

CAVES HABITAT NARRATIVE

Habitat description

Subterranean Systems Caves: Connected underground rooms and passages beyond natural light penetration.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in caves habitat in Indiana:

Rank	Threats to wildlife in caves habitat
1	Habitat loss (breeding range)
2	Habitat loss (feeding/foraging areas)
3 (tie)	Specialized reproductive behavior or low reproductive rates
3 (tie)	High sensitivity to pollution
4	Bioaccumulation of contaminants
5	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
6	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
7	Small native range (high endemism)
8	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
9	Predators (native or domesticated)
10	Viable reproductive population size or availability
11	Near limits of natural geographic range
12	Diseases/parasites (of the species itself)
13	Unregulated collection pressure
14	Large home range requirements
15	Invasive/non-native species

Respondents offered additional threats to wildlife in caves habitat in Indiana (not ranked):

- Loss of forest habitat surrounding winter hibernacula/caves
- Need caves or mines for hibernation within 60 miles of summering ground
- Unregulated collection pressure/unregulated human activity

Appendix F-63: Caves

- Disturbance related to research/monitoring
- In hibernacula

Respondents listed top threats to wildlife in caves habitat in Indiana (not ranked):

- Human disturbance of hibernating bats
 - E.g., Ray's Cave in Greene County
 - Development/commercialization that allows for human visitation
 - Lack of education for cavers; education is critical to Indiana bat survival
 - Lack of cave gates: Gates are critical to Indiana bat survival
- Habitat loss, degradation
 - Some traditional hibernacula have been rendered unsuitable or degraded due to development/commercialization
 - Threats also occur within summer habitat (not addressed here because it is not captured within "cave habitat" category)
 - Modification of cave environment
 - Alteration of surface features
 - Alterations to microclimate within hibernacula
 - Loss of winter caves habitat
 - Loss of traditional roosting structures (large snags with sloughing bark)
- Pollution
 - Nonpoint sources: sediments and pesticides
 - Point sources: sewage and spills of chemicals transported by roads and rail

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the top threats to wildlife in cave habitat. There were no responses.

Habitat threats

Respondents ranked threats to caves habitat in Indiana:

Rank	Threats to caves habitat
1	Habitat degradation
2	Commercial or residential development (sprawl)
3	Climate change
4 (tie)	Habitat fragmentation
4 (tie)	Agricultural/forestry practices
5 (tie)	Residual contamination (persistent toxins)
5 (tie)	Point source pollution (continuing)
6	Nonpoint source pollution (sedimentation and nutrients)
7 (tie)	Stream channelization
7 (tie)	Impoundment of water/flow regulation
8	Mining/acidification
9	Drainage practices (stormwater runoff)

Appendix F-63: Caves

- 10 (tie) Successional change
- 10 (tie) Invasive/non-native species
- 11 Diseases (of plants that create habitat)

Respondents noted other threats to caves habitat in Indiana (not ranked):

- Dumping refuse in sinkholes; refuse often contains persistent toxins associated with transformers, tires, appliances, pesticide containers and electronic devices
- Loss of habitat (caves and mines)

Respondents listed top threats to caves habitat in Indiana (not ranked):

- Habitat loss, degradation, fragmentation
 - Of forested areas surrounding caves used by bats during the fall swarming period
 - Of breeding habitat (note that breeding habitat also occurs in areas not associated with caves)
 - Of roost trees and other habitat via man-related activities (commercial, agricultural, etc.)
 - Of caves and mines needed for hibernation
 - By potential migration of chemicals that alter cave ecosystems
 - Point and nonpoint pollution associated with increasing human population in Southern Indiana

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the top threats to caves habitat. There were no responses.

Additional research and survey efforts

Current body of research

Species research

Seventeen percent of respondents stated that the current body of science for wildlife in caves habitat in Indiana is adequate; fifty percent stated that it is inadequate. A respondent also noted, "There is lots of research but also great need due to endangered status."

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in cave habitats in Indiana.

