PROTECTING VIRGINIA'S CAVES AND KARST THROUGH THE ENVIRONMENTAL PROJECT REVIEW PROCESS

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Abstract

Within the Virginia Department of Conservation and Recreation, the Natural Heritage Program maintains a Project Review Office that screens a variety of proposed development projects for potential impacts to natural heritage resources. All projects involving state funds pass through this process, as do projects with potential wetland impacts, those subject to the National Environmental Policy Act, and those submitted voluntarily or as required by local governments. Emphasis is placed on protection of natural heritage resources — occurrences of rare plants, animals, or natural communities — and significant geologic formations. Caves designated as significant by the Virginia Speleological Survey and the Virginia

Cave Board, following the provisions of the Virginia Cave Protection Act of 1979, are treated as natural heritage resources during project review. For screening purposes, natural heritage resources are represented as conservation site — landscape areas where activities could impact one or more occurrences of natural heritage resources. Projects within two miles of a conservation site are reviewed for potential impacts to natural heritage resources. If these sites are cave-related, projects are sent to both the Karst Program and the Virginia Speleological Survey, because the Natural Heritage Program does not maintain a database of cave entrance locations. The Survey also provides information on additional caves and karst features not designated as significant, but potentially impacted by the project. This arrangement facilitates protection of caves without public ownership of cave locations. Seventy-two delineated conservation sites cover 151 of Virginia's nearly 400 significant caves. Caves awaiting conservation site delineation are represented by 3-kilometer radius buffers with centers offset from entrances.

Introduction

The mission of the Virginia Department of Conservation and Recreation Natural Heritage Program is the conservation of Virginia's biodiversity through inventory, protection, and stewardship. As a part of Natural Heritage, the objectives of the Virginia Karst Program are to conserve and protect the extensive biological and hydrological resources present in Virginia's karst regions. The Virginia Karst Program addresses these objectives through education, data development, and technical assistance.

An official survey of the National Speleological Society, the primary mission of the Virginia Speleological Survey is to gather and maintain an informational and survey database on Virginia's caves and associated karst features. The Survey's collections include three components: maps, other printed material, and a digital database. The Survey currently tracks over 4,300 caves, 369 of which were designated significant as of December 2005 under the provisions of the Virginia Cave Protection Act of 1979. The map database currently includes 1989 maps covering 1,483 caves.

Through its office of environmental project review, the Natural Heritage Program screens a wide variety of proposed development and conservation projects for potential effects on natural heritage resources. A natural heritage resource is defined as rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations. Caves designated as significant under the Cave Protection Act are treated as natural heritage resources during project review. An additional 50 caves are home to natural heritage resources and are tracked by Natural Heritage, although they are not on the Significant Cave List. Only about 60% of the designated significant caves include other natural heritage resources.

For project review purposes, natural heritage resources are represented either as (1) conservation sites — landscape areas where activities could impact one or more occurrence of terrestrial natural heritage resources, or (2) stream conservation units — stream segments one mile downstream and two miles upstream of a documented occurrence of an aquatic natural heritage resource. Significant caves and occurrences of rare cave fauna or subterranean natural communities are currently represented by conservation sites or by surrogate conservation sites (discussed below). Conservation sites are assigned a biodiversity value (B-rank), depending on the rarity, number, and quality of occurrences of natural heritage resources within the site. Appendix A contains an explanation of the basis for B-rank determination. This method is the Natureserve™ standard, used by natural heritage programs throughout North America.

Projects submitted for review that are within 2 miles of a conservation site or are adjacent to stream conservation units, and have potential to impact natural heritage resources are referred to staff scientists or conservation partners with appropriate expertise, who determine whether fur-

ther coordination by the developer is required to avoid or mitigate impacts. In the case of legally protected species or habitat, the Natural Heritage Program notifies and consults with the appropriate regulatory authorities. Projects within two miles of cave conservation sites, or which intersect surrogate conservation sites, are sent to both the Karst Program and the Virginia Speleological Survey. Additional projects in areas not within conservation sites, yet overlying karst topography, are also reviewed. The Survey plays a critical role in that the state does not maintain a comprehensive database

