

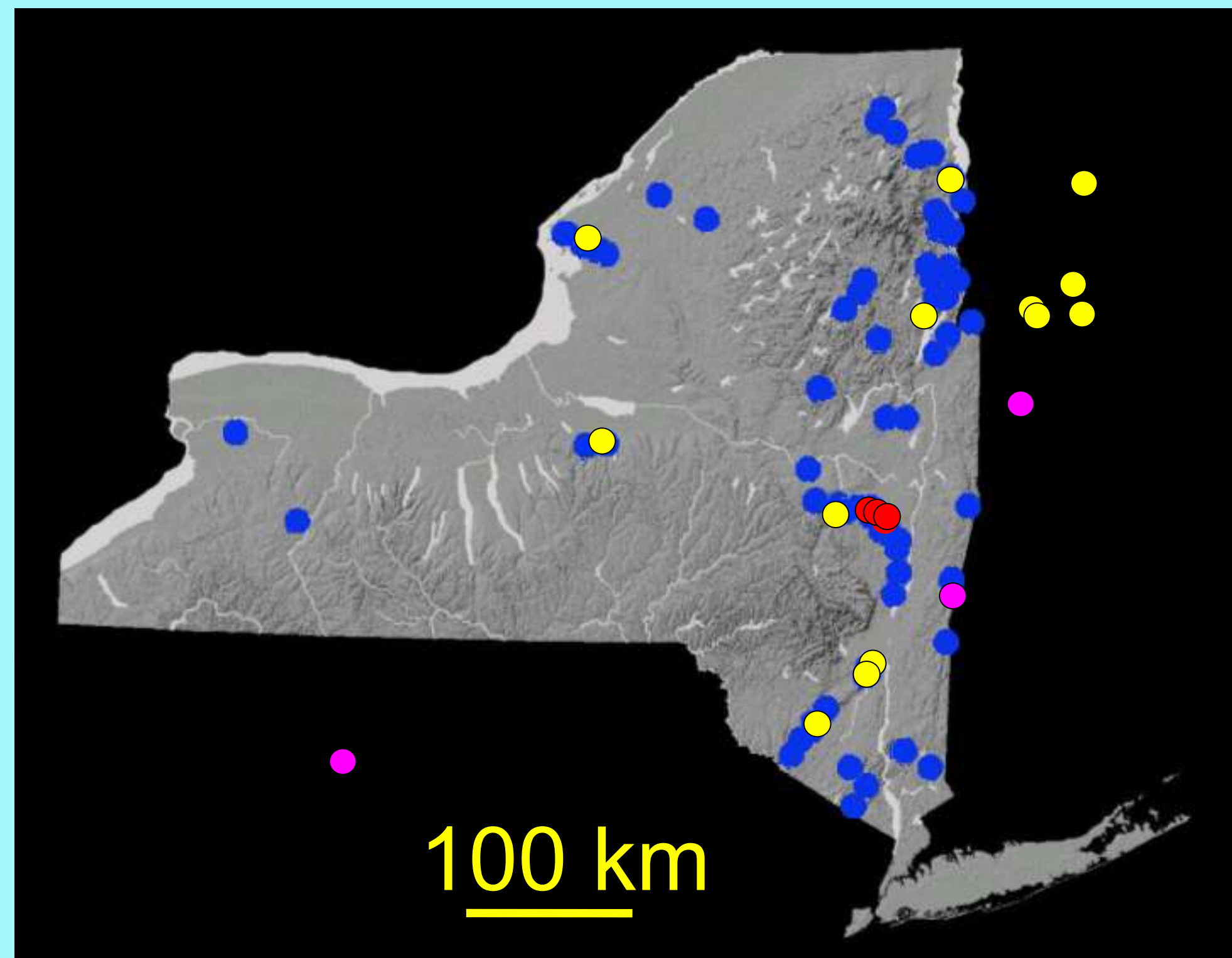
Unusual Winter Mortality Events at Four New York Hibernacula during 2007

Introduction:

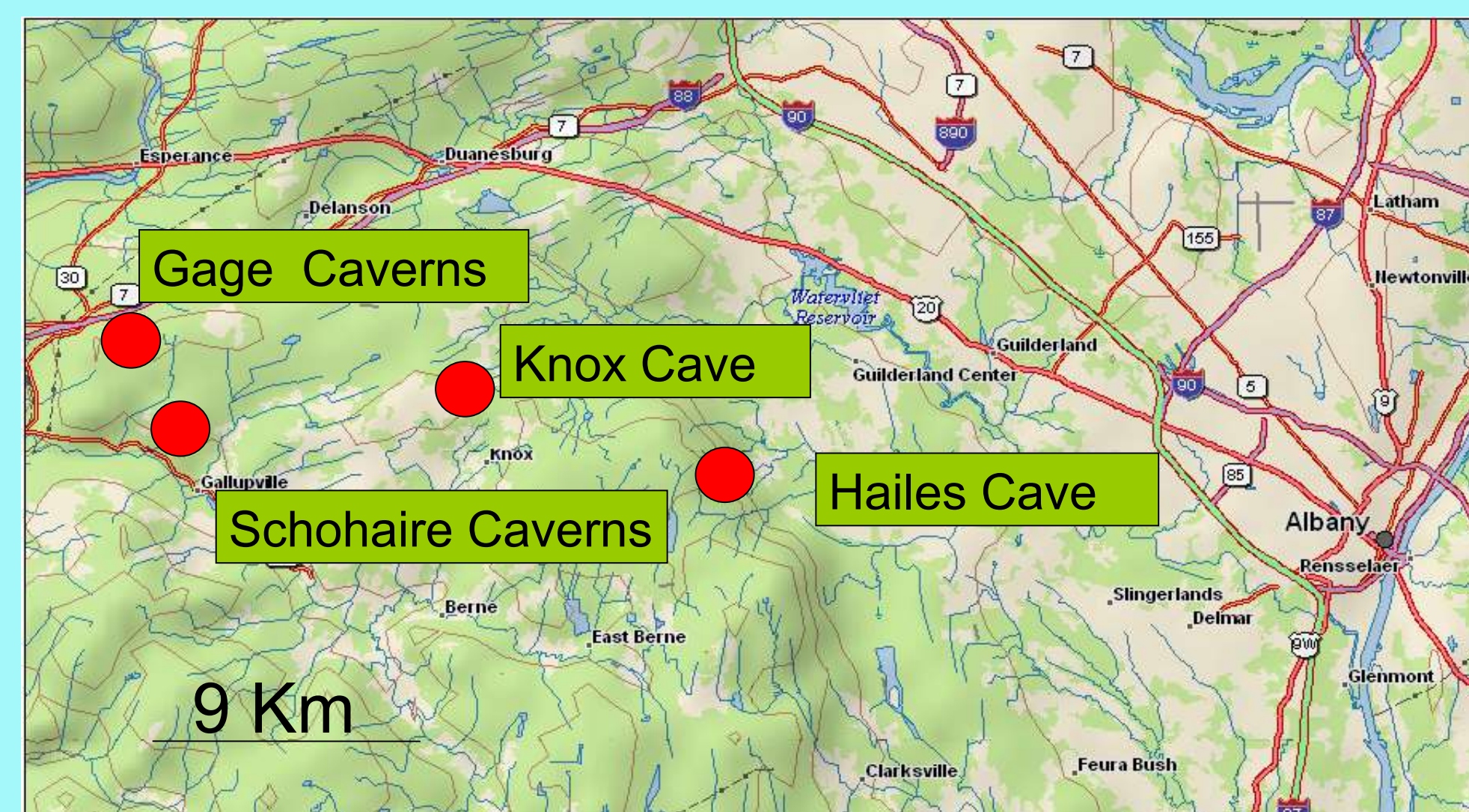
Mortality events at bat hibernacula have been attributed to a range of factors from vandalism (Greenhall 1973, Humphrey 1978, Murphy 1987) and flooding (Hall 1965, DeBlase et al. 1965, Hicks and Novak 2002) to freezing (Humphrey 1978, Richter et al. 1993). Declines in hibernating populations, without observations of direct mortality have been attributed to temperature increases due to air flow alterations (Richter et al. 1993, Humphrey 1978) and excessive human disturbance (Barbour and Davis 1969).

In this poster we describe mortality events that occurred in four New York hibernacula during the winter of 2007 for which we do not yet have an explanation. This is the first event of this nature that has come to our attention in the nearly 30 years that DEC has been monitoring bat hibernacula.

Study Area:

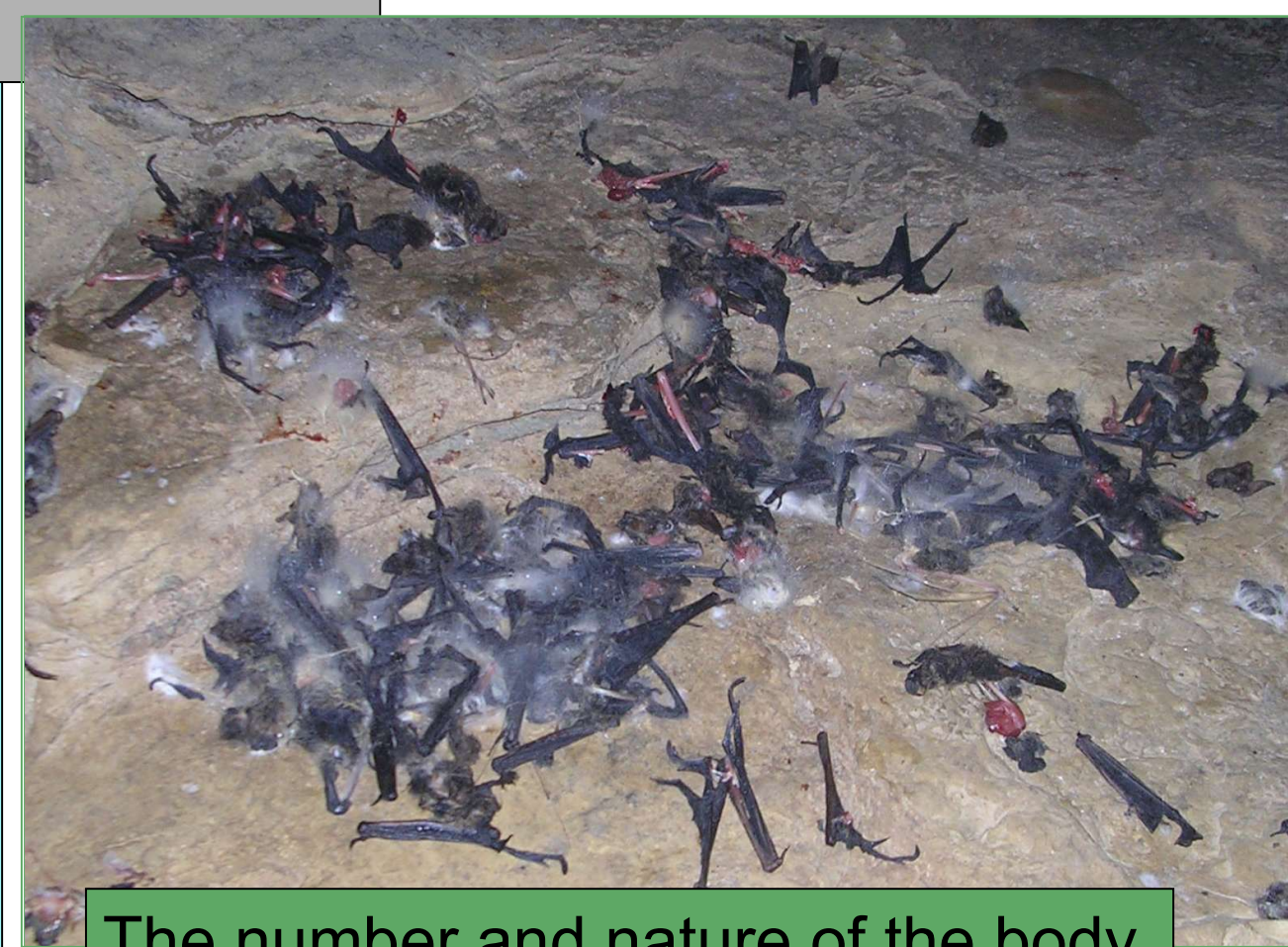


Mortality events were discovered at four New York hibernacula: Hailes and Knox Caves in Albany Co., and Gage and Schoharie Caverns in Schoharie Co. Hibernacula that were not found to contain dead bats included 8 sites in NY, the Glen Park Caves (Jefferson Co.), Barton Hill Mine (Essex Co.), Main Graphite Mine (Warren Co.), Howe Cavern (Schoharie Co.), Surprise Cave (Ulster Co.), and the three mines comprising the Williams Mine Complex (Ulster Co.). Five Vermont sites without mortality events included Greeley Mine (Windsor Co.), Ely Copper Mine (Orange Co.) Brandon Silver Mine and Nickwackett Cave (Rutland Co.), Plymouth Cave (Windsor Co.). We received reports of mortality events at three other sites (Centre Co., PA; Columbia Co., NY; and Bennington Co., VT) but these lacked sufficient detail and background to warrant inclusion in this report.



All 4 are within a 12 km radius, and all are single entrance solution caves with between 600 m and 1200 m of accessible passage occurring in the Coeymans or Manlius limestone formations. Hailes and Schoharie Caverns have entrances that are resurgent streams and are comprised of low gradient, single passages. Both Knox and Gage are more complex systems, and have entrances at their highest points. The greatest restriction of air flow at their entrances is roughly 4 and 1 sq. meters respectively.

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The number and nature of the body parts documented thus far, the lack of canine punctures in the wings membranes, and the distribution of some parts on small ledges suggests that at least some of these bats were consumed by *Peromyscus* spp. or similar sized mammals.