Title = Distribution and status of the northern cavefish;
Author = Pearson, W. D. and C. Boston;
Date = 1995;
Publisher = Final report to IN Department of Nat. Res.Div. of F&W

Title = Age, growth and fin erosion of the northern cavefish, *Amblyopsis spelaea*, in KY and IN;
Author = Louis, M.;
Date = 1999;
Publisher = Unpubl. M.S. Thesis, University of Louisville

Appendix F-63: Caves

Title = Wintering populations of bats in Indiana, with emphasis on the endangered Indiana Myotis, *Myotis sodalis*;

Author = Virgil Brack, Jr., Scott A. Johnson, and R. Keith Dunlap;

Date = 2003;

Publisher = Proceedings of the IN Academy of Science

Title = Management of hibernacula in the state of Indiana;

Author = Johnson, Brack, Dunlap;

Date = 2002;

Publisher = Bat Conservation International

Title = Biennial hibernacula survey reports;

Publisher = reports submitted to IDNR

Title = Home range near hibernacula in spring and autumn;

Author = Russell C. Romme, Amy B. Henry, R. Andrew King, T. Glueck, and K. Tyrell;

Date = 2002;

Publisher = The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International

Title = The nonhibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, *Myotis sodalis*;

Author = Virgil Brack, Jr.;

Date = 1983;

Publisher = Purdue University

Title = Brack, Johnson and Dunlap, 2003.;

Publisher = Proc. Ind. Acad. Sci. 112: -61-74.

Title = Mumford and Whitaker 1982

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in cave habitat. There were no responses.

Habitat research

Seventeen percent of respondents stated that the current body of science for caves habitat in Indiana is adequate; sixty-seven percent stated that it is inadequate.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of cave habitats in Indiana.

Title = Cave adaptation in Amblyopsid fishes;

Author = Poulson, T.;

Date = 1963;

Publisher = Amer. Midl. Nat. 70(2):257-290

Title = A faunal inventory of subterranean streams using a modified index of biotic integrity;

Author = Jones, T.G.;

Date = 1997;

Publisher = Unpubl. Ph.D. Disst. University of Louisville

Appendix F-63: Caves

Title = Hibernacula of the endangered Indiana bat in Indiana;
Author = Brack, Virgil Jr., A.M. Wilkenson, R.E. Mumford;
Date = 1984;
Publisher = Proceedings of the Indiana Academy of Science, vol. 93:463-468

Title = Distribution and ecology in Indiana. Pp 48-54 in Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, Eds.); Author = John Whitaker Jr. & Virgil Brack Jr.;
Date = 2002;
Publisher = Bat Conservation International

Title = Mumford and Whitaker 1982

Title = Veilleux et al. 2003.;
Publisher = J. Mamm, 841068-1075.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for cave habitat. There were no responses.

Research needs

Species research

Respondents ranked research needs for wildlife in caves habitat in Indiana:

Rank	Research needs for wildlife in caves habitat
1	Threats (predators/competition, contamination)
2 (tie)	Relationship/dependence on specific habitats
2 (tie)	Limiting factors (food, shelter, water, breeding sites)
3	Distribution and abundance
4	Population health (genetic and physical)
5	Life cycle

Respondents noted additional research needed for wildlife in caves habitat in Indiana (not ranked):

- Urgent need to determine effects of loss/fragmentation/timber management on summer habitats and forests regarding maternity colonies and reproductive success
- More information needed on autumn swarming and spring staging. Similarly, new hibernacula need to be recorded
- Metapopulation dynamics
- Extent of populations in subterranean systems which cannot be entered by humans
- Need to know more about rabies in bats

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wildlife in cave habitat. There were no responses.

Appendix F-63: Caves

Habitat research

Respondents ranked research needs for caves habitat in Indiana:

Rank	Research needs for caves habitat
1	Threats (land use change/competition, contamination/global warming)
2	Relationship/dependence on specific site conditions
3	Distribution and abundance (fragmentation)
4	Growth and development of individual components of the habitat
5	Successional changes

Respondents noted additional research needs for caves habitat in Indiana (not ranked):

- How much forest habitat needs to remain around a hibernaculum to sustain a population of "size X" during the fall swarming period?
- Indiana bats:
 - How does cave environment, especially temperature and temperature stability, affect suitability and use of cave by Indiana bats
 - What components of habitat immediately surrounding caves are most important to Indiana bats during fall swarming and spring staging? How is this habitat used
- Recommend a detailed analysis of forest canopy to openness ratio and habitat intricacies that provide preferred home range requirements, e.g. primary roosts, secondary roosts, water, night roosts, food
- Cave fishes:
 - Physical dimensions of the phreatic environment available to cavefishes
 - Connections between known windows into the system
 - Toxin concentrations in cave sediments and their recruitment rates into underground waters
- Need to know more of the relationship between winter and summer habitat, and migration

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for cave habitat. There were no responses.