Entities Using Project Review	Type of Project
Federal Agencies	
Energy Regulatory Commission (FERC)	Interstate energy transmission projects.
Army Corps of Engineers	Projects affecting waters of the US and designated wetlands
Forest Service	Various projects (e.g., harvesting, prescribed burning, trail construction/modification)
National Park Service	Various projects (facility construction, trail construction/ modification, historical restoration activities)
Fish and Wildlife Service	Various projects (e.g. species recovery plans, property acquisitions)
USDA Natural Resources Conservation Service	A variety of agricultural and urban best management practice implementations.
State Agencies	
Department of Transportation	All construction and maintenance projects
Department of Environmental Quality	Water Protection Permits - State waters including wetlands
	Environmental Impact Reviews for State Projects (all agencies) over $100K
	NEPA Reviews – Environmental Impact Statements and Environmental Assessments
Department of Game and Inland Fisheries	Various projects (e.g. stream restoration, Section 7 Funded projects)
Department of Agriculture and Consumer Services	Various projects (e.g. gypsy moth spraying, other pest control projects)
Department of Forestry	Various projects (e.g. Forest Legacy Program, conservation easements)
Marine Resource Commission	Joint Permit Applications-Impacts to state submerged bottomlands
State Corporation Commission (in coordination with DEQ)	Anything regulated by SCC, including power plants and transmission lines.
Regional Planning District Commissions	Projects with state or federal funding nexus
Local Governments	Projects with state or federal funding nexus
	Coordination for rezoning requests in compliance with Comprehensive Plans
Universities	Research and Teaching
The Nature Conservancy	Conservation planning and land/easement acquisition
Land Trusts	
Virginia Outdoors Foundation	Conservation easements
Local land trusts	Conservation easements
Consultants	Development projects; project scoping

Table 1. Sources of projects passing through state environmental review in Virginia.

of cave locations, leaving it up the Survey to identify caves of undetermined significance that may be impacted by a specific project.

Scope of Project Review

Table 1 summarizes the sources and types of projects passing through environmental project review. Many of these projects utilize project review to comply with environmental laws and regulations, including but not limited to the Clean Water Act, the National Environmental Policy Act, and the Endangered Species Act. The single biggest user of environmental project review is the Virginia Department of Transportation, responsible for about a third of the monthly workload. Proposed conservation projects such as implementation of best management practices and acquisition of easements or real property also commonly pass through project review, both to help avoid unintended impacts and to help better estimate their conservation value. Consulting companies frequently use project review to proactively identify environmentally sensitive areas to avoid when determining locations of development projects.

Unfortunately, many potentially high impact projects such as residential and commercial development do not pass through project review unless there is a state or federal nexus, such as a wetland permitting issue. Recently, however, some local governments have begun to require that rezoning requests pass through environmental review to ensure that they are consistent with the environmental protection component of local comprehensive plans.

Over 3,000 projects pass through the Natural Heritage Program environmental review office each year, and the number of annual projects is growing, with an all-time high of over 3,500 in 2005 (see Table 2). Of these projects, slightly fewer than 10% or about 300 per year are identified as having potential impacts to caves and/or karst, and are sent to the Karst Program and the Virginia Speleological Survey for further review. In Table 2, the higher number of karst hits prior to 2003 reflects that before implementation of the conservation site methodology, all projects in Virginia's 26 western karst counties were reviewed for impacts to karst.

Development of Conservation Sites for Caves

Prior to adopting the conservation site approach for natural heritage resource protection, projects were screened for proximity to element occurrences — documented locations of natural heritage resources. This resulted in review of many projects with little to no potential impact to those resources. The conservation site approach is superior in that it predetermines the area of potential impact, thereby reducing the number of projects selected for further screening. Development of conservation sites and stream conservation units for surface species is fairly straightforward, and can be accomplished in the office using a combination of aerial photographs and field notes. However, development of conservation sites for caves is not as straightforward, due to both the nature of the resource and the nature of the data.

The Nature of the Resource. Caves are three dimensional, subterranean features, and frequently extend beyond constrictions or blockages through which humans won't fit. In addition, the watershed

Calendar Year viewed for	Total Projects	Projects Re- **Impacts to Caves and Karst**
2001	3388	626 (18%)
2002	3034	579 (19%)
2003	3112	176 (6%)
2004	3462	294 (8%)
2005	3514	298 (9%)

Table 2. Environmental Project Review and Karst in Virginia (2001–2005).

of streams or pool in caves with hydrological significance and/or rare aquatic fauna in many cases can only be determined by the performance of dye trace investigations. Thus in contrast to surface element occurrences, development of conservation sites for caves requires more in depth analysis of data and frequently new field investigations.

The Nature of the Data. As noted above, the Commonwealth of Virginia does not maintain a comprehensive database of cave locations or maps. Publication of cave locations in Douglas (1964) and Holsinger (1975) had facilitated a myriad of undesirable acts, including trespassing, vandalism, pothunting, bat disturbance, and visitation by ill-prepared individuals. Both the cave resources and landowner relations for responsible cavers suffered. Shortly after the publication of Holsinger (1975), the Virginia Speleological Survey decided to never again publish cave location information, or otherwise make such information available to the general public.

