Myotis sodalis - Miller and Allen, 1928
Indiana Myotis

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Other English Common Names: Indiana Bat, Indiana bat
Taxonomic Status: Accepted
Related ITIS Name(s): *Myotis sodalis* Miller and Allen, 1928 (TSN 180001)
French Common Names: chauve-souris de l'Indiana
Unique Identifier: ELEMENT_GLOBAL.2.100428
Element Code: AMACC01100
Informal Taxonomy: Animals, Vertebrates - Mammals - Bats

Kingdom	Phylum	Class	Order	Family	Genus
Animalia	Craniata	Mammalia	Chiroptera	Vespertilionidae	Myotis

Genus Size: D - Medium to large genus (21+ species)

Check this box to expand all report sections: ☐

Concept Reference

Concept Reference: Wilson, D. E., and D. M. Reeder (editors). 1993. Mammal species of the world: a taxonomic and geographic reference. Second edition. Smithsonian Institution Press, Washington, DC. xviii + 1206 pp. Available online at: http://www.nmnh.si.edu/msw/.
Concept Reference Code: B93WIL01NAUS
Name Used in Concept Reference: *Myotis sodalis*

Conservation Status

NatureServe Status

Global Status: G2
Global Status Last Reviewed: 12Mar2015
Global Status Last Changed: 04Nov1996
Ranking Methodology Used: Ranked by calculator
Rounded Global Status: G2 - Imperiled
Reasons: Wide range in the eastern United States; total population exceeded 500,000 in 2013; most of the population hibernates in relatively few caves, which makes the species exceptionally vulnerable to disturbance by humans and to local habitat (cave) changes; suitable summer habitat (forest) remains plentiful, and recent surveys have found numerous maternity colonies; species is vulnerable to white-nose syndrome, and this rapidly spreading fungal disease is projected to cause massive declines in *M. sodalis* populations in the near future.
Nation: United States
National Status: N2 (05Sep1996)

U.S. & Canada State/Province Status	
United States	Alabama (S2), Arkansas (S1), Connecticut (SHN), Georgia (S1), Illinois (S1), Indiana (S1), Iowa (S1), Kentucky (S1S2), Maryland (S1), Massachusetts (SH), Michigan (S1), Mississippi (SH), Missouri (S1), New Jersey (S1), New York (S1), North Carolina (S1S2), Ohio (S1), Oklahoma (SNR), Pennsylvania (SUB,S1N), South Carolina (S1), Tennessee (S1), Vermont (S1), Virginia (S1), West Virginia (S1)

Other Statuses

U.S. Endangered Species Act (USESA): LE: Listed endangered (11Mar1967)
U.S. Fish & Wildlife Service Lead Region: R3 - North Central
IUCN Red List Category: EN - Endangered

NatureServe Global Conservation Status Factors

Range Extent: 200,000-2,500,000 square km (about 80,000-1,000,000 square miles)
Range Extent Comments: The overall range extends west to the western Ozark region in eastern Oklahoma (Saugey et al. 1990) and Iowa (Clark et al. 1987), north and east to southern Wisconsin and Michigan (Evers 1992, Kurta and Teramino 1994, Kurta 1995), New York, New England, and northern New Jersey, and south to northern Alabama and Arkansas, with accidental or nonregular occurrences outside this range (e.g., Florida, Marks and Marks 2006). The species has disappeared from or greatly declined in most of its former range in the northeastern United States (e.g., Trombulak et al. 2001).

Most capture records of reproductively active females and juveniles have occurred in glaciated portions of the Midwest including southern Iowa, northern Missouri, much of Illinois, most of Indiana, southern Michigan, and western Ohio, and in Kentucky, with a growing number of maternity records documented in New York, New Jersey, and Vermont in recent years (USFWS 2009). Maternity colonies also exist to the south in Arkansas (Brandebura et al. 2011) and in heavily forested regions to at least eastern Tennessee and western North Carolina (Britzke et al. 2003). However, the geographic locations of the majority of Indiana bat maternity colonies remain unknown (USFWS 2009).

Northern populations migrate south to Alabama, Tennessee, Kentucky, Indiana, Missouri, and West Virginia for winter. In winter, the species is apparently absent from Michigan, Ohio, and northern Indiana where suitable caves and mines are unknown. About 42 percent of the total population hibernates in southern Indiana (USFWS 2013).

Area of Occupancy:
Area of Occupancy Comments: Based on hibernacula that contain the vast majority of the population, the area of occupancy is very small. This is the most limiting portion of the species annual cycle. In contrast, the area occupied in summer is much larger and minimally affected by localized threats.

Number of Occurrences:
Number of Occurrences Comments: The number of distinct occurrences has not been determined using standardized criteria. This species is represented by many maternity occurrences and hibernacula. As of 2007, USFWS had records of extant winter populations at approximately 281 hibernacula in 19 states and 269 maternity colonies in 16 states (USFWS 2009). However, based on hibernaculum counts and the fact that maternity colonies rarely include more than 100 adult females and their young (e.g., Gardner et al. 1996), the total number of maternity colonies must be very large (at least a few thousand) (USFWS 2009).

Individuals from particular hibernacula may split and form multiple maternity colonies and these colonies can be made up of bats from multiple hibernacula; individuals from a particular hibernaculum may use many roost trees in summer (Britzke et al. 2006; Britzke, pers. comm., 2015).

Population Size: 100,000 - 1,000,000 individuals
Population Size Comments: According to USFWS (2009), the total population was approximately 880,000 in the 1960s-1970s. USFWS (2013) reported a range-wide population of 534,239 for 2013 (includes the large colony discovered in Missouri in 2012; see following)..

A previously unknown hibernaculum was discovered in Missouri in 2012. This site contained approximately 123,000 bats when

photographically surveyed in January 2013. First-hand accounts of very large clusters/numbers of hibernating bats being observed at this site for several decades prior to its discovery by bat biologists indicate that it was not a new colony but rather had been overlooked for a long time (USFWS 2013).

Number of Occurrences with Good Viability/Integrity: Few (4-12)
Viability/Integrity Comments: The majority of the population hibernates at relatively few sites, including several caves and one mine in Indiana, Missouri, Kentucky, and Illinois (Brady et al. 1983; USFWS 1999, 2009, 2013). About 85% of the total population hibernates in nine caves, each of which contains at least 30,000 bats; the remaining 15 percent of the population have been or currently are distributed among 50+ hibernacula (Menzel et al. 2001).

Overall Threat Impact: Very high
Overall Threat Impact Comments: White-nose syndrome (WNS) has quickly and significantly raised the degree of threat against the species and has lowered the species overall recovery potential (USFWS 2009). A model developed by Thogmartin et al. (2013) projected that WNS will cause a severe range-wide decline (> 86 percent) in the *M. sodalis* population over the next decade, with few of the remaining wintering populations exceeding 250 females.

The original (pre-WNS) recovery plan (USFWS 1983) identified threats or "causes of decline" as: natural hazards (i.e., flooding, freezing, mine ceiling collapse); human disturbance and vandalism at hibernacula (identified as "the most serious cause of Indiana bat decline"); deforestation and stream channelization; pesticide poisoning; indiscriminate scientific collecting; handling and banding of hibernating bats by biologists; commercialization of hibernacula; exclusion of bats from caves by poorly designed gates; man-made changes in hibernacula microclimate (blocking or adding entrances and/or by poorly designed gates; and flooding of caves by dams/reservoir developments. See also Twente (1955), Hall (1962), Mohr (1972), Engel et al. (1976), Brady et al. (1982), Richter et al. (1993), and Johnson et al. (1998) for discussions of these threats. According to USFWS (2009), several of these threats have largely been addressed and are no longer adversely affecting the species to the degree or extent that they once had (e.g., human disturbance at hibernacula, indiscriminate scientific collecting, banding of hibernating bats, commercialization of hibernacula, and poorly designed cave gates).

The 2007 recovery plan (USFWS 2007) identified and expounded upon additional threats including: quarrying and mining operations (summer and winter habitat); loss/degradation of summer/migration/swarming habitat; loss of forest habitat connectivity; some silvicultural practices and firewood collection; disease and parasites; predation; competition with other bat species; environmental contaminants (not just "pesticides"); climate change; and collisions with man-made objects (e.g., wind turbines). USFWS (2009) stated that with few exceptions all of the identified threats were still affecting the species to varying degrees.

