



INDIANA DEPARTMENT OF NATURAL RESOURCES 2018 WILDLIFE SCIENCE REPORT



Snake tracks meander through a sand bowl at a Newton County prairie. An adult bullsnake (*Pituophis catenifer sayi*) was found a short distance away.

ON THE COVER

Snapshot Indiana is a citizen-science trail camera program that collects information on wildlife species throughout Indiana. The program uses citizen volunteers to deploy cameras provided by the Division of Fish and Wildlife (DFW) on their property in October and November. Cameras are returned after the survey period, and the photos are analyzed. Initiated as a pilot project in 2015, Snapshot Indiana has since expanded to 190 cameras statewide, with the ultimate goal of having five cameras in each of Indiana's 92 counties.

Snapshot Indiana yields useful information for many of Indiana's most common wildlife species, such as white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and wild turkey (*Meleagris gallopavo*). Although the main purpose of Snapshot Indiana is to track trends in wildlife

populations, photographs also provide insight into a particular species' distribution, range expansion and activity patterns, as well as documenting occurrences of uncommon or secretive wildlife, such as badgers (*Taxidea taxus*). DFW's deer biologists have begun to use Snapshot Indiana to collect sex and age information that will help to monitor Indiana's deer herd.

Although remote-trigger cameras cannot answer every wildlife question, Snapshot Indiana is a valuable tool for the DFW and a fun way for the public to get involved in a wildlife survey. To learn more about Snapshot Indiana and how to volunteer, see wildlife.IN.gov/9625.htm.

Photograph Note

Indiana DNR photographers Frank Oliver and John Maxwell, along with Wildlife Science staff, took many of the copyrighted photos in this publication. The others are in the public domain, unless otherwise noted.

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A view from the boardwalk at Pisgah Marsh FWA in Kosciusko County.

WILDLIFE SCIENCE ADMINISTRATION

INTRODUCTION

The year 2018 marks the Wildlife Science Unit's five-year anniversary. Although "Wildlife Science" was a new name in 2014, the unit was formed by the merger of two established and successful DFW programs. These were Wildlife Research, which originated in the 1940s, and Wildlife Diversity, the roots of which trace back to the 1980s. The new name and organizational structure reflects a holistic approach to managing one of Indiana's most valuable assets: its fish and wildlife resources.

Although responsibilities, funding sources, focal species, and user groups may differ, both programs share the central mission of managing and conserving wild animal populations throughout the state. In its five years, Wildlife Science has grown from 14 to 19 full-time professionals. The staff now includes a biometrician, hired in 2018, to provide quantitative and analytical support to Wildlife Section staff.

This report shares the work of Wildlife Science's 11 major programs in 2018. We hope it informs and encourages you to take part in helping conserve Indiana's wildlife.

PERSONNEL CHANGES

Four key positions in Wildlife Science were filled in 2018. Sadie Dainko was promoted to the newly created assistant waterfowl biologist position. Brad Westrich was promoted to nongame mammalogist. Emily McCallen was hired as DFW's first wildlife biometrician, and Jacob (Jake) Adams joined as the assistant nongame aquatic biologist. All positions are stationed in the Bloomington Field Office, except for Jake, whose office is at Atterbury Fish & Wildlife Area (FWA).

Sadie obtained her B.S. in environmental management at Indiana University, and began work with the Indiana DNR in November 2015 as an intermittent, working on habitat use by northern bobwhite (*Colinus virginianus*). She moved to the waterfowl program for three seasons, assisting in surveys and banding Canada geese (*Branta canadensis*) and wood ducks (*Aix sponsa*), before becoming the program's full-time assistant. Sadie also assists other science efforts, such as installing nest boxes for barn owls (*Tyto alba*), manning deer check stations, surveying nongame birds and Allegheny woodrats (*Neotoma magister*), and processing river otter (*Lontra canadensis*) carcasses.

Brad was born and raised near Albuquerque, New Mexico, where he spent his youth outdoors, hiking and fly fishing in the mountains of northern New



Sadie Dainko with a banded Canada goose along the White River in Muncie.

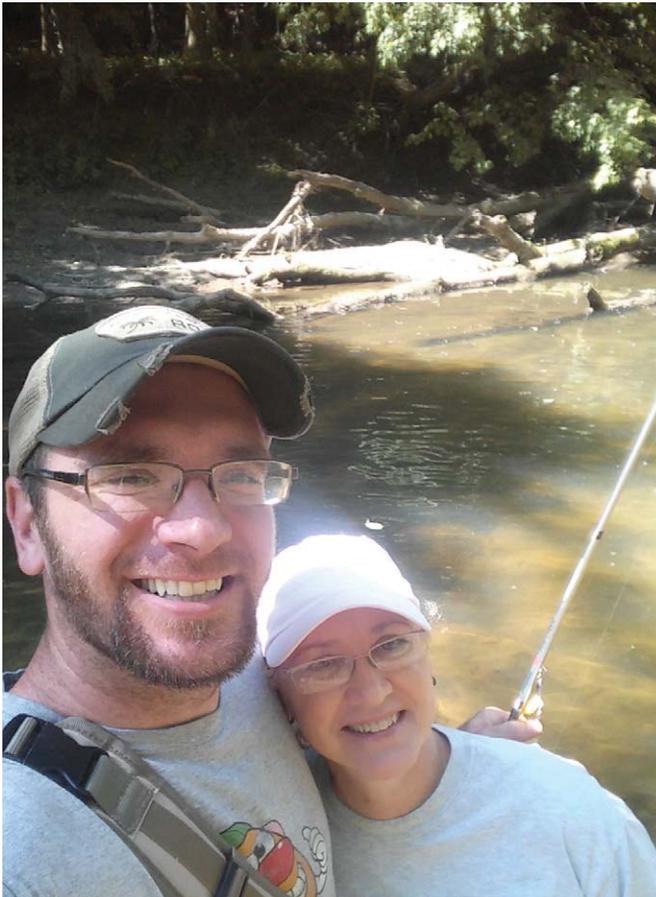


DNR mammalogist Brad Westrich with his wife and son, Michelle and Callum, exploring Indiana Dunes State Park.

Mexico. He attended New Mexico State University, where he received his B.S. in conservation ecology while also completing a research project to assess linkages between regional populations of gray fox (*Urocyon cinereoargenteus*). He then worked on several endangered species research projects from Central America to Utah to Florida. Brad received his M.S. in biology from Texas State University, where he studied the interaction between mammalian community structure and composition with vector and



Emily McCallen joined the Indiana DNR in 2018 as the agency's first wildlife biometrician.



Jake Adams and his mother during a fishing trip to Otter Creek in Vigo County.

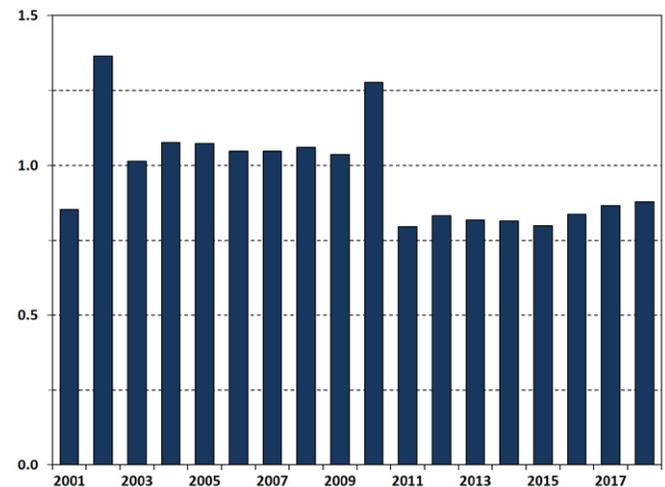
pathogen maintenance. His research interests include disease ecology, community ecology, endangered species management, and mitigating anthropogenic disturbances. Brad and his wife recently had their first child, and they now spend any and all free time with their baby boy.

Emily earned her B.S. and M.S. from Eastern Illinois University. Her master's work focused on developing spatially explicit estimates of heavy metal and radiocesium body burdens for river otters on the Department of Energy's Savannah River Site. She completed her Ph.D. at Purdue University, with research concentrated on advancing hellbender (*Cryptobranchus alleganiensis*) conservation through genetic and spatial modeling. More broadly, her research interests include animal movement, habitat use, and community dynamics. In her free time, Emily enjoys exploring Indiana's state parks with her husband, son, and two beagles.

Jake grew up in Vigo County and earned his B.A. in fisheries & aquatic science from Purdue University in 2016. He worked for several years as a lab assistant for Reuben Goforth's laboratory on campus, and was heavily involved in the student chapter of the American Fisheries Society. Jake previously worked for DFW in 2013, as the Big Rivers Aide, under Tom Stefanavage and Craig Jansen. After graduation, Jake worked with the University of Missouri as a field technician, supporting freshwater mussel modeling in the Meramec River drainage, and later as a saw man for a small tree service in his hometown. In his free time, Jake enjoys subsistence hunting, fishing and foraging in and around Indiana.

FUNDING

Wildlife Science programs are financed by both State and federal dollars. The two sources of State funds are



Indiana's annual apportionment (in millions) from the USFWS's State Wildlife Grant program from 2001 to 2018. Indiana has received an average of \$971,300 annually, totaling nearly \$17.5 million.

2018 WILDLIFE SCIENCE STAFF

Indianapolis Office

Scott Johnson, Program Manager;
sjohnson@dnr.IN.gov

Sam Jordan, Staff Specialist;
sjordan1@dnr.IN.gov

Bloomington Office

Theresa Bordenkecher, Supervisor;
tbordenkecher@dnr.IN.gov

Gerianne Albers, Furbearer Biologist;
galbers@dnr.IN.gov

Matt Broadway, Small Game Biologist;
mbroadway@dnr.IN.gov

Joe Caudell, Deer Biologist;
jcaudell@dnr.IN.gov

Olivia Vaught, Assistant Deer Biologist;
ovaught@dnr.IN.gov

Nate Engbrecht, Nongame Herpetologist;
nengbrecht@dnr.IN.gov

Jason Mirtl, Assistant Nongame Herpetologist;
jmirtl@dnr.IN.gov

Allisyn-Marie Gillet, Nongame Ornithologist;
agillet@dnr.IN.gov

Emily McCallen, Wildlife Biometrician;
emccallen@dnr.IN.gov

Adam Phelps, Waterfowl Biologist;
aphelps@dnr.IN.gov

Sadie Dainko, Assistant Waterfowl Biologist;
sdainko@dnr.IN.gov

Brad Westrich, Nongame Mammalogist;
bwestrich@dnr.IN.gov

Tim Shier, Assistant Nongame Mammalogist;
tshier@dnr.IN.gov

Cassie Hudson, Regional Office Manager;
chudson@dnr.IN.gov

Steve Burcham, Clerk;
sburcham@dnr.IN.gov

Edinburgh Office

Brant Fisher, Nongame Aquatic Biologist;
bfisher@dnr.IN.gov

Jacob Adams, Assistant Nongame Aquatic Biologist;
jaadams@dnr.IN.gov

Mitchell Office

Steve Backs, Ruffed Grouse and Wild Turkey Biologist;
sbacks@dnr.IN.gov

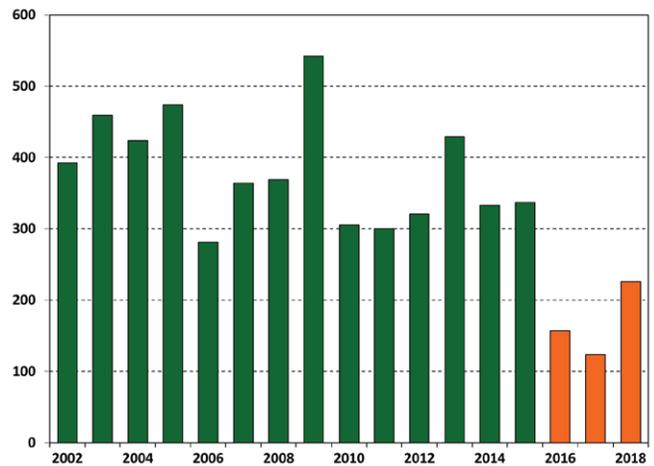
Amy Kearns, Assistant Nongame Ornithologist;
akearns@dnr.IN.gov

Roger Hunter, Clerk

West Lafayette Office, Purdue University

Nancy Boedeker, Wildlife Veterinarian;
nboedeker@dnr.IN.gov

Naturalist Aides: Taylor Ailes, Julia Buchanan-Schwanke, Charles Conner, Rachel Grayless, Elizabeth Johnson, Lindsey Magnicheri, Daniel Prymek, Meghan Raley, Mitchell Sargent, Allan Saylor, Cody Widner, Danielle Williams, Julia Wilson, Ken Wilson, Hunter Yazel



Annual donations (in thousands) to the Indiana Nongame Wildlife Fund from 2002 to 2018. The orange columns represent the totals received after changes were made to the state's income tax form. Hoosiers have donated nearly \$12.8 million to the Nongame Wildlife Fund since it was established in 1982.

