The Influence of Environmental Factors on Cave Biota Locality within Cave Hollow Cave

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Introduction

Cave Hollow Cave (CHC) is located in Lee County, Kentucky within the Red River Gorge Geological Area. In coordination with other karst research in the area, a statistical analysis of environmental factors within CHC was initiated by conducting cave and biological inventories along with collecting temperature and water data. Four zones were established based on similar surface area and habitat niche while also accounting for all parts of typical cave zones: entrance, twilight, and dark. To make this research publicly accessible, 3D models, a visual walkthrough, and a storymap of CHC were created to depict the conditions of each zone and display compiled and analyzed data (*Figs. 2, 3, & 4).*

Key Findings

- This research serves as a baseline for species distribution in KY karst based upon several environmental factors (distance from entrance, temperature variation, nutrients, water sources, and surrounding prey/predators)
- Total and class abundance were greatest in locations close to the entrance of the cave except for that of crustaceans
- Temperature variation plays a significant role in distribution for total abundance and class abundance of spiders, insects, and salamanders
- Distance from the entrance was only statistically significant for total abundance
- Both temperature variation and distance from the entrance combined were significant for total, salamander, and insect abundance

Methods

In order to create an immersive viewing experience for Cave Hollow Cave, mapping and photography were conducted during June and July of 2024. Data collected from these trips were used to create a 3D model of CHC in *Compass*. This model was then textured with photographs taken throughout the cave, producing Fig. 1.

CHC was split into four zones, each hosting unique environments at varying points throughout the cave. Cave inventory, including environmental factors, was taken throughout the cave while a seperate biological inventory recorded data specifically for each of the four zones.

Water samples were collected in Zones 2, 3, and 4 producing quality and discharge data used for statistical analysis.

Pictures of a specific portion of each zone were compiled into *Agisoft Metashape* to create photogrammetry replicas. The 3D models formulated from ~2,500 photos provide visual access to the conditions of all zones at varying degrees. Six models were used to aid in this replication including the floor of Zone 1 and a pool in Zone 4 (*Figs. 2 & 3*).

Arranged inventory data including cave features, biological makeup, and environmental factors were input into *RStudio* to run statistics. The outcomes were used to deduce which hypotheses were statistically significant.

These data and models were arranged in a story map, (*Fig. 4*) allowing for public accessibility of CHC.