In 2000, the Data Committee of the Virginia Cave Board dissolved and the Board officially delegated maintenance of the Significant Cave List to the Virginia Speleological Survey, which in practice had been the case for quite some time because of crossover between Cave Board Membership and the Survey Directorate. A major concern of the Survey to this point was the security of cave entrance location information. When Natural Heritage staff began to work on development of cave conservation sites in 2002, it became apparent that access to the Virginia Speleological Survey database was essential for development of meaningful conservation sites. Several months of negotiations resulted in the establishment in October of 2002 of a data sharing agreement between the Survey and the Natural Heritage Program. The main provisions of the agreement are:

- The Natural Heritage Program will no longer maintain an electronic database of cave entrance locations.
- The Virginia Speleological Survey will work with Natural Heritage Staff to create polygons representing surface overlays of designated significant caves and other caves with natural heritage resources. These polygons will be used to represent cave locations in the internal electronic databases of the Natural Heritage Program, replacing previous point entrance locations. These polygons will not be shared externally without the written permission of the Survey.
- Natural Heritage Staff will work with the Survey to assemble and digitize information to establish conservation sites. These conservation sites will be shared with other agencies, organizations, companies, or individuals in the interest of cave and karst protection.
- Prior to establishment of a conservation site, caves will represented for conservation screening by "Surrogate Conservation Sites" – 3 km radius circles enclosing cave entrances, with centers offset up to 2 kilometers from cave entrance locations.
- The word "cave" would be removed from the "sitename" field in electronic databases, so that their names do not identify the presence of a cave.
- As resources allow, Natural Heritage will provide maps and digital coverage of significant cave information to the Virginia Cave Board and the Survey.
- The Survey will update Natural Heritage when caves are added to the Significant Cave List, or when updated information about significant caves are determined, subject to restriction placed on the data when acquired by Survey.
- Unless restricted by the landowner, Natural Heritage staff will provide Survey with any cave-related data generated in house, including cave locations; cave surveys and maps; biological inventories; updates on ownership, condition of the cave, and conservation status; and the results of hydrological information.
- Natural Heritage staff and the Survey will continue to work together to review projects for possible impacts to caves.

Implementation of the data sharing agreement necessitated both additional funding and staffing for the Natural Heritage Karst Program. Major sponsors of conservation site development for caves to date include the Cave Conservancy of the Virginias, the Virginia Department of Transportation, and the Virginia Land Conservation Fund. Additional staffing needs have been met through partnership with Virginia Tech and the hiring of temporary employees. All individuals working on

the project have significant experience working with caves and karst.

Conservation site designs for caves are based on numerous factors including hydrology, geology, topography, extent of the cave passage, and security of cave entrance locations. For caves that are hydrologically significant (that is, a stream or phreatic water exists in the cave), conservation sites encompass the watershed contributing to the cave. Because karst systems commonly bypass surface drainage divides, watershed delineations rely heavily on new and prior tracer dye studies. In some cases, geologic formation boundaries are inferred to be hydrologic barriers.

For caves that are not hydrologically significant, conservation sites are designated as the ground area that covers all of the underlying cave passages, or the cave "footprint," plus an additional buffer. The shape and extent of the buffer depends upon a variety of case specific factors, including local geology, proximity of surface karst features, and protection of entrance location security.

An example of conservation site development — The Central Lee County, Virginia, Karst

The karst of central Lee County, Virginia, as shown in Figure 1, contains 19 designated significant caves. An additional four caves are homes to other natural heritage resources. Prior to development of conservation sites, projects were screened from proximity to these caves, and then analysis was performed to check for potential impacts. Furthermore, these datapoints placed the cave entrance location information at risk should they fall into the wrong hands.

Figure 2 shows the polygons developed cooperatively by the Natural Heritage Program and the VSS, for internal use only by Natural Heritage staff. Note the presence of 3 significant caves not previously tracked by the state, which could now be better protected through project review. In addition, the development of these polygons revealed incorrect locations statewide within the Natural Heritage database. Also shown in Figure 2 is a pair of karst springs not associated with specific caves, yet from which natural heritage resources, in this case globally rare and legally protected invertebrates, have been collected. Such springs, although not caves per se, require the same methodology for development of conservation sites.