DONATE TO SUPPORT WILDLIFE CONSERVATION

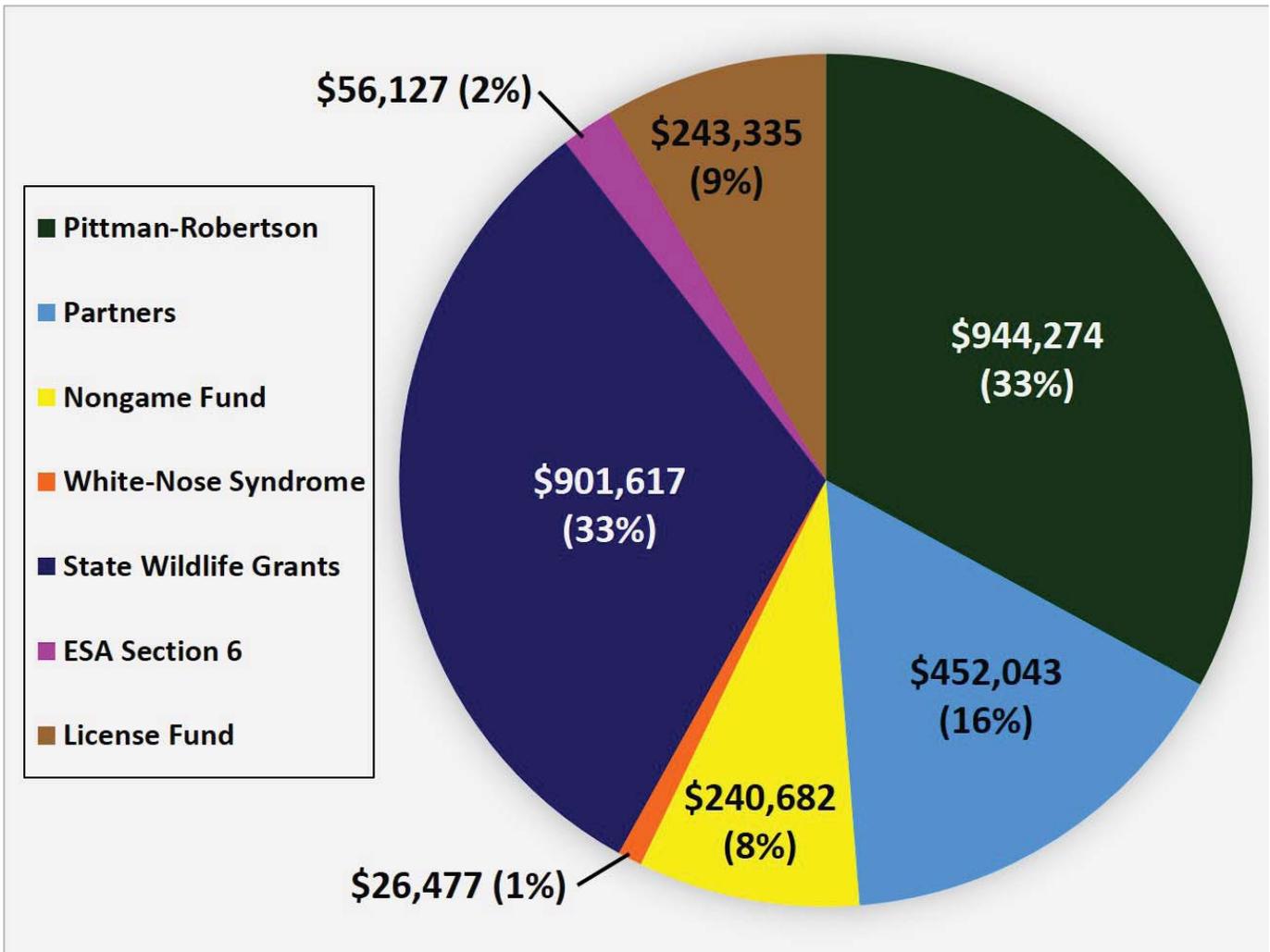


The DFW invites you to play an active role in conserving Indiana's nongame and endangered wildlife by donating to the Indiana Nongame Wildlife Fund. No state tax dollars are earmarked for these projects; activities to benefit these species are supported by public donations to this fund. Money from the Nongame Wildlife Fund has another important use—it serves as a grant match for federal funding. For every \$5 received in donations, an additional \$9 is provided in federal grants. The money donated goes directly toward the conservation of more than 750 species in Indiana, from shiners and rails to turtles and bats.

To donate, follow one of these easy steps:

- Donate online at endangeredwildlife.IN.gov.
- Donate all or part of your state tax refund using Schedule 5/Schedule IN-DONATE. The Indiana Nongame Wildlife Fund three-digit code is 200.
- Send a check to:

Indiana Nongame Wildlife Fund
402 West Washington Street, Room W273
Indianapolis, IN 46204



Wildlife Science programs spent nearly \$2.9 million from seven different funding sources in 2018. About two-thirds of this total was provided through the Pittman-Robertson Act and the State Wildlife Grant program.

revenue from the sale of Indiana hunting and trapping licenses and donations to the Indiana Nongame Wildlife Fund. Federal funds come to the DFW several ways but the two primary means for wildlife conservation are the Pittman-Robertson (PR) Act and the State Wildlife Grant (SWG) program.

PR monies are derived from an 11% federal excise tax on sporting arms, ammunition and archery equipment, and a 10% federal excise tax on handguns. When hunters and shooters purchase these items, the manufacturers pay the excise tax. This revenue is deposited into the Wildlife Restoration Trust Fund that is administered by the U.S. Fish and Wildlife Service (USFWS). Funds are made available as grants to each eligible state, based on the size of the state and its number of licensed hunters. The grants fund up to 75% of the eligible costs. The remaining 25% is supplied by the state, usually from license revenue, but other partners, such as universities, may provide the match.

The SWG program, authorized by Congress in

2001, provides funds to address rare, declining, and at-risk species. These dollars, however, are not permanent—they are subject to annual budget battles. Indiana’s share in 2018 was \$878,461—the highest in eight years. During the 18-year lifespan of the SWG program, Indiana has received nearly \$17.5 million to support rare species conservation. We are grateful to our many university partners that provide the required 35% non-federal match, allowing SWG monies to be used to their full potential.

Additional federal funds were received in 2018 from a competitive white-nose syndrome (WNS) grant (\$30,000) and an Endangered Species Act (ESA) Section 6 grant (\$93,851). The WNS grant will support counts of winter bat populations and travel to regional and national meetings. Field surveys for the state-endangered alligator snapping turtle (*Macrochelys temminckii*) are the focus of the ESA grant.

Contributions to the Nongame Wildlife Fund, used solely for nongame and endangered species conservation in Indiana, totaled \$225,600 in 2018. Most



Indiana's 2018 ESA Section 6 funds will support field surveys for the alligator snapping turtle in southwest Indiana.

donations to this fund are received when Indiana citizens donate all or part of their refund when filing their annual state income taxes. However, changes to the state's tax forms that went into effect in 2016 have affected contribution totals with annual donations falling more than \$200,000 short of the long-term average. The DFW appreciates every contribution. Staff continues to explore ways to increase donations to the Nongame Wildlife Fund and to better communicate to Hoosiers how their generous gifts support nongame and endangered species conservation in Indiana.

PARTNERSHIPS: STRETCHING THE CONSERVATION DOLLAR

Effective and informed wildlife management sometimes requires detailed investigation of the complex and interrelated factors that influence populations. In these situations, the DFW often forms research partnerships with Indiana's institutions of higher education. Through these partnerships, funding is directed toward addressing pressing management questions. The funding also supports and enhances the training of the next generation of wildlife professionals. As part of their normal operation, colleges and universities pay their faculty and provide student scholarships while maintaining facilities, support staff, and equipment (i.e., overhead). Such expenditures, used in a partnership context, can be claimed as a non-federal match. This maximizes use of Indiana's federal dollars. It's a win-win. Without increasing state spending, matching federal funds are brought to conservation. Indiana's citizenry, future scientists and wildlife benefit.

Click on the external project links associated with the 2018 Wildlife Science report to view the progress on this year's 11 research partnerships.



STATE WILDLIFE GRANT—INDIANA
Status of Blanding's Turtle and Spotted Turtle Populations in Indiana



Blanding's turtle and spotted turtle populations are unable to recover quickly because they have delayed sexual maturity and females lay fewer eggs as compared to other species. (Photo by Jessica Hinson)

CURRENT STATUS
Second year of a three-year project

FUNDING SOURCES AND PARTNERS
State Wildlife Grant Program (T7R21)
Purdue University Fort Wayne

PROJECT PERSONNEL
Dr. Bruce Kingsbury, Principal Investigator, Purdue University Fort Wayne
Dr. Mark Jordan, Project Partner, Purdue University Fort Wayne
Jessica Hinson, Graduate Student, Purdue University Fort Wayne
Elpheth Pierce, Graduate Student, Purdue University Fort Wayne
Tyler Scoville, Graduate Student, Purdue University Fort Wayne

BACKGROUND AND OBJECTIVES
Blanding's turtles (*Emydoidea blandingii*) and spotted turtles (*Clemmys guttata*) are two aquatic turtles in Indiana with populations in decline. Both are listed as an endangered species in Indiana and in many other states throughout the eastern United States. The historical distribution of both species in Indiana is largely restricted to the northern portion of the state. Declines may be due to wetland loss and fragmentation, wetland degradation, road mortality, and poaching. Although efforts have been made to document occurrences of these species as they are observed in Indiana, comprehensive population status assessments for both are lacking. An understanding of the status of populations, their genetic composition, and the spatial distribution of suitable habitat for them is needed to inform the development of conservation strategies for these turtles. Given the relative isolation of populations

2018 Wildlife Science Report—Blanding's Turtle and Spotted Turtle Populations 1

The state-endangered Blanding's turtle (*Emydoidea blandingii*) and spotted turtle (*Clemmys guttata*) are the subject of a multi-year partnership with Purdue University Fort Wayne.



WILDLIFE RESTORATION GRANT—INDIANA
Movement and Harvest of Local Mallards from Urban Environments of Indiana



A hen mallard using urban habitats studied through collaborative work of the DNR and Franklin College. (Photo by Ryan Ashren)

CURRENT STATUS
Third year of a four-year project

FUNDING SOURCES AND PARTNERS
Wildlife Restoration Grant Program (W49R1)
Franklin College
Branigan Foundation

PROJECT PERSONNEL
Dr. Benjamin O'Neal, Franklin College
Seth Eckert, Wanda Gaines, Andrew Kammerer, Hannah McIntosh, Franklin College undergraduates (2016)
Alex Bird, Katelyn Pierce, Ricky Smith, Franklin College undergraduates (2017)
Brady Wehus-Tow, Logan Vandermark, Gaeron Gruber, Ricky Smith, Franklin College undergraduates (2018)

BACKGROUND AND OBJECTIVES
Land cover analyses show that the area of water bodies in the developed regions of the Midwest has

increased in recent decades. Collectively, these water bodies provide a meaningful amount of habitat for generalist species such as mallards (*Anas platyrhynchos*). While aquatic habitats have been increasing in states like Indiana, the acreage of grass cover in the primary region for duck reproduction (i.e., the Prairie Pothole region of the northern plains) has decreased, particularly in recent years, as acreage enrolled in U.S. Department of Agriculture farm bill conservation programs has plummeted. As such, the mallards produced in developed areas (hereafter "urban mallards") may play an increasingly significant role, both ecologically and recreationally.

To begin to understand the ecological impact of this population segment, we have to determine the extent of its members' seasonal movements outside their natal areas. At present, there is little information on whether urban mallards migrate and, if so, how far. The extent of these seasonal movements and the type of habitat occupied (e.g., urban vs. rural) can

2018 Wildlife Science Report—Movement and Harvest of Local Mallards 1

The DFW is partnering with Franklin College to study the ecology of mallard (*Anas platyrhynchos*) populations in the urban environments of central Indiana.

RULE CHANGES

Indiana's fish and wildlife resources are governed by state laws and administrative rules that set forth the requirements that regulate wild animals. The DFW has statutory authority for wild mammals, birds, reptiles, amphibians, fish, crayfish, and freshwater mussels.

Two categories designate rare and at-risk species in Indiana: endangered and special concern.

Species listed as special concern are defined as any animal species requiring monitoring because of known or suspected limited abundance or distribution, or because of a recent change in federal status or required habitat.

