

DISTRIBUTION MAP OF CAVES AND CAVE ANIMALS IN THE UNITED STATES

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The distributions of nearly 45,000 caves and 924 obligate cave species and subspecies (stygobites and troglobites) in the 48 contiguous states of the United States were mapped by county. Both maps show a highly clumped distribution. Approximately one-half of the variance in the number of species in a county is explained by variance in the number of caves per county.

While several maps of karst and pseudo-karst areas of the 48 contiguous states are available, most notably that of Davies *et al.* (1986) and its variants (Culver 1999), we know of no similar map of cave locations. We have a special interest in the distribution of caves since we have compiled a list of the obligate cave-dwelling species by county for each of the 3100 counties in the 48 contiguous states (available at www.karstwaters.org). In particular, we were interested in the explanatory power the distribution of caves has in accounting for the distribution of obligate cave-dwelling species. Therefore, we have assembled data on the number of caves by county, based on information in the National Speleological Society cave files and from records of state cave surveys. The list includes not only solution caves, but lava tubes, sea caves, etc.

The purpose of this brief communication is to present dot

maps of the distribution of caves by county and the distribution of obligate cave species by county, and briefly to compare the two. A more complete analysis of the spatial distribution of cave species will appear elsewhere at a later date.

The maps presented below were generated using the Geographic Information System software package, MapView™. Each cave (or species) in a county is represented by a dot so that, for example, a county with 10 caves has 10 dots. The position of the dot within the county is assigned at random by MapView™. While this produces some loss of accuracy, it also ensures that no precise location information can be determined from the maps. For some counties, the number of caves is so great that the dots completely fill the county, and individual dots are indistinguishable and superimposed.

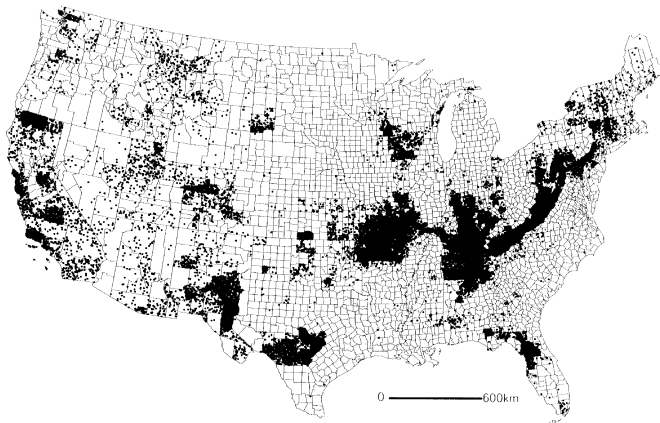


Figure 1. Dot map of the number of caves per county. Each dot represents one cave.

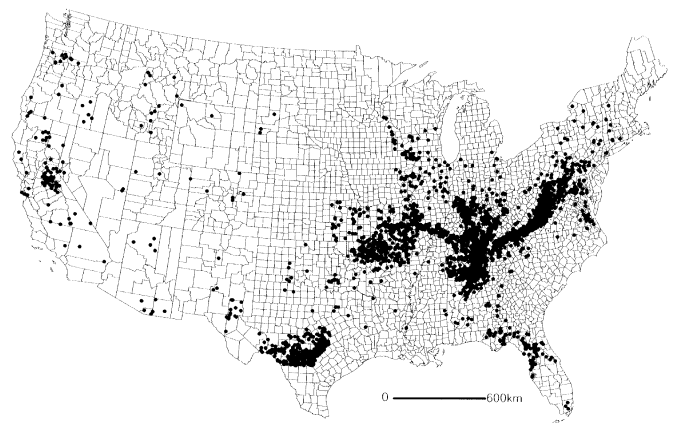


Figure 2. Dot map of the number of stygobites and troglobites per county. Each dot represents one county record of a stygobite or troglobite.

