



Unique Construction Considerations in Karst Areas

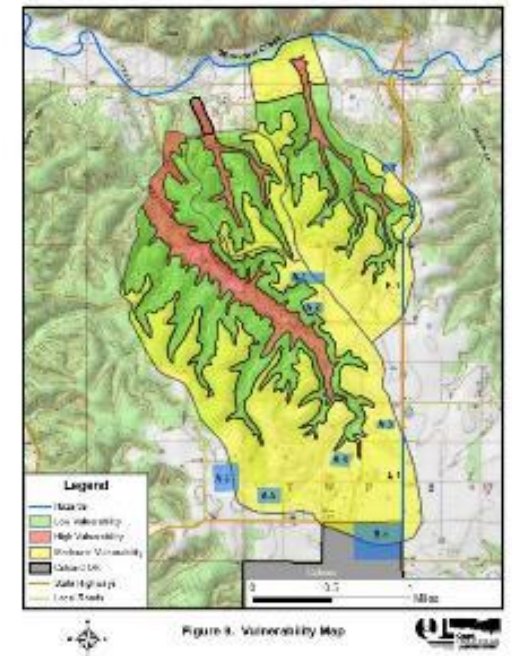
Tom Aley and Dave Woods

Ozark Underground Laboratory, Inc.



Ozark Underground Laboratory

- Founded in 1973
- Water and land use investigations with special emphasis on karst and fractured rock landscapes.
- Specialize in fluorescent tracer dyes
- Projects in 44 U.S. states and all continents except Antarctica