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in caves habitat in Indiana:

Appendix F-63: Caves

Rank	Conservation efforts for wildlife in caves habitat
1 (tie)	Habitat protection
1 (tie)	Regulation of collecting
2	Threats reduction
3	Public education to reduce human disturbance
4	Limiting contact with pollutants/contaminants

Respondents noted additional conservation efforts for wildlife in caves habitat in Indiana (not ranked):

- To control human disturbance
 - Posting signs at caves
 - Install bat-friendly gates
 - Install fake video cameras to deter cave visits
 - Use light-sensitive "speloggers" to monitor human visitation
 - Manage research-related disturbance
- Habitat acquisition and protection
 - Protect caves and mines in which bats occurs
 - Land acquisition

Respondents recommended these practices for more effective conservation of wildlife in caves habitat in Indiana (not ranked):

- Reduce human disturbance
 - Negotiate with owner of Ray's Cave and other hibernacula to allow them to be gated or employ one or more techniques to control human disturbance (see Q44 above)
 - Gating
 - Limit public access to population concentrations already under agency control at Harrison/Crawford State Forest and Spring Mill State Park
 - Indiana bat/other bats: Public education is needed on importance of caves, snags and importance of bats to man
- Habitat protection, acquisition
 - Secure conservation easements
 - Purchase unprotected hibernacula (prioritizing on current numbers or potential of hibernacula to harbor large numbers if disturbance is presently limiting numbers)
 - Protect surface features and forest cover surrounding hibernacula and manage for high quality swarming habitat
 - Purchase and protect recorded Indiana bat hibernacula and summer habitat
 - Protect caves and mines
 - Acquire and protect a reserve at Blue Springs Caverns

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the effective conservation of wildlife in cave habitat. Their responses included:

- Regarding the bulleted item, "Install fake video cameras to deter cave visits" under the "To control human disturbance" heading above...

PLEASE remove the word "fake" from this item ASAP!!! Especially if this website is accessible to the general public. Let's not let the www in on an effective means of deterring would-be cavers and/or vandals at sensitive sites. Thanks.

Appendix F-63: Caves

Habitat actions

Respondents ranked conservation efforts by how well they address threats to caves habitat in Indiana:

Rank	Conservation efforts for caves habitat
1	Technical assistance
2	Cooperative land management agreements (conservation easements)
3	Restrict public access and disturbance
4	Protection of adjacent buffer zone
5 (tie)	Land use planning
5 (tie)	Habitat protection on public lands
6	Habitat protection through regulation
7 (tie)	Habitat restoration on public lands
7 (tie)	Pollution reduction
7 (tie)	Habitat protection incentives (financial)
7 (tie)	Habitat restoration through regulation
7 (tie)	Corridor development/protection
7 (tie)	Habitat restoration incentives (financial)
7 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
7 (tie)	Managing water regimes

Respondents listed additional conversation efforts for caves habitat in Indiana (not ranked):

- Public education
 - On retaining old, dead or dying trees that provide habitat for wildlife, including Indiana bat
- Restrict human access
 - Closing access or year-round gating of caves with large populations of hibernating or reproducing bats will ensure normal trophic cascades for those systems
 - Restrict recreational caving in some caves might reduce periodic disturbances, increases in turbidity and remobilization of toxins in sediments

Respondents recommended the following practices for more effective conservation of caves habitat in Indiana (not ranked):

- Conservation easements
 - On private property containing important swarming habitat and connected karst features around key hibernacula
 - With selected cave owners in Orange, Washington, Lawrence and Harrison counties