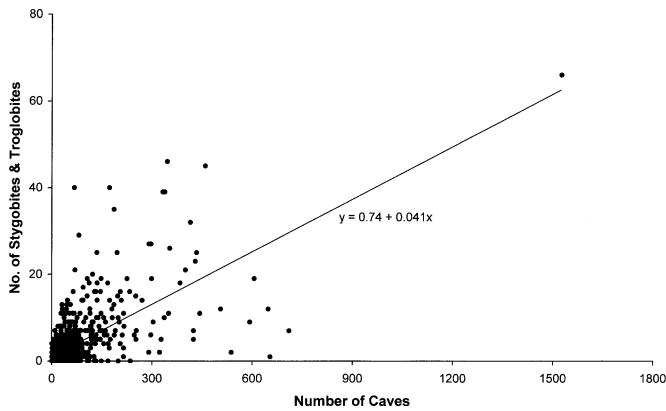


Figure 3. Scatter plot of number of stygobites and troglobites versus number of caves for counties with one or more caves. The line is the least squares linear regression.

Figure 1, a dot map of cave locations, shows the county distribution of 44,681 caves in our database. Over one-third of the counties in the U.S. (1144 of 3211) have at least one cave. The major karst regions in the U.S. are apparent—the Appalachians, the Interior Low Plateau and associated areas immediately to the west, the Florida Lime Sinks, the Ozarks, the Driftless Area (Iowa, Illinois, and Wisconsin), the Edwards Plateau and Balcones Escarpment, the Guadalupe Mountains, the Black Hills, and a scattering of caves throughout the western U.S. The large number of caves in the West, especially in California and Colorado, may come as a surprise to some who think of caves as primarily an eastern and midwestern phenomenon.

Figure 2, a dot map of obligate cave animals, shows the county distribution for the number of species and subspecies of obligate aquatic organisms (stygobites) and terrestrial organisms (troglobites), based on a total of 924 species and subspecies. This map shows a combined total of 2774 records. Each dot in this map represents a county record for a stygobite or troglobite, and each dot is 4 times the area of the dots in figure 1, in order to facilitate comparison. Some of the same cave regions shown in figure 1 are apparent in the stygobite and troglobite distribution map: the Appalachians, the Interior Low Plateau and Cumberland Front, the Florida Lime Sinks, the Ozarks, and the Edwards Plateau and Balcones Escarpment. Cave areas to the north (Driftless Area) and west (Guadalupe Mountains and Black Hills) are not well represented by stygobites and troglobites. Another way of putting it is that, relative to figure 1, the density of dots in figure 2 is less to the west and to the north. The exception is a small cluster of records from Calaveras County, California.

The number of caves in a county is a surprisingly good predictor of the number of stygobites and troglobites. We considered those 1144 counties with one or more caves, and did a simple least squares linear regression of the number of species of stygobites and troglobites (S) on the number of caves (C), with the resulting equation (Fig. 3):

$$S = 0.74 + 0.041C$$

This relationship accounted for 47% of the variance in the number of stygobites and troglobites, and was highly significant ($t=31.62$, $p<.00001$). The intercept was also significant ($t=5.69$, $p<.00001$). There is considerable scatter (Fig. 3) and other variables, such as the number of caves in adjoining counties or latitude, are likely important. The one extreme is Jackson County, Alabama with more than 1500 caves and 66 species, nearly twice the number of caves and half again as many species as any other county. Excluding this county from the regression analysis has little influence on the estimated regression relationship, implying that the results and conclusions are not due to this single county. The analysis does not look at the level of individual cave, which would require a much more detailed analysis. However, this simple regression does demonstrate the important link between number of caves reported and number of species reported.

ACKNOWLEDGMENTS

We are grateful to the many cavers who provided us with up to date information on the number of caves per county. Richard Blenz, Chair of the NSS Cave Files Committee, and William Torode, NSS Librarian, were especially helpful in this regard. The compilation of the species list was supported by a contract from The Nature Conservancy to DCC and HHH.

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