Species listed as endangered are defined as any animal species whose prospect for survival or recruitment within Indiana is in jeopardy and is in danger of disappearing from the state. This designation also includes all animal species occurring in Indiana that are listed as threatened or endangered by the USFWS. Whereas endangered species receive legal protection by state law, pursuant to the Indiana Nongame and Endangered Species Conservation Act (IC 14-22-34), species of special concern do not have

equivalent levels of protection, and some can be taken from the wild.

In 2018, several changes were made to Indiana's list of endangered and special concern species. The little brown bat (*Myotis lucifugus*), northern long-eared bat (*M. septentrionalis*), tri-colored bat (*Perimyotis subflavus*) and rufa red knot (*Calidris canutus rufa*) were elevated from special concern to endangered.

Six species of freshwater mussels—the pyramid pigtoe (*Pleurobema rubrum*), orangefoot pimpleback (*Plethobasus cooperianus*), pink mucket (*Lampsilis abrupta*), tubercled blossom (*Epioblasma torulosa*), longsolid (*Fusconaia subrotunda*), and white wartyback (*P. cicatricosus*) were removed from the endangered list because they are no longer found in the state and are considered to have been extirpated.

The osprey (*Pandion haliaetus*) met recovery goals, and was down-listed from endangered to special concern.

The northern leopard frog (*Lithobates pipiens*) was removed from special concern status, while the plains gartersnake (*Thamnophis radix*) was added to the special concern list.

The current list can be found at endangeredwildlife.IN.gov.



Indiana's osprey populations exceeded recovery goals and were removed from the state endangered species list in 2018.

WILDLIFE SCIENCE PROGRAMS

NONGAME AMPHIBIANS & REPTILES Nongame Herpetological Findings

DFW herpetologists conduct field surveys annually for amphibians and reptiles at various sites throughout Indiana. Some surveys target a particular species, especially those listed as a Species of Greatest Conservation Need (SGCN) in Indiana, whereas others seek to describe the broad array of herpetofauna on a specific property. In 2018, surveys were conducted



The Blanding's turtle is readily identified by its bright yellow throat.



Copperbelly watersnakes are listed as state endangered in Indiana. An isolated population in northeast Indiana is listed as federally threatened by the USFWS.



Eastern spadefoots spend much of their lives in underground burrows dug with a spade-like appendage on each of their hind feet.



The common five-lined skink is Indiana's most widespread lizard species.

on more than 20 state-owned properties in 35 Indiana counties. This work resulted in the documentation of many amphibians and reptiles, including several listed as endangered or special concern by the Indiana DNR. State-endangered species included copperbelly watersnakes (*Nerodia erythrogaster neglecta*) at four sites in Posey, Warrick, and Spencer counties; spotted turtles in Lake County; a hellbender in Harrison County; and a Blanding's turtle at a new locality in St. Joseph County. In addition, new county records were



DFW herpetologists assisted Purdue University in searches for hellbender nests in the Blue River during summer and fall of 2018.



Streamside salamander eggs found under a partially submerged rock at Ferdinand State Forest in Dubois County. The eggs will eventually hatch into free-swimming larvae that, in turn, transform into terrestrial adults.

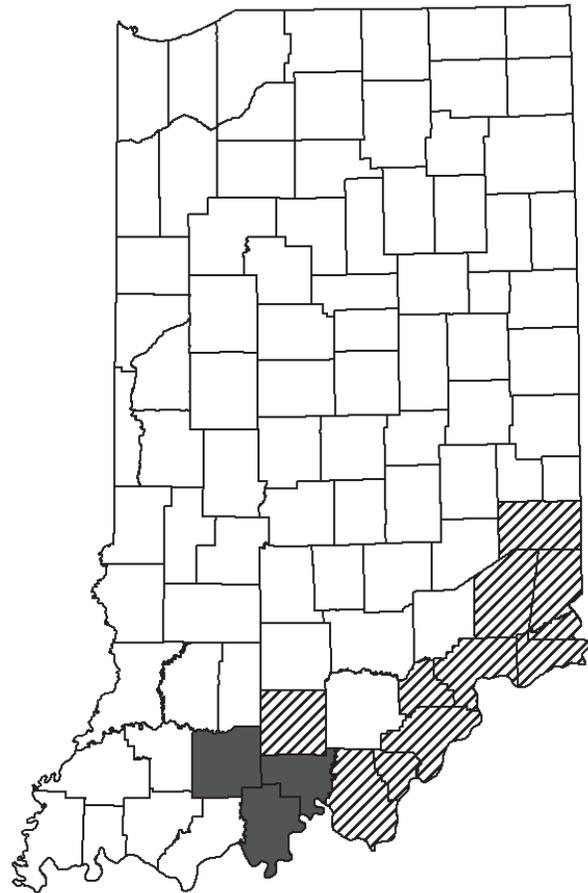
documented for the eastern spadefoot (*Scaphiopus holbrookii*) in Shelby and Lawrence counties, the eastern newt (*Notophthalmus viridescens*) in Warrick County, and the common five-lined skink (*Plestiodon fasciatus*) in Newton County.

Streamside Salamanders

Streamside salamanders (*Ambystoma barbouri*) are a Species of Special Concern in Indiana and are currently under federal review by the USFWS. These salamanders have a small range that occurs primarily in parts of Indiana, Kentucky, and Ohio. In Indiana, they are found in the southernmost counties near the Ohio River, where they inhabit forested areas near small streams. Although streamside salamanders are highly fossorial (living underground), they can be found



A streamside salamander from Perry County. Note the proportionally large, thick tail.



Distribution of the streamside salamander in Indiana. Dark-shaded counties represent records collected in 2018. Crosshatched counties depict the overall range of the species in Indiana.

along headwater streams in winter and early spring when they mate and deposit their eggs. From January to March, biologists conduct searches for breeding adults or their eggs in an effort to document sites where populations remain.

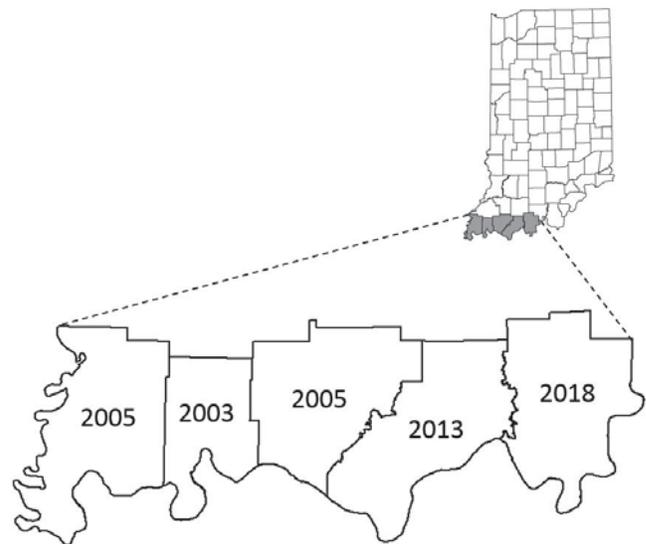
In 2018, DNR biologists conducted surveys in Washington, Orange, Crawford, Perry, and Dubois counties. Streamside salamanders or their eggs were observed at eight sites in the latter three counties. Populations discovered in Dubois County represent a slight westward extension in the known range of the species. Surveys will continue during the 2019 field season.

Green Treefrog

The green treefrog (*Hyla cinerea*) is a southern species that ranges up the Mississippi Embayment into parts of western Kentucky, southern Illinois, and southern Indiana. It is a relative newcomer in Indiana. The state's first population was discovered in Evansville in 2003. Not long after that, DFW biologists began finding the frogs at other Indiana sites at which they had not previously been detected, and additional surveys continued to reveal new populations along the lower Wabash and Ohio rivers. In 2018, Wildlife Science staff documented green treefrog range expansions up the Ohio River valley, identifying six new sites in Spencer County and one in Perry County. The record in Perry County is about a 32-mile range expansion up the Indiana side of the Ohio River valley and establishes the species' presence in a fifth Indiana county. In an age of amphibian declines, range expansions by the green treefrog are an intriguing phenomenon, and wildlife science staff will continue to search for new populations in 2019.



Green treefrogs can be distinguished from Indiana's other species of treefrogs by the rich green coloration and distinct white stripe that runs along the side of the body.



Green treefrog distribution in southwest Indiana by county. Dates indicate when the species was first confirmed in each county.

NONGAME BIRDS

Bald Eagle

The growth of the bald eagle (*Haliaeetus leucocephalus*) population is a remarkable conservation accomplishment. Habitat loss, millinery trade, and persecution once caused a dramatic decline in eagle numbers, leading to their extirpation in Indiana in 1897. Pesticides like DDT further thwarted eagle population recovery after World War II; however, through state reintroductions and legislative efforts such as the Bald Eagle Protection Act, the banning of DDT, and the Endangered Species Act, bald eagles have bounced back. Today, nearly 300 breeding pairs occur throughout Indiana.

DFW biologists continue to monitor eagle populations, protect nests, and inform the public of the increasing eagle numbers. Reports from property managers, conservation officers, and the public bring attention to new nests and document the status of known nests. In 2018, a total of 258 nests were reported, of which 249 appeared in good shape, and at least 181 chicks were raised. Fifty-two nests were new, including the first nest documented in DeKalb County. Bald eagles now nest in 85 of Indiana's 92 (92%) counties.

Wintering bald eagles are counted to monitor long-term trends in the region and to inform the status of populations throughout North America. These surveys are part of the U.S. Army Corps of Engineers' National Midwinter Bald Eagle Survey, which has been conducted in Indiana since 1979. In 2018, eagles were counted from the ground at 10 locations, mainly DFW properties or public lakes. Helicopter surveys were conducted on eight routes, along rivers that are inaccessible by



An adult bald eagle carrying an American coot (*Fulica americana*) at Stillwater Marsh, Monroe Lake. (Photo by Jeff Danielson)



Steel mills and power plants partner with DFW staff and volunteers to manage nest boxes for peregrine falcons. In May 2018, two chicks were banded at a lime plant nest box in East Chicago.

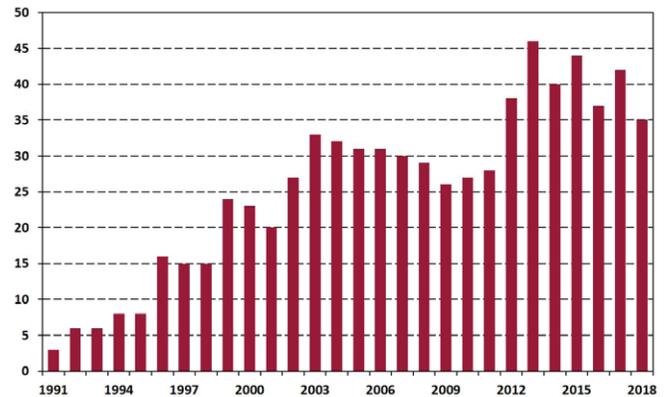
foot. Overall, 179 eagles were tallied at these sites, which is below the previous 10-year average of 214 for the state. This figure is less than the number counted during the same period in 2017 (274), but two fewer sites were surveyed in 2018.

Information obtained from ground surveys represents population trends more precisely because sample effort is consistent each year. At 10 sites surveyed from the ground, 56 eagles were counted in 2018 compared to 217 in 2017, a 74% decrease. The largest concentrations of wintering eagles were at the Mississinewa River roost (11), Salamonie River roost (8), and a roost near Sugar Creek (8).

If you would like to help bald eagles in Indiana, make sure to observe nests and roosts from a distance of at least 330 feet, roughly the length of a football field. Photographers should take photos of eagles with a telephoto lens. Finally, foster a climate of respect for wildlife by sharing these guidelines with your friends.

Peregrine Falcon

The peregrine falcon (*Falco peregrinus*) is one of the fastest animals alive, reaching flight speeds greater than 200 mph. These birds can be spotted in some of the most unexpected places, such as the Indiana War Memorial in downtown Indianapolis. Such a sighting was not possible in the 1970s, when peregrine falcons were absent from the Midwest. Because of reintroductions and their flexibility in nesting sites, these birds now occupy some of Indiana's most developed and densely populated areas, nesting on skyscrapers and the stacks of power plants. In 2013, peregrine falcons were removed from the state list of



The number of peregrine falcon chicks fledged in Indiana since the DFW reintroduction program began in 1991.

endangered species, and are now monitored annually to track population recovery after delisting.

DFW biologists identified 18 locations that had peregrine falcons present during the 2018 nesting season (compared to 21 in 2017). One exceptional territory hosted two adult males. Thirteen nesting attempts were documented, 12 of which were successful. Thirty-two chicks were banded, and 35 young fledged (42 in 2017). Biologists also took blood samples, checked for signs of trichomoniasis, and collected unhatched eggs to monitor health.