Figure 3 shows the conservation sites designed as protection tools for these 23 caves and two springs. Two of these caves have not yet been incorporated in conservation sites. Also shown are

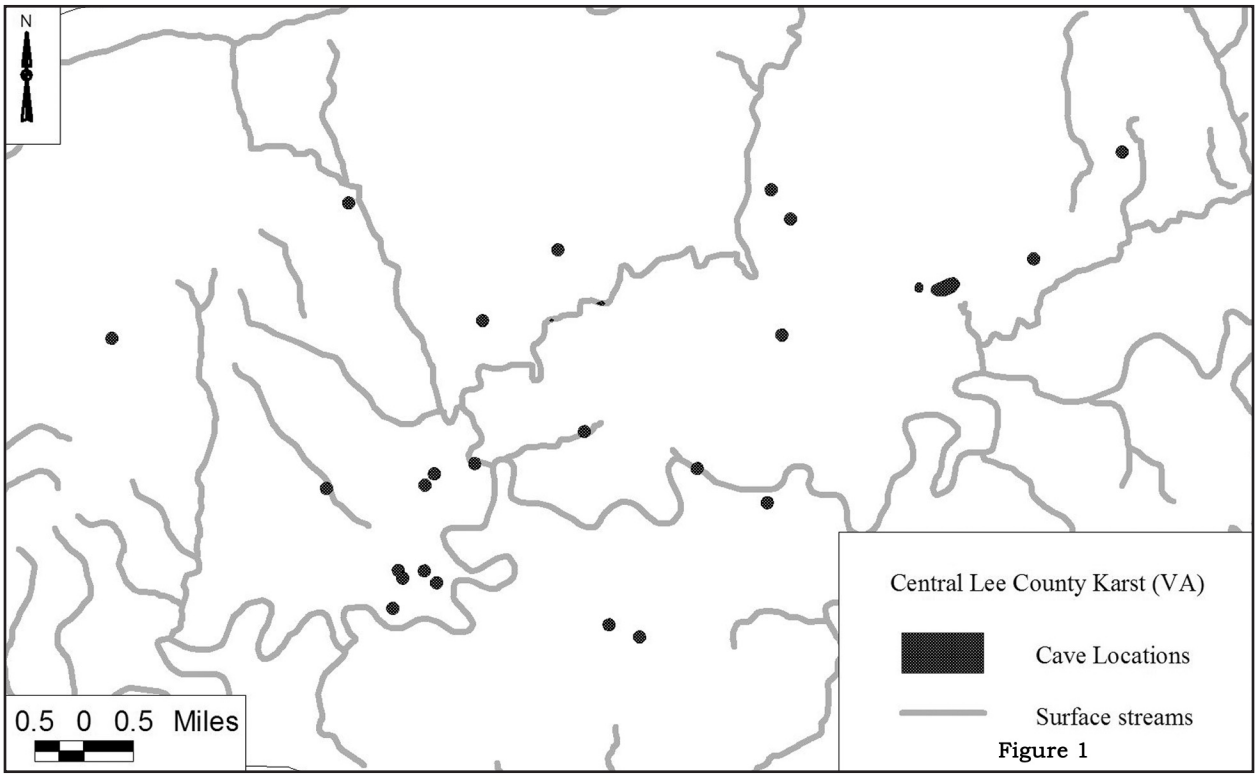

Figure 1

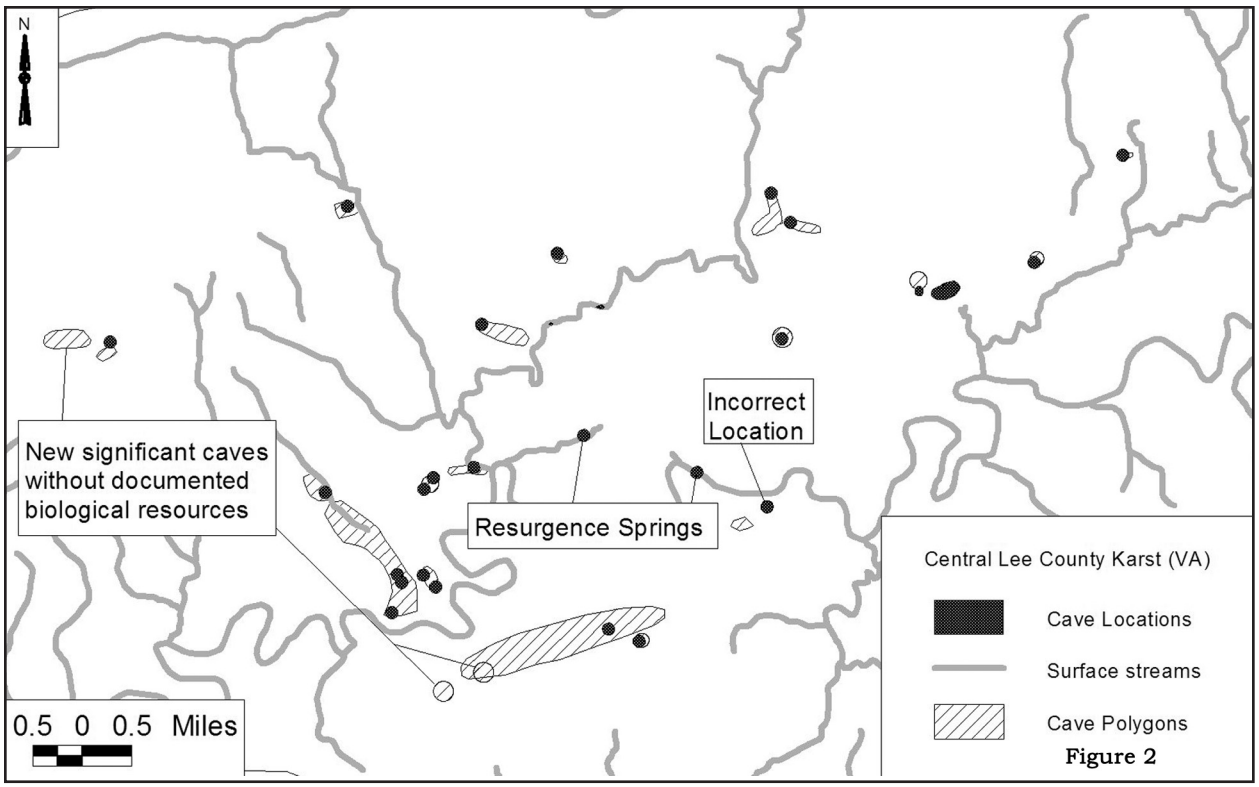

Figure 2

vectors representing the results of dye trace studies, which form the basis for many of the conservation sites. In general, the conservation site for a cave of hydrological significance is the buffered footprint of the cave plus its watershed. In cases where water entering the subsurface diverges, conservation sites may overlap as shown in the figure. In other cases, dye traces may pass beneath a site that lacks hydrological significance, and thus not be relevant to site delineation.