According to USFWS (2009), the most significant rangewide threats to the species at that time were habitat loss/degradation, forest fragmentation, winter disturbance, and environmental contaminants. The greatest single cause of loss of forest habitat within the range of the species is urbanization and development (USFWS 2007), but the forested habitat used by this species remains extensive and probably is not limiting the population. Disturbance of hibernating bats by cavers remains a threat in many hibernacula, but progress has been made in reducing the number of caves in which disturbance threatens hibernating bats (USFWS 2007, 2009). The effects of climate change on *M. sodalis* populations are uncertain (USFWS 2009), as are the population effects of environmental contaminants.

Short-term Trend: Relatively Stable (<=10% change)
Short-term Trend Comments: The range-wide population estimate in 2005, 2007, 2009, and 2013 was relatively stable (ranged from 534,239 in 2013 to 590,875 in 2007), though abundance declined significantly between 2005 and 2013 in some states (e.g., New York and West Virginia) (USFWS 2013).

Long-term Trend: Decline of 30-50%
Long-term Trend Comments: Population estimate declined in the 1980s and to a smaller degree in the 1990s; an increasing trend began after 2001 and continued through 2007 (USFWS 2009, 2013). Population estimate in 2013 was about 60 percent of the 1960s estimate (USFWS 2013).

Estimates of trend from hibernacula count data suggested that the species declined in abundance by 57 percent from 1965-2001 though recent evidence indicated no appreciable change in abundance between 1983 and 2009 (Thogmartin et al. 2012).

Some local population changes result from bats shifting among different caves (USFWS 2009). The species also has colonized mines and other sites that historically were not available (USFWS 2009).

Other NatureServe Conservation Status Information

Protection Needs: Hibernacula should be adequately protected from human disturbance. Known maternity roosts should be protected; compatible forest management is most important for ensuring long-term availability of suitable summer habitat (see management information).

Distribution

Global Range: (200,000-2,500,000 square km (about 80,000-1,000,000 square miles)) The overall range extends west to the western Ozark region in eastern Oklahoma (Saugey et al. 1990) and Iowa (Clark et al. 1987), north and east to southern Wisconsin and Michigan (Evers 1992, Kurta and Teramino 1994, Kurta 1995), New York, New England, and northern New Jersey, and south to northern Alabama and Arkansas, with accidental or nonregular occurrences outside this range (e.g., Florida, Marks and Marks 2006). The species has disappeared from or greatly declined in most of its former range in the northeastern United States (e.g., Trombulak et al. 2001).

Most capture records of reproductively active females and juveniles have occurred in glaciated portions of the Midwest including southern Iowa, northern Missouri, much of Illinois, most of Indiana, southern Michigan, and western Ohio, and in Kentucky, with a growing number of maternity records documented in New York, New Jersey, and Vermont in recent years (USFWS 2009). Maternity colonies also exist to the south in Arkansas (Brandebura et al. 2011) and in heavily forested regions to at least eastern Tennessee and western North Carolina (Britzke et al. 2003). However, the geographic locations of the majority of Indiana bat maternity colonies remain unknown (USFWS 2009).

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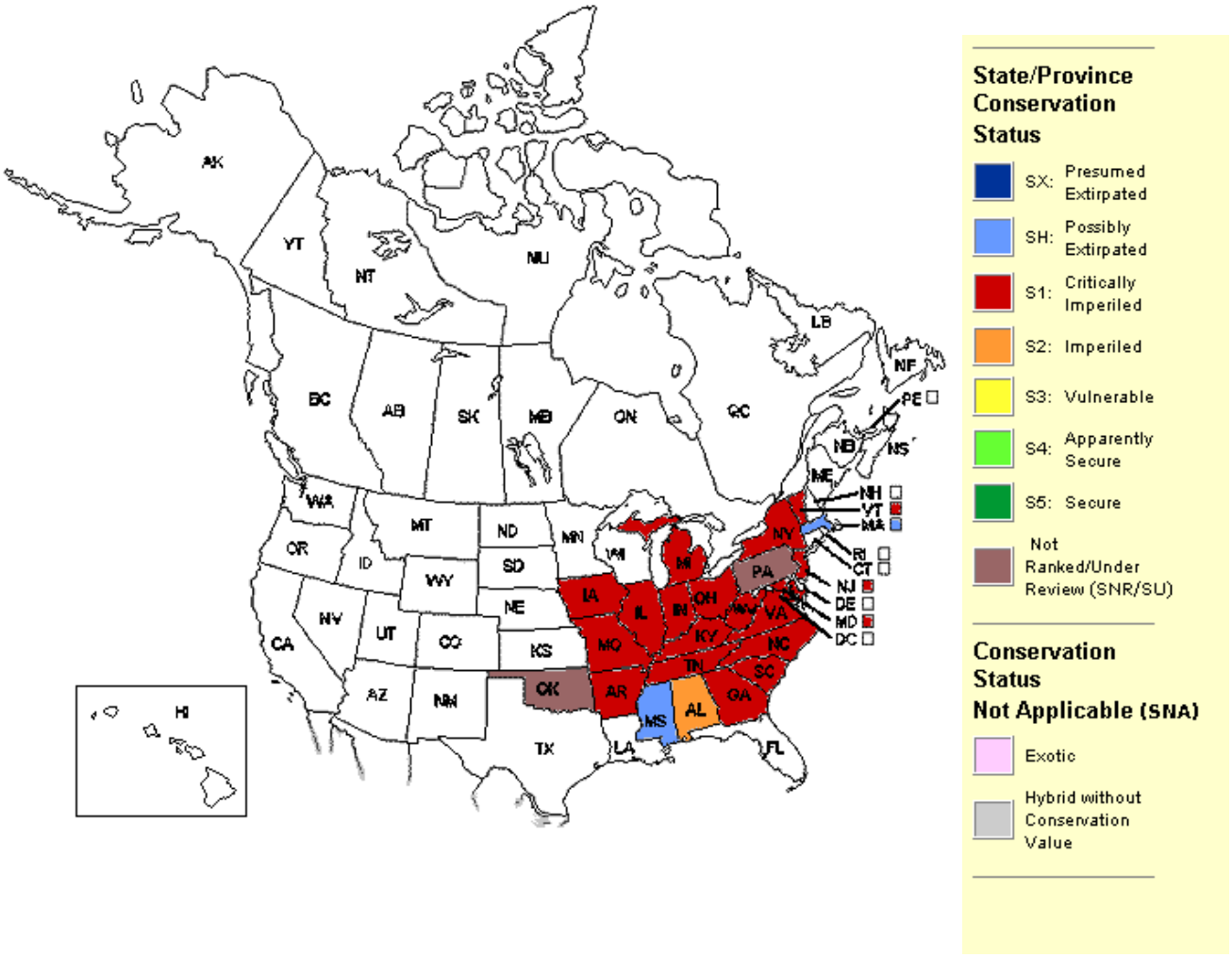
U.S. States and Canadian Provinces

