia Cave Protection Act (aka Virginia Cave Law), which passed in 1979.

The Cave Law established the Cave Commission for an additional year, outlawed the sale speleothems, removal of material from a cave without a Cave Board permit, and dumping in sinkholes. Landowners were exempted from the final two restrictions, and shielded from liability for caving accidents as long as the owner did not charge for access to the cave. During its first year, the Cave Commission compiled a list of 220 significant caves and seven significant karst areas and completed an inventory of caves on public land. In 1980, the Cave Commission was given nonfunded, permanent status within the Department of Conservation and Economic Development. Since then, reorganization of state government led to name changes leading to the current (2003) nomenclature: the Virginia Cave Board of the Department of Conservation and Recreation.

The establishment of the Cave Commission as a state agency came without funding from the General Assembly. In 1980, members of the Cave Commission responded by establishing the Cave Conservancy of the Virginias to promote the conservation, scientific study, and responsible management of caves. The Cave Conservancy was also to serve as a non-profit fund-raising organization to help achieve the above purposes and to provide grants to other organizations devoted to similar goals.

The Cave Protection law said the Cave Board would act as an advisory board to any requesting state agency on matters relating to caves and karst, maintain a significant cave list and report any real and present danger to such caves, assist in publishing materials on caves and cave-related concerns, and inform the public about the value of cave resources and the importance of conserving them for the citizens of the Commonwealth. The Cave Board worked with the caving community to fulfill these duties and Virginia agencies started hearing the word "karst" and the importance of its protection.

Education projects by the Virginia Cave Board included producing a cave conservation poster titled "In Karstlands . . . What Goes Down Must Come Up." The poster was distributed to earth science teachers across the state and is now distributed in Project Underground workshops. The Cave Board also produces an informative Cave Owner's Newsletter, periodically mailed to over 1,500 landowners in Virginia who have caves on their property (Kastning, 1995) The Cave Board also established "Virginia Cave Week" in 2000 to bring attention to cave and karst education and protection. During Cave Week the Cave Board sends packets of materials to interested teachers, members give talks at media events, and show caves present educational displays. The general public is encouraged to visit show caves, many of which offer special discounts and host special cave week events. Members of the Cave Board also serve as consultants with other Virginia cave organizations on conservation projects.

Several other organizations have also contributed to karst education and protection in Virginia. The Cave Conservancy of the Virginias has initiated many karst education projects including two museum displays. In a joint project with the Richmond Area Speleological Society, the Cave Conservancy of the Virginias sponsored a man-made cave at the Children's Museum in Richmond, Virginia, allowing thousands of children to explore and experience the wonderment of a cave, coupled with a strong cave conservation message (the Cave Conservancy of the Virginias web site). In a joint project between the Cave Conservancy of the Virginias and the Virginia Natural History Museum, a mobile mini-theater and exhibit were created to tour various locations in the Virginias and educate the public on the geology, biology, hydrology, history, and ecology of caves and karst (the Cave Conservancy of the Virginias web site). The Cave Conservancy of the Virginias also produced the *Living on Karst* publication talked about later in this paper. The Virginia Speleological Survey has established and maintains a database of cave resources, from which the significant cave list was developed. The Virginia Region of the National Speleological Society, as well as local grottoes (cave clubs), has lead numerous cave conservation activities, including restoration of degraded caves and sinkholes. Many cavers in Virginia have also lent time and expertise when needed to cave education and conservation activities. All of these activities continue today.

As significant as the efforts of these volunteer groups were (and continue to be), by the early 1990s, the demand for karst education greatly exceeded their capacity. Karst education needed to be brought into classrooms, boardrooms, and living rooms.

Three initiatives of the mid-1990s help to make this possible: (1) the initial development by the Richmond Area Speleological Society of Project Underground, (2) the establishment of a salaried, state position in karst protection in the Virginia Department of Conservation and Recreation's Natural Heritage Program, and (3) the publication of *Living On Karst – a Reference Guide for Landowners in Limestone Re-*

gions by the Cave Conservancy of the Virginias. The Richmond Area Speleological Society worked together with several groups to produce the Project Underground Natural Resource Activity Guide. The Virginia Department of Conservation and Recreation received a grant to start a Karst Protection Program within the agency. These three programs provided a means to increase cave and karst education, which in turn has led to many new protection strategies in Virginia.