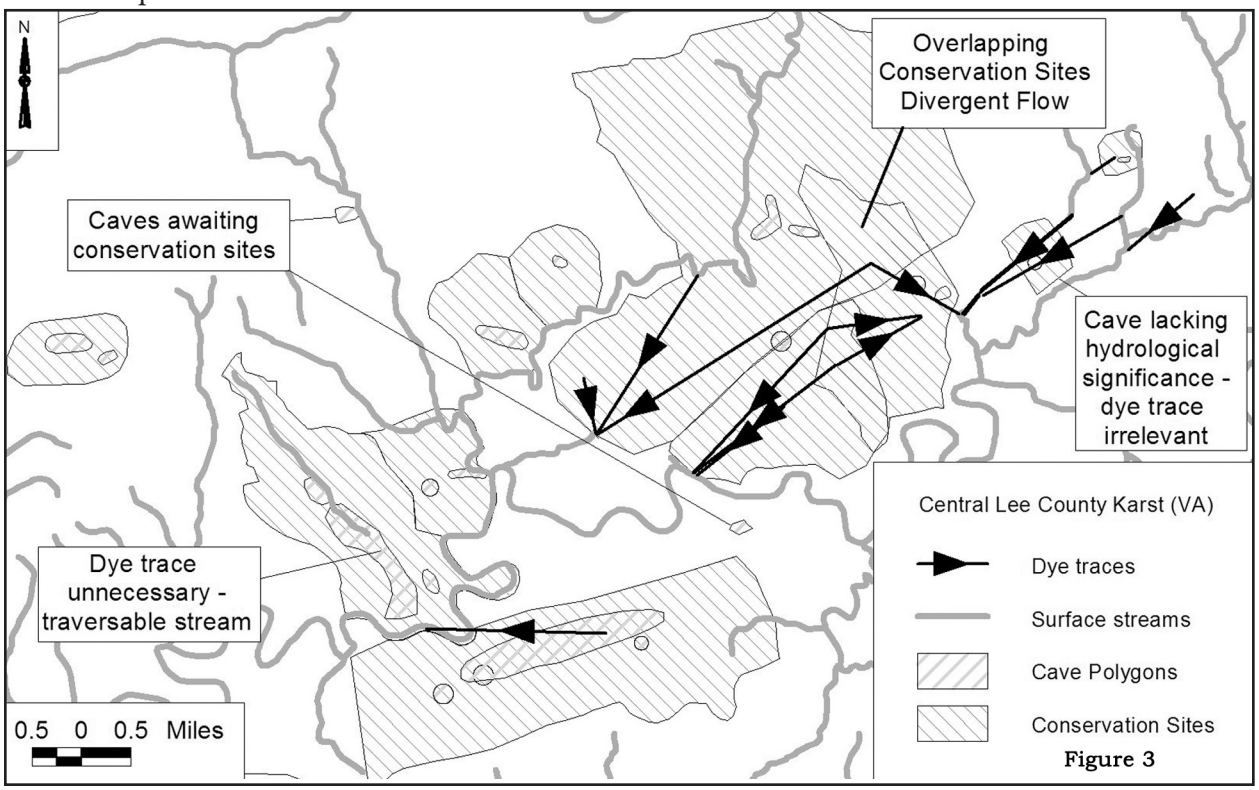

Figure 3

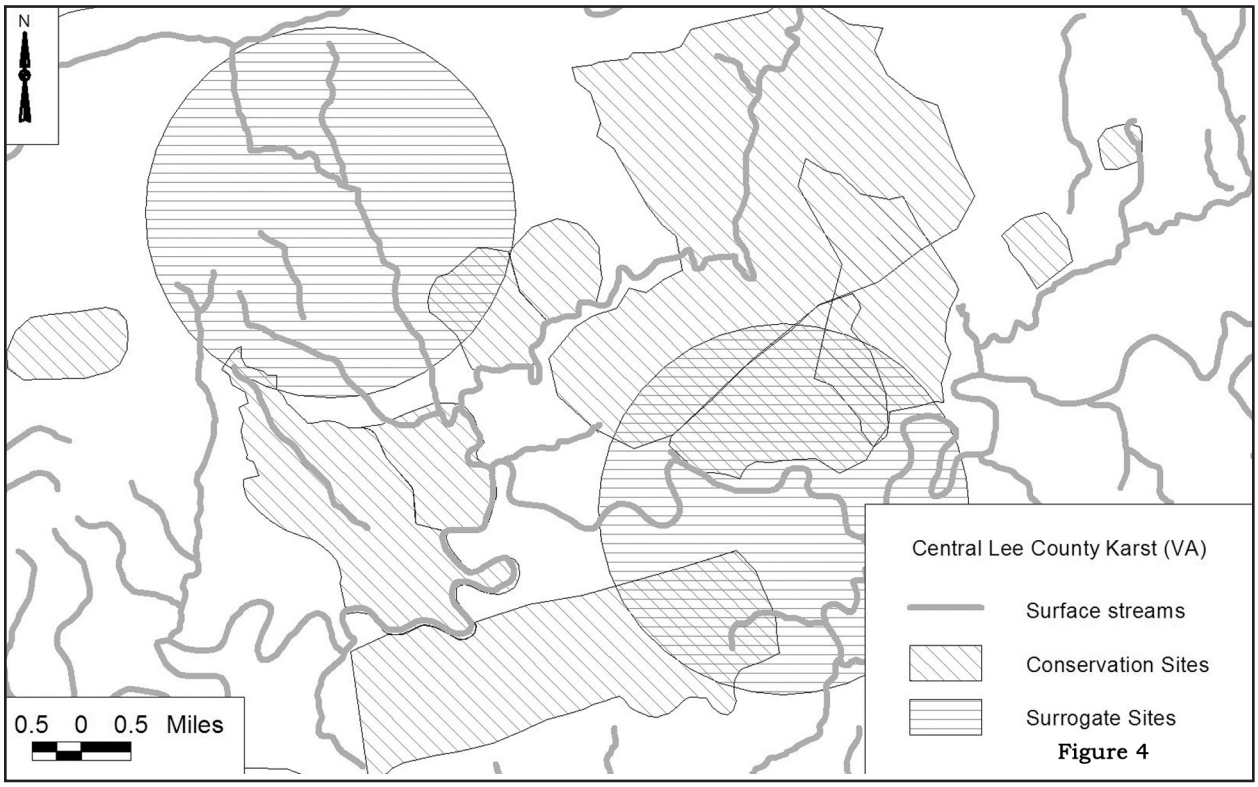

Figure 4

Figure 4 shows the current cave screening coverage used during project review for central Lee County. The two, six-kilometer-diameter circles are surrogate conservation sites that will be replaced by conservation sites when design is complete, and are much larger than most conservation sites.