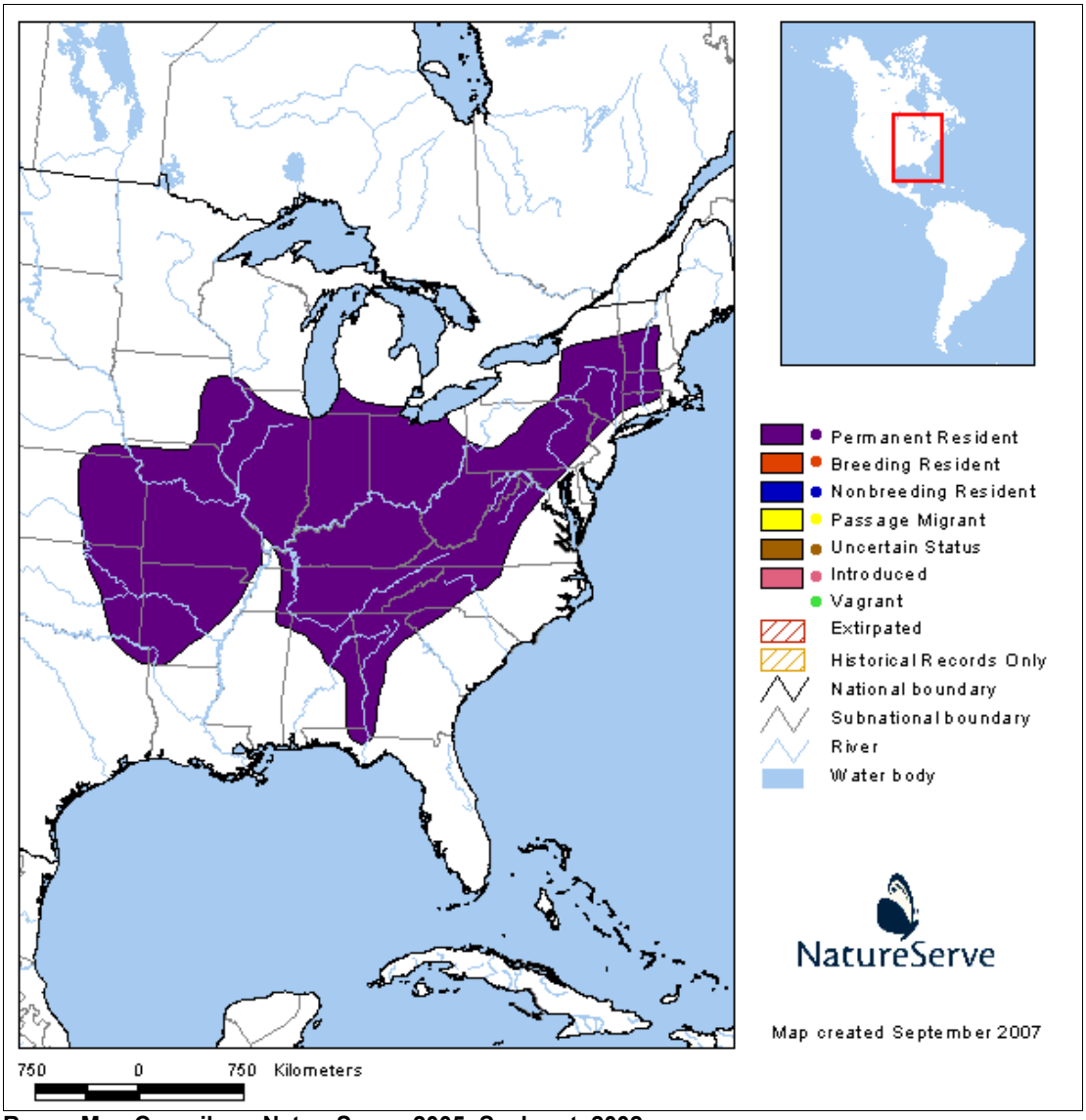


Endemism: endemic to a single nation

U.S. & Canada State/Province Distribution	
United States	AL, AR, CT, GA, IA, IL, IN, KY, MA, MD, MI, MO, MS, NC, NJ, NY, OH, OK, PA, SC, TN, VA, VT, WV

Range Map

Note: Range depicted for New World only. The scale of the maps may cause narrow coastal ranges or ranges on small islands not to appear. Not all vagrant or small disjunct occurrences are depicted. For migratory birds, some individuals occur outside of the passage migrant range depicted. For information on how to obtain shapefiles of species ranges see our Species Mapping pages at www.natureserve.org/conservation-tools/data-maps-tools.



Range Map Compilers: NatureServe, 2005; Sechrest, 2002

U.S. Distribution by County	
State	**County Name (FIPS Code)**
AL	Blount (01009)*, Cleburne (01029), DeKalb (01049), Jackson (01071), Jefferson (01073), Lauderdale (01077)*, Lawrence (01079), Marshall (01095), Morgan (01103)*, Shelby (01117)
AR	Benton (05007)*, Independence (05063), Izard (05065), Madison (05087), Marion (05089)*, Newton (05101), Searcy (05129)*, Stone (05137), Washington (05143)
CT	Litchfield (09005)*
GA	Dade (13083), Gilmer (13123), Walker (13295)
IA	Appanoose (19007), Clarke (19039), Dallas (19049), Davis (19051), Decatur (19053), Des Moines (19057), Dubuque (19061)*, Guthrie (19077), Jasper (19099), Johnson (19103), Keokuk (19107), Lee (19111), Louisa (19115)*, Lucas (19117), Madison (19121), Marion (19125), Monroe (19135), Poweshiek (19157), Ringgold (19159), Taylor (19173), Van Buren (19177), Wapello (19179), Warren (19181), Washington (19183)
IL	Adams (17001), Alexander (17003), Bond (17005)*, Bureau (17011), Calhoun (17013), Cass (17017)*, Champaign (17019), Clinton (17027), Coles (17029), Edgar (17045), Fayette (17051), Ford (17053), Franklin (17055), Fulton (17057), Gallatin (17059), Hardin (17069), Henderson (17071)*, Jackson (17077), Jersey (17083), Jo Daviess (17085)*, Johnson (17087), La Salle (17099), Lawrence (17101)*, Macoupin (17117)*, Marshall (17123), Mcdonough (17109), Mercer (17131), Monroe (17133), Ogle (17141), Perry (17145)*, Pike (17149), Pope (17151), Pulaski (17153), Putnam (17155), Randolph (17157), Saline (17165), Sangamon (17167)*, Schuyler (17169)*, Scott (17171)*, St. Clair (17163), Union (17181), Vermilion (17183), Warren (17187), Washington (17189), Williamson (17199), Woodford (17203)