In territories with active nests, 14 banded adults were identified. These birds originated from six states and one province: three falcons each from Indiana and Wisconsin, two each from Kentucky,

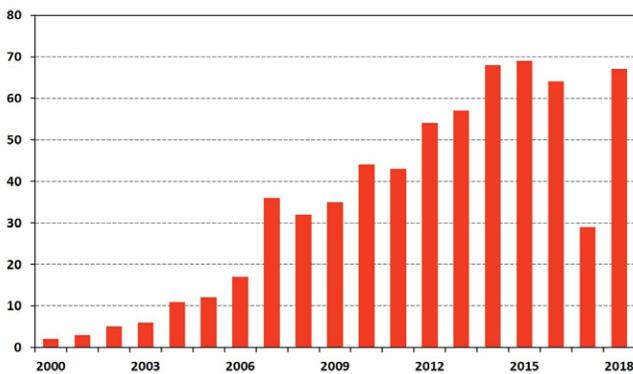
Michigan, and Ohio, and one falcon each from Missouri and Ontario.

Five permits were allocated to Indiana falconers to take an unbanded peregrine in the fall for falconry. These birds are juvenile migrants that originate from breeding populations in the Arctic. Permits are given in low numbers annually, but no falcons have been captured since 2014.

Information collected during the last five years provides evidence that Indiana's breeding population remains productive; however, if you would like to continue to see these falcons thrive, advocate for them by educating and getting people excited about your local urban wildlife.

Osprey

After reintroductions from 2003 to 2006 released 96 juveniles from coastal Virginia at four DNR properties, ospreys exceeded recovery goals and were delisted as state endangered in 2018. DFW biologists continue to



Number of osprey territories in Indiana from 2000 to 2018. The decline in 2017 was likely due to fewer reports being filed, as opposed to there being a decrease in the actual number of nests.



The first chick from an osprey nest on Crooked Lake takes flight (upper right hand corner). The adult female is on the left. The chick's two siblings are on the right. This nest is monitored using a live camera feed. (Photo provided by John Meier)

collect reports of osprey nests to monitor any possible effects of delisting on the population. In 2018, a total of 67 nests was counted (29 in 2017), and at least 57 chicks were produced (29 in 2017). This is more than double last year's number but is consistent with years previous to 2017.

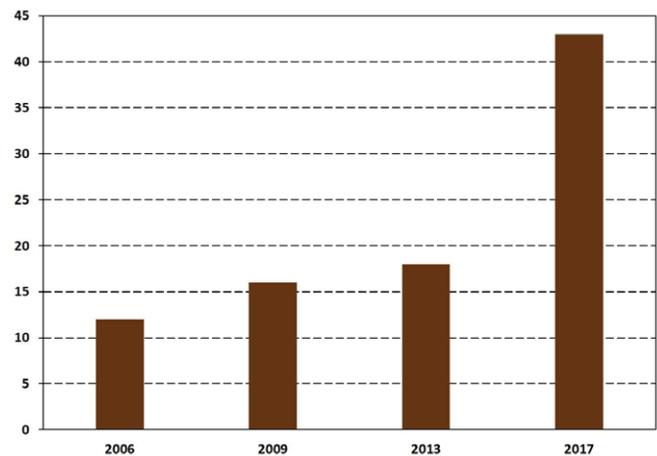
If you would like to help, report banded ospreys and nest locations to DFW staff when you see them. You can find ospreys nesting at DNR properties like Patoka Lake, Pigeon River FWA, Potato Creek State Park, and Brookville Lake. You can also attract ospreys to your local reservoir by installing nesting platforms. Ospreys readily nest on platforms and can be viewed from a safe distance that prevents disturbance.

Companies that service communication and utility towers can help ospreys by contacting the DFW for guidance when encountering their nests. Delaying maintenance until after the nesting season prevents ospreys from abandoning nests and losing eggs or chicks to exposure. Vacant nests can be removed from towers without a permit but companies are encouraged to keep part of the nest at a location on the tower where it is less likely to interfere with its operation.

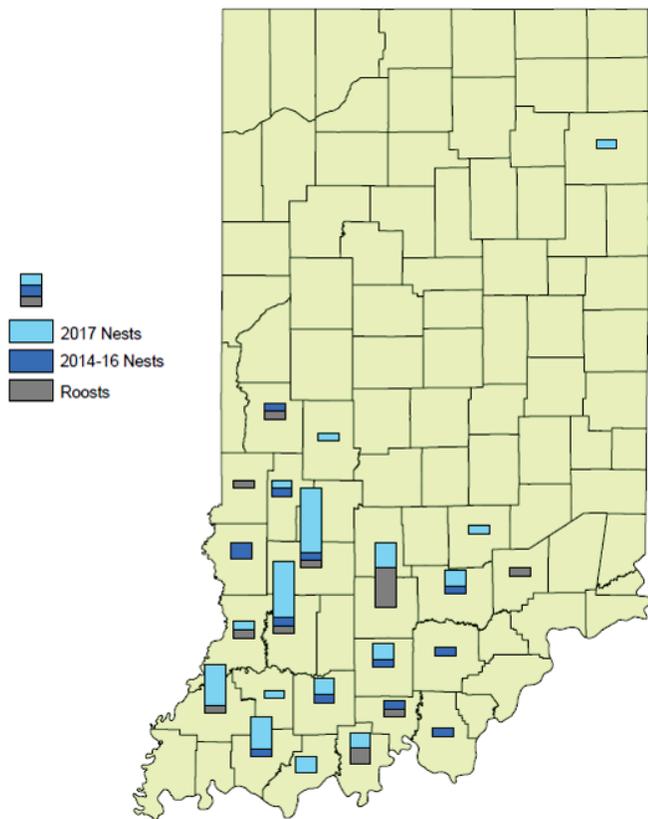
Assessing whether the population is recovering depends largely on reports from private companies and the public. DFW staff members encourage the reporting of osprey nests and breeding activity such as nest building, incubation, food deliveries, and begging chicks to Allisyn Gillet at agillet@dnr.IN.gov.

Barn Owl Management

Barn owls are a state-endangered species, identified by their ghostly pale appearance, black eyes, and heart-shaped face. They feed at night, preying on small mammals like mice and voles. An adult owl can eat an average of three to four small mammals each day. A nesting pair with several owlets will consume nearly 3,000 prey items annually, making barn owls an effective, safe, and economical form of pest control.



Number of barn owl nests counted during comprehensive surveys in 2006, 2009, 2013 and 2017.



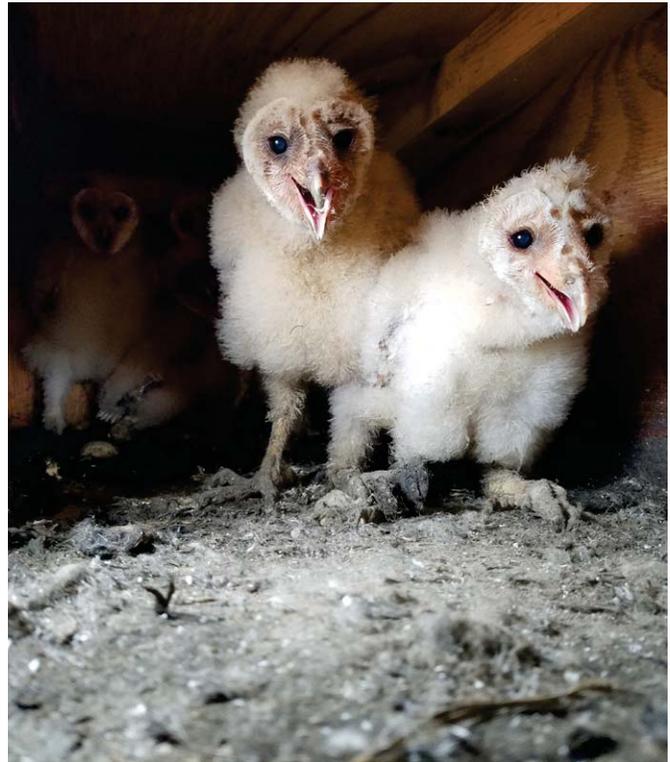
Distribution of barn owl nests and roosts detected during the 2017–18 comprehensive survey.

Barn owls are uncommon in Indiana due to loss of permanent grassland habitats for them to hunt, such as pastures, hayfields, and prairies. They also need cavities in large trees or structures like haylofts, steeples, and silos in which to raise their young. Such conditions are declining statewide, but still persist in small pockets in Daviess, Gibson, Greene, Lawrence, Orange, and Warrick counties.

To augment Indiana’s barn owl population, DFW biologists and volunteers have installed more than 300 nest boxes during the past three decades. These boxes provide nesting opportunities that are protected from severe weather and predators. Boxes are placed in grassland habitats across the state and are periodically checked and maintained.

A statewide check of 246 boxes was conducted during the 2017–18 winter to determine occupancy rates since the last survey in 2013. The presence of owls, feathers and pellets (regurgitated fur and bones), suggests owls used the box for roosting or nesting. Accumulated pellet mass, unhatched eggs, owl carcasses, and live owlets provide definitive evidence of nesting.

A record 43 nests were found active in 2017–18, more than twice what was recorded in 2013 (18 nests). Of these, 39 (91%) were in nest boxes mounted on interior barn walls. Single nests were in a silo, grain bin,



A brood of five barn owl chicks was encountered during the checking of a nest box in southern Indiana. DFW biologists quickly leave active nests to reduce disturbance and return later to clean the box.



Julia Wilson checks a nest box in a barn.

and hayloft. One nest in Clay County was found when a dog brought a barn owl chick to a landowner.

Thirteen additional boxes had evidence of nests from interim years (2014–2016). Fifteen roost sites were found, seven of which were in boxes, six in haylofts, and two in silos. Forty-five live owls, 21 of which were chicks, were encountered. In these situations, biologists left the site to minimize disturbance and later returned to clean the box.

Of all boxes checked, 63 were used by barn owls, 64 by common starlings (*Sturnus vulgaris*), 46 by rock pigeons (*Columba livia*), 19 by American kestrels (*Falco sparverius*), six by raccoons, three each by tree squirrels and mice, and two by screech owls (*Megascops asio*).

As of April 2018, a total of 273 nest boxes were available for owls, including 65 that were installed in 2017–18. Only 33 boxes were lost from barn collapses or demolitions. DFW staff will continue to place boxes in barns and other buildings to help barn owls raise their young. Please report sightings of barn owls, especially nesting pairs, to DFW@dnr.IN.gov.

Loggerhead Shrike

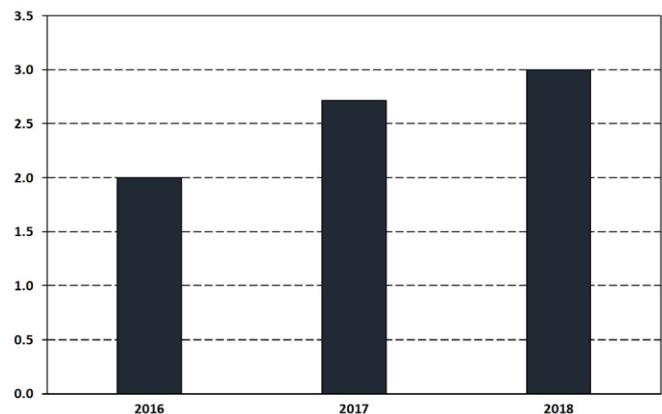
The loggerhead shrike (*Lanius ludovicianus*) is a robin-sized songbird that earned the nickname “butcher bird” due to its habit of hanging prey on thorns or barbed wire. Shrike populations in Indiana have declined dramatically, with an 83% drop in the number of nesting pairs over the last 30 years. In 2000, a total of 58 occupied territories were found statewide but now fewer than 10 are documented annually. Reasons for this decline include loss of quality breeding habitat, pesticide use, and increasing development of their wintering grounds.



Danielle Williams releases an adult loggerhead shrike after it was banded in Spencer County in 2018. Each shrike receives a unique color band combination, allowing biologists to identify them from a distance.



A juvenile loggerhead shrike perches on barbed wire.



Number of loggerhead shrike fledglings per adult pair in Indiana from 2016 to 2018.

DFW biologists monitor, capture, and band shrikes throughout the year to better understand the obstacles this state-endangered species faces.

In 2018, nine breeding territories were located in Orange (5), Daviess (2), and Lawrence and Spencer (1 each) counties; eight (89%) of these breeding pairs nested on Amish or Mennonite farms. Fourteen nesting attempts were documented, eight of which (57%) were successful. Causes of nest failure were presumed depredation (3), unknown factors (2), and exposure to inclement weather (1). A total of 27 shrike fledglings were confirmed, compared to 19 in 2017.

Of the 24 shrikes banded in 2017, five adults and one juvenile were re-sighted in 2018, producing return rates of 42% for adults and 8% for juveniles. In addition, three birds banded as adults in 2016 were re-sighted in 2018. Nine of 18 nesting adults were previously banded in 2016 or 2017, and eight returned to nest in or near their previous territory. The female that did not return was banded as a juvenile in 2017. She nested 17 miles from her banding location, and is the only shrike banded as a juvenile that is known to have nested in Indiana.