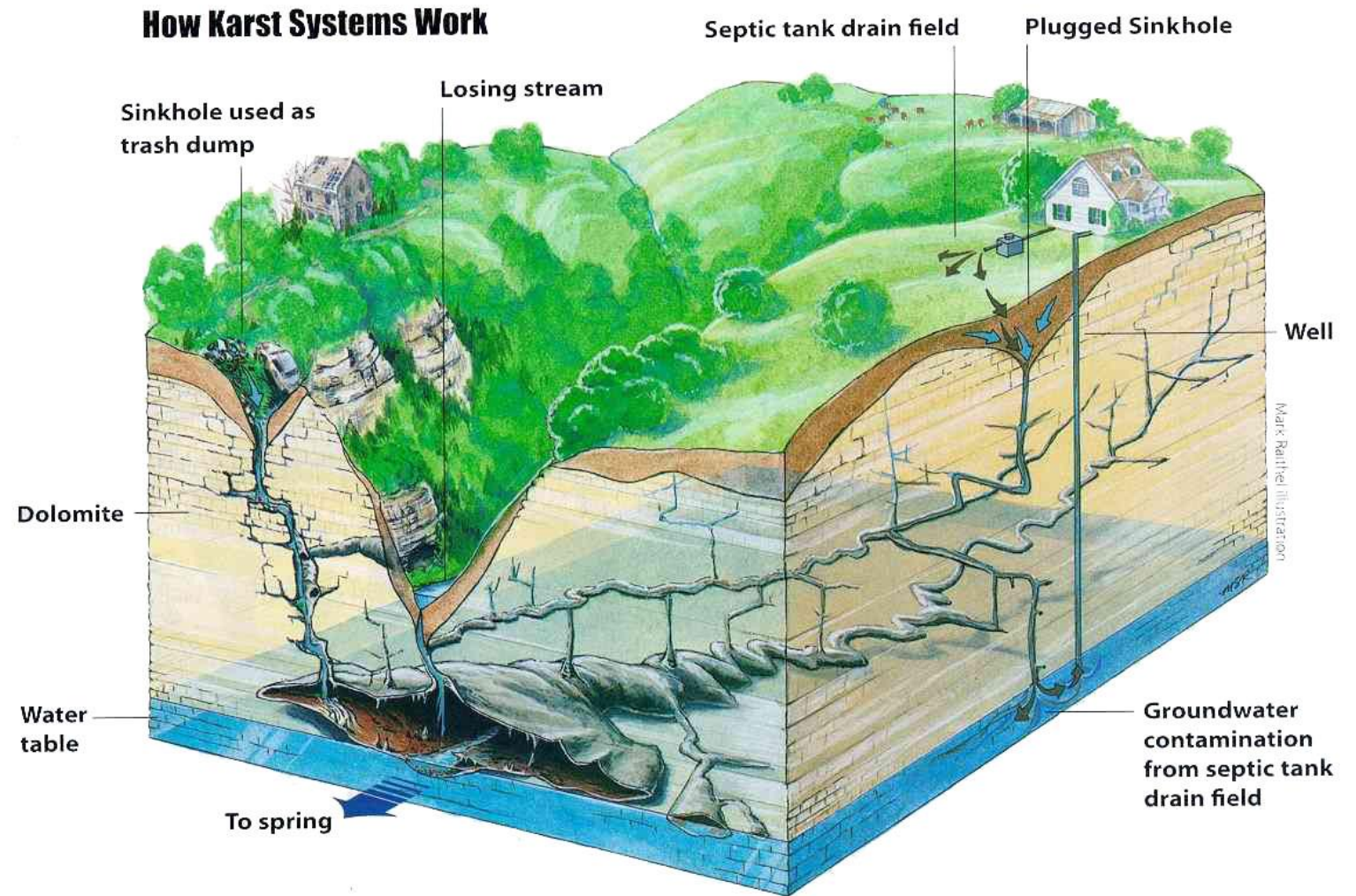


Welcome to Missouri – The Cave State



Karst and Caves

- Water-soluble rocks
 - Limestone
 - Dolomite
 - Marble
 - Gypsum
- 60% of Missouri
- 25% of the U.S.



- Construction in karst areas comes with unique challenges

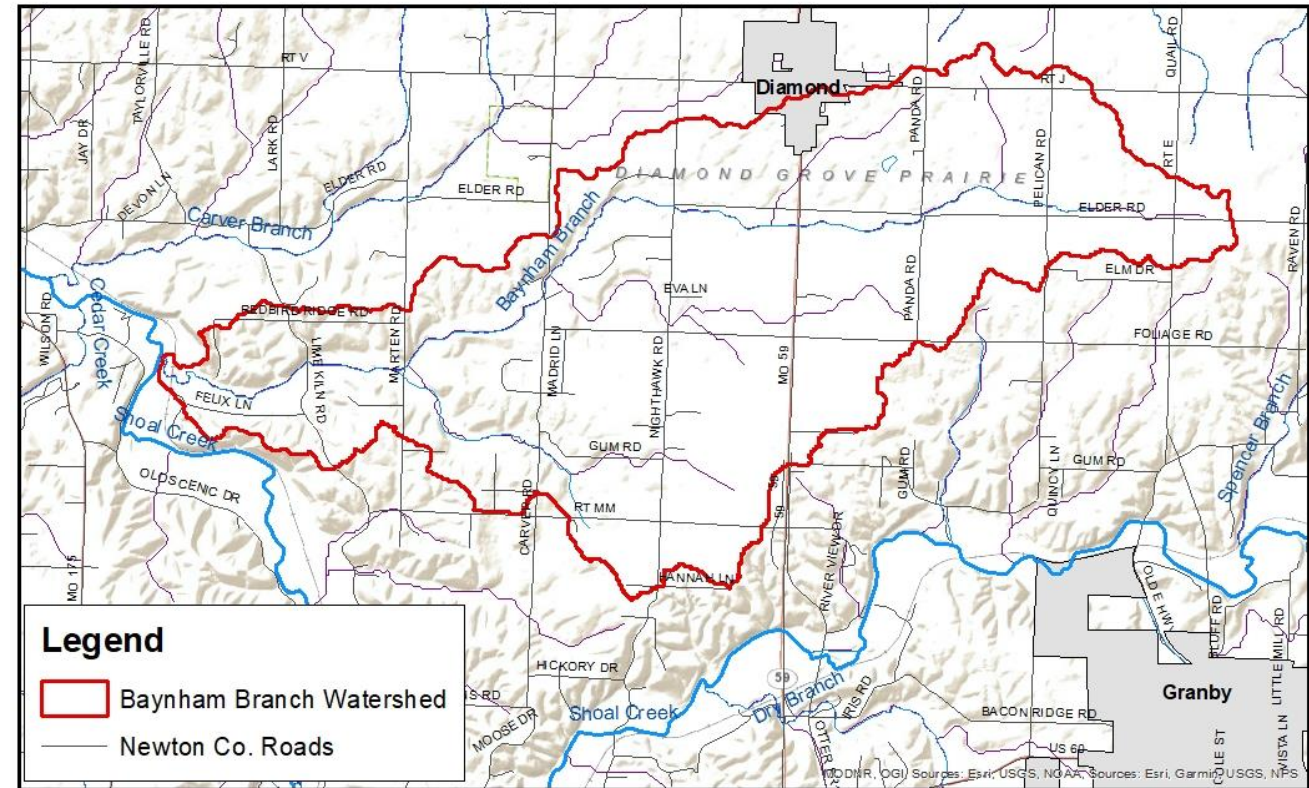
Real World Examples

Proposed Joplin Water Supply Reservoir

“Two Hills Close Together Does Not Necessarily Equal a Dam Site in Karst”

Proposed Joplin Reservoir

- Missouri American Water Company
- 1000 acre reservoir on Baynham Branch
- Site selection by desktop review
- Unique operations plan