3D Cave Model

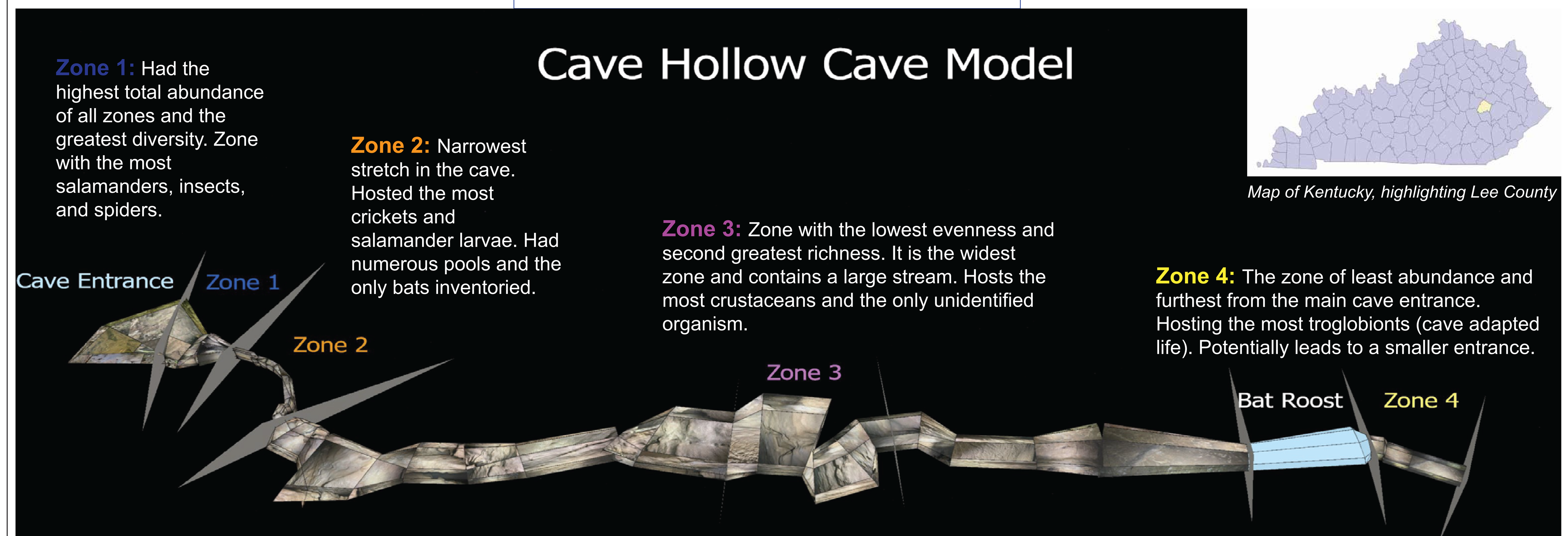

Fig. 1: 3D model of Cave Hollow Cave depicting standout features (zones, entrance, and bat roost)

Results

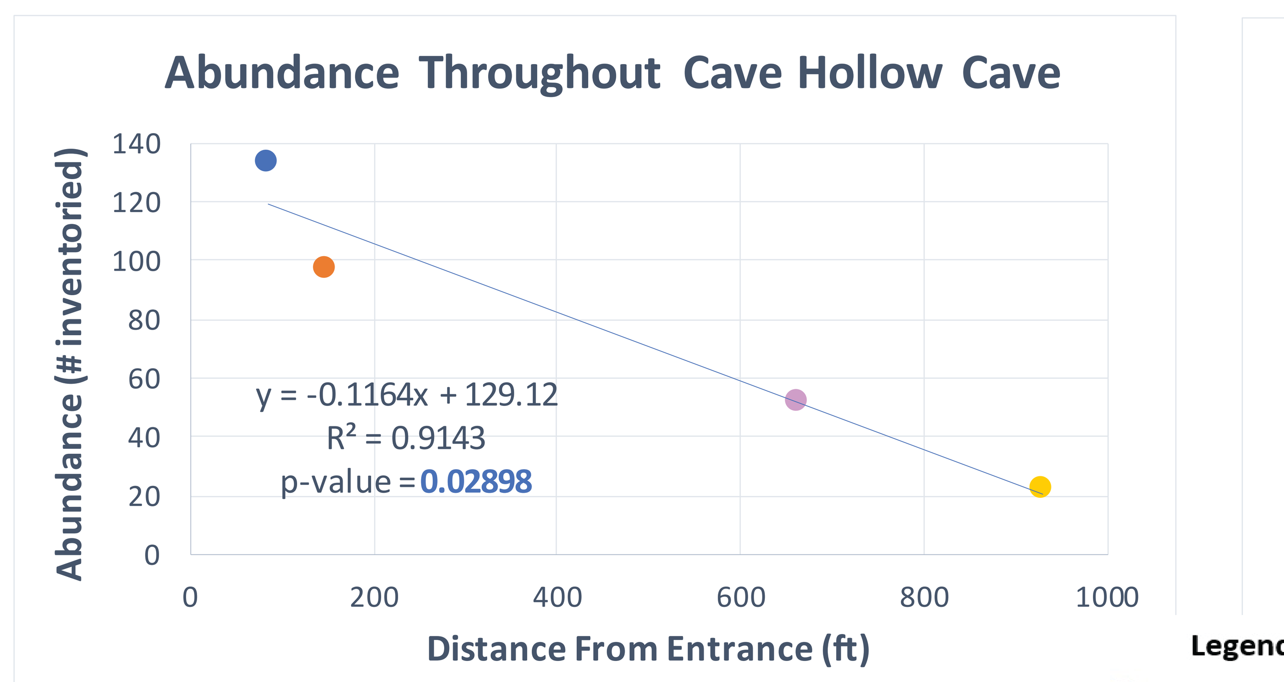

Fig. 5: A linear regression model of distance from the entrance on total abundance distribution. This model produces a statistically significant p-value and an R-squared value (goodness of fit) that is slightly greater than that of only temperature variation.