The DFW participates in the Loggerhead Shrike Working Group. It seeks to fill knowledge gaps that hinder shrike conservation through coordinated and collaborative research aimed at stabilizing and reversing population declines. Landowners can help shrikes and other wildlife by preserving shrubby fencerows. Because shrikes usually nest in isolated bushes and trees along fencerows, eliminating these linear features effectively destroys their nesting habitat. If fencerows must be cleared, landowners should avoid the nesting season (late April to late August) to give young shrikes a better chance to survive. Fencerows provide important habitat for many native birds and other wildlife such as bobwhite quail, deer, and eastern cottontails (*Sylvilagus floridanus*).

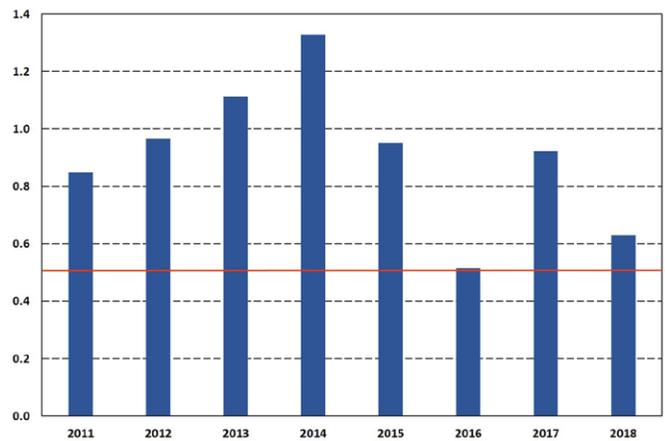
Interior Least Tern

The least tern (*Sternula antillarum*), the smallest tern species in North America, nests along Indiana's rivers in spring and summer. Least terns do not build nests from twigs, grass, or other vegetation, but form small depressions in sand or gravel to secure their eggs. River islands and sandbars provide natural nest sites, but these areas are popular recreational sites and can easily flood when water levels are high. For these reasons, the interior population of least terns is listed as federally endangered.

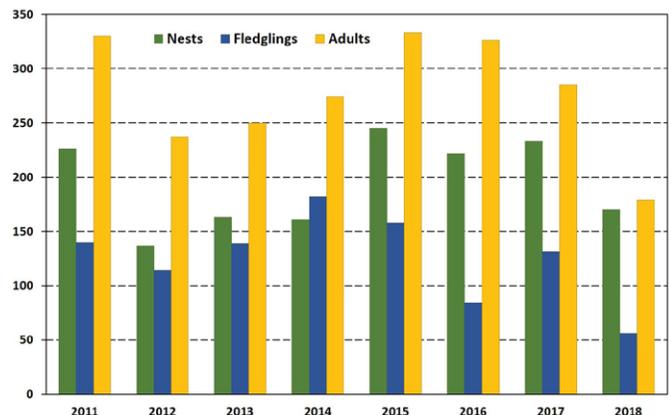
Least terns nest at four sites in Indiana: Duke Energy's Gibson Lake and USFWS's Cane Ridge Wildlife Management Area (WMA) in Gibson County; the American Electric Power (AEP) Rockport Plant, on the Ohio River in Spencer County; and Goose Pond FWA in Greene County. DFW staff work closely with partners to monitor these colonies and take measures to ensure successful breeding.



Least terns nest on the ground of gravel bars or river islands. Their downy chicks leave the nest at two days of age, relying on camouflage to protect them from predators.



Annual number of least tern fledglings per adult nesting pair in Indiana from 2011 to 2018. The solid red line is the estimate needed to maintain viable populations.



Annual number of least tern nests, fledglings, and adults observed at Indiana colonies from 2011 to 2018.

In 2018, a total of 101 nests in Gibson County produced 42 fledglings. Most (84%) of the nests, and all of the young fledged, were at Cane Ridge WMA. The center dike at Gibson Lake hosted 16 nests, all of which failed. Five young fledged from 61 nests at the AEP plant. Goose Pond FWA hosted eight nests, which produced nine fledglings.

The number of tern fledglings in 2018 was lower than the average from previous years. Productivity was 0.63 fledglings per pair in 2018, compared to 0.90 in 2017. Both figures exceeded the published rate needed to maintain viable populations, 0.51 fledglings per pair.

If you find a nesting colony while boating or riding off-road vehicles along Indiana's rivers, choose a different spot to recreate. When disturbed, terns will leave their nests, exposing chicks to threats from predators and the elements. DFW biologists work closely with landowners at colonies to reduce these risks, employing tactics such as predator deterrents. These efforts have resulted in adequate reproduction in four of the

last five years, and a steadily increasing population of least terns in Indiana since their discovery in the state in 1986.

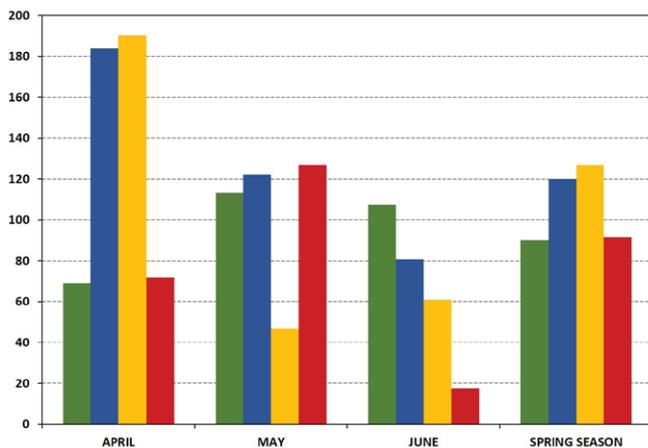
Shorebird Migration

Shorebirds, as a group, undertake some of the most remarkable seasonal migrations of all North American birds. To illustrate, white-rumped sandpipers (*Calidris fuscicollis*) venture between wintering grounds as far south as the southern tip of South America and nesting territories as far north as the Canadian Arctic. Quality foraging habitat at stopover sites can mean the difference between life and death. Some shorebirds need to increase their body mass by 10% or more each day at a stopover site to survive their long-distance migrations.

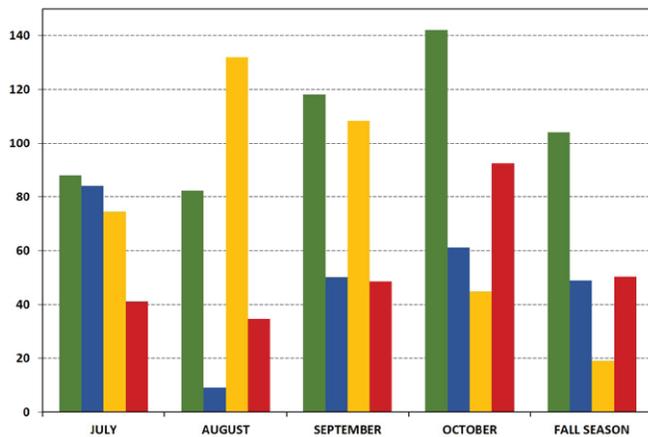
The DFW coordinates surveying at Goose Pond FWA, one of the largest wetland restorations in the country, to document its importance as a stopover site for migrating shorebirds. To date, 36 species have been



A single Hudsonian godwit was detected at Goose Pond FWA during spring migration in April 2018.



Number of shorebirds observed per hour during spring migration at Goose Pond FWA in 2015 (green), 2016 (blue), 2017 (yellow), and 2018 (red).



Number of shorebirds observed per hour during fall migration at Goose Pond FWA in 2015 (green), 2016 (blue), 2017 (yellow), and 2018 (red).

recorded during spring and fall migrations, including the federally endangered piping plover (*Charadrius melodus*). Eight of Indiana’s species of greatest conservation need are regular visitors to, or breed on, Goose Pond FWA.

In 2018, surveyors counted 6,273 shorebirds representing 25 species, a 57% decline in detections from the annual average, since 2015, of 14,698 shorebirds. Five fewer species were observed compared to the total for 2017. Survey effort (100 hours) was also 28% less than the 2015–2017 average (138 hours). Lesser yellowlegs (*Tringa flavipes*; 1,237 individuals) were the most abundant species, representing 20% of the 2018 total count. Other plentiful species included killdeer (*C. vociferous*; 994; 16%), pectoral sandpipers (*C. melanotos*; 839; 13%), least sandpiper (*C. minutilla*; 611; 10%), and dunlin (*C. alpina*; 501; 10%). These five species accounted for nearly 67% of all shorebirds in 2018, with 20 other species representing the remaining 33% of the annual count.

Spring surveys detected 3,033 shorebirds from



Volunteer Lee Sterrenburg counts shorebirds at Goose Pond FWA in March 2018.

22 species, a 62% decline from the three-year average (7,927 detections). Spring effort (35 hours) also declined 50% from the average of 70 hours. Notable records during spring migration were 25 American golden-plovers (*Pluvialis dominica*), three ruddy turnstones (*Arenaria interpres*), a Hudsonian godwit (*Limosa haemastica*), a Baird's sandpiper (*C. bairdii*), and 26 white-rumped sandpipers.

Fall surveys counted 3,240 shorebirds of 21 species, a 52% decrease from the three-year average (6,772 detections). Fall effort (65 hours), however, was only 3% less than the average (67 hours). A state-endangered upland sandpiper (*Bartramia longicauda*) was found during fall migration.

Colonial Waterbirds

Colonial waterbirds include a variety of species that nest in large congregations, typically obtaining most of their food from aquatic environments. Entering a colony of nesting waterbirds produces a frenzy of deafening alarm calls and defensive behaviors.

Each year, DFW biologists visit Lake Michigan's southern shoreline to count the number of nesting gulls, terns, night-herons, and cormorants. The state-listed black-crowned night-heron (*Nycticorax nycti-*



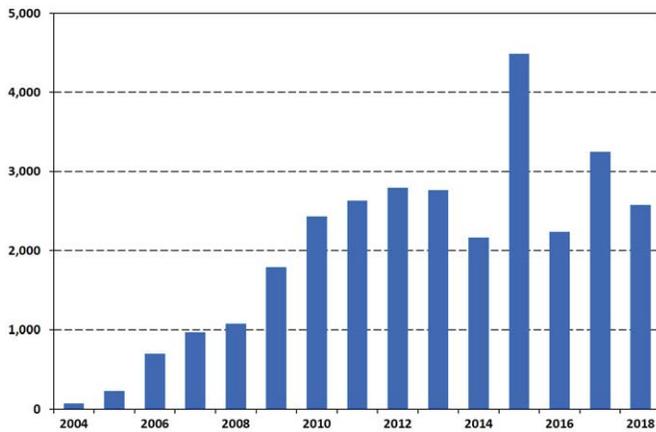
Robert Page, Danielle Williams and Allisyn Gillet count colonial nesting waterbird nests in East Chicago in May 2018.



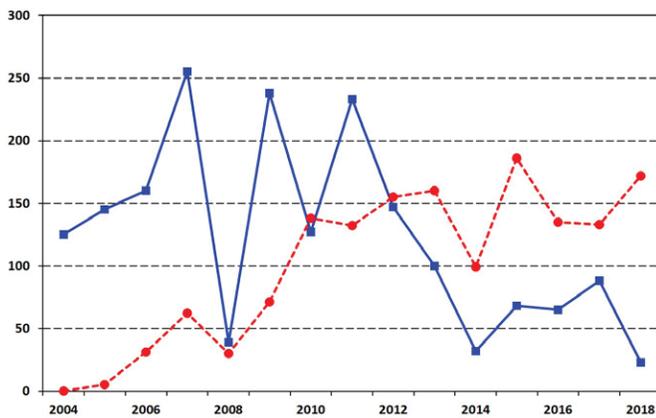
A colony of double-crested cormorants nests at the ArcelorMittal Steel plant in East Chicago.

corax) and great egret (*Ardea alba*) nest in only two locations in Indiana, making them vulnerable to catastrophic weather events or disease outbreaks. Although not endangered, double-crested cormorants (*Phalacrocorax auritus*) are of concern in the Great Lakes region, as growing populations pose a potential threat to local fisheries. Cormorants may also compete for nest sites with the less common egrets and night-herons.

DFW biologists surveyed colonial nesting waterbirds at the ArcelorMittal Steel Mill in Lake County on May 21, 2018. Only one black-crowned night-heron nest was found on the west side, a decrease from the eight nests in 2017. The number of great egret nests, however, more than doubled (45 in 2017 to 92 in 2018). Nesting cormorants have yet to be observed at ArcelorMittal Steel West.



Number of double-crested cormorant nests at the ArcelorMittal Steel plant in Lake County from 2004 to 2018.