Project Underground

The Richmond Area Speleological Society initially developed the Project Underground Activity Guide in 1993 in response to a lack of educator training materials available on cave and karst resources (Figure 1). A writing workshop brought together cavers and environmental educators to develop activities to teach about cave and karst resources. Titles and objectives of some of these activities are shown in Table 1. These activities were field tested by educators and revised to best meet the needs of educators. To encourage incorporation into lesson plans, each activity includes information on the objectives, subject, skill level, group size, time required, and key vocabulary words. Following the successful model of other national environmental education programs, Project Underground activities are hands on and lead to participant discovery of the objectives. These lessons and activities are both interdisciplinary and adaptable, covering many subject areas and all grade levels.

Table 1. Examples of Project Underground Exercises

Activity	**Objective**
Lost River Village	Illustrates potential impact to karst of land development, teaching participant importance of careful planning.
Sinkhole in a Cup	Shows students how sinkholes are formed via collapse of voids.
Hungry Cave Critters	Demonstrates that cave animals compete for limited food resources. Explains the concepts of food generalist vs. food specialist and the food web.
Hello, Who's There?	Demonstrates that caves provide suitable habitats for wildlife species.
Belly-Crawl Mapping	Recognize and apply simple map-making and map-reading skills.

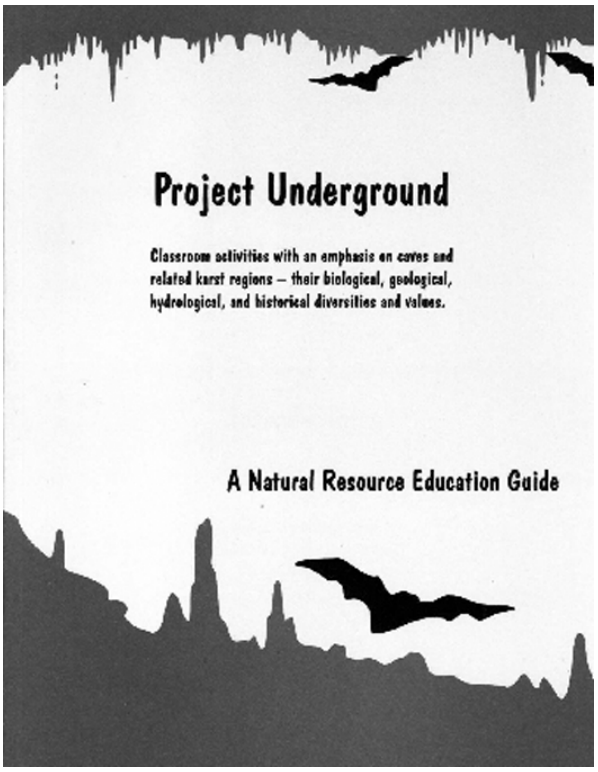

Figure 1. The Project Underground Activity Guide

The challenge became developing an environmental education program using the Project Underground activity guide. In 1996, a non-profit corporation for Project Underground was established and a Board of Directors elected. Carol Zokaites was hired to create and direct the Project Underground program. Carol established a workshop format for the program using a "train the trainer" model to establish a facilitator, or workshop leader, network. Following the example of other highly

successful national environmental education programs, Project Underground materials are only distributed through these workshops. This provides a level of quality control not present in many environmental education curricula.

Project Underground staff holds trainings for facilitators, who in turn hold workshops for teachers. This two-tiered approach in training facilitators and educators through workshops is a good avenue for reaching a large number of students with cave and karst information. If ten facilitators each lead one workshop with ten educators then 100 educators are trained to use the Project Underground materials with students in classrooms. If each educator has a class with 20 students then 2,000 students will be introduced to these materials. These students will learn the importance of protecting the valuable cave and karst resources.