IN	Bartholomew (18005), Benton (18007), Blackford (18009), Boone (18011), Brown (18013), Carroll (18015), Clark (18019), Clay (18021)*, Clinton (18023), Crawford (18025), Daviess (18027), Delaware (18035), Fayette (18041), Fountain (18045), Fulton (18049), Gibson (18051), Greene (18055), Hancock (18059), Harrison (18061), Hendricks (18063), Henry (18065), Howard (18067), Huntington (18069), Jackson (18071), Jasper (18073), Jay (18075), Jefferson (18077), Jennings (18079), Johnson (18081), Knox (18083), Kosciusko (18085), La Porte (18091), Lagrange (18087)*, Lawrence (18093), Marion (18097), Martin (18101), Monroe (18105), Montgomery (18107), Morgan (18109), Newton (18111), Orange (18117), Owen (18119)*, Parke (18121), Perry (18123), Pike (18125), Porter (18127), Posey (18129), Putnam (18133), Randolph (18135), Ripley (18137), Rush (18139), Scott (18143), Shelby (18145), St. Joseph (18141), Starke (18149), Sullivan (18153), Tippecanoe (18157), Vermillion (18165), Vigo (18167), Wabash (18169), Warren (18171), Warrick (18173), Washington (18175), Wayne (18177)*, Wells (18179)
KY	Adair (21001)*, Allen (21003)*, Ballard (21007), Barren (21009), Bath (21011), Bell (21013), Boone (21015), Boyd (21019)*, Breathitt (21025), Breckinridge (21027), Bullitt (21029), Calloway (21035)*, Carlisle (21039), Carter (21043), Christian (21047), Clay (21051), Clinton (21053), Daviess (21059)*, Edmonson (21061), Elliott (21063), Estill (21065), Fayette (21067)*, Fleming (21069)*, Floyd (21071), Grayson (21085)*, Greenup (21089)*, Hardin (21093), Harlan (21095), Hart (21099), Henderson (21101), Hickman (21105), Jackson (21109), Jefferson (21111), Jessamine (21113)*, Kenton (21117), Knott (21119), Lawrence (21127), Lee (21129), Leslie (21131), Letcher (21133), Lewis (21135)*, Livingston (21139), Logan (21141)*, Magoffin (21153), Mason (21161), McCracken (21145), McCreary (21147), Meade (21163), Menifee (21165), Morgan (21175), Muhlenberg (21177), Nelson (21179), Owen (21187), Owsley (21189), Perry (21193), Pike (21195), Powell (21197), Pulaski (21199), Rockcastle (21203), Rowan (21205), Spencer (21215), Taylor (21217)*, Trigg (21221), Trimble (21223), Union (21225), Warren (21227), Wayne (21231), Whitley (21235), Wolfe (21237)
MA	Berkshire (25003)*, Hampden (25013)*, Worcester (25027)*
MD	Allegany (24001), Carroll (24013), Garrett (24023), Washington (24043)
MI	Barry (26015), Branch (26023), Calhoun (26025), Cass (26027), Clinton (26037)*, Eaton (26045), Hillsdale (26059)*, Ingham (26065)*, Jackson (26075), Lenawee (26091), Livingston (26093)*, Manistee (26101), St. Joseph (26149)*, Van Buren (26159), Washtenaw (26161)
MO	Adair (29001), Audrain (29007), Barry (29009)*, Boone (29019), Camden (29029), Cape Girardeau (29031), Carroll (29033), Chariton (29041), Christian (29043)*, Clark (29045), Clinton (29049), Crawford (29055), Daviess (29061), Dent (29065), Franklin (29071), Gasconade (29073), Harrison (29081), Iron (29093), Jefferson (29099), Knox (29103), Laclede (29105), Lewis (29111), Linn (29115), Macon (29121), Madison (29123), Marion (29127), McDonald (29119)*, Mercer (29129), Monroe (29137), Nodaway (29147), Oregon (29149), Pike (29163), Pulaski (29169), Putnam (29171), Randolph (29175), Reynolds (29179), Schuyler (29197), Scotland (29199), Shannon (29203), St. Charles (29183), St. Louis (29189), Ste. Genevieve (29186), Stone (29209)*, Sullivan (29211), Taney (29213), Texas (29215), Washington (29221), Wayne (29223), Worth (29227), Wright (29229)
MS	Benton (28009), Tishomingo (28141)*
NC	Cherokee (37039), Graham (37075), Haywood (37087), Jackson (37099)*, Mitchell (37121)*, Rutherford (37161), Swain (37173)
NJ	Essex (34013), Morris (34027), Somerset (34035), Sussex (34037), Union (34039)
NY	Albany (36001), Cayuga (36011), Columbia (36021), Dutchess (36027), Essex (36031), Jefferson (36045), Onondaga (36067), Orange (36071), Oswego (36075), Seneca (36099), Ulster (36111), Warren (36113)
OH	Adams (39001)*, Ashland (39005), Ashtabula (39007), Athens (39009), Butler (39017), Clermont (39025), Cuyahoga (39035), Franklin (39049), Greene (39057), Hamilton (39061), Highland (39071)*, Hocking (39073), Lawrence (39087), Miami (39109)*, Paulding (39125), Pickaway (39129), Preble (39135), Richland (39139), Summit (39153), Wayne (39169)
OK	Adair (40001)*, LeFlore (40079), McCurtain (40089)*, Pushmataha (40127)*
PA	Adams (42001), Armstrong (42005), Beaver (42007), Bedford (42009), Berks (42011), Blair (42013), Butler (42019), Centre (42027), Fayette (42051), Franklin (42055)*, Fulton (42057)*, Greene (42059), Huntingdon (42061), Lawrence (42073), Luzerne (42079), Mifflin (42087), Monroe (42089)*, Somerset (42111), Washington (42125), Westmoreland (42129)*, York (42133)
SC	Oconee (45073)
TN	Bedford (47003)*, Benton (47005), Blount (47009), Campbell (47013), Claiborne (47025), Cumberland (47035), Fentress (47049), Franklin (47051), Grainger (47057)*, Hawkins (47073), Henry (47079), Jefferson (47089), Lincoln (47103)*, Marion (47115), Maury (47119)*, Monroe (47123), Montgomery (47125), Perry (47135)*, Pickett (47137), Sevier (47155)*, Stewart (47161), Union (47173), Van Buren (47175), Warren (47177), White (47185)*
VA	Bath (51017), Bland (51021), Craig (51045), Dickenson (51051), Giles (51071)*, Highland (51091), Lee (51105), Montgomery (51121)*, Shenandoah (51171)*, Tazewell (51185), Wise (51195)
VT	Addison (50001), Bennington (50003), Chittenden (50007), Orange (50017)*, Rutland (50021), Windsor (50027)*

WV	Boone (54005), Brooke (54009), Fayette (54019), Grant (54023), Greenbrier (54025), Hardy (54031)*, Kanawha (54039), Mercer (54055), Monroe (54063), Nicholas (54067), Ohio (54069), Pendleton (54071), Pocahontas (54075), Preston (54077), Raleigh (54081), Randolph (54083), Tucker (54093), Wetzel (54103)

* Extirpated/possibly extirpated

U.S. Distribution by Watershed	
Watershed Region	**Watershed Name (Watershed Code)**
01	Upper Connecticut-Mascoma (01080104)+*, Black-Ottauquechee (01080106)+*, Westfield (01080206)+*, Blackstone (01090003)+*, Quinebaug (01100001)+*, Housatonic (01100005)+
02	Upper Hudson (02020001)+, Hudson-Hoosic (02020003)+, Middle Hudson (02020006)+, Rondout (02020007)+, Hudson-Wappinger (02020008)+, Hackensack-Passaic (02030103)+, Raritan (02030105)+, Middle Delaware-Mongaup-Brodhead (02040104)+, Middle Delaware-Musconetcong (02040105)+, Schuylkill (02040203)+, Upper Susquehanna-Lackawanna (02050107)+, Lower Susquehanna-Penns (02050301)+, Upper Juniata (02050302)+, Raystown (02050303)+, Lower Juniata (02050304)+, Lower Susquehanna-Swatara (02050305)+*, Lower Susquehanna (02050306)+, Gunpowder-Patapsco (02060003)+, South Branch Potomac (02070001)+, North Branch Potomac (02070002)+, Cacapon-Town (02070003)+*, Conococheague-Opequon (02070004)+, North Fork Shenandoah (02070006)+*, Monocacy (02070009)+, Upper James (02080201)+
03	Upper Roanoke (03010101)+*, Upper Broad (03050105)+, Tugaloo (03060102)+, Coosawattee (03150102)+, Upper Coosa (03150105)+, Upper Tallapoosa (03150108)+, Cahaba (03150202)+, Sipsey Fork (03160110)+, Locust (03160111)+
04	Little Calumet-Galien (04040001)+, St. Joseph (04050001)+, Kalamazoo (04050003)+, Upper Grand (04050004)+, Thornapple (04050007)+, Manistee (04060103)+, Shiawassee (04080203)+*, Huron (04090005)+*, Ottawa-Stony (04100001)+*, Raisin (04100002)+, St. Joseph (04100003)+*, Auglaize (04100007)+, Black-Rocky (04110001)+, Cuyahoga (04110002)+, Ashtabula-Chagrin (04110003)+, Irondequoit-Ninemile (04140101)+, Salmon-Sandy (04140102)+, Seneca (04140201)+, Oneida (04140202)+, Oswego (04140203)+, Black (04150101)+, Chaumont-Perch (04150102)+, Upper St. Lawrence (04150301)+, Indian (04150303)+, Mettawee River (04150401)+, Otter Creek (04150402)+, Lake Champlain (04150408)+
05	Middle Allegheny-Redbank (05010006)+, Conemaugh (05010007)+*, Lower Allegheny (05010009)+, Tygart Valley (05020001)+, Cheat (05020004)+, Lower Monongahela (05020005)+*, Youghiogheny (05020006)+, Upper Ohio (05030101)+, Beaver (05030104)+, Connoquenessing (05030105)+, Upper Ohio-Wheeling (05030106)+, Little Muskingum-Middle Island (05030201)+, Hocking (05030204)+, Mohican (05040002)+, Walhonding (05040003)+, Middle New (05050002)+, Greenbrier (05050003)+, Lower New (05050004)+, Gauley (05050005)+, Upper Kanawha (05050006)+, Elk (05050007)+, Coal (05050009)+, Upper Scioto (05060001)+, Upper Levisa (05070202)+, Lower Levisa (05070203)+, Big Sandy (05070204)+, Upper Great Miami (05080001)+, Lower Great Miami (05080002)+, Whitewater (05080003)+, Raccoon-Symmes (05090101)+, Little Scioto-Tygarts (05090103)+, Little Sandy (05090104)+, Ohio Brush-Whiteoak (05090201)+, Little Miami (05090202)+, Middle Ohio-Laughery (05090203)+, Licking (05100101)+, North Fork Kentucky (05100201)+, Middle Fork Kentucky (05100202)+, South Fork Kentucky (05100203)+, Upper Kentucky (05100204)+, Lower Kentucky (05100205)+, Upper Green (05110001)+, Barren (05110002)+, Middle Green (05110003)+, Rough (05110004)+, Lower Green (05110005)+, Pond (05110006)+, Salamonie (05120102)+, Mississinewa (05120103)+, Eel (05120104)+, Middle Wabash-Deer (05120105)+, Tippecanoe (05120106)+, Wildcat (05120107)+, Middle Wabash-Little Vermilion (05120108)+, Vermilion (05120109)+, Sugar (05120110)+, Middle Wabash-Busseron (05120111)+, Embarras (05120112)+, Upper White (05120201)+, Lower White (05120202)+, Eel (05120203)+, Driftwood (05120204)+, Flatrock-Haw (05120205)+, Muscatatuck (05120207)+, Lower East Fork White (05120208)+, Patoka (05120209)+, Upper Cumberland (05130101)+, Rockcastle (05130102)+, Upper Cumberland-Lake Cumberland (05130103)+, South Fork Cumberland (05130104)+, Obey (05130105)+, Collins (05130107)+, Caney (05130108)+, Lower Cumberland (05130205)+, Red (05130206)+*, Silver-Little Kentucky (05140101)+, Salt (05140102)+, Rolling Fork (05140103)+, Blue-Sinking (05140104)+, Lower Ohio-Little Pigeon (05140201)+, Highland-Pigeon (05140202)+, Lower Ohio-Bay (05140203)+, Saline (05140204)+, Lower Ohio (05140206)+
06	Holston (06010104)+, Pigeon (06010106)+, Lower French Broad (06010107)+*, Nolichucky (06010108)+*, Watts Bar Lake (06010201)+, Upper Little Tennessee (06010202)+, Tuckasegee (06010203)+*, Lower Little Tennessee (06010204)+, Upper Clinch (06010205)+, Powell (06010206)+, Lower Clinch (06010207)+*, Middle Tennessee-Chickamauga (06020001)+, Hiwassee (06020002)+, Sequatchie (06020004)+, Guntersville Lake (06030001)+, Wheeler Lake (06030002)+, Upper Elk (06030003)+*, Lower Elk (06030004)+*, Pickwick Lake (06030005)+*, Bear (06030006)+*, Upper Duck (06040002)+*, Lower Duck (06040003)+*, Kentucky Lake (06040005)+, Lower Tennessee (06040006)+*
07	Turkey (07060004)+*, Apple-Plum (07060005)+*, Flint-Henderson (07080104)+, South Skunk (07080105)+*, North Skunk (07080106)+, Skunk (07080107)+, Middle Iowa (07080208)+, Lower Iowa (07080209)+, Lower Rock (07090005)+, North Raccoon (07100006)+, South Raccoon (07100007)+, Lake Red