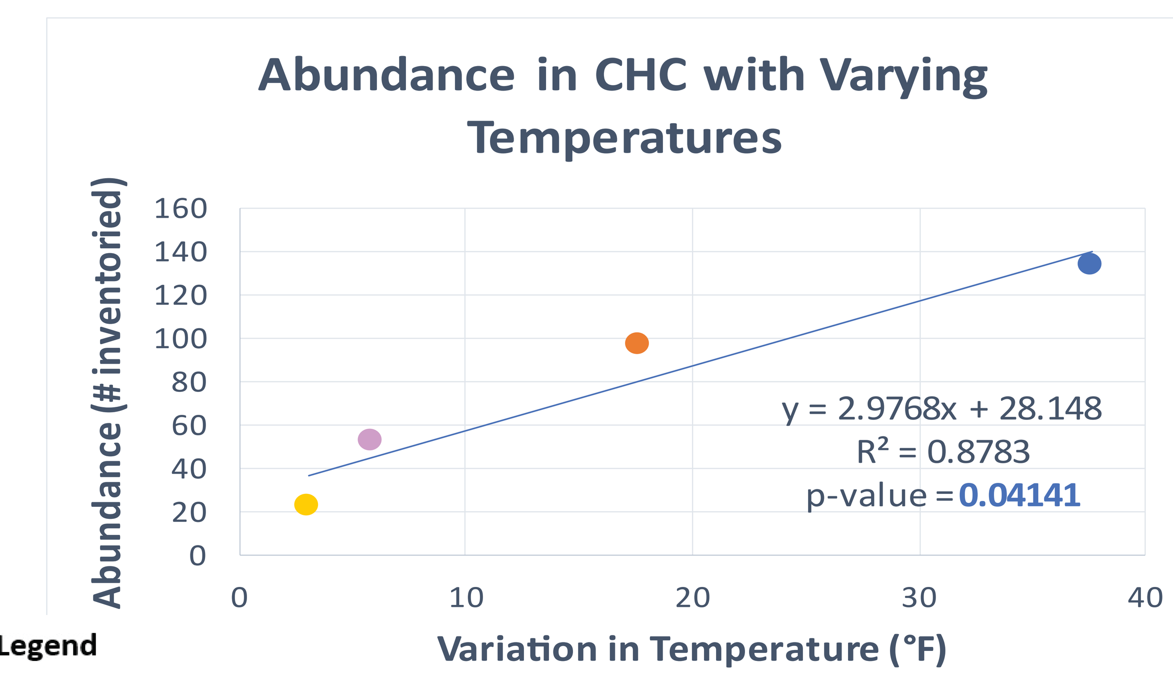

Fig. 6: A linear regression model of temperature variation on total abundance distribution. This model indicates that abundance increases with more temperature variation in contrast to abundance decreasing further away from the cave entrance.

