Helping Conserve Resources in Natural Caves

Montana high school students incorporate GIS

Since 2003, students from Browning and Bigfork high schools, both in northwestern Montana, have volunteered at Glacier National Park, mapping, monitoring, and conserving resources in natural caves. Recently, the project adopted a GIS component to help students manage and present their data.

Prior to using GIS, students and their teacher/sponsor, Hans Bodenhamer, mapped and established monitoring in 13 park caves. One of these caves is more than one mile long. Cave locations were recorded using GPS, but underground surveys were completed using compasses, inclinometers, and tape measures. Cave maps were at a scale of 1:240. After drafting maps, students returned to the caves to photograph, record, and assess the natural resources in each cave. The results of monitoring efforts were drafted on maps created in Adobe Photoshop, which were explained in a series of reports submitted to the park. The number of student reports submitted since 2003 exceeds 200 pages and includes many oversized maps. One map covers two sheets, each 8 feet long by 3 feet wide.

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In fall 2007, Denny Rae, GIS specialist with Flathead County, approached Bodenhamer with a proposal to incorporate GIS into his curriculum. Bodenhamer showed copies of the students' reports to Rae, who suggested that putting the data into GIS would be an excellent student project. Rae contacted Bern Szukalski, ESRI's cave and karst program coordinator, who prompted ESRI to donate ArcGIS 9.3 software to Bigfork High School. At that point, it became apparent that none of the school's computers were capable of running ArcGIS. For the next year and a half, Bodenhamer applied for grants. Finally, in spring 2009, Bigfork High School received a $10,000 grant from Best Buy. This grant, one of only 15 awarded nationally, was given for its innovative proposal to use real-world technology in a K–12 setting. Using the grant, computers were purchased for a GIS cave lab at the high school.

With computers on the way, Bodenhamer contacted Ben Sainsbury, GIS specialist at Central Washington University. In 2000, as a graduate student at Northern Arizona University, Sainsbury used GIS to present 10 years of photo monitoring of cave resources in Arizona. Sainsbury volunteered to help with the students' cave project in Montana. He spent countless hours tutoring Bodenhamer in GIS and developed a procedure by which students could enter and manipulate their cave maps and monitoring data. Bodenhamer took Sainsbury's procedures back to his students, who were eager and quickly learned the material.

In less than a month—thanks to many extracurricular hours—the students had entered most of the data that had been amassed over five years. In early June of 2009, the students presented their GIS to a gathering of about 20 park managers. The group was very impressed and suggested the student project be expanded to caves on nearby U.S. Forest Service lands and in other parks.

Bigfork High School's cave GIS uses scans of detailed cave maps, which are cleaned up and oriented using Photoshop. The cleaned-up maps are georeferenced on a topographic map as raster images and are set to be visible below a scale of 1:800. In addition to the detailed cave maps, a filled-in vector image of the cave map is included as a separate layer. The vector image can be turned on to show the orientation of caves with respect to one another and the overlying topographic map or to provide background for the raster cave map and other layers.

Beyond raster and vector cave maps, a layer that provides general information is tied to the entrance of each cave. General information includes entrance elevation, cave length and depth, average air temperatures, and overall classification of the cave's resource significance in comparison to other caves in the region. Classified resources include biology, mineralogy, paleontology, archaeology, geology, meteorology, and hydrology. Significance classes use readily understandable terms—none, poor, fair, good, and outstanding—that are qualified in accompanying text.

Specific cave resources within each cave are also included in Bigfork High School's cave GIS. Cave temperatures, graffiti (if present), mineralogy, biology, and photo points are all included on separate layers. Points and polygons for these layers are located relative to features on the cave map. For mineralogy and biology, features are described and classified according to significance, fragility, condition, and proposed management action. Simple terms are used for each class, which are explained in accompanying text.

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