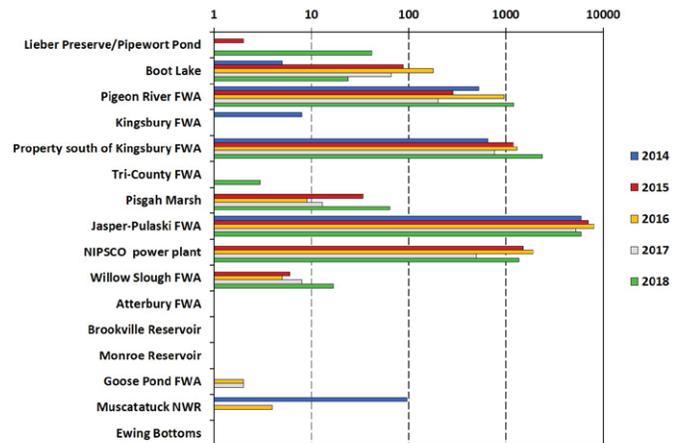
Number of black-crowned night heron (blue) and great egret (red) nests at the ArcelorMittal Steel plant in Lake County from 2004 to 2018.

On the east side, 2,579 double-crested cormorant nests were counted, 21% fewer than what was tallied in 2017 (3,250 nests). The number of great egret nests decreased slightly, with 80 recorded, compared to 88 in 2017. Twenty-two black-crowned night-heron nests were counted, a 73% drop from 2017 (80 nests), and below the 10-year average of 67 nests. The maximum count since surveys began in 2004 was 255 night-heron nests in 2007.

The number of great egret nests at the ArcelorMittal Steel Mill has grown during the past decade, while black-crowned night-heron numbers have declined. Continued monitoring will guide the management of the nesting areas and explore the possible impacts of double-crested cormorants on state-listed species.

Sandhill Cranes

Each fall, most of the eastern population of sandhill cranes (*Antigone canadensis*) stops at Jasper-Pulaski



The number of sandhill cranes observed at each location from 2014 to 2018. The number of cranes is in logarithmic scale to help compare disproportionately high numbers at Jasper-Pulaski FWA and the NIPSCO power plant. Locations are arranged north to south.

FWA and other properties throughout Indiana before continuing south to overwinter in Tennessee, Georgia, and Florida. DFW biologists coordinate surveys at these properties to contribute to the USFWS's population census of sandhill cranes. Such surveys are an important way to inform research priorities and detect threats to the population.

A total of 11,035 cranes were counted at 16 sites in 2018. Jasper-Pulaski FWA hosted the most cranes (5,965). Fewer birds were tallied at a private property next to Kingsbury FWA (2,383), the Northern Indiana Public Service Company (NIPSCO) power plant (1,369), Pigeon River FWA (1,210), Pisgah Marsh (64), Lieber Preserve/Pipewort Pond (42), Boot Lake (24), Willow Slough FWA (17), and Tri-County FWA (3). No cranes were observed at Atterbury FWA, Brookville Lake, Ewing Bottoms in Jackson County, Goose Pond FWA, Kingsbury FWA, Monroe Lake, or Muscatatuck NWR.

In addition to the USFWS fall crane count, weekly surveys are conducted at Jasper-Pulaski FWA. Nearly 30,000 cranes were observed by the end of November. The 2018 survey ended on December 18, with 2,578 cranes counted.

The eastern population has averaged more than 85,000 sandhill cranes during the past three years. It is difficult to imagine that they were once nearly extirpated. The protection of wetland habitat is largely responsible for their recovery, and it's important such measures continue, so that sandhill cranes and other wetland species will continue to have a place to call home.

Whooping Crane Conservation

The whooping crane (*Grus americana*) is one of the rarest species in North America, with only 849 individuals remaining. Cranes that migrate through



DFW biologists Allisyn Gillet and Amy Kearns (pictured) traveled to Wisconsin in January 2018 to receive training on handling techniques from the International Crane Foundation. These techniques, practiced on captive birds, will be used in future collaborative efforts to benefit endangered whooping cranes.

Indiana or overwinter in our wetlands belong to the experimental Eastern Migratory Population (EMP). This population was once extirpated in the east, but through extensive conservation and reintroduction efforts, the EMP has reached 101 cranes.

In 2018, six whooping cranes hatched from wild nests in Wisconsin and survived to fledging. This is the highest success rate documented for wild nests in the history of the EMP. One chick is the offspring of a crane that was wild-hatched, making it the first individual to belong to the second generation of wild-hatched birds in the EMP. Five of the six chicks were still alive in December, and several overwintered in Indiana.

Cranes in the EMP are marked with unique colored leg band combinations so individuals can be identified from a distance. Some birds also carry satellite or radio transmitters to track migration, but these devices have limited lifespans. DFW biologists assist the International Crane Foundation, the Whooping Crane Eastern Partnership, and Operation Migration in the capture of whooping cranes if their bands or transmitters are in need of repair or replacement. Tracking improves our understanding of crane migration ecology and the threats cranes face throughout their life cycle.

It is imperative that people view these endangered birds from a distance and do not attempt to approach or feed them. Whooping cranes that learn to approach vehicles for food often die after being hit by cars. Illegal shooting is also a concern—five cranes have been shot in Indiana since 2009.

You can help by educating friends and family about whooping cranes and keeping a distance of at least 200 yards, the length of two football fields, when viewing them. It's important not to trespass on private land to get closer to whooping cranes.

NONGAME FISH & FRESHWATER MUSSELS

Nongame Fish Findings

Crooked Lake in Noble and Whitley counties was sampled with Fisheries Section Staff using a combination of gill nets, trap nets, seining, and electrofishing. Twenty-three species were collected, including 11 cisco (*Coregonus artedii*), a special concern species. Crooked Lake is one of only seven lakes in Indiana still known to contain cisco. A single redspotted sunfish (*Lepomis miniatus*) was also collected. A few sporadic records for this species exist from natural lakes near Crooked Lake, but not from the lake itself. Redspotted sunfish is a strictly southwestern Indiana species, and this puzzling disjunct population in northcentral Indiana is persisting at barely detectable levels.

A photo of a dead, relatively small, state-endangered lake sturgeon (*Acipenser fulvescens*) was submitted in late July to the DNR's online Fish Identification Form. It was discovered on a Lake Michigan beach east of Marquette Park in Lake County. The fish was collected and found to have a floy tag attached to the base of its pectoral fin and a PIT tag. Using the Great Lakes Lake Sturgeon Tag Identification Database, DFW biologists learned this sturgeon was stocked on September 26, 2015, at Lakeshore Park in Milwaukee, Wisconsin. It had grown nearly a foot in length since its release.

Surveys for banded killifish (*Fundulus diaphanus*) were conducted with the Illinois Natural History Survey in northern Indiana from Wolf Lake, which straddles the Illinois-Indiana border in Lake County,



One of 11 cisco collected from Crooked Lake in 2018.



This small lake sturgeon washed up dead along the Lake Michigan shoreline in Lake County in July 2018. It was tagged and found to have been released in Milwaukee, Wisconsin in 2015.

to Clear Lake in Steuben County. It is a listed species in Illinois, where it has experienced a significant increase in distribution. This is perhaps due to the release of bait bucket individuals of the eastern subspecies (*F. d. diaphanus*) rather than the native western subspecies (*F. d. menona*) expanding its range on its own. There could also potentially now be hybrids between the two. DFW biologists have witnessed an increase in the distribution and abundance of banded killifish along the Lake Michigan coastline and in the St. Joseph River in Elkhart and St. Joseph counties. Specimens collected from natural lakes will serve as good references for native *F. d. menona*, to which other suspect populations can be compared.

The St. Joseph River below the dam at Johnny Appleseed Park in Fort Wayne and the lowest section of the St. Marys River were surveyed in search of the state-endangered greater redhorse (*Moxostoma valenciennesi*). No greater redhorse were collected, but surveys provided evidence of their distribution in the Lake Erie drainage of Indiana. They only seem to occupy the St. Joseph River upstream of Cedarville Reservoir, whereas river redhorse (*M. carinatum*) inhabit sections below. Neither have been found in the St. Marys River or the

Maumee River. Both species potentially inhabit certain sections of the Maumee River, and additional sampling in the lowest section near the Indiana-Ohio state line may provide more insight.

A site on Pipe Creek in Franklin County was sampled extensively for trout-perch (*Percopsis omiscomaycus*), a special concern species. One trout-perch was collected from the location in 1997 during a routine survey of the watershed. Twenty-nine species were collected in 2018 but the trout-perch was not among them.

Freshwater Mussel Surveys

Wavyrayed lampmussel (*Lampsilis fasciola*) and kidneyshell (*Ptychobranthus fasciolaris*), both species of special concern, were found live at one site in Buck Creek in Marion County. In contrast, and on the other side of Marion County, no live or fresh dead mussels were found in Eagle Creek at three sites sampled in the section downstream of Eagle Creek Reservoir to its confluence with the West Fork White River.

Lick Creek, a tributary of Fall Creek in Madison County, was surveyed for the first time by DFW biologists in 2018. A robust population of spike (*Elliptio dilatata*) was found, with nearly 200 live individuals recorded in two hours of sampling at one site. Wavyrayed lampmussel, kidneyshell, and rainbow (*Villosa iris*), another relatively rare species, were also found live in the drainage. In Fall Creek, one live kidneyshell was the only species collected live. These live kidneyshell are the first to be seen in the upper West Fork White River drainage in recent times.

Little evidence of native mussel species was found in the Lost River and two tributaries, Upper Sulphur Creek and Lick Creek, below the Orangeville Rise in Orange County. Only two very common species, giant floater (*Pyganodon grandis*) and fatmucket (*L. siliquoidea*), were collected live. Fresh dead shell



Lick Creek in Madison County supports several mussel species listed as special concern in Indiana.



A kidneyshell collected from Fall Creek in Madison County.



A little spectaclecase, a special concern species, collected from the Patoka River in Orange County.



Surveys of Lick Creek in Orange County found little evidence of native mussel species.



George R. Dale dam on the West Fork White River in Delaware County.

material of rainbow was found at several sites in Lick Creek. The Lost River has hard pan banks with steep drop-offs into relatively deep, sandy, mid-channel trenches. Habitat in Lick Creek varied considerably, with stretches of bedrock, cobble, gravel, sand, hard pan, and woody debris within the same reach.

Live rainbow; little spectaclecase (*V. lienosa*), a special concern species; and a previously unknown population of threeridge (*Amblema plicata*) were found during surveys of the Patoka River in Orange County upstream of Patoka Lake.

Mussel surveys were conducted near three potential dam removal/modification projects in the West Fork White River through Muncie in Delaware County. A robust population consisting of 16 live species was found directly upstream from the George R. Dale dam at McCulloch Park.

Mussel sampling was completed with the National

Park Service (NPS) in the East Arm Little Calumet River within the Indiana Dunes National Park. Only one native species, white heelsplitter (*Lasmigona complanata*), was found live. Nearly 20 other native species were found as weathered shell material. The decimated mussel fauna in this watershed is unrivaled in the state, which has prompted discussions of future mussel conservation efforts with the NPS.

The dam on the West Fork White River below the 16th Street bridge in Indianapolis breached in early October, quickly draining what was called Lake Indy. Swift, temporary repairs restored water levels until a new leak formed the following week. These events provided a unique opportunity to witness pre-impounded conditions of the river and search for stranded mussels on the extensive, exposed mud flats and gravel bars. Ten species were collected live or fresh dead from four locations in mid-October. All



Assistant nongame aquatics biologist Jake Adams digs a quadrat during ellipse sampling at Coffee Creek, Porter County.



Female snuffbox collected from the Salamonie River for use in propagation.



An ellipse buried in and filtering in Coffee Creek, Porter County.



The gills of a female snuffbox, filled with glochidia.

were common species, but the most noteworthy find was a live juvenile threeridge. The closest known population of threeridge in the West Fork White River drainage is in nearby Fall Creek.

Systematic sampling was conducted at three locations on Coffee Creek, Porter County, at the only known location of reproducing ellipse (*Venustaconcha ellipsiformis*), a special concern species, in the Lake Michigan portion of northwest Indiana. It was part of a larger effort to estimate ellipse densities across the range of the species in northeastern Illinois and northwest Indiana. The ellipse is a priority species for Chicago Wilderness, a regional conservation alliance whose work extends into northwest Indiana.

Snuffbox Augmentation

Another year of successful snuffbox (*Epioblasma triquetra*) propagation was completed in 2018. Cages

were placed in Lake Shafer on April 27, and six female snuffbox were secured from the Salamonie River on April 30. The next day, 86 logperch (*Percina caprodes*) collected from the Tippecanoe River were transported to the Salamonie River. Glochidia (parasitic larvae) were extracted from the female snuffbox to infect the logperch, which were then returned to Lake Shafer and placed in previously prepared cages.

