Flooding of Hibernacula in Indiana: Are Some Caves Population Sinks?

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Introduction

Many species of bats hibernate in caves, but unfortunately, many caves also are conduits for water that occasionally flood, killing bats. Flooding is particularly troublesome because hibernating bats are insensitive to many types of environmental stimuli (Speakman et al., 1991; Twente and Twente, 1987), so they may not arouse from hibernation and escape. Because bats spontaneously arouse only once every 10 or more days (Brack and Twente, 1985; Hardin and Hassell, 1970), few individuals are likely to be aroused at the specific time that a flood occurs, thus allowing them to escape imminent danger. Even if the noise associated with flooding or actual contact with water disturbs bats that are in deep hibernation, arousal takes 30–40 min (Thomas et al., 1990), which may be too long to allow the animal to escape rapidly rising water.

Caves that attract bats for hibernation, but flood and cause mortality, may be population sinks (i.e., the population in the cave requires net immigration to sustain itself). Both chronic removal of a few individuals by frequent flooding and infrequent or sporadic removal of a large number of bats could affect population levels, because bats have such low fecundity. Knowledge that specific caves may be population sinks for some species, including those of special interest like the endangered Indiana bat (Myotis sodalis), present specific managerial and regulatory challenges.

A number of flood-related catastrophes have been recorded in North America. For example, skeletons of 300,000 Indiana bats were found in a flood-prone portion of Bat Cave, Kentucky (Hall, 1962). Ninety percent of a population of 5,000 little brown (Myotis lucifugus) and Indiana bats was drowned in Aitkin Cave, Pennsylvania, and in Wind Cave, Kentucky, all except 370 of 6,545 little brown and Indiana bats were killed (Mohr, 1972). An estimated 150 Indiana bats drowned when debris from forest clearing was bulldozed into a sinkhole, blocking a cave’s rainwater outlet, and debris that accumulated against the inside of a bat gate at the lower entrance of another cave acted as a dam, causing flooding and the death of 3,000 Indiana bats (United States Fish and Wildlife Service, 1999). In this note, we describe several instances of flooding in caves in Indiana, where mortality of bats was documented or inferred.

Bats and Flooding in Caves of Indiana

During surveys in 1991, 1999, and 2003, Mitchell Crushed Stone Quarry Cave, Lawrence County, contained 9–38 Indiana bats, 178–380 little brown bats, 41–65 eastern pipistrelles (Pipistrellus subflavus), and 162–224 big brown bats (Eptesicus fuscus—Brack et al., 2003). The nearby White River crested at 11 m on 9 January 2005, the highest level in 68 years, and on 17 January 2005, we could not enter the cave because of flooding. One month later on 17 February, floodwaters had receded somewhat, allowing us to access anterior portions of the cave. Twenty-five dead bats were found; the bodies were heavily decomposed, and most appeared as floating, amorphous, gelatinous balls of fungus. Fourteen were big brown bats, and eleven could be identified only as probable Myotis. Water flows sluggishly and towards the back of the cave,
but there is no stream in the front. Because currents were slow, dead bats in the front of the cave probably were found near where they died. Live bats in unflooded anterior portions of the cave included only 3 Indiana bats, 90 little brown bats, 21 eastern pipistrelles, and 76 big brown bats, or 8, 32, 32, and 43%, respectively, of the numbers found during the most recent survey in 2003 (Brack et al., 2003).

Anterior portions of the cave flooded to a depth of 5–7 m, and some of the ceilings in these areas remained above the floodwaters; deeper portions of the cave, however, were entirely flooded. Nevertheless, observations in previous years indicated that few bats typically hibernated in the high areas that escaped flooding in 2005. Most Indiana bats, for example, usually hibernated deep (low) in the cave, in a section that flooded completely in January 2005 and was still impassable one month later; consequently, most Indiana bats probably were killed, with only three present on 17 February. Despite the apparent risk, many of the living bats found on 17 February were hibernating in low areas that had flooded earlier in that winter.

Ashcraft Cave, Greene County, also is near the White River. This cave contained 20, 28, and 3 Indiana bats in 1993, 1995, and 1999, respectively (Brack et al., 2003). It also contained 190, 170, and 29 little brown bats during those same years, 6 and 14 eastern pipistrelles in 1993 and 1995, and 4 big brown bats in 1993. In 2005, 13 little brown bats and two eastern pipistrelles were the only bats found. Fresh mud and debris during our visit in 2005 indicated that water had risen ca. 2.3 m earlier in the winter, which would have inundated most of the cave, including areas typically used by hibernating bats of all species, resulting in the death of most bats. We believe that declines in abundance between 1995 and 1999 also likely were caused by flooding, although specific evidence was not documented.