Facilitators first provide workshop participants with a primer on cave and karst science, using background discussions and slide shows to explain to participants both what they need to know about karst resources, and why it is important, emphasizing the connections between surface and groundwater and the need for groundwater protection. Facilitators not only provide educational materials, but also instruction on the use of these materials in the classroom. Using the Project Underground Activity Guide as the focus, workshops supply teachers with lesson plans, posters, fact sheets, brochures, and reference books.

One component of project underground that makes it attractive to classroom teachers is its compatibility with state and national science education standards. In Virginia, the karst education coordinator (see below) has developed charts for teachers that correlate specific Project Underground activities with state Standards of Learning. This is critical because these Standards of Learning drive what goes on in the classroom.

Project Underground trainings and workshops incorporate materials, tools, and experiences in addition to the Project Underground Activity Guide. A wide range of brochures and posters on cave, karst, and groundwater topics from a variety of sources are distributed to participants. Of particular importance is the *Living on Karst* pamphlet produced by the Cave Conservancy of the Virginias (see below). One of the most effective visual aids used in workshops is the University of Nebraska Karst Groundwater model (Figure 2). The plexiglass tabletop model is a good visual tool emphasizing the differences between karst and non-karst aquifers. Participants see how fast surface water can interact with groundwater in karst. Many ambivalent adult Virginians have become advocates for karst protection after seeing the groundwater model. For workshops in Virginia, project underground staff coordinates with karst program staff to provide field trips to sinkholes, sinking streams, and springs. Many participants have never seen these features in the field, or if they have did not realize their significance. Use of these additional resources greatly enhances workshops, helping to make educators into advocates.

Though the Project Underground Activity Guide and curriculum were initially designed for K-12 education, it quickly became apparent that its usefulness extended to adults as well. Activities such as "Lost River Village" help

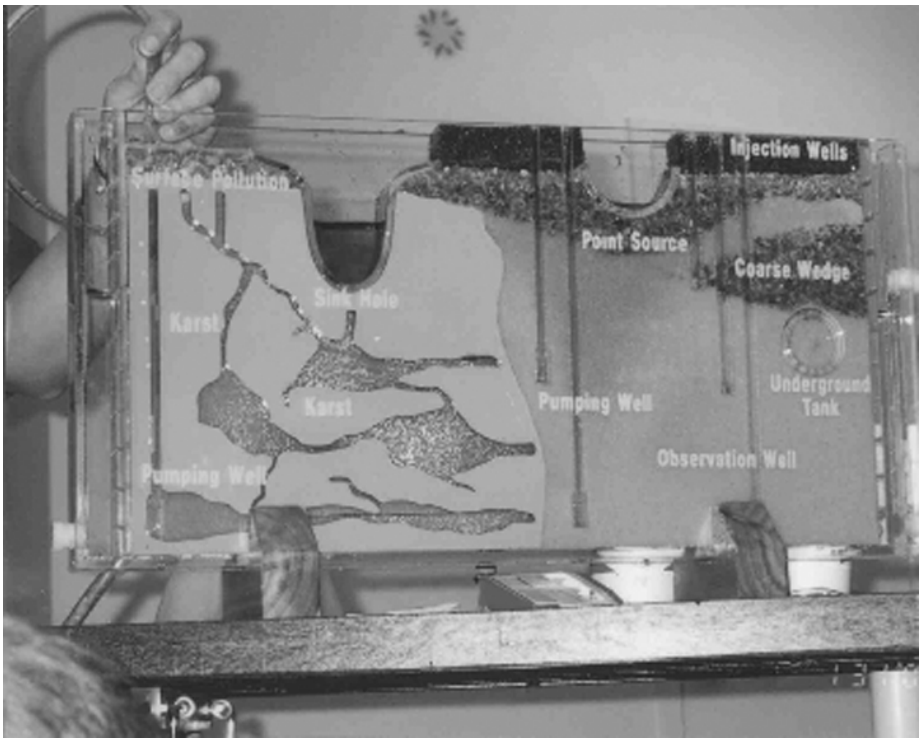

Figure 2. The Karst Groundwater Model

adults understand the risks of improper land use on karst, and the importance of careful planning. Future development of more advanced versions of Project Underground activities should go even further to educate local government officials and agency staff about the importance of karst protection.