One cage was checked on May 23, to examine the logperch and their attached glochidia. One of the 18 logperch had died, but the remainder were healthy, with many small, maturing mussels attached to their gills. On July 11, their gills were clean, indicating all glochidia had transformed, and baby mussels had dropped. The logperch were released from their cages. The cages will stay in Lake Shafer until August-September 2019, when hopefully a nice crop of 1+ year old snuffbox will be harvested for augmentation in the Tippecanoe River.



Snuffbox propagation conducted at a streamside laboratory on the Salamonie River in Huntington County.



2016-produced snuffbox between 34-42 mm in length, nearly 2.5 years after infection on logperch.



Logperch gills with attached snuffbox glochidia.



Propagated snuffbox receive an epoxied PIT tag and plastic tag before being placed at the augmentation site.



2016-produced snuffbox between 6-12 mm in length, nearly six months after infection on logperch.



Snuffbox augmentation site on the Tippecanoe River in White County.

On October 9, snuffbox propagated in 2016 were collected from their cages. Individuals ranged in size from 6–12 mm in October 2016 (169 days post-infection on logperch); to 10–23 mm in August 2017 (498 days); and 34–42 mm in October 2018 (902 days). The next day, 79 snuffbox propagated in 2016, and four from 2014 were placed in the Tippecanoe River at an augmentation site. Every individual received a numbered plastic tag on each valve. Thirty also had a PIT tag epoxied to one valve to monitor their growth, survival, and movement. When checked in late October, they had adapted well. Many were buried in the substrate and actively filtering, and no PIT-tagged individuals had moved substantially from the grid location where they had been placed.

Cages from 2017 propagation work were also checked on October 9, but no 1+ year old snuffbox were found. However, several 2018 propagated individuals were found in the 2017 cages. It is not uncommon for baby mussels that fall from logperch to actually end up in a nearby cage from a different propagation year. If they can move between cages, it is speculated that they could also be settling to the bottom of Lake Shafer. On October 25, searches of the substrate in the area where cages are kept revealed four live snuffbox (two 2+ year old and two young of the year). The older snuffbox were tagged and placed at the Tippecanoe River augmentation site; the two younger ones were returned to the 2018 cages. This discovery may be used to salvage additional snuffbox in the future.

Northern Riffleshell Augmentation & Clubshell Reintroduction

Northern riffleshell (*Epioblasma rangiana*) and clubshell (*Pleurobema clava*) were once widely distributed within the Ohio River and Lake Erie drainages of Indiana. Northern riffleshell has not



This northern riffleshell was originally placed at the augmentation site on the Tippecanoe River on August 3, 2016.



Reintroduction site for clubshell on the Eel River in Miami County.



Augmentation site for northern riffleshell on the Tippecanoe River in Pulaski County.

been seen live for many years in Indiana but is still believed to persist in the Tippecanoe River. Clubshell is reproducing in the upper section of the Tippecanoe River; it is still found live in Fish Creek, although reproduction, if occurring there, is at very low levels. Increasing the northern riffleshell population in the Tippecanoe River and re-establishing a clubshell population in another Indiana drainage (Eel River, in the upper Wabash River drainage) would improve prospects for the continued persistence of both species in Indiana.

The salvage of northern riffleshell and clubshell, among other species, from the Hunter Station bridge replacement project on the Allegheny River in Pennsylvania provided an unprecedented opportunity to augment and reintroduce populations of both species within their historic ranges in Pennsylvania,

Illinois, West Virginia, Kentucky, Ohio, and Indiana. In 2015, Indiana received approval from Pennsylvania to receive adult mussels of both species.

The first 150 northern riffleshell and 150 clubshell arrived in Indiana in September 2015. They were packed in a cooler with moist burlap and ice and shipped overnight by FedEx. All mussels had a PIT tag epoxied to one valve and a small numbered plastic tag attached to the other valve. These mussels were placed at three sites in each receiving river (50 per site) and monitored for survival in October 2015 and June 2016.

All 300 mussels were relocated in October 2015, and none had moved outside their original area of placement. Five individuals at each site were checked—all were alive and closed tightly upon handling. They were actively filtering at each site and many, especially the clubshell, were buried deep in the substrate.

In June 2016, all 50 PIT-tagged northern riffleshell were found at two of the three Tippecanoe River sites; 46 of 50 were found at the third. At each site, five random mussels were dug up to see if they were still alive. Four of five were live at two sites, and three of five were found live at the third. Overall, 11 of 15 (73%) were live. This is a good survival rate for northern riffleshell when compared to those of other states that have moved this species from the Hunter Station bridge location. All 50 clubshell were relocated at two of three Eel River sites; 49 of 50 were found at the third site. All 15 mussels dug up to check for survival were alive. With these promising results, Pennsylvania granted Indiana receipt of additional adults of each species for continued augmentation and reintroduction.

In late July 2016, a total of 3,000 adult clubshell, packed on ice in coolers, arrived in Indiana via overnight FedEx. Only one died in transit but two arrived as mudders (i.e., had been dead for a while but were thought to have been alive when shipped). Ten percent had a PIT tag attached to one valve. The rest were marked with green glitter, which was super glued to their shell to distinguish that they were placed in 2016.

Also in late July 2016, a total of 3,000 adult northern riffleshell arrived in Indiana. About 2% were dead on arrival; interestingly, almost all were males. Similar to the clubshell, 10% arrived with a PIT tag attached to one valve, while the rest were marked with green glitter on their shell.

The 2,997 clubshell and 2,934 northern riffleshell were placed in the Eel River and Tippecanoe River, respectively, at the three sites where pilot studies were initiated in 2015. At each location, they were placed at a density of eight individuals/m² within the previously designated 8- by 20-meter grid. This monumental effort was made much easier by the assistance of Manchester University students/faculty, USFWS, The Nature Conservancy (TNC), and DFW Fisheries Section staff.



This clubshell was originally placed at the reintroduction site on the Eel River on September 17, 2015.



Assistant nongame aquatic biologist Jake Adams searches for tagged clubshell at the Eel River reintroduction site in Miami County.

Total No. Placed (September 2015 & July 2016)	October 2016		September 2017		September 2018		
	No. known dead	No. not found	No. known dead	No. not found	No. known dead	No. not found	
Pit-tagged	441	48 (11%)	10 (2%)	93 (21%)	37 (8%)	137 (31%)	78 (18%)
Glitter	2,642	103 (4%)	-	201 (8%)	-	256 (10%)	-

Status of 3,084 northern riffleshell placed in the Tippecanoe River in 2015 and 2016.

Total No. Placed (September 2015 & July 2016)	October 2016		September 2017		September 2018		
	No. known dead	No. not found	No. known dead	No. not found	No. known dead	No. not found	
Pit-tagged	449	1 (<1%)	4 (0.9%)	2 (<1%)	29 (6%)	4 (1%)	37 (8%)
Glitter	2,698	0 (0%)	-	0 (0%)	-	1 (<1%)	-

Status of 3,147 clubshell placed in the Eel River in 2015 and 2016.

The survival of northern riffleshell and clubshell has been monitored annually since the two species' placement. Survival of northern riffleshell has not been as high as that of clubshell, but it is similar to that seen in other states receiving mussels. Only five clubshell are confirmed dead to date. The survival of these animals has been nothing short of incredible. These two populations will continue to be monitored. Effort will also be spent in coming years to search for juvenile individuals of each species and determine if any successful reproduction is occurring. No additional adult mussels were received in 2017 or 2018, but we hope for other opportunities in the future.

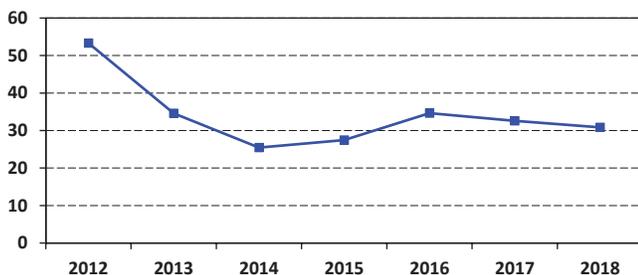
NONGAME MAMMALS

Acoustic Monitoring Of Bats

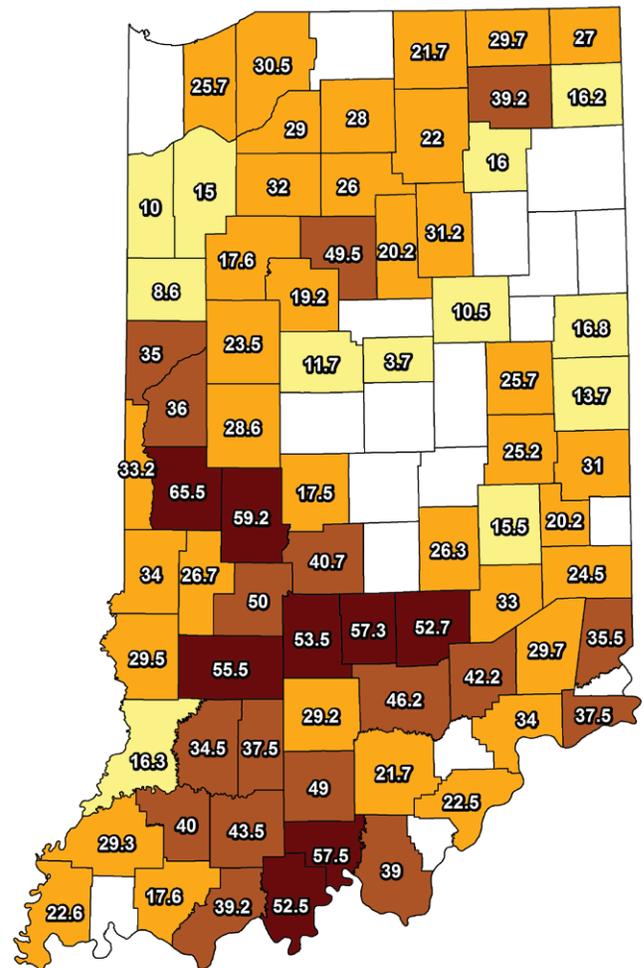
Statewide mobile acoustic bat surveys began in Indiana in 2012. Surveys are done by connecting an electronic bat detector to an ultrasonic microphone on the roof of a vehicle. The echolocation calls of bats are then recorded while slowly driving predetermined routes during summer evenings. Biologists have been able to conduct these surveys in more than 70 counties across the state, covering a variety of regions and habitats where Indiana's 13 resident bat species are known to occupy. In 2014, permanent bat monitoring stations became the most recent addition to the acoustic surveying effort. Ten stations were installed across the state at local, state, and federal properties to record acoustic data from surrounding environments, year-round.

Mobile acoustic surveys in 2018 were completed in July, and data compilation and analysis are ongoing. Preliminary results returned an average of 30.8 bat calls detected per survey. This figure is consistent with those of recent years, which may indicate a stabilization in bat activity after confirmation of white-nose syndrome (WNS) in 2011. However, it still represents a 42% decline from 2012.

Data analysis for the acoustic bat monitoring stations is evolving. An initial analysis in 2015 revealed basic trends in bat behavior that reflect annual hibernation and migration patterns. However, the stations have since experienced a number of issues, including



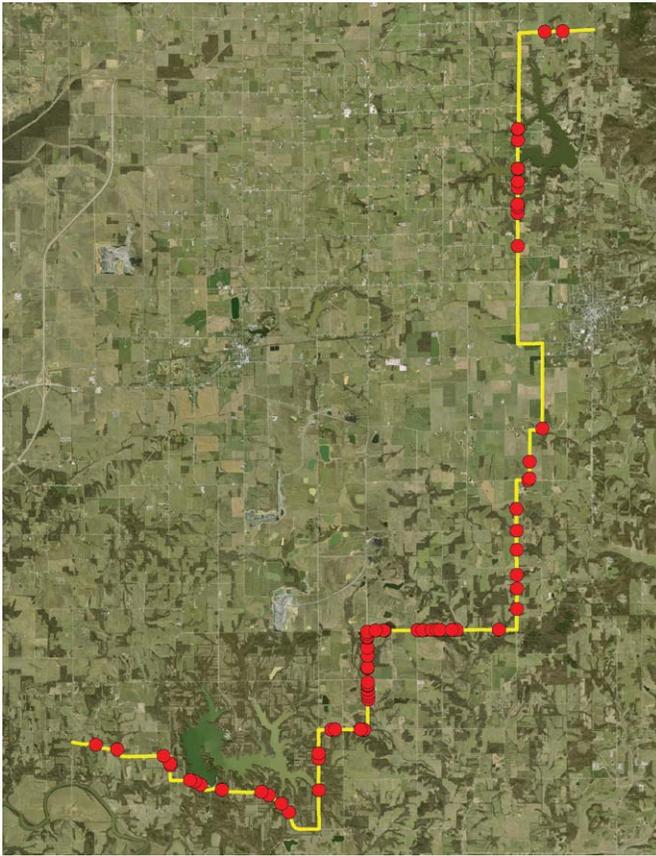
Average number of bat calls detected per mobile acoustic survey from 2012 through 2018.