In some cases, the portions of a cave that flood infrequently appear to attract bats so that the population increases during years between flooding events. Binkley Cave, Harrison County, contained 84 Indiana bats and 197 little brown bats on 12 January 1997. It flooded in early March 1997, and on 10 March, only three live bats and 10 dead bats were found (J. Benton, pers. comm.). However, four years later, on 10 February 2001, nine Indiana bats and 110 little brown bats were again hibernating in this cave. Salamander Cave, Monroe County, is well known for the dangers it presents to cavers when areas near the entrance flood. In 1982, 74 Indiana bats used this portion of the cave, but only one bat ever was found during five surveys between 1987 and 2005. This decline was more abrupt and complete than for other caves in the region, and we think it was attributable to flooding, rather than disturbance caused by cavers. On 23 January 2005, we visited Clifty Cave, Greene County, and found that an area of the cave used by hibernating Indiana bats had flooded prior to our visit; only two bats were using the area. This cave was surveyed 11 times between 1982 and 2005, yielding counts of 66–575 Indiana bats, with 0–44% of the population roosting in the area that floods. Over those years, the population of bats using the cave has been through two cycles of low and high numbers. Because we did not know when or how often this cave floods, we could not directly trace these population changes to flooding, but it was clear that bats that hibernated in this portion of the cave were very susceptible to drowning. Drowned bats would be washed from the cave, leaving no evidence of the kill.

There are many caves in Indiana that routinely flood, but which, nevertheless, attract a few bats. The following are two examples. Primitive Baptist Spring Cave, Monroe County, is a low wet cave with obvious signs of flooding to the ceiling in most places. Only nine bats, including an Indiana bat, were found during a survey in 2005, but most roosted in areas where they would be killed by flooding. In 2002, Bluff House Cave, Martin County, was visited. Only seven
eastern pipistrelles and one Indiana bat were discovered, but it was obvious that many portions of
the cave flooded. When visited in 2003, two little brown bats, two eastern pipistrelles, and two big
brown bats were seen.

In some cases, alteration by man, inside or outside the cave, may contribute to flooding. At
one time, Batwing Cave, Crawford County, contained 50,000 Indiana bats (Richter et al., 1978). In
1995, the entrance of nearby Big Windy Cave, which has a hydrologic connection to Batwing
Cave, was enlarged and extended into the bed of a small drainage. Water entering Big Windy
Cave via this drainage caused flooding in Batwing Cave to a level 11 m above normal, and in
1996, several hundred dead Indiana bats were found in the lower level of the cave, which houses
about 83% of this cave’s winter population (Johnson et al., 2002). The carcasses were in fresh
mud, and there was other evidence of recent flooding.

There are probably many more instances of mortality from flooding, but these are likely
overlooked, especially when few bats are involved. Floodwaters can disperse carcasses and
deposit drowned bats in hidden locations within the cave, or the bodies may be washed from the
cave. Dead bats may be buried in mud or scavenged by predators. Even when carcasses are
deposited where they can be found, remains are quickly reduced to bones, and unless these form
a large concentration, they are easily overlooked. After signs of a flood (e.g., debris on walls or
ceilings) have diminished, carcasses or bones cannot be easily related to a flooding event.
Finally, few caves are routinely entered by biologists, limiting the opportunity to discover flood-
related mortality.

Conclusions

Flood-related deaths may be an important source of mortality for some North American
species, especially the Indiana bat. There are 34 caves in Indiana known to have served as a
hibernaculum for at least one Indiana bat during at least one winter during the last 25 years
(Brack et al., 2003; V. Brack, Jr., unpublished data). Eight of these are known to have flooded,
with known or inferred kills of Indiana bats. Thus, 24% are potential population sinks.
Although, numbers of bats using most of these caves have been small, one cave once harbored
50,000 bats.

There are many issues with caves that act as population sinks. Should managers exclude
bats from caves that flood? At what point is the sink detrimental to the long-term health of local
populations or the species? Both Mitchell Crushed Stone Quarry and Ashcraft caves contain
large quantities of fresh mud and silt and are situated below a landscape that is dominated by
agriculture. Is flooding a result of surface activities, and have those activities converted once
suitable hibernacula into death traps? If so, how can the regulatory, conservation, and scientific
communities help landowners reduce flooding and the loss of bats? Finally, these caves may
provide an opportunity to understand better the mechanisms of colonization and characteristics
of caves that entice colonization.

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Literature Cited