Project Underground has worked closely with the Department of Conservation and Recreation 's Virginia Karst Program since its inception in 1994. In May 2000, the Virginia State Corporation commission held hearings on a proposed high voltage power transmission line to be constructed across one of Virginia's more significant karst areas. The State Corporation Commission approved construction of the line, but required a much higher degree of water quality protection where it crossed sensitive karst areas. The hearings brought karst concerns to the attention of then Department of Conservation and Recreation director David Brickley, who established the karst education coordinator position in the Virginia Karst Program. This three-quarter-time position has been filled since its creation by National Project Underground Coordinator Carol Zokaites.

Project Underground was developed in Virginia and has worked closely with the Virginia Department of Conservation and Recreation for the last eight years. The program is growing nation wide and has reached over 3,500 teachers in 14 states. In 2002 the Project Underground program held 30 workshops reaching 540 teachers and educators. The teachers used these lesson plans and activities with over 11,000 students and targeted members of the general public. And Project Underground should exceed that number in 2003.

Living on Karst

The Cave Conservancy of the Virginias recognized the need for information about karst resources for the layman and worked with the Virginia Karst Project to produce *Living on Karst - A Reference Guide for Landowners in Limestone Regions* (Figure 3). Carol Zokaites, coordinator for Project Underground, edited the publication, with significant help from Terri Brown, the VA-DCR Karst Program Coordinator. Written in an easily understandable fact sheet format, the *Living on Karst* guide targeted a very large, general audience. To quote from the guide:

"This guide will be helpful to homeowners, farmers, cave entrance owners, business people, and anyone who lives, works, or plays in karst areas. Additionally, the guide will be useful to educators, developers, park managers,

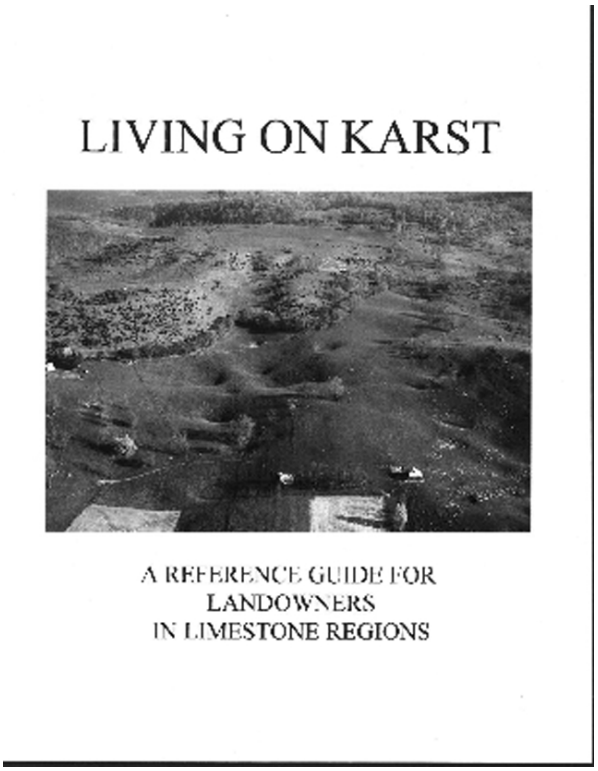

Figure 3. Living on Karst: a Reference Guide for Landowners in Limestone Regions

watershed, and conservation groups. Karst is an important resource in your state. Not only does karst contain beautiful features such as fragile cave formations, it also may hold the key to health of an entire town or city by its links to drinking water."

The *Living On Karst* guide became a general primer for karst education. Topics like "What is Karst" and "Karst and Groundwater Protection" defined karst and made the case for its protection. Topics relevant to the homeowner included "How's Your Septic System Doing," "Pollution and Protection of Karst Wells and Springs," and "Pesticides on the Home and Farm." Thousands of copies of this guide have been distributed across Virginia leading to many discussions on karst and groundwater protection. Such published information has increased awareness and led to better karst protection practices. Stakeholders began asking two questions: "What can be done to protect our karst resources?" and "Why aren't we doing it?" The result has been that numerous localities and state agencies have or plan to revise their ordinances and policies to address karst protection needs.