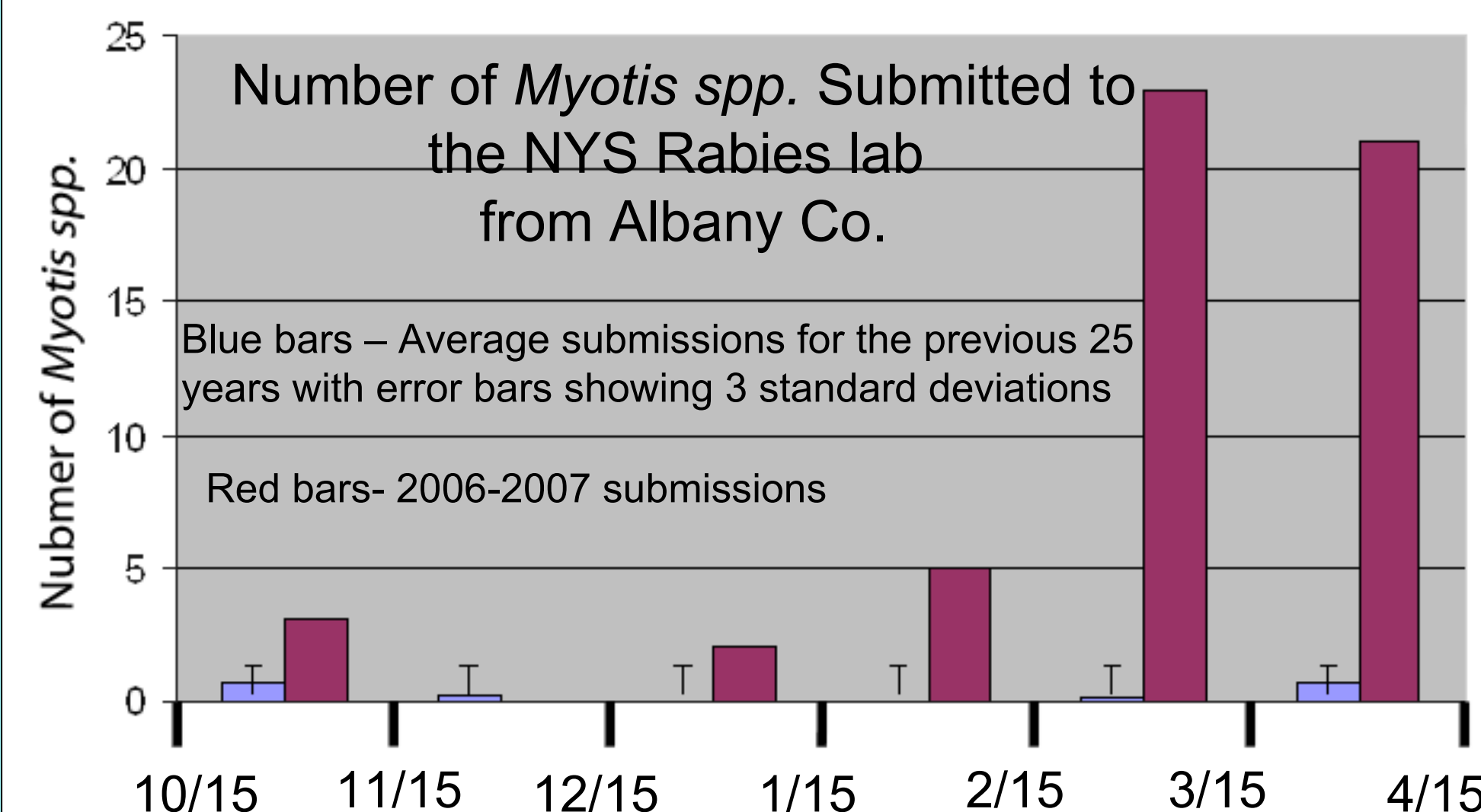
An abundance of raccoon droppings filled with bat bones, and the presence of mink droppings, indicate that substantial numbers of bats were consumed within Hailes Cave. There has never been evidence of predation in the 30 years we have been surveying the site, nor anything this year that would make live animals more vulnerable to predators. We believe that they were scavenged.



Site	# of Carcasses Recovered	# of Live Bats During the Most Recent Survey (year)	% Mortality
Hailes	count not yet complete	15,584 (2005)	NA
Gages	805	968 (1985)	83%
Knox	350	1,948 (2001)	18%
Schoharie Caverns	125	1,329 (2006)	8%

Although these mortalities do not involve particularly large numbers of bats, they do represent significant portions of the wintering populations. This is especially true given that many bats leave the hibernacula before dying, or the carcasses are scavenged.