Progress to Date

At present, the Natural Heritage Program internal database contains 381 polygons representing 410 caves, including the 362 designated as significant under the Virginia Cave Protection Act. The smallest cave polygon is just under 3 acres, the largest 1,100 acres, and the median 40 acres. These polygons have completely replaced point locations in the Natural Heritage electronic geographical database (GIS).

Design of conservation sites for these caves and their associated biological resources is well underway. To date, 72 conservation sites have been designed encompassing 163 of these caves, including 151 designated as significant. The minimum size cave conservation site is 80 acres, the maximum 9,000 acres, with a median of 695 acres. Ninety percent of the conservation sites exceed 200 acres.

The remaining approximately 250 caves are represented for project review by 200 surrogate conservation sites. The size of a surrogate site is 6,900 acres, larger than all but four of the conservation sites. Ninety percent of the conservation sites are less than half of the size of a surrogate site. Replacing these surrogate sites with realistic conservation sites is a top priority of the Natural Heritage Program, in order to better and more efficiently protect these resources.

Biodiversity significance

The caves and karst of Virginia are home to a rich and varied invertebrate cave fauna, as well as eight bat species. Virginia's caves include about 650 element occurrences of natural heritage resources, mostly rare invertebrates, including about 25% of rare invertebrates statewide. Many undescribed species are present, some of which are not yet tracked in the Natural Heritage database. New species and new occurrences of known species are found on a regular basis.

Biodiversity values (B-ranks) are assigned to all conservation sites in an attempt to quantify this significance. Appendix A (after Wilson and Tuberville, 2003) illustrates the methodology behind B-rank determination, developed by Natureserve™ and used by natural heritage programs throughout

Table 3. Biodiversity significance of Virginia's Cave Conservation Sites

Biodiversity Rank	Conservation sites	Surrogate Sites
B1	16	17
B2	20	43
B3	16	29
B4	7	32
B5	13	79

Most B5 sites represent significant caves or groups of caves where little to no biological inventory work has been performed.

North America. Ranks range from B1 (outstanding significance) to B5 (general significance).

Table 3 summarizes the biodiversity ranking of Virginia's cave conservation sites. Of the 72 conservation sites, half rank B2 or higher. An addition 30% of the surrogate sites (60) also rank B2 or higher. Because of the lack of biological surveys for many of the significant caves, the true degree of biodiversity may be even greater.

Sites are also coded for the presence of legally protected species. Of the 72 cave conservation sites, 24 include species with legal status. In addition, 30 of the 200 surrogate conservation sites include legally protected species.

Conclusions

The project review office in the Virginia Natural Heritage Program screens hundreds of projects each year for potential impacts to caves, karst, and associated biological resources. The numerous success stories arising from this process will be the topic of future papers. Successful implementation of this process depends on a partnership between the Natural Heritage Program, the Virginia Speleological Survey, and the Virginia Cave Board. Working together, these organizations have found a way to screen cave resources for potential impact from development projects without compromising data security. Caves are protected by screening proposed projects against conservation sites, then coordinating with the Virginia Karst Program, the Virginia Speleological Survey, the Cave Board, and appropriate regulatory agencies. To date, 40% of Virginia's caves containing natural heritage resources are incorporated into conservation sites. The remaining 60% are represented by larger, surrogate sites until conservation sites can be designed.

Acknowledgements

The authors would like to acknowledge the Virginia Natural Heritage Program Data Management staff and the Virginia Speleological Survey Directors for working to establish this process. Special thanks go to the Cave Conservancy of the Virginias, the Virginia Department of Transportation, and the Virginia Land Conservation Fund for financial support of conservation site development for Virginia's significant caves.

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APPENDIX A

Conservation Sites Ranking (after Wilson and Tuberville, 2003)

Brank is a rating of the significance of the conservation site based on presence and number of natural heritage resources; on a scale of 1-5, 1 being most significant. Sites are also coded to reflect the presence/absence of federally/state listed species:

Conservation Site Ranks
B1 – Outstanding significance
B2 – Very High significance
B3 – High significance
B4 – Moderate significance
B5 - Of general Biodiversity significance

Legal Status of
FL – Federally listed species present
SL – State listed species present
NL – No listed species present

Examples: A B1NL site is of outstanding significance with no listed species present.
A B4FL site is of moderate significance with a federally listed species present.