The Virginia Karst Program

By 1993, the Cave Board's efforts had opened the eyes of the Department of Conservation and Recreation's Natural Heritage program staff to the importance of protecting karst resources through education, outreach, and technical assistance. Natural Heritage submitted a successful Projects of Statewide Importance Grant Proposal as part of Virginia's proposal to the Environmental Protection Agency Section 319 Clean Water Act fund. The resulting karst project educated the legislature and the public about the importance of protecting karst areas in order to protect groundwater and to promote the development of karst protection regulations. In 1994, the Department of Conservation and Recreation hired Terri Brown as Karst Protection Coordinator and established an office in Blacksburg, the center of Virginia's 300-mile belt of karst. Terri gave talks across the state at agency meetings, conferences, and local governments. She worked very closely with the Virginia Cave Board and enlisted the help of local cavers, Project Underground, and The Cave Conservancy of the Virginias. Fact sheets on karst areas and karst biota were developed and disseminated across the state through the soil and water conservation districts. Workshops have been held in several karst watersheds bringing stakeholders with varying interests to the table, including government officials, citizens, developers, consultants, and agency staff.

The Department of Conservation and Recreation's Karst Project continued to be supported by successful annual grant applications from 1995 through 2000. During this period, Virginia's karst received increasing consideration from state and federal agencies, local governments, and citizens. The karst protection coordinator served as Virginia's full-time, on-call karst expert. Informal networks sprung up, and people began working across agency boundaries on karst protection problems. Numerous partners in karst protection have emerged, including the U.S. Fish and Wildlife Service, the USDA Natural Resources Conservation Service, the Nature Conservancy, and the Virginia Departments of Transportation, Environemental Quality, Health, and Game and Inland Fisheries.

This networking facilitated the equally important technical assistance and data development aspects of the Karst Project. Working with the Cave Board and the Virginia Speleological Survey, the karst project has provided technical assistance to the Department of Conservation and Recreation environmental project review staff, identifying potential impacts to cave and karst resources and working to develop and implement avoidance, mitigation, and compensation strategies. The karst project has also helped revise state stormwater and nutrient management policies to better address karst concerns, provided training to agency staff, and assisted localities in development of ordinances, project review, and long-term planning.

The karst project has made substantial strides in watershed delineation via dye trace studies, inventory of karst resources, and biological inventory of Virginia's caves. Work has concentrated in areas rich in biological resources that were threatened by both existing and proposed land use practices.

In 2000, the Karst Project became the Virginia Karst Program, adding a second full-time Karst Protection Specialist and the three-quarter-time Karst Education Coordinator. The expanded Karst Program has continued to work on the same basic set of issues. Current projects include the development of conservation site boundaries for Virginia's significant caves, and the compilation of a GIS-based karst hydrology atlas.

Since 1994, karst education, technical assistance, and data development efforts have worked synergistically to make them collectively stronger than the sum of parts. For instance, results from hydrological investigations are integrated into Project Underground trainings and workshops at the local level. Project Underground lessons are used to illustrate karst principles to participants in technical assistance workshops, and the karst groundwater model is deployed at nearly every event.

Conclusions

The Virginia experience illustrates what can happen when education is used to increase the knowledge of citizen groups, public officials and students. At the heart of Virginia's success lies environmental education about karst, which led to a greater awareness about karst and a willingness to prioritize its protection. Following the lead of the volunteer caving community, the state of Virginia has pursued an increasingly significant role in both education about karst and karst protection. Ultimately, the success of this education program will be measured by the attitudes and actions of the planners, government officials, developers, and land managers working Virginia's karstlands.

About the Author

Carol Zokaites started caving in 1973 while attending Virginia Tech. She participated in many cave mapping and conservation projects. She has helped create several karst publications including *Living On Karst*, educational materials for the IMAX film, "Journey into Amazing Caves," and the guidebook for the 1995 NSS Convention "Underground in the Appalachians." Carol is a Fellow of the NSS and has received the NSS Conservation Award. She is now the National Coordinator of Project Underground and Karst Education Coordinator for the Virginia Department of Conservation and Recreation.

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