Study Area

Proposed Joplin Reservoir

- Landowner-funded investigations



Proposed Joplin Reservoir

- Losing streams

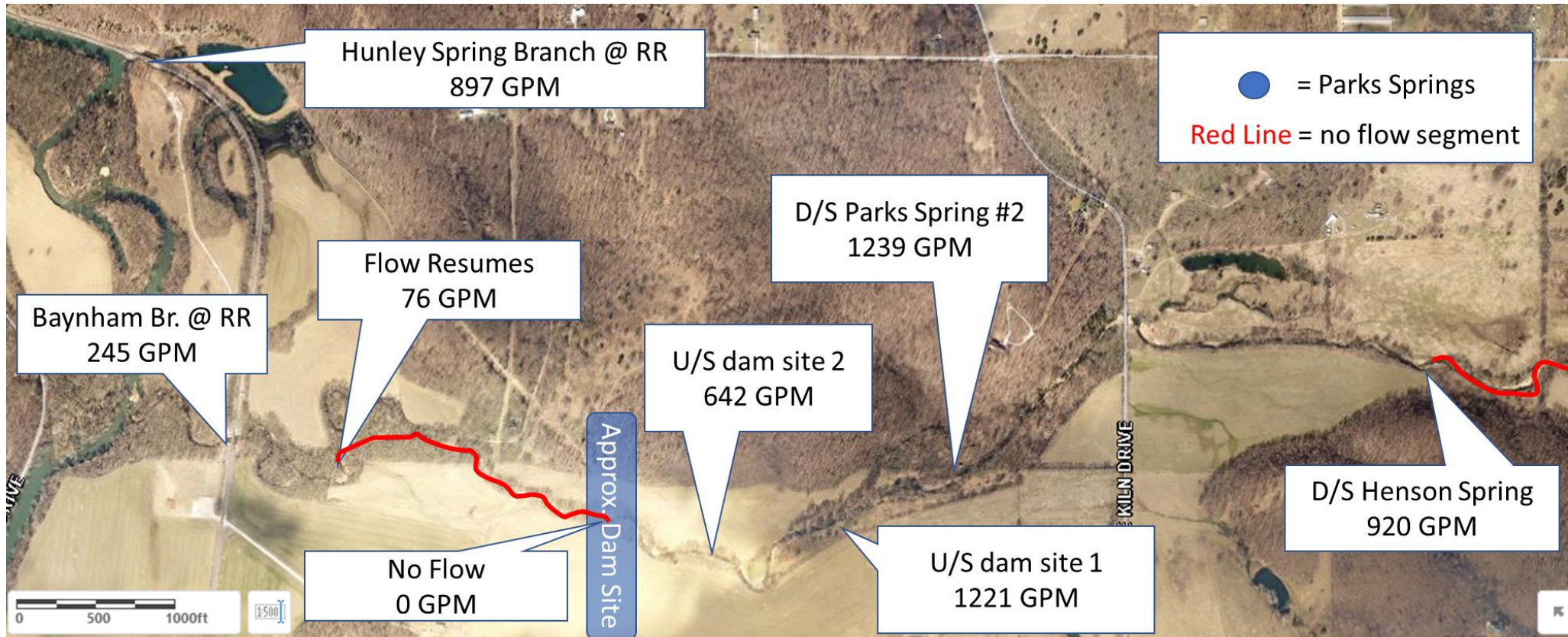
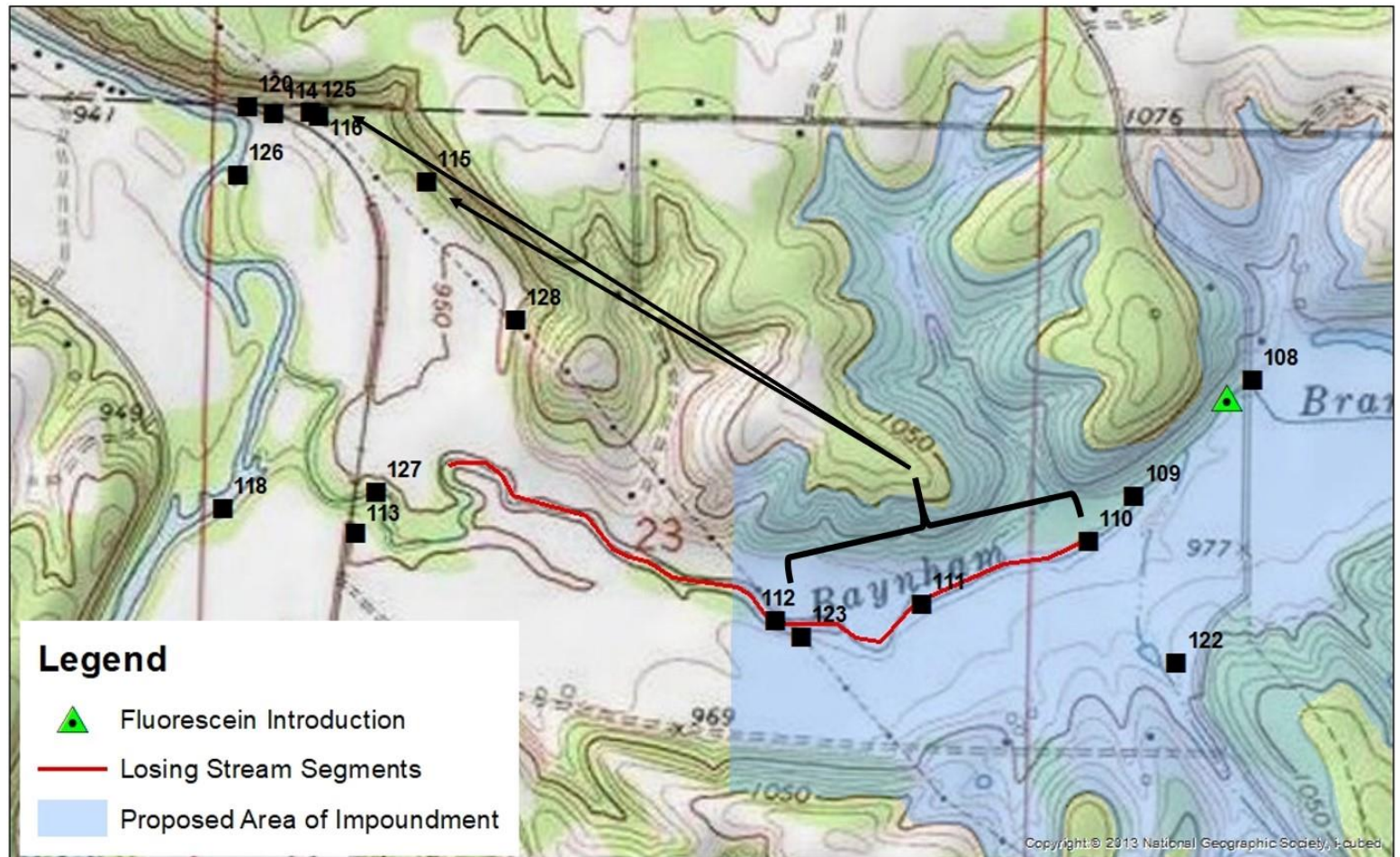