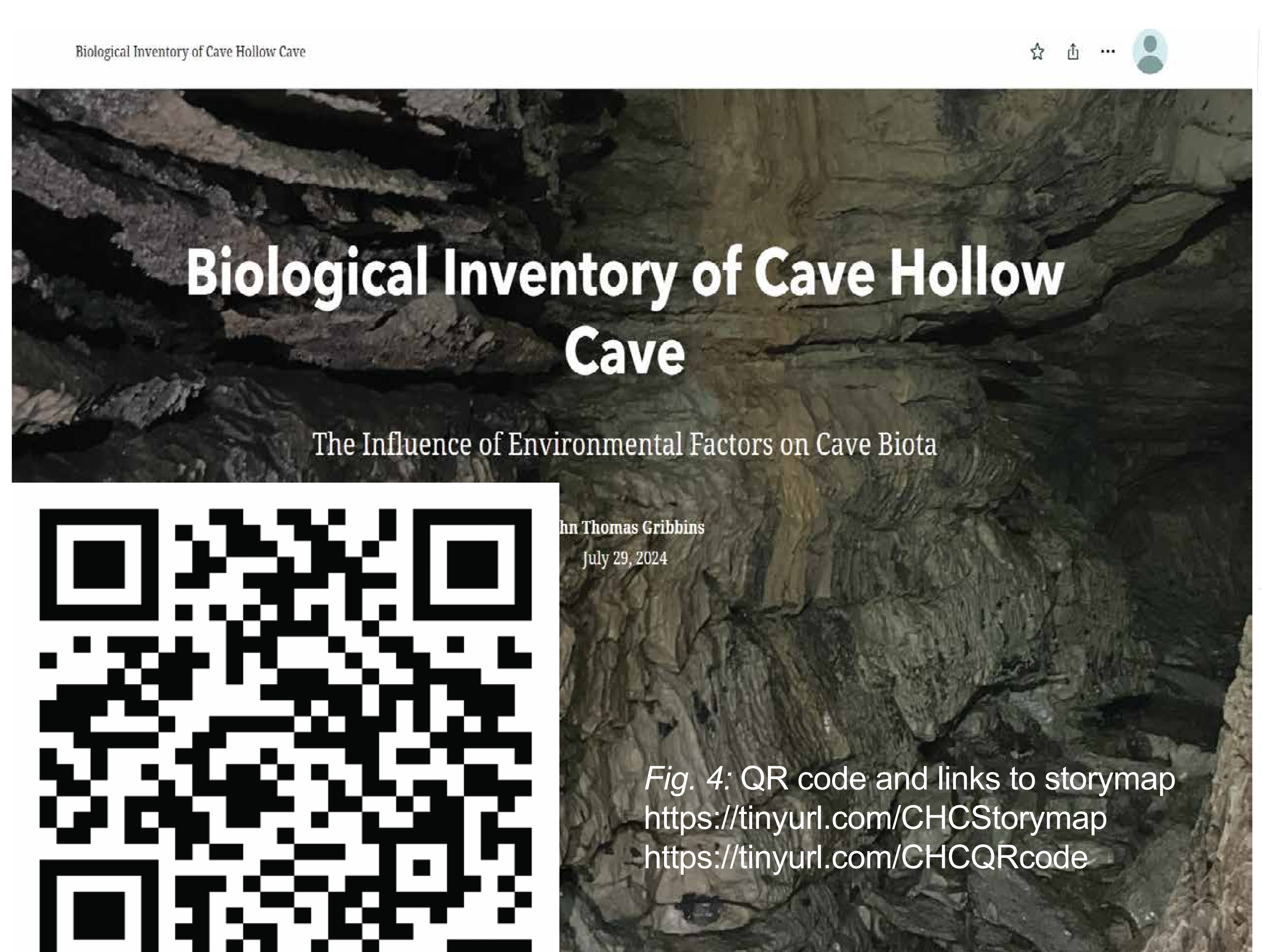

Fig. 4: QR code and links to storymap
https://tinyurl.com/CHCStorymap
https://tinyurl.com/CHCQRcode