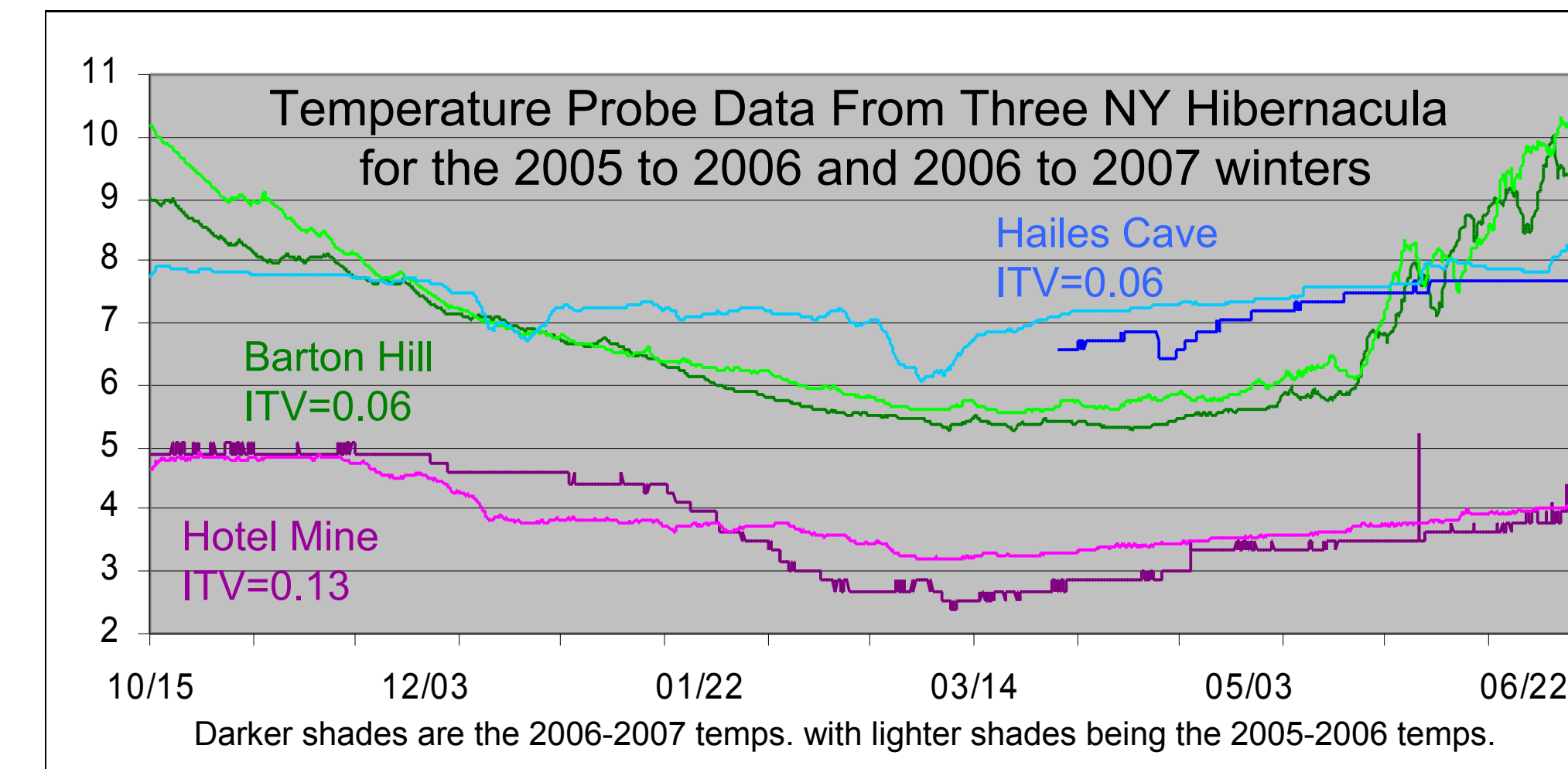
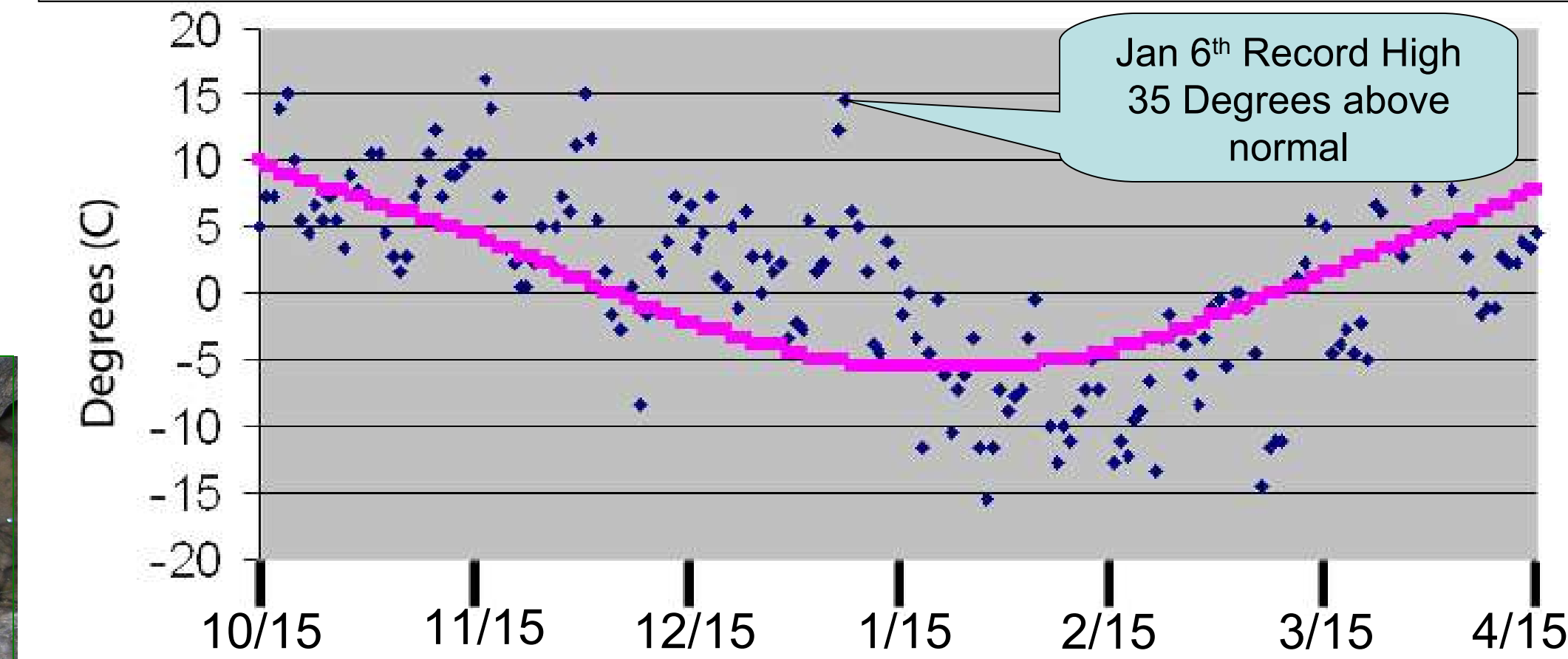
Site	Previous count (year)	2007 survey count	% Decline
Hailes	15,584 (2005)	6,735	56%
Schoharie Caverns	1,329 (2006)	478	64%