	Rock (07100008)+, Lower Des Moines (07100009)+, Bear-Wyaconda (07110001)+, North Fabius (07110002)+, South Fabius (07110003)+, The Sny (07110004)+, North Fork Salt (07110005)+, South Fork Salt (07110006)+, Salt (07110007)+, Cuivre (07110008)+, Peruque-Piasa (07110009)+, Kankakee (07120001)+, Lower Illinois-Senachwine Lake (07130001)+, Vermilion (07130002)+, Spoon (07130005)+, South Fork Sangamon (07130007)+*, Lower Sangamon (07130008)+*, La Moine (07130010)+, Lower Illinois (07130011)+, Macoupin (07130012)+*, Cahokia-Joachim (07140101)+, Meramec (07140102)+, Big (07140104)+, Upper Mississippi-Cape Girardeau (07140105)+, Big Muddy (07140106)+, Cache (07140108)+, Middle Kaskaskia (07140202)+, Shoal (07140203)+*, Lower Kaskaskia (07140204)+
08	Lower Mississippi-Memphis (08010100)+, Bayou De Chien-Mayfield (08010201)+, Wolf (08010210)+, Upper St. Francis (08020202)+, Lower St. Francis (08020203)+
10	Platte (10240012)+, One Hundred and Two (10240013)+, Upper Grand (10280101)+, Thompson (10280102)+, Lower Grand (10280103)+, Upper Chariton (10280201)+, Lower Chariton (10280202)+, Little Chariton (10280203)+, Lake of the Ozarks (10290109)+, Niangua (10290110)+, Upper Gasconade (10290201)+, Big Piney (10290202)+, Lower Gasconade (10290203)+, Lower Missouri-Moreau (10300102)+, Lower Missouri (10300200)+
11	Beaver Reservoir (11010001)+, James (11010002)+*, Bull Shoals Lake (11010003)+, Middle White (11010004)+, Buffalo (11010005)+, North Fork White (11010006)+, Upper Black (11010007)+, Current (11010008)+, Eleven Point (11010011)+, Elk (11070208)+*, Illinois (11110103)+*, Robert S. Kerr Reservoir (11110104)+, Poteau (11110105)+, Kiamichi (11140105)+*, Upper Little (11140107)+*

+ Natural heritage record(s) exist for this watershed
* Extirpated/possibly extirpated

Ecology & Life History

Basic Description: A small bat.

General Description: Pelage very fine and fluffy, dull grayish chestnut above (hair tips slightly glossy; basal two-thirds blackish, followed by a grayish band and cinnamon tip), pinkish white underparts; membranes and ears blackish-brown; total length 75-102 mm; tail length 27-44 mm; wingspread 240-267 mm; length of head and body 41-49 mm; ear 10-15 mm, does not extend past end of nose when laid forward; forearm 36-41 mm; calcar obviously keeled (not always evident in dried study skins); hind foot small, 7-11 mm, hairs do not extend beyond toes; mass 5-11 g; greatest length of skull 14.2-15.0 mm, usually greater than 14.5 mm; length of maxillary toothrow 5.2-5.6 mm; complete sagittal crest usually present in adults; dentition I 2/3, C 1/1, P 3/3, M 3/3 (Hall 1981, Barbour and Davis 1969, Sealander 1979).

Diagnostic Characteristics: Differs from *M. grisescens*, *M. lucifugus*, *M. velifer*, and *M. austroriparius* in having an obviously keeled calcar. Has shorter ears than does *M. septentrionalis* (in which the ears extend more than 2 mm beyond the nose when laid forward). Lacks the distinct black face mask of *M. leibii*, which has a shorter skull (greatest length 13.1-14.7 mm, usually less than 14.5 mm). Skull is smaller, narrower, and lower than that of *M. lucifugus*. *Myotis lucifugus* has long hairs on toes, foot length greater than 10 mm, fur with a glossy sheen. *Myotis grisescens* has fur the same color from base to tip, and web attached to ankle. *Myotis austroriparius* has long hairs on toes and foot is greater than 10 mm. *Pipistrellus subflavus* is smaller, with a lightly colored forearm, partially furred tail membrane, and paler fur. See Barbour and Davis (1969).

Reproduction Comments: Mating occurs from late August to early October prior to hibernation, or in spring. Bats assemble at cave entrances at dusk and dawn in late August and September. Such staging is believed to facilitate breeding and reduce the chances of inbreeding in small summer colonies (Humphrey and Cope 1977). Males arrive first at the staging areas. Females begin to appear as early as late July, and the number of bats and the proportion of females rise to a maximum in early September. Ovulation takes place after the bats arouse in spring. Delayed fertilization (from sperm stored during the autumn matings) occurs in most reproductively active females (Guthrie 1933). Young are born in June-July. Litter size is 1. Young first fly at 25-37 days. Maximum longevity is about 15 years. A maternity roost in Illinois included up to 95 individuals (including juveniles) (Kurta et al. 1993). Main tree roost in Michigan was inhabited by up to 45 individuals (Kurta et al. 1993).

In Indiana, Humphrey et al. (1977) studied a maternity colony that contained between 25 and 28 reproductively active females. Females arrived at the roost sites starting on May 4, with the majority arriving in late May. Each female bore a single young between June 25 and July 4. The young required about 25 to 37 days before learning to fly; this time interval was dependent on weather, particularly the temperature. Mortality between birth and weaning was about 8%. The authors observed mothers moving non-volant young to warmer roost spots. Apparently, the first flights of the young were tandem flights with the mother.