Figure 12. Measured Flow Rates on 11-5-2020



Proposed Joplin Reservoir

- Flow discharges outside of proposed reservoir basin



0 0.125 0.25 0.5 0.75 1 Miles

Figure 10. Dye Trace 20-03
Principle Groundwater Flow Paths for
Fluorescein Dye



Real World Examples

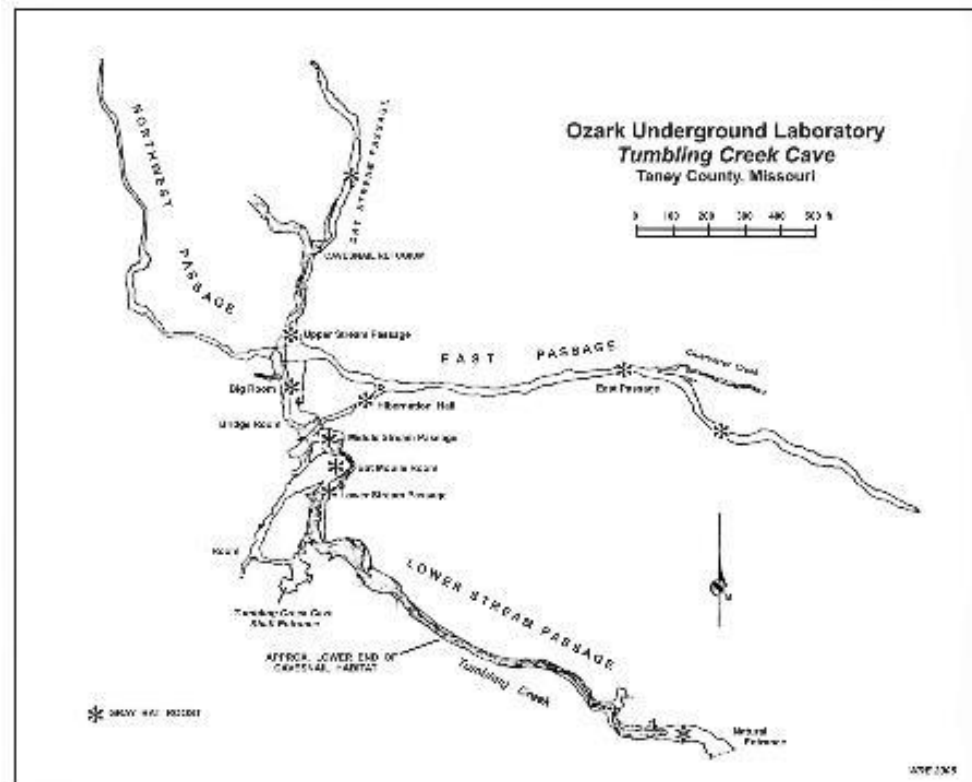
Reservoir Operation and Endangered Species