Submission to the Rabies Lab from Albany County clearly indicate that there were unusual numbers of *Myotis* on the landscape during the winter of 2007. Results indicate that bats began abandoning Hailes Cave after, but not during, the mid winter drop in temperatures. This suggests that the bats were not responding to the temperature change, but that some were dangerously short of fat reserves 1-2 months before they would typically emerge.

During February and March DEC received an unusually high number of reports from the public living in the general vicinity of Hailes cave about bats seen outdoors. Several individuals reported seeing multiple bats at the same time. Eight dead *Myotis lucifugus* were found in a woodpile at one nearby residence.

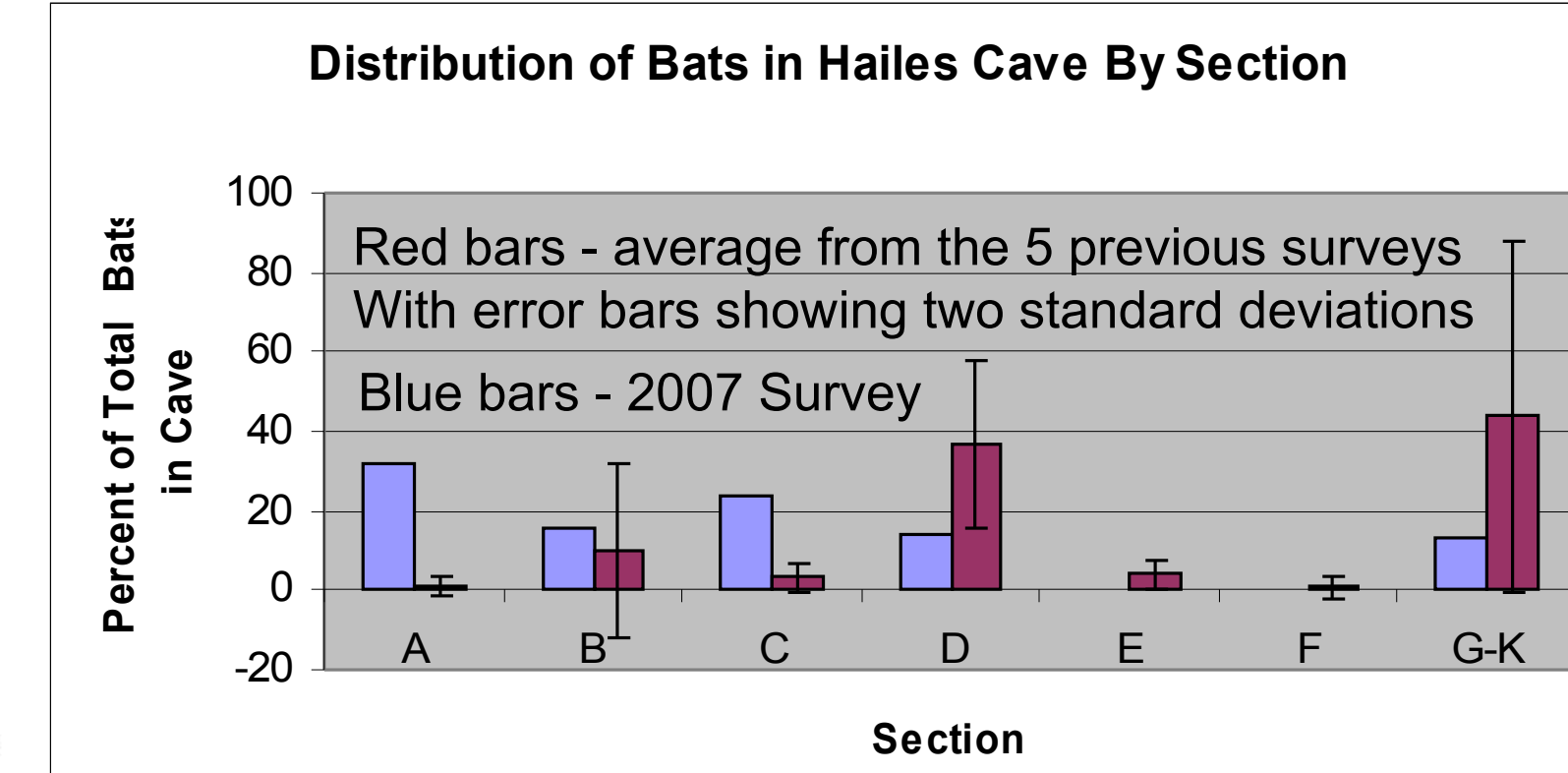
The 30 year mean daily temperature at Albany (pink) vs. mean daily temperatures during 2007 (blue). Note the near normal temperatures heading into the fall, including September (unlisted) turning to above average temperatures until about Jan 15 (including the warmest December on record). At that point they dropped to below average until near the end of the season. (National Weather Service Forecast office, Albany, NY). Normal fall temperatures should not have reduced the accumulation of fat reserves heading into the winter (Speakman and Rowland 1999). Whatever increased consumption rate caused by early winter warm temperatures should have been offset by late winter cold temperatures.