Ecology Comments: Hibernating individuals characteristically form large, compact clusters of as many as 5,000 individuals (averaging 500 to 1,000 bats per cluster; Hall 1962); the clusters may average 300 individuals per square foot (LaVal and LaVal 1980). Clusters

form in the same area in a cave each year, with more than one cluster possible in a particular cave (Hall 1962, Engel et al. 1976). Clustering may perform certain functions, such as protecting the central individuals from temperature changes (Twente 1955), reducing the sensitivity of most bats to external disturbance (Hall 1962), or rapid arousal and escape from predators (Humphrey 1978).

Female survivorship in an Indiana population was 76% for ages 1 to 6 years, and 66% for ages 6 to 10 years (Humphrey and Cope 1977). Male survivorship was 70% for ages 1 to 6 years and 36% for ages 6 to 10 years. Maximum ages of banded individuals were 15 years for females and 14 years for males.
Habitat Type: Terrestrial
Non-Migrant: N
Locally Migrant: Y
Long Distance Migrant: Y
Mobility and Migration Comments: Northern breeding populations migrate south to limestone cave area in Alabama, Tennessee, Kentucky, Indiana, Missouri, and West Virginia. Winter and summer habitats may be as much as 480 km apart (Layne 1978). Migrants leave hibernation sites in late March and April. Females generally leave earlier than do males, with the greatest exodus in mid- to late April (Barbour and Davis 1969). Some males migrate while most remain in the general geographic vicinity of the hibernaculum throughout the summer (Hall 1962).

Migration from nursery roosts occurs during late summer; arrival at hibernacula occurs from late August to early September (Barbour and Davis 1969). Staging or swarming occurs from September to mid-October and involves a large number of bats congregating at the mouths of a few caves.

Kurta and Murray (2002) banded 29 adult females, 2 juveniles, and 1 adult male from a maternity colony in Michigan. Four banded bats were later found in Indiana and Kentucky, hibernating in caves that were separated by 100-325 km, indicating that all members of a summer colony do not hibernate or mate in the same location. Migration distances were approximately 410, 424, 472, and 532 km (mean 460 km) for the four bats.

Garner and Gardner (1992) reported the following data on movements of foragers in Indiana. Data are sequenced as follows: reproductive condition-sex-age, number of individuals, number of nights, mean foraging range (ha), distance (km) (mean distance from the roost to the geometric center of foraging range). FEMALE: adult pregnant, 2, 8, 51.85, 1.05; adult lactating, 5, 16, 94.25, 1.04; adult post-lactating, 1, 6, 212.67, 2.60; volant juvenile, 2, 3, 37.00, 0.25. MALE: adult nonreproductive, 2, 6, 57.33, 0.56; volant juvenile nonreproductive, 2, 4, 28.25, 0.54. A post lactating female had the largest foraging range. Pregnant adults traveled farther than 1 km to reach preferred foraging areas but had a smaller mean foraging range.

In Indiana, 11 foraging adult females that were tracked for 2-7 days moved up to 8.4 km from their roost; home range during this period averaged 3.35 square kilometers (335 ha) (Sparks et al. 2005).

Indiana bats show strong homing instincts after being released varying distances from their hibernaculum. For example, when Hassel (1963) released bats to the west of a winter cave in Kentucky, over 68% returned to the cave from 12 miles away and only 4% returned from 144 miles away. Hassell and Harvey (1965) released approximately 500 female bats in all directions (up to 200 miles from their winter cave) and found that over two-thirds returned. Hassell and Harvey (1965) noted much stronger homing tendencies along a north-south axis, the direction for migrating to and from summer roosts, than along the east-west direction. Strong homing tendencies are reflected in fidelity to hibernacula; although only 180 miles apart (east to west), the two major hibernating populations in Kentucky do not appear to mix (Hall 1962, Barbour and Davis 1969).
Riverine Habitat(s): Aerial
Lacustrine Habitat(s): Aerial
Palustrine Habitat(s): Aerial, FORESTED WETLAND, Riparian
Terrestrial Habitat(s): Aerial, Forest - Hardwood, Forest - Mixed, Forest/Woodland, Woodland - Hardwood
Subterranean Habitat(s): Subterrestrial
Special Habitat Factors: Standing snag/hollow tree
Habitat Comments: *Myotis sodalis* hibernates primarily in caves (about 70 percent of population), also in mines and in one dam and one tunnel (USFWS 2009). Maternity sites generally are behind loose bark of dead or dying trees or in tree cavities (Menzel et al. 2001). Foraging habitats include riparian areas, upland forests, ponds, and fields (Menzel et al. 2001), but forested landscapes are the most

important habitat in agricultural landscapes (Menzel et al. 2005).

In hibernation, limestone caves with pools are preferred. Hall (1962) noted that preferred caves are of medium size with large, shallow passageways. Roosts usually are in the coldest part of the cave. Preferred sites have a mean midwinter air temperature of 4-8 C (tolerates much broader range) (Hall 1962, Henshaw and Folk 1966), well below that of caves that are not chosen (Clawson et al. 1980). Roost sites within caves may shift such that bats remain in the coldest area (Clawson et al. 1980); individuals may move from a location deeper in the cave to a site nearer the entrance as the cold season progresses; they may move away from areas that go below freezing. Hibernation in the coldest parts of the cave ensures a sufficiently low metabolic rate so that the fat reserves last through the six-month hibernation period (Henshaw and Folk 1966, Humphrey 1978). Relative humidity in occupied caves ranges from 66 to 95% and averages 87% throughout the year (Barbour and Davis 1969, Clawson et al. 1980). Because of these requirements, *M. sodalis* is highly selective of hibernacula.

During the fall, when these bats swarm and mate at their hibernacula, males roost in trees nearby during the day and fly to the cave during the night. In Kentucky, Kiser and Elliott (1996) found males roosting primarily in dead trees on upper slopes and ridgetops within 2.4 km of their hibernaculum. During September in West Virginia, males roosted within 5.6 km in trees near ridgetops, and often switched roost trees from day to day (C. Stihler, West Virginia Division of Natural Resources, pers. obs., October 1996, cited in USFWS 1999). Fall roost trees tend to be in sunnier areas rather than being shaded (J. MacGregor, pers. obs., October 1996, cited in USFWS 1999).

In summer, habitat consists of wooded or semi-wooded areas, often but not always along streams. Solitary females or small maternity colonies bear their offspring in hollow trees or under loose bark of living or dead trees (Humphrey et al. 1977, Garner and Gardner 1992). Known roost tree species include elm, oak, beech, hickory, maple, ash, sassafras, birch, sycamore, locust, aspen, cottonwood, pine, and hemlock (Cope et al. 1974, Humphrey et al. 1977, Garner and Gardner 1992, Britzke et al. 2003, Britzke et al. 2006).

Humphrey et al. (1977) determined that dead trees are preferred roost sites and that trees standing in sunny openings are attractive because the air spaces and crevices under the bark are warmer. In Illinois, Garner and Gardner (1992) found that typical roosts were beneath the exfoliating bark of dead trees; other roost sites were beneath the bark of living trees and in cavities of dead trees. Kurta et al. (1993) found a large maternity colony in a dead, hollow, barkless, unshaded sycamore tree in a pasture in Illinois. In Michigan, a reproductively active colony occupied eight different roost trees (all green ash), all of which were exposed to direct sunlight throughout the day; bats roosted beneath loose bark of dead trees (Kurta et al. 1993). In western Virginia, a male used a mature, live, shagbark hickory tree as a diurnal roost; the bat foraged primarily among tree canopies of an 80-year-old oak-hickory forest (Hobson and Holland 1995). In Missouri, primary maternity roosts were in standing dead trees exposed to direct sunlight; there were 1-3 primary roosts per colony; alternate roosts were in living and dead trees that typically were within the shaded forest interior (Callahan et al. 1997). In eastern Tennessee and western North Carolina, several maternity colonies were in sun-exposed conifer snags (roost sites were above the surrounding canopy); some of these snags fell and were not used in subsequent years (Britzke et al. 2003). Rarely maternity colonies have been found in crevices in utility poles or in bat boxes (e.g., Ritzi et al. 2005). See Menzel et al. (2001) for a review of forest habitat relationships.