Tumbling Creek Cavesnail

Tumbling Creek Cave

- Most biodiverse cave west of the Mississippi River
 - 118 documented species
 - 4 Federally listed species
 - 2 Endemics

- National Natural Landmark

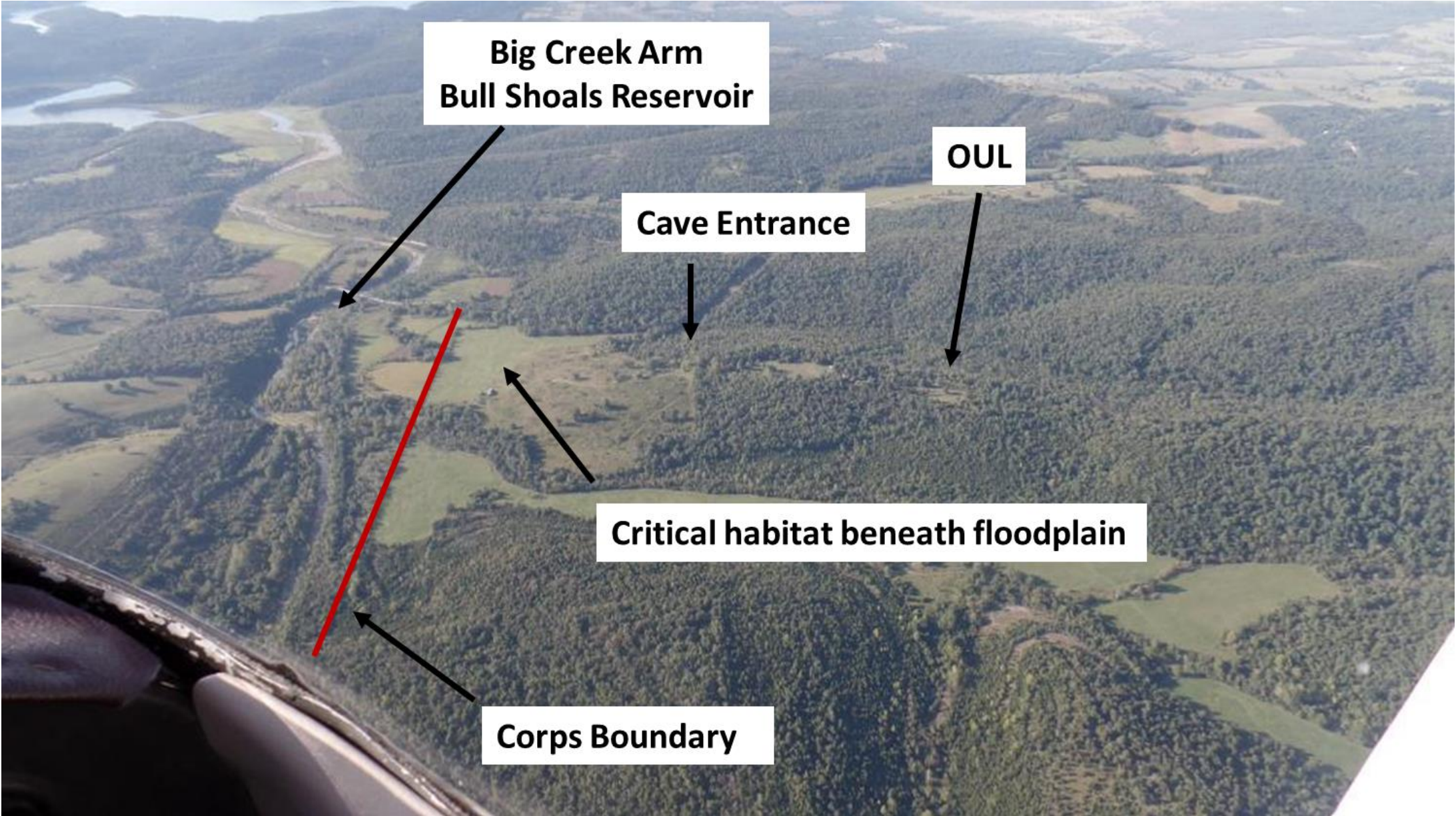


Tumbling Creek Cavesnail

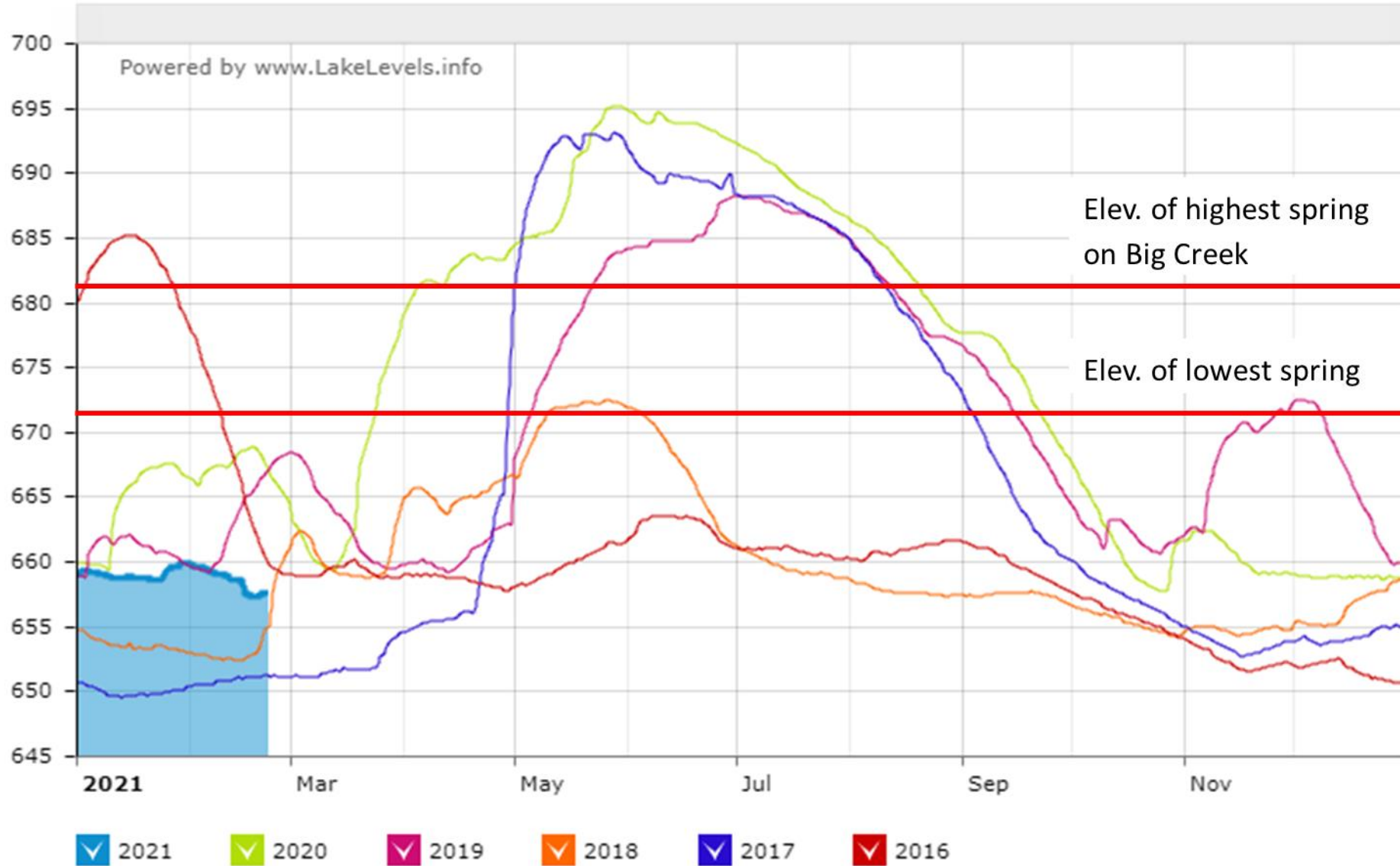
- Small, white, blind aquatic snail
 - 1-2mm in diameter
- Described as a new species in 1971
- Only known to exist in Tumbling Creek Cave
- Feeds on biofilm growing on rocks



Tumbling Creek Cavesnail



Tumbling Creek Cavesnail



Tumbling Creek Cavesnail

- Invasive Crayfish
- Trapping began in June, 2011
- MDC grants 2013-2021
- Since 2011 – 150 trapping events and about **5,500** crayfish removed