Global and State Ranks (defined on next page)

Element Occurrence Ranks		**G2**	**G3**	**G4/S1**	**G5/S1**	**G4 or G5 & S2**	G4 or G5 & S3	**Any Community**
A		B2	B2	B4	B4	B4	B5	B3
4 or more with A rank		B1	B2	B3	B3	B4	B4	B2
B		B2	B3	B4	B4	B5	B5	B4
4 or more with B rank		B1	B2	B3	B3	B4	B5	B3
C		B3	B4	B5	B5	B5		B5
4 or more with C rank		B2	B3	B5	B5	B5		
D		B3	B5	B5	B5	B5		

- EO ranks not yet assigned, "E", or "H" ranked treated as "C" rank for ranking of cave-associated populations.
- Borderline EO ranks are treated as the lower of the two (i.e. AB=B)
- Borderline G- and S- ranks are treated as the higher of the two (i.e. G1G2=G1)
- Range ranks are treated as the middle rank (i.e. G1G3=G2)
- Question marks should be ignored
- Ranks with T are treated as next lower G-rank (G4T1=G2)
- **B1** rank is assigned to sites that include single-site endemics
- Most outstanding EO of any community element is assigned a rank of **B2**

Definitions of Abbreviations Used on Natural Heritage Resource Lists of the Virginia Department of Conservation and Recreation

Natural Heritage State Ranks

The following ranks are used by the Virginia Department of Conservation and Recreation to set protection priorities for natural heritage resources. Natural Heritage Resources, or "NHR's," are rare plant and animal species, rare and exemplary natural communities, and significant geologic features. The criterion for ranking NHR's is the number of populations or occurrences, i.e. the number of known distinct localities; the number of individuals in existence at each locality or, if a highly mobile organism (e.g., sea turtles, many birds, and butterflies), the total number of individuals; the quality of the occurrences, the number of protected occurrences; and threats.

S1 - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically 5 or fewer populations or occurrences, or very few remaining individuals (<1000).

S2 - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically 6 to 20 populations or occurrences or few remaining individuals (1,000 to 3,000).

S3 - Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically having 21 to 100 populations or occurrences (1,000 to 3,000 individuals).

S4 - Apparently secure; Uncommon but not rare, and usually widespread in the state. Possible cause of long-term concern. Usually having >100 populations or occurrences and more than 10,000 individuals.

S5 - Secure; Common, widespread and abundant in the state. Essentially ineradicable under present conditions, typically having considerably more than 100 populations or occurrences and more than 10,000 individuals.

S#B - Breeding status of an animal within the state

S#N - Non-breeding status of animal within the state. Usually applied to winter resident species.

S#? - Inexact or uncertain numeric rank.

SH - Possibly extirpated (Historical). Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.

S#S# - Range rank; A numeric range rank, (e.g. S2S3) is used to indicate the range of uncertainty about the exact status of the element. Ranges cannot skip more than one rank.

SU - Unrankable; Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SNR - Unranked; state rank not yet assessed.

SX - Presumed extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

SNA - A conservation status rank is not applicable because the element is not a suitable target for conservation activities.

Natural Heritage Global Ranks are similar, but refer to a species' rarity throughout its total range. Global ranks are denoted with a "G" followed by a character. Note GX means the element is presumed extinct throughout its range. A "Q" in a rank indicates that a taxonomic question concerning that species exists. Ranks for subspecies are denoted with a "T". The global and state ranks combined (e.g. G2/S1) give an instant grasp of a species' known rarity. **These ranks should not be interpreted as legal designations.**

FEDERAL LEGAL STATUS

The Division of Natural Heritage uses the standard abbreviations for Federal endangerment developed by the U.S. Fish and Wildlife Service, Division of Endangered Species and Habitat Conservation.

LE - Listed Endangered
LT - Listed Threatened
PE - Proposed Endangered

PT - Proposed Threatened
C - Candidate (formerly C1 - Candidate category 1)
E(S/A) - treat as endangered because of similarity of appearance
T(S/A) - treat as threatened because of similarity of appearance
SOC - Species of Concern species that merit special concern (**not a regulatory category**)
NL – no federal legal status

STATE LEGAL STATUS
The Division of Natural Heritage uses similar abbreviations for State endangerment.

LE - Listed Endangered
PE - Proposed Endangered
SC - Special Concern - animals that merit special concern according to VDGIF (not a regulatory category)
LT - Listed Threatened
PT - Proposed Threatened
C - Candidate
NL - no state legal status

For information on the laws pertaining to threatened or endangered species, please contact:

U.S. Fish and Wildlife Service for all **FEDERALLY** listed species;
Department of Agriculture and Consumer Services, Plant Protection Bureau for **STATE** listed plants and insects
Department of Game and Inland Fisheries for all other **STATE** listed animals