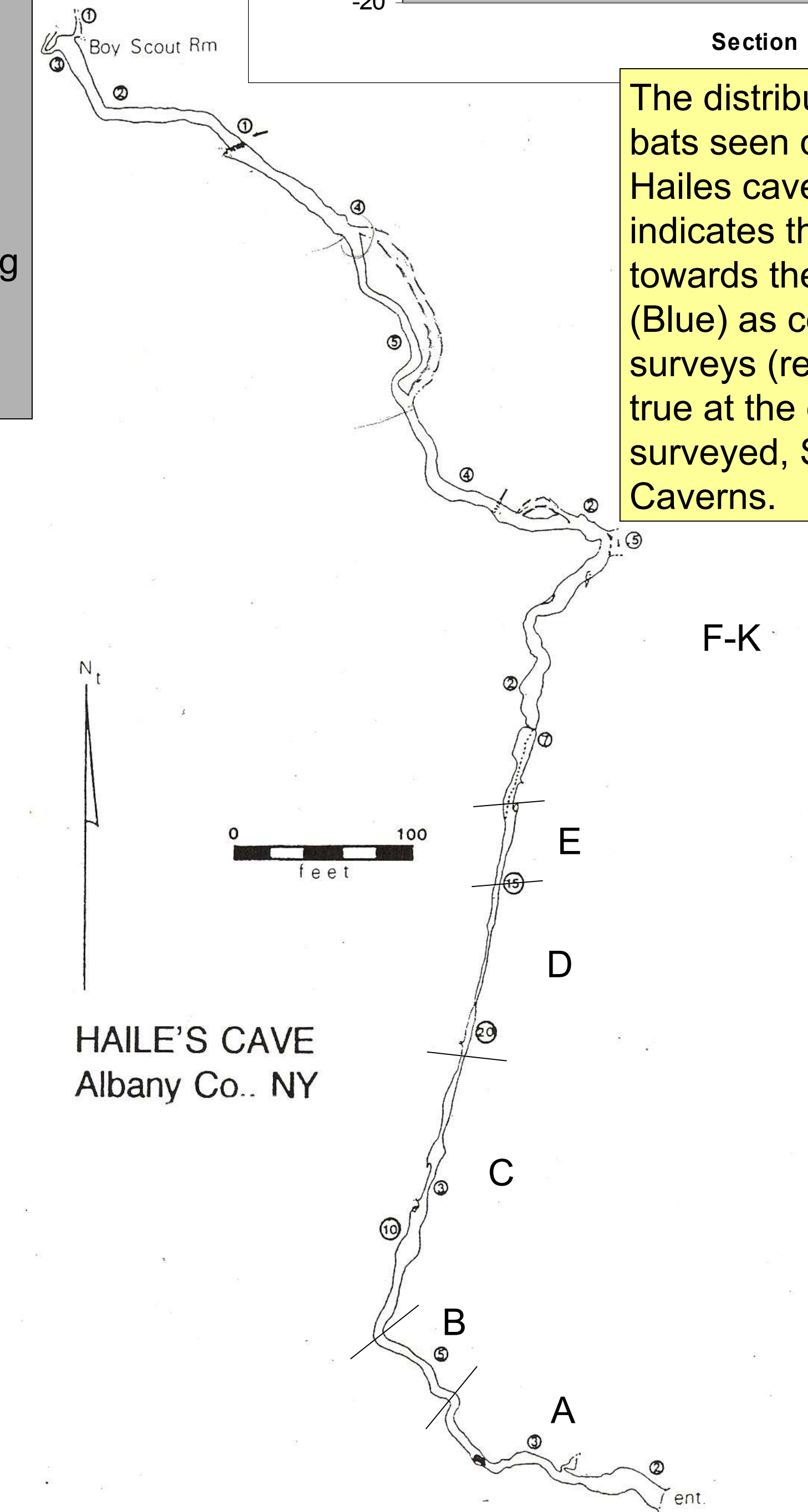
There were no temperature probes in Hailes Cave (Hailes Cave is the state's warmest known *Myotis sodalis* hibernacula) during this year until after the mortalities were discovered. However, by applying the "Index of Temperature Variability" (Tuttle and Kennedy 2002) which is a measure of the responsiveness of cave temperatures to outside temperature change, and using a baseline year common to NY hibernacula with similar ITV values (2005-2006), we can roughly estimate what Hailes Cave temperatures were likely to have been. These data suggest that mid winter temperatures at the portion of the cave containing the bulk of Indiana bats was not likely to have exceeded 8 deg C.