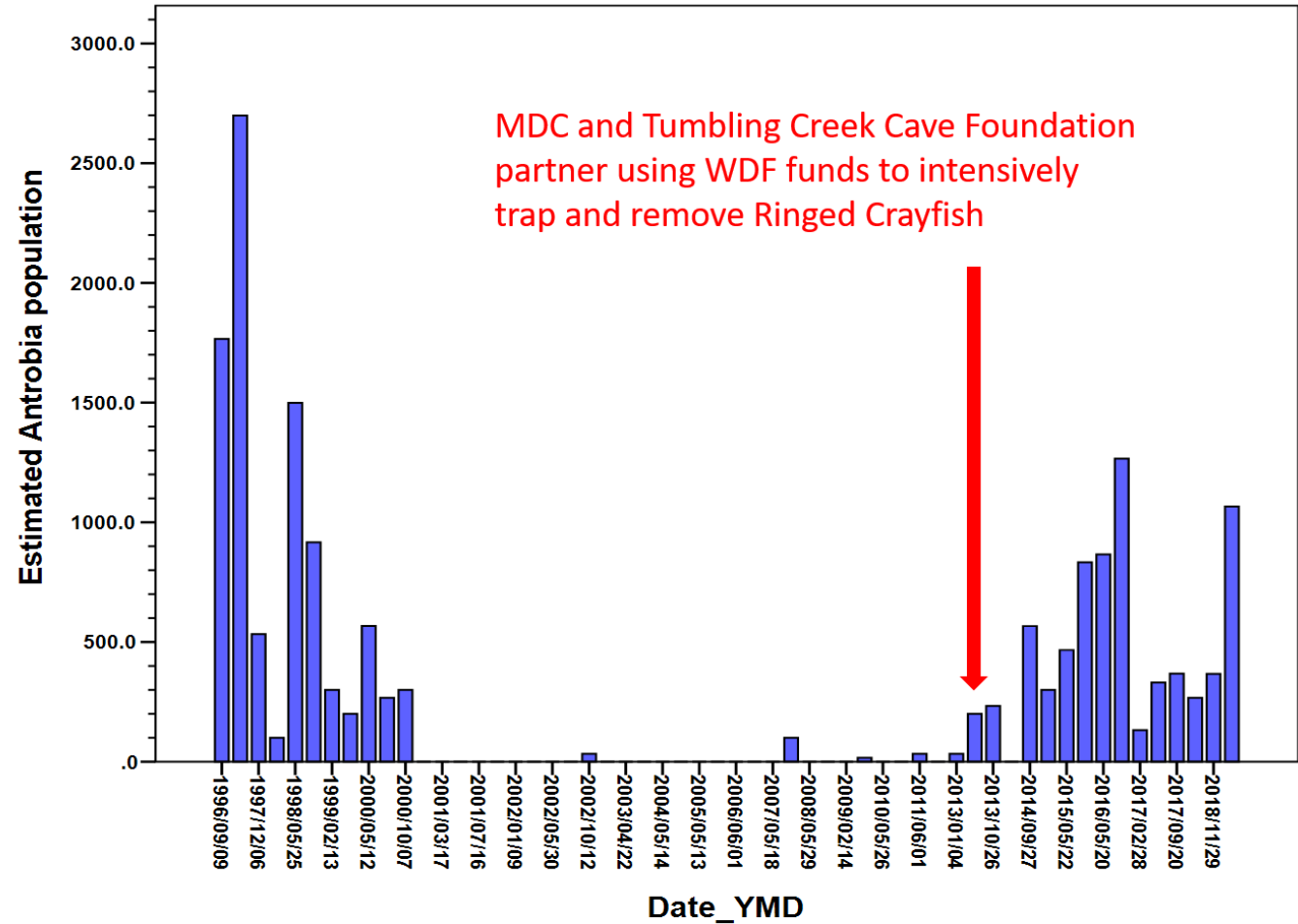


Fig. 1. Population estimates for *Antrobia culveri* (through 5/21/2019) within the sampling transect of Tumbling Creek Cave

Real World Examples

Down, but not straight down

Blanchard Springs Caverns Parking Lot

Blanchard Springs Caverns

- Ozark-St. Francis National Forest
- Developed as a show cave
- Year end money to improve parking areas



Blanchard Springs Caverns

- Infiltration beds and pavement
- Assumed water goes “straight down”
- Dye tracing showed significant lateral flow
 - Up to 784 feet



Real World Examples

The “Chimney Effect”