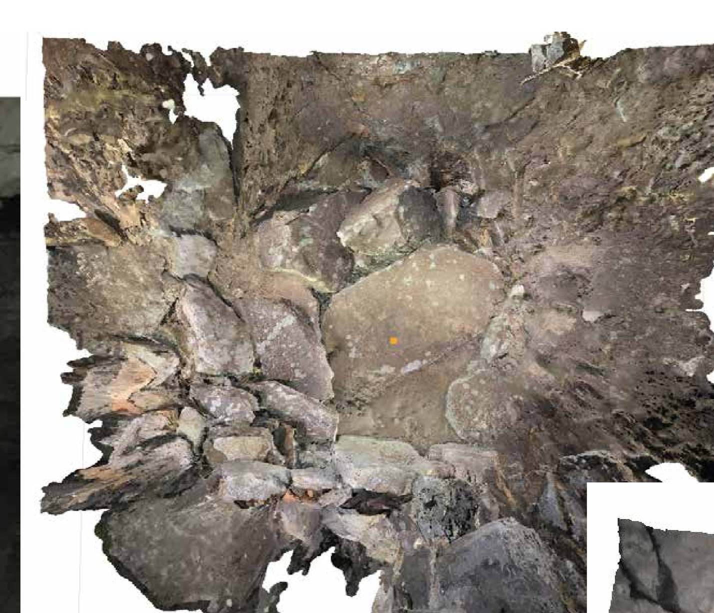

Fig. 2: Photogrammetry model depicting breakdown on the floor in zone 1.

Fig. 3: Photogrammetry model depicting a pool on the gravel floor of zone 4.

Discussion

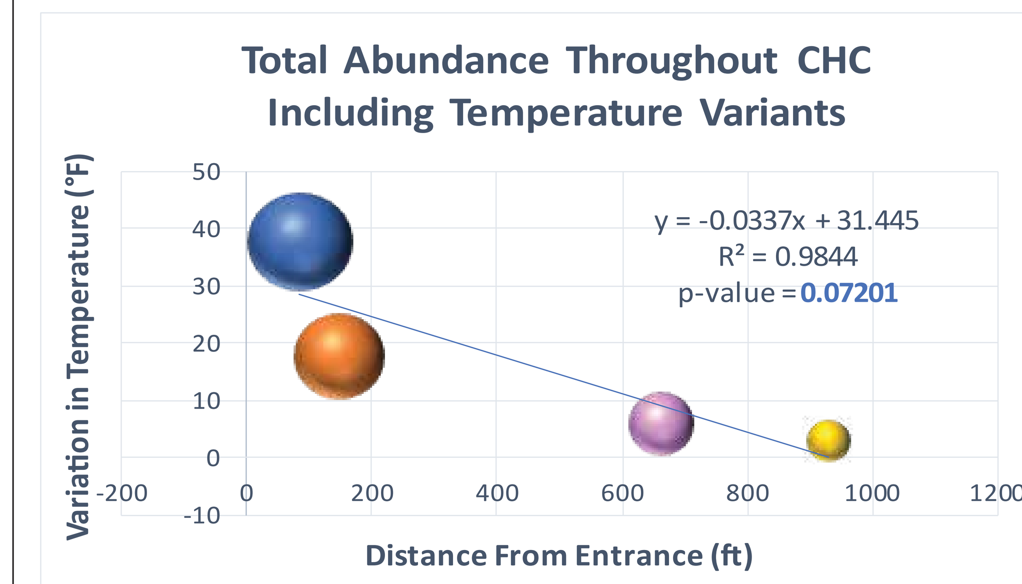

Fig. 7: Linear regression model depicting predictors in relation to total abundance

Based on statistical analysis from the data collected, distance from the entrance and temperature variation resulted in the most significant outcomes for total abundance in each zone (*Figs. 5 & 6*). Total abundance was broken into class abundances and the same environmental factors were tested adding predator/prey relations for each class. While these relations did not result in statistically significant results, temperature variation produced significant results for some classes. Distance from the entrance and temperature variation combined resulted in one significant outcome, salamander abundance. This combination resulted in two other outcomes that were in the 90th percentile: total and insect abundance distribution (*Fig. 7).* My initial hypothesis of other environmental factors (water quality, zone makeup, and predator/prey relations) did not produce significant outcomes, but as this was a baseline inventory, results may change with monthly inventories.

Conclusions

Cave Hollow Cave hosts ~25+ species throughout varying portions of the cave. Total and class abundance distribution in CHC statistically register variation of temperature and distance from the cave entrance as significant predictors.

This research was conducted using a small scale of data collection. Future research can continue this work by assessing zones more frequently throughout the span of a year. Further testing of water quality in all zones, nutrient distribution, and humidity can induce further variations of species distribution.

Issues with the creation, export, import, and view of photogrammetry models can be explored and discussed in further research that addresses visual outreach aids.

References

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