Though maternity sites have been reported as occurring mainly in riparian and floodplain forests (Humphrey et al. 1977, Garner and Gardner 1992), recent studies indicate that upland habitats are used by maternity colonies much more extensively than previously reported. Garner and Gardner (1992) reported that 38 of 51 roost trees in Illinois occurred in uplands and 13 trees were in floodplains. Of the 47 trees in forested habitat, 27 were in areas having a closed (80-100%) canopy, and 15 were in areas having an intermediate (30-80%) canopy. A single roost tree was found in the following types of habitat: a heavily grazed ridgetop pasture with a few scattered dead trees, a partially wooded swine feedlot, a palustrine wetland with emergent vegetation, a forested island in the Mississippi river, and a clearcut around a segment of an intermittent stream where dead trees were retained for wildlife. Roosts were not found in forests with open canopies (10-30%) or in old fields with less than or equal to 10% canopy cover.

In Illinois, Indiana bats used the same, evidently traditional, roost sites in successive summers. Recapture of the same individuals within traditional roost sites during subsequent summers suggests site fidelity (Garner and Gardner 1992, Gardner et al. 1996).

Relatively few individuals roost in caves at the mouths of which late summer swarming occurs (Cope and Humphrey 1977, Barbour and Davis 1969).

Adult Food Habits: Invertivore
Immature Food Habits: Invertivore
Food Comments: Flying insects are the typical prey items; diet reflects prey present in available foraging habitat. Forages along river and lake shorelines, in the crowns of trees in floodplains (Humphrey et al. 1977), and in upland forest (Brack and LaVal 1985). In Illinois, generally foraged within about a mile of roost tree (Garner and Gardner 1992). In Indiana, reproductively active females showed a preference for foraging in floodplain forests with closed canopies and impounded water (farm ponds; Garner and Gardner 1992). The foraging habitat for an Indiana colony included an airspace 2-30 m above a stream and a linear distance of 0.8 km; foraging density was 17-29 bats/ha; feeding rate on aerial insects was 8-17 capture attempts/minute (Humphrey et al. 1977).
Adult Phenology: Hibernates/aestivates, Nocturnal
Immature Phenology: Hibernates/aestivates, Nocturnal
Phenology Comments: Females begin hibernation soon after mating, whereas males often remain active through mid-October to November (Cope and Humphrey 1977). Most individuals are in hibernation by late November although some are still active until December (Barbour and Davis 1969). Activity is resumed generally in April, with few bats still in the hibernation caves by mid-May. In Michigan, bats were present at tree roosts as late as 10 September (Kurta et al. 1993).
Colonial Breeder: Y
Length: 9 centimeters
Weight: 8 grams

Economic Attributes

Management Summary

Stewardship Overview: Summer habitats need to be identified and protected. Monitoring of hibernacula should continue and entry to hibernacula should be restricted using signs, gates, or fences. Proper gating and fencing is critical. Before any management decisions are made concerning physical barriers at hibernacula, managers should consult with members of the Indiana bat recovery team (see MONIT.PROG for contact information).
Restoration Potential: A number of important hibernacula have been secured with varying success (see USFWS recovery plan). Further research is necessary to determine the recovery potential of summer roost sites.
Management Requirements: Hibernacula need continued protection and management (Engel et al. 1976, Thom 1981). Cave management involves preventing human disturbance. In addition, because deforestation alters cave temperature, humidity, and air and water flow, forests above and around hibernacula should not be dramatically altered.

Signs at cave entrances may be used at most caves but should not be used at well-concealed caves where the sign might attract visitors. All signs should contain a warning and may include information on the Indiana bat (Brady et al. 1983). Signs should not block air flow or bat flight.

In many cases, signs are not adequate to prevent human disturbance. Gating may be appropriate if the size and shape of the entrance are amenable. Improperly constructed gates can impede air flow and/or fill with debris; this may alter internal temperature/humidity characteristics, prevent bat flight, or subject bats to severe predation; abandonment of the site may result. Any constructed physical barriers should be monitored after they are in place. For details of acceptable types of physical barriers see Tuttle and Stevenson (1978) and Tuttle (1977).

Fences are less expensive than gates but are easier to vandalize and climb. Chain link fences should have barbed wire on the top to discourage climbers, but the wire should not protrude into bat flying space (Brady et al. 1982, 1983). Fences have successfully blocked flooded entrances adjacent to reservoirs (Brady et al. 1983). See Tuttle and Stevenson (1978) and Tuttle (1977) for further details.

Eliminating trails to cave entrances prevents many people from finding the cave. Public education, prosecution of trespassers, and strict control over who may enter the hibernacula may reduce human disturbance.

Habitat within the currently delineated summer range needs to be identified as suitable or essential according to the guidelines set forth by Garner and Gardner (1992). If activity is planned in suitable or essential habitats, a mist net survey for Indiana bats should be conducted. If M. SODALIS is present, the project should be altered accordingly or terminated (Garner and Gardner 1992). Summer roosts and surrounding forest and foraging areas need to be maintained in as natural a state as possible (Brady et al. 1983, Garner and Gardner 1992), so that cave temperature, humidity, and air and water flow, forests above and around hibernacula should not be

dramatically altered.

Habitat within the currently delineated summer range needs to be identified as suitable or essential according to the guidelines set forth by Garner and Gardner (1992). If activity is planned in suitable or essential habitats, a mist net survey for Indiana bats should be conducted. If M. SODALIS is present, the project should be altered accordingly or terminated (Garner and Gardner 1992). Summer roosts and surrounding forest and foraging areas need to be maintained in as natural a state as possible (Brady et al. 1983, Garner and Gardner 1992).

Draft revised recovery plan became available in 1999 (www.fws.gov/r3pao/bat.pdf).

See Luensmann (2005) for some detailed management recommendations.
Monitoring Requirements: Searches for summer populations should be conducted where impoundments are proposed (reservoirs may destroy foraging habitat and nursery colonies) (Layne 1978).

Miniature radio-transmitters can be used to study roosting ecology and foraging behavior in summer habitat (Garner and Gardner 1992).

Since disruption during hibernation is detrimental, winter censuses should be conducted no more frequently than every other year; preferred dates are between January 15 and February 15. To reduce disturbance during a census, the cave should be mapped in the fall before the bats arrive. During the census, only two or three trained people should be involved, and they should collect the minimum data needed. Bright lights directly on the bats and excessive noise should be avoided. To estimate total population, measure the number of square feet of cave wall covered by roosting bats and multiply by 300 bats/square foot (Brady et al. 1983).

See Garner and Garner (1992) for mist netting guidelines.
Management Research Needs: (1) Identify summer habitat requirements, and determine the effect of disturbance and habitat degradation. (2) Assess effects of cave management. (3) Study the effect of pesticides. (4) Study food sources, foraging habitat requirements, and threats to food resources. (5) Study reproductive biology and potential for artificial propagation and stocking.

In the early 1990s, the recovery team recommended that genetic studies be initiated to determine if small peripheral populations warrant special protection (End. Sp. Tech. Bull. 16(6):10).

Population/Occurrence Delineation

Group Name: Small and Medium Bats

Use Class: Bachelor colony
Subtype(s): Diurnal Roost, Foraging Area, Nocturnal Roost
Minimum Criteria for an Occurrence: An area occupied either historically or at present by a persisting or recurring population of males during summer (approximately May through August). Includes mist net captures away from roost sites obtained during the summer months even if the actual roost site(s) are not known. Identification evidence minimally includes collection or reliable observation and detailed documentation of one or more individuals. In certain regions, recorded echolocation sequences of individuals may be considered reliable observations for certain species that can be confidently identified by their echolocation calls alone, although caution must be used in determining Location Use Class for such observations during the breeding season.
Mapping Guidance: EO includes both the colony site and the associated foraging areas. If separate, the colony site and foraging areas are bounded by separate polygons; that is, areas over which the bats simply commute to and from foraging areas and the colony are not included in the EO.
Separation Barriers: None.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: The assigned separation distance is intended to generate occurrences that consist of spatially proximate roost sites and capture locations. However, include in the same occurrence (1) any roost sites between which significant of individuals are known to move, regardless of how far apart they are, and (2) known significant foraging areas of occurrences that are based on roost sites.