Uncontrolled Airflow in Oregon Caves National Monument, Oregon

Oregon Caves National Monument

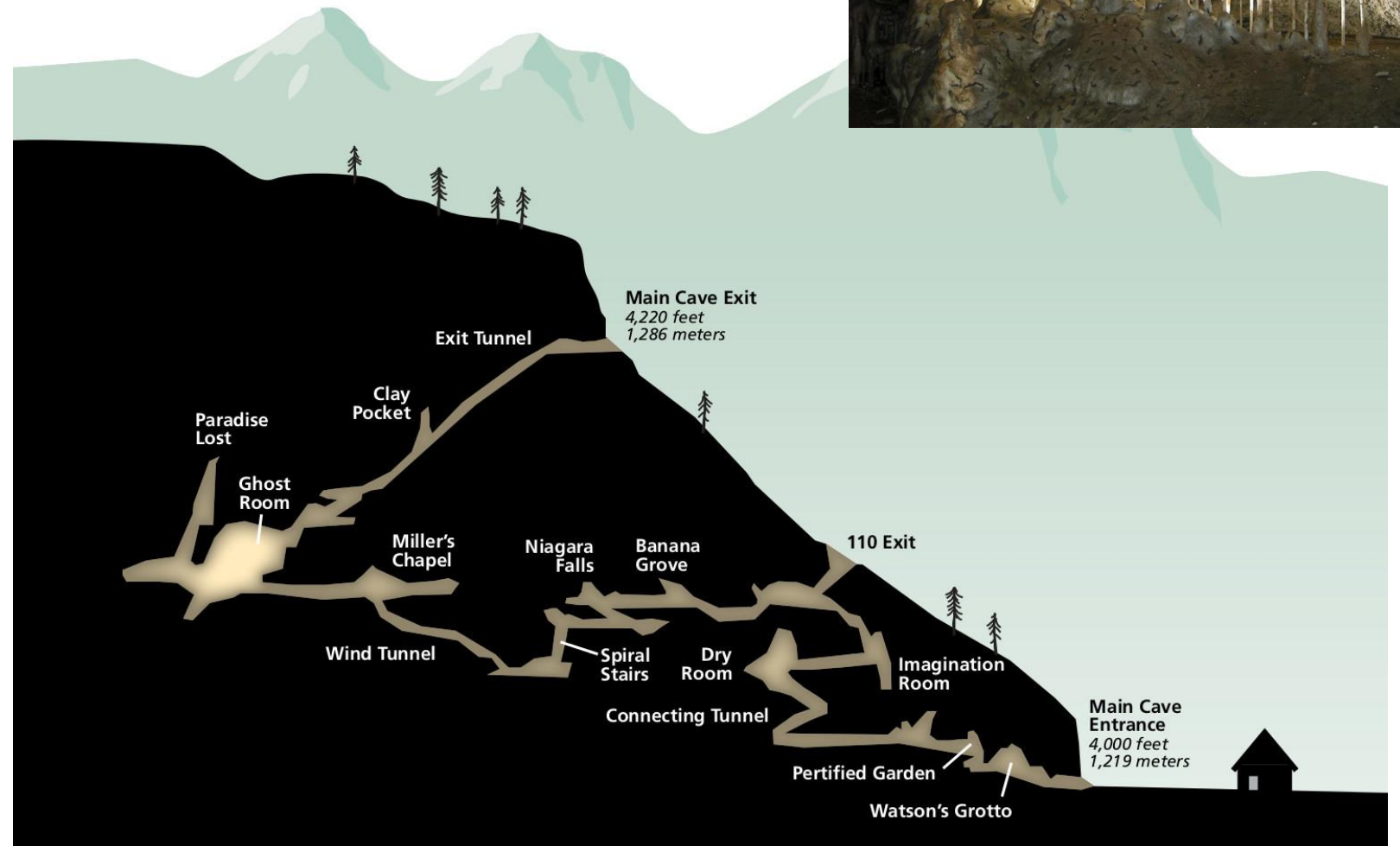
- National Park Service
- Development of connecting passages and an exit tunnel
- Desiccation of cave formations



Oregon Caves National Monument

- Elevation difference
 - 218 feet
- Unnatural airflow patterns
 - 5 fold increase
- Freezing of soda straws

www.npsmaps.com



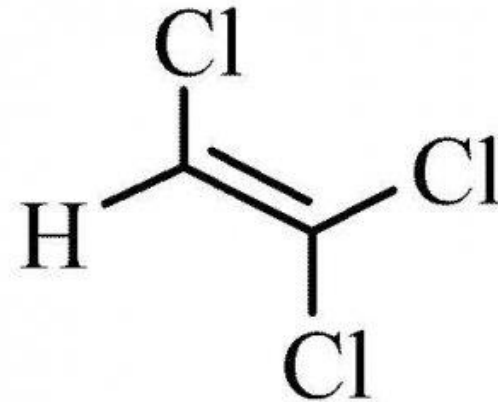
Real World Examples

Long Distance Migration of Contaminants

Trichloroethylene in Underground Air

Trichloroethylene in Underground Air

- Trichloroethylene (TCE)
- The Houdini of contaminants
- Used as an industrial solvent



Trichloroethylene in Underground Air

- TCE has affected two major show caves in Missouri
- Underground airflow 3-5 miles from Superfund Sites
- Significant and expensive mitigation
- Must minimize effects of unnatural airflow





Questions?

Contact us at:

www.ozarkundergroundlab.com

www.tumblingcreekcave.org