Appendix F-63: Caves

- Restrict human access
 - Establish reserve at Blue Springs Cavern
 - Restrict entry to caves at Harrison/Crawford State Forest

Respondents instructed readers to see answers to question 47 as well.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for effective conservation of cave habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in caves habitat in Indiana (not ranked):

- Periodic statewide (less than once a year but still regularly scheduled) monitoring
- Occasional statewide (less than once a year and not regularly scheduled) monitoring
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring

Respondents were aware of the following monitoring efforts by other organizations for wildlife in caves habitat in Indiana (not ranked):

- Statewide once a year monitoring
- Periodic statewide (less than once a year but still regularly scheduled) monitoring
- Occasional statewide (less than once a year and not regularly scheduled) monitoring
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in caves habitat in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in caves habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2	Periodic statewide (less than once a year but still regularly scheduled) monitoring
3	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
4	Statewide once-a-year monitoring
5 (tie)	Regional or local once-a-year monitoring
5 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring

Appendix F-63: Caves

6 Regional or local year-round monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in caves habitat in Indiana:

Rank	Monitoring efforts by other organizations for conservation of wildlife in caves habitat
1	Periodic statewide (less than once a year but still regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
4 (tie)	Regional or local once-a-year monitoring
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
4 (tie)	Statewide once-a-year monitoring
5 (tie)	Statewide year-round monitoring
5 (tie)	Regional or local year-round monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in caves habitat in Indiana (not ranked):

- I-bat hibernacula
- Indiana bat monitoring
 - IDNR: Conducts biennial hibernacula surveys in all known Indiana bat hibernacula in the state (except Batwing and Twin Domes caves, which are surveyed under a separate federal contract)
 - State agencies occasionally monitor/research cave habitats on a local basis for specific purposes (such as the swarming bat habitat study at Wyandotte Cave)
 - Monitoring is also occasionally conducted in summer habitat (not included in this survey)
 - Caves in Southern Indiana are monitored. Currently there are 33 hibernacula reported for Indiana bat here

Respondents listed regional or local monitoring by other organizations for wildlife in caves habitat in Indiana (not ranked):

- Indiana bat:
 - Rick Clawson, Missouri DOC, conducts biennial winter surveys at Twin Domes and Batwing caves
 - Indiana Karst Conservancy (Keith Dunlap) also assists with monitoring efforts, especially at hibernacula that they own or oversee.
 - I have monitored the I-bat population in Reeves Cave in Monroe County
- There are surveys conducted throughout Indiana, primarily in summer habitat; cave habitat work addresses specific management or research needs. For example, surveys are conducted at all Department of Defense properties

Appendix F-63: Caves

- University of Louisville has been monitoring the Northern Cavefish at irregular intervals and locations in southern Indiana since 1994
- Biyearly monitoring for cave bats in about 18 caves in which Indiana myotis is known to hibernate

Respondents listed organizations that monitor wildlife in caves habitat in Indiana (not ranked):

- Indiana DNR (Dr. Virgil Brack/ESI, Keith Dunlap, Scott Johnson)
- Indiana Karst Conservancy
- Local NSS Grotto members
- U.S. Fish and Wildlife Service
- USDA Forest Service
- Department of Defense
- U.S. Army Corps of Engineers
- Educational institutions with federal permits
 - Purdue University
 - Indiana State University
 - University of Louisville, Biology Department
- Ecological consultants with federal permits
- Local/county agencies
- Indiana Cave Survey
- Private conservation organizations

Respondents considered monitoring techniques for wildlife in caves habitat in Indiana:

Monitoring techniques for wildlife in caves habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	X	--	--
Modeling	X	X	--
Spot mapping	--	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	--	--
Mark and recapture	X	X	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	X	--	--
Representative sites	X	X	--

Appendix F-63: Caves

- 1 Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
- 2 Periodic regional or local (less than once a year but still regularly scheduled)
- 3 Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
- 4 Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
- 5 Statewide once-a-year inventory and assessment
- 6 (tie) Statewide annual inventory and assessment
- 6 (tie) Regional or local year-round inventory and assessment
- 6 (tie) Regional or local once a year inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of caves habitat in Indiana:

Rank	Inventory and assessment by other organizations for conservation of caves habitat
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
3	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for caves habitat in Indiana (not ranked):

- Cave habitat is assessed when winter surveys of hibernacula are conducted statewide
- State conducted annual monitoring of the cave environment in most major hibernacula
- Human disturbance in key hibernacula is also monitored
- The contractor who conducts the biennial hibernacula surveys also documents information on cave condition (e.g., breakdown) and makes management recommendations
- Karst regions and summer habitat in Indiana
- South-central Indiana

Appendix F-63: Caves

Respondents listed regional or local inventory and assessment by other organizations agencies for caves habitat in Indiana (not ranked):

- Completed by Rick Clawson, Missouri DOC, for Twin Domes and Batwing caves
- Completed by USFWS for Reeves Cave and others
- Several organizations collect information on the location and condition of caves, as well as the presence of bats in caves, which provides useful information
- Karst regions and summer habitat in Indiana
- Hoosier National Forest
- Harrison/Crawford State Forest
- Spring Mill State Park
- Caves of south-central Indiana

Respondents listed organizations that monitor caves habitat in Indiana (not ranked):

- Indiana Karst Conservancy
- NSS Grottos
- U.S. Fish and Wildlife Service
- I-69 bat consultants
- The Nature Conservancy
- U.S. Geological Survey
- Indiana Cave Survey
- USDA Forest Service
- Indiana Department of Natural Resources
- Indiana Cave Survey
- Ecological consultants (federal permit holders)
- Universities (federal permit holders)
 - Purdue University
 - Indiana State University
 - University of Louisville
- Virgil Brack and his company

Respondents considered inventory and assessment techniques for caves habitat in Indiana:

Inventory and assessment techniques for caves habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	--	--
Aerial photography and analysis	X	--	--
Systematic sampling	X	X	--
Regulatory information	X	--	--
Participation in land use programs	--	X	--
Modeling	X	X	--
Voluntary landowner	X	--	--

Appendix F-63: Caves

reporting

Respondents listed additional inventory and assessment techniques for caves habitat in Indiana (not ranked):

- Temperature and relative humidity monitoring with remote dataloggers
- Cave survey

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for cave habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in caves habitat in Indiana (not ranked):

- Continue ongoing biennial winter surveys at all known hibernacula
- Indiana bats
 - Biennial hibernacula surveys (which I would classify as "professional survey/census") are the only means currently available to track Indiana bat population trends on a statewide or range-wide basis.
 - Survey and monitoring activities conducted in summer habitat to: 1) evaluate summer distribution in the state, and 2) evaluate roosting and foraging habitat use/needs. These surveys are conducted in Indiana as well as other states
 - Trapping for Indiana bat includes mist netting and harp trapping
- Hibernacula counts to track population levels (already being done)
- Intensive radio telemetry that tracks roost and foraging movements of specific colonies in representative areas across the state
- Internal cave surveys are important and more emphasis should be placed on the use of AnaBat
- Development of an index of biotic integrity (IBI) for vertebrate cave communities in southern Indiana
- Select 5 to 10 locations for survey/counts every two to five years. A similar survey schedule has been established for cavefish populations in Mammoth Cave National Park and could be used as a model (both IBI and survey)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation for wildlife in cave habitat. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of caves habitat in Indiana (not ranked):

- Cave microclimate monitoring with dataloggers should continue. A range-wide protocol for monitoring cave temperature and humidity has been developed by Bat Conservation International and is being widely used (contact Jim Kennedy or Merlin Tuttle at BCI). I believe Scott Johnson has been following this protocol in Indiana
- Cave microclimate data used in conjunction with results of hibernacula surveys

Appendix F-63: Caves

- Techniques to link summer/winter populations (new genetic techniques such as stable isotope analysis; pit tagging)
- Information on habitat use/needs in the vicinity of caves during swarming is a critical need. At present, radio telemetry represents the best potential to collect this information
- Population surveys every five years and development of an IBI to be applied at five to 10 critical locations. These to include Blue Spring Caverns, Spring Mill State Park, and Harrison/Crawford State Forest
- Cave survey in winter, and net survey in summer

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of cave habitat. There were no responses.