In two studies, male MYOTIS SODALIS foraged a maximum of 2.0 and 4.2 kilometers from their summer roosts (summarized in USFWS 1999).
Date: 29Mar2004
Author: Cannings, S., and G. Hammerson

Use Class: Breeding
Subtype(s):
Minimum Criteria for an Occurrence: An area occupied either historically or at present by a persisting or recurring breeding population during spring/summer (approximately May through August). Includes mist net captures away from colony sites obtained even if the associated roost site is not known. Identification evidence minimally includes collection or reliable observation and detailed documentation of one or more individuals. In certain regions, echolocation sequences of individuals may be considered reliable observations for certain species that can be confidently identified by their echolocation calls alone, although caution must be used in determining Location Use Class for such observations during the breeding season.
Separation Barriers: None.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: It is impractical to attempt to delineate occurrences on the basis of discrete populations. Instead, the assigned separation distance is intended to generate occurrences that consist of spatially proximate roost sites and capture locations.
Date: 02Jul2014
Author: Hammerson, G.

Use Class: Hibernaculum
Subtype(s): Pre-hibernation roost site, Hibernaculum
Minimum Criteria for an Occurrence: A site occupied either historically or at present by a recurring population of hibernating individuals. Identification evidence minimally includes collection or reliable observation and detailed documentation of one or more individuals. EO also includes immediately surrounding areas used by bats immediately before hibernation, where these areas are known.
Mapping Guidance: Cave/mine passages should be projected to the surface for the purpose of mapping EO boundary.
Separation Barriers: None.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: These bats sometimes move long distances between different hibernacula. For example, individuals of M. LUCIFUGUS and M. SEPTENTRIONALIS have been recorded flying up to 219 and 89 kilometers respectively between hibernacula during the winter months (Linzey 1998, Griffin 1940). However,
such movements are not a good basis for distinguishing occurrences (occurrences would become too expansive). The assigned separation distance is intended to generate occurrences that consist of spatially proximate hibernacula.

Separation distances suggested take into account the fact that, during the fall, some bats (e.g. M. SODALIS) swarm and mate at their hibernaculum, and males roost in trees nearby during the day and fly to the cave during the night. In two studies, M. SODALIS males roosted within a maximum of 5.6 kilometers of the hibernaculum (Kiser and Elliott 1996; Craig Stihler, West Virginia Division of Natural Resources, pers. observ., October 1996, cited in USFWS 1999).

Although they do not generally fly from one hibernaculum to another, hibernating bats are known to wake and move around to some extent within their hibernating site. As long as the areas are connected (even though they may not be passable by humans) the bats could be expected to move from one part of the system to another (e.g. MYOTIS SODALIS, Clawson et al. 1980).
Date: 29Mar2004
Author: Cannings, S., and G. Hammerson

Use Class: Maternity colony
Subtype(s): Colony Site, Foraging Area, Nocturnal Roost
Minimum Criteria for an Occurrence: An area occupied either historically or at present by a persisting or recurring population of breeding females and their young during summer (approximately May through August). Includes mist net captures away from colony

sites obtained during the summer months even if the associated roost site is not known. Identification evidence minimally includes collection or reliable observation and detailed documentation of one or more individuals. In certain regions, echolocation sequences of individuals may be considered reliable observations for certain species that can be confidently identified by their echolocation calls alone, although caution must be used in determining Location Use Class for such observations during the breeding season.
Mapping Guidance: The EO includes both the colony site and the associated foraging areas. If separate, the colony site and foraging areas are bounded by separate polygons; that is, areas over which the bats simply commute to and from foraging areas and the colony are not included in the EO.
Separation Barriers: None.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: It is impractical to attempt to delineate occurrences on the basis of discrete populations. Instead, the assigned separation distance is intended to generate occurrences that consist of spatially proximate roost sites and capture locations.

Nursing female *Myotis sodalis* moved an average of 1.04 kilometers from roost to center of foraging area, giving a mean foraging diameter of 2.08 kilometers; however, post-lactating females moved more than twice as far, travelling an average of 2.6 kilometers (Garner and Gardner 1992). In Indiana, 11 foraging adult females that were tracked for 2-7 days moved up to 8.4 km from their roost; home range during this brief period averaged 3.35 square kilometers (Sparks et al. 2005). *Myotis grisescens* females move up to 6.6 kilometers (Tuttle 1976). Female *M. septentrionalis* had an average foraging home range of 61.1 hectares (Menzel et al. 1999), equivalent to a circle with a diameter of 880 meters.
Date: 08Mar2001
Author: Cannings, S.

Use Class: Nonbreeding
Subtype(s): Diurnal Roost, Foraging Area, Nocturnal Roost
Minimum Criteria for an Occurrence: A site occupied either historically or at present by a recurring population of migrating or otherwise nonhibernating individuals during the nonbreeding season. Identification evidence minimally includes collection or reliable observation and detailed documentation of one or more individuals. In certain regions, recorded echolocation sequences of individuals may be considered reliable observations for certain species that can be confidently identified by their echolocation calls alone.
Separation Barriers: None.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: The assigned separation distance is intended to generate occurrences that consist of spatially proximate roost sites and capture locations. However, include in the same occurrence (1) any roost sites between which individuals are known to move, regardless of how far apart they are, and (2) known significant foraging areas of occurrences that are based on roost sites.

In California, Fellers and Pierson (2002) studied a group of *Corynorhinus townsendii* inhabiting a maternity colony site after the nursery season had passed and found that the mean center of female foraging activity was 3.2 kilometers from the diurnal roost, whereas the mean center of male foraging activity was only 1.3 kilometers from the roost. No bats traveled more than 10.5 kilometers from the roost, and individuals showed considerable loyalty to the primary roost. Otherwise, little movement data are available.
Date: 19Apr2001
Author: Cannings, S.

Population/Occurrence Viability

Justification: Use the Generic Guidelines for the Application of Occurrence Ranks (2008).
The Key for Ranking Species Occurrences Using the Generic Approach provides a step-wise process for implementing this method.
Key for Ranking Species Element Occurrences Using the Generic Approach (2008).

U.S. Invasive Species Impact Rank (I-Rank)

Authors/Contributors

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NatureServe Conservation Status Factors Author: Hammerson, G.

Management Information Edition Date: 10Apr1992

Management Information Edition Author: J. E. EVANS, NANCY DRILLING, AND R. L. HENSON

Element Ecology & Life History Edition Date: 13Jun2014

Element Ecology & Life History Author(s): Hammerson, G., J. Jefferson, and P. Novak

Zoological data developed by NatureServe and its network of natural heritage programs (see **Local Programs**) and other contributors and cooperators (see **Sources**).

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Note: This report was printed on **April 11, 2017**

Citation for data on website including State Distribution, Watershed, and Reptile Range maps:
NatureServe. 2017. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: April 11, 2017).

Citation for Bird Range Maps of North America:
Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2003. Digital Distribution Maps of the Birds of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Bird Range Maps of North America:
"Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy - Migratory Bird Program, Conservation International - CABS, World Wildlife Fund - US, and Environment Canada - WILDSPACE."

Citation for Mammal Range Maps of North America:
Patterson, B.D., G. Ceballos, W. Sechrest, M.F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B.E. Young. 2003. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Mammal Range Maps of North America:
"Data provided by NatureServe in collaboration with Bruce Patterson, Wes Sechrest, Marcelo Tognelli, Gerardo Ceballos, The Nature Conservancy-Migratory Bird Program, Conservation International-CABS, World Wildlife Fund-US, and Environment Canada-WILDSPACE."

Citation for Amphibian Range Maps of the Western Hemisphere:
IUCN, Conservation International, and NatureServe. 2004. Global Amphibian Assessment. IUCN, Conservation International, and NatureServe, Washington, DC and Arlington, Virginia, USA.

Acknowledgement Statement for Amphibian Range Maps of the Western Hemisphere:
"Data developed as part of the Global Amphibian Assessment and provided by IUCN-World Conservation Union, Conservation International and NatureServe."

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