While conducting our biannual *Myotis sodalis* survey at Hailes Cave many, perhaps half, of the living bats were observed to have a white substance around their noses. This "white nose syndrome" was also observed on bats at Knox Cave. Periodic Acid Schiff (PAS) and hematoxylin and eosin stained sections of the snout, of three bats showing the white nose syndrome, showed extensive fungal growth on the surface of the skin and within associated sebaceous-type glands. A culture of snout material from the same bats yielded a growth *Fusarium* sp. a pathogenic fungus, along with the opportunistic yeast *Candida glabrata*. A possible explanation for the "halo" effect on the hairs and whiskers is that the fungal infection of the skin and glands resulted in glandular secretions and fungi sticking to hairs and whiskers resulting in the "halo" pattern. Additional histopathology will be conducted. Analyses for organochlorine pesticides and PCBs on the livers of two bats suggested that these environmental contaminants were not involved in this die-off. There was no evidence of rabies found in a sample of 21 bats from Hailes cave or from samples of *Myotis* spp. provided to the rabies lab by the public during this period. The necropsies and postmortem studies seem to indicate that the bats were weakened by malnutrition. Post mortem examination of 24 bats generally showed an absence or near absence of subcutaneous fat. Fungal infections of the skin and sebaceous glands (and perhaps elsewhere) occurred in some of the bats, but starvation is the likely principal cause of the mortalities.



The distribution of hibernating bats seen during the 2007 Hailes cave survey clearly indicates there was a shift towards the front of the cave (Blue) as compared to earlier surveys (red). The same was true at the only other site surveyed, Schoharie Caverns.



Discussion and Conclusions:

We have not yet finished the collection and analysis of data associated with this mortality event, and analyzed only a limited number of fresh specimens. Despite this, existing information does not suggest that organochlorine pesticides or PCBs were involved. Neither is there yet evidence to suggest that the die offs were caused by infectious, or parasitic disease, although the clumped distribution of the mortality events within the state might suggest otherwise. The shift of bats towards the front of Hailes Cave, and the potential exposure to lethal temperatures, was unlikely to have been a cause of mortality as temperatures should never have dropped below freezing in the area where most of the dead bats were found. Predation was not the cause, although many animals were scavenged at Hailes.

We do know that starvation is the likely cause of mortalities for most, but not all, of the animals examined to date. We have not yet examined carcasses from Knox, Gages or Schoharie or all those from Hailes. We also know that large numbers of animals chose to leave Hailes Cave beginning no later than February, nearly 2 months before their normal emergence, and died out on the landscape. One collected alive in a snow covered yard was fed and recovered, and was released in the spring.

This unusual mortality event likely arose from equally unusual circumstances. Two possibilities stand out, the record breaking warm temperatures of early winter, and the truly unusual appearance of the "white nose syndrome" on live bats in both Hailes and Knox Caves. None of the many bat researchers we contacted in the Eastern United States had ever seen it despite having collectively observed millions of hibernating bats. Although fungi were not implicated in the death of the three animals examined histopathologically, it seems likely to have been related to the mortality event in some way.

Although we did experience record warm, outside temperatures during early winter of 2007, it is not yet certain that hibernacula temperatures are responsible for the fat depletion. There are no temperature data for sites other than Hailes, but the structure of both Gages and Knox suggests that they might respond differently to outside temperature changes than either Schoharie or Hailes. The buffering capacity of Hailes Cave and temperature records from earlier years (Hicks unpublished data) suggests that the likely temperatures in the cave, while slightly above the range suggested as suitable for *sodalis* (Kennedy and Tuttle 2002) only occurred during the first half of the winter season. They were offset by equally cooler than normal temperatures during the second half.

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