Number of bats detected per survey for each county surveyed in 2018 (maroon: more than 51, brown: 34–51, orange: 17–34 detections, yellow: less than 17, white: no data).



A bat monitoring station at J.E. Roush Lake FWA. The microphone at the top of the pole detects bat calls and sends this information to the bat detector, where data are processed and saved.



Preliminary results from a 2018 mobile acoustic survey in Daviess County. The solid yellow line represents the survey route, and the red dots represent each bat call detected. Most calls were detected in areas of suitable foraging habitat, such as permanent water features and forest cover.

vandalism, maintenance problems, and having memory cards filled by insect activity. Despite these flaws, a great deal of information is collected at these stations, and a full analysis and critique of data received through 2018 is planned for the future.

The most striking result of both mobile and stationary surveys is the sharp decline in detected tri-colored bats, particularly in the southern half of the state, where this species is historically much more abundant. The *Myotis* genus, which includes little brown and northern long-eared bats, experienced the second largest decline. This information helped to inform the listing of these three species as state-endangered, providing them with added protection to aid in recovery efforts. The cause for the decline is due largely to the effects of WNS, which is still devastating bat populations across the country.

Summer Bat Roosts

In 2016, the DFW initiated a volunteer summer bat roost monitoring program to better understand roosting behavior and colony populations. As part of this program, 200 bat houses were also distributed

to private citizens across the state to provide additional roosting alternatives and secure habitat for bats. Through the program, still in its infancy, about a dozen people have collected data on the bats that enter and exit roosts on their property during summer. Several new volunteers in 2018 also received bat houses and have already had bats move in.

Bat roosts monitored in 2018 included barns, bat houses, and an old chimney. The most common species in buildings and bat houses in Indiana is the big brown bat (*Eptesicus fuscus*). Little brown, northern long-eared, tri-colored, and Indiana bats (*Myotis sodalis*) may also be found, but to a much lesser extent. Four roosts identified by volunteers in 2018 were big brown bat roosts; the species in other roosts were not identified. Some species may form maternity colonies in man-made structures, while males are more solitary. Roosts that exhibit an increase in exit counts toward the end of the survey period may indicate a maternity colony in which young bats beginning to fly on their own.

Moving forward, an increase in the number of participating volunteers and improvement of methods to identify the species at each roost are needed to improve the knowledge gained from this project.

Plans are also in place to install larger bat houses at a number of state properties, signifying the possibility of future projects to encourage Indiana residents to build or buy a bat house to install on their property.

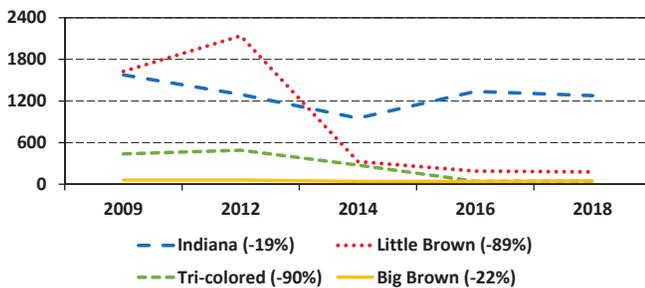


Bats roosting in a bat house attached to a volunteer's home. (Photo by Denise Harter)

Winter Bat Counts

Fifteen of Indiana's smaller bat hibernation sites were surveyed in 2018. Of these, 11 were surveyed before the arrival of white-nose syndrome (WNS) in the state, thus allowing biologists to gauge the impacts of that fungal disease on local bat populations. Winter bat counts have been conducted in Indiana since the early 1980s. The initial focus was to monitor the federally-endangered Indiana bat, but with bat populations in decline, most of Indiana's species are now listed as endangered, threatened, or of special concern. Winter surveys now collect information on all cave-hibernating bats.

Counts of Indiana and little brown bats in 2018 both decreased slightly from 2016, while those for big brown and tri-colored bats increased marginally. All four species have declined since the first detection of WNS in Indiana in 2011. Little brown and tri-colored bats have experienced declines of about 90%. Recently, populations appear to have stabilized, although multiple tri-colored bats still exhibited severe symptoms



Total number of four bat species in 11 minor hibernacula from the last pre-WNS survey in 2009 through 2018. WNS was first detected in Indiana in January 2011.



Two tri-colored bats in Sullivan Cave in 2018, both exhibiting the white fungus indicative of white-nose syndrome. It appeared that neither bat would be able to survive.



A rare, white-furred Indiana bat roosts next to another Indiana bat in Saltpeter Cave.



One of the largest Indiana bat clusters seen in the 2018 winter counts. There can be hundreds of Indiana bats hibernating in one square foot of cave ceiling, with some of the largest clusters in other caves containing thousands of individuals.

of WNS during the 2018 surveys. Nine federally-threatened northern long-eared bats were seen, comparable to numbers seen during other recent surveys.

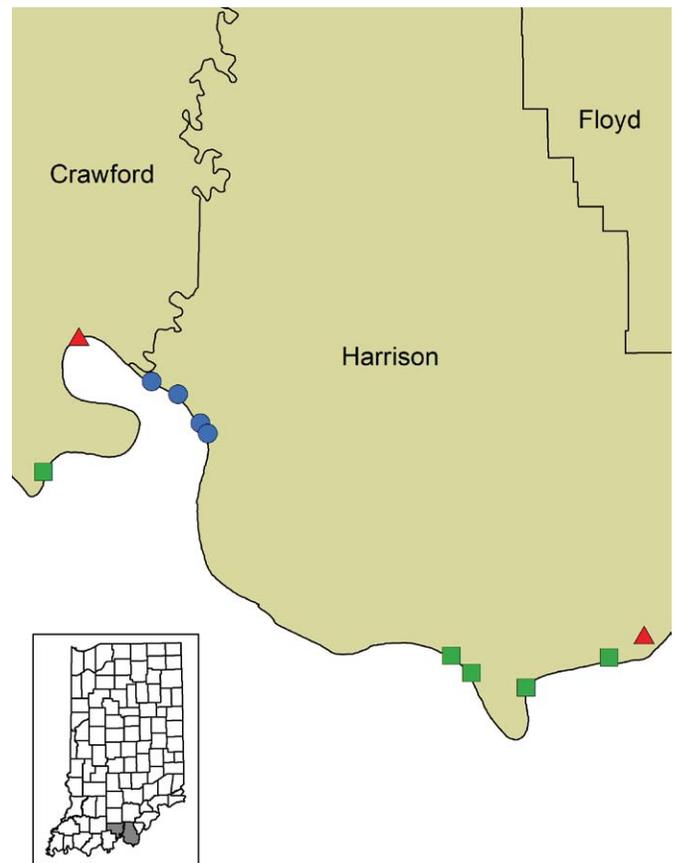
WNS has now been detected in 39 caves in 11 Indiana counties, and it is likely pervasive throughout Indiana's caves and the abandoned underground mines where bats hibernate. Researchers continue to develop and test potential treatments for WNS in the laboratory and at field sites. Many caves on public lands in Indiana remain closed to the public to minimize the spread of the fungus by people. With these and other conservation efforts, remnant cave-dwelling bat populations may stabilize on their own before any species are in jeopardy of extirpation.

Winter bat counts at 11 of the largest Indiana bat hibernacula in the state will be conducted in early 2019, as efforts to protect these ecologically and economically important mammals continue.

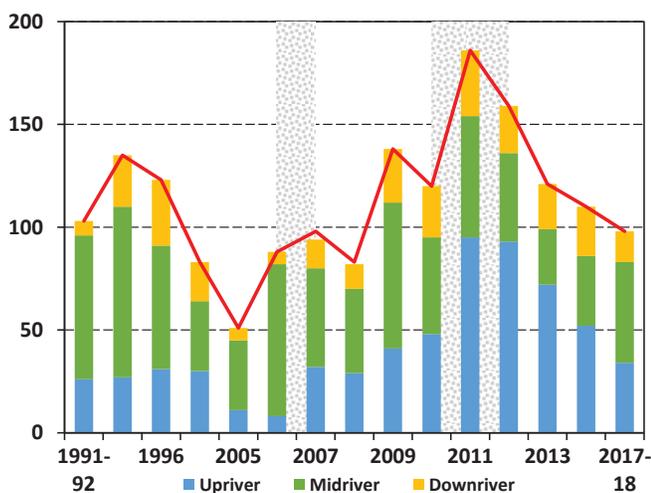
Allegheny Woodrat

The Allegheny woodrat (*Neotoma magister*) has been a state-listed species since 1984, and is one of the rarest and least-observed mammals in Indiana. Woodrats are nocturnal, and live in the limestone and sandstone cliffs along the Ohio River. They face numerous threats including habitat fragmentation, reduced genetic diversity, and environmental parasites.

The current distribution of woodrats in Indiana includes about 15 cliff lines scattered along nearly 40 miles of the Ohio River, from Rosewood in Harrison County to Alton in Crawford County. Since 1991, DFW biologists have periodically surveyed these sites, as well as other areas with suitable habitat, to monitor the species' distribution and relative abundance.



Distribution of Allegheny woodrat populations along the Ohio River. The most recent complete survey, initiated in 2017 (blue circles), was completed in 2018 (green squares). Red triangles represent extirpated populations that were not surveyed in 2017–18.



Number of Allegheny woodrats captured across all sites (red line) and their distribution by upriver (blue), midriver (green), and downriver (yellow) cliff lines. The gray stippled bars denote translocations of woodrats from other states (2007–08) and the release of captive-reared individuals (2010–12).



An Allegheny woodrat settles into a nest made from finely shredded plant material. Woodrats collect and store acorns, stems, leaves, seeds, and fungi to eat when environmental conditions are poor or food resources are unavailable.



Allegheny woodrats are marked with uniquely numbered ear tags to allow DFW biologists to identify them in future surveys.



A woodrat has stored seeds for the upcoming winter months in a cave on the Ohio River cliffs. This male was later captured, tagged, and safely released back into the cave.



Often referred to as packrats, Allegheny woodrats gather not only food and vegetation from the environment, but also items left by humans, such as shotgun shells, disposable cameras, and combs. Pictured here, a woodrat has collected sticks to prevent potential predators from entering its nest.

Proactive conservation efforts, including translocations from other states (2007–08) and releases of individuals produced in a captive breeding program (2010–12), have also benefitted Indiana’s remnant woodrat populations.

Survey results typically show natural fluctuations in populations with peaks followed by declines. Reasons

for this likely include food availability, winter severity, predator-prey relationships, and limited availability of cliff habitat. Woodrat populations across all sites were at an all-time low (51 individuals) in 2005, but due to conservation efforts these same populations rebounded to a high of 186 animals in 2011. Populations have since declined, but the most recent survey in 2017–18

suggests abundance may be stabilizing, demonstrating that woodrats respond to conservation efforts.

Future work will address two major ecological issues that limit woodrat populations: environmental parasites and genetic diversity. The goal is to reduce the presence of parasites through vaccinating raccoons (the definitive host of this parasite), followed by strategic translocations of woodrats to maximize genetic diversity across the species' Indiana distribution.

Black Bear

Prior to 2015, black bears (*Ursus americanus*) had not been confirmed in Indiana for 144 years. These animals were extirpated from Indiana and much of the Midwest by 1850 due to overharvest and habitat loss. During the past century, however, much of the Midwest has reestablished habitats suitable for black bears. As a result, bear populations have expanded across the Appalachian Mountains and upper Midwest, recolonizing several states that had previously lost their resident bear populations. States such as Kentucky and Michigan have seen increases in their bear populations. Bears dispersing from these areas were confirmed in Indiana in three of the last four years.



This track in soft soil was noted by Indiana Conservation Officers while searching for the bear that was struck by a vehicle on Interstate 64 in November 2018. (Photo by James Hash)



This black bear was photographed by a trail camera five days after being struck by a vehicle near New Albany, Indiana. It had moved 12 miles during this period. (Photo by Jeff Everage)

In November 2018, a bear was struck by a vehicle on Interstate 64 in Floyd County. It was unknown if it suffered injuries in the collision. However, five days later, a bear assumed to be the one from the collision was observed on a trail camera 12 miles north. Its movements were monitored through public reports; the accuracy of two of seven reports was confirmed by a photo or qualified biologist who investigated the report.

Indiana, like nearly every other state in the eastern United States, will learn to live with bears in time. However, as seen elsewhere, negative human-bear interactions may occur. It is essential for state agencies, local governments, and the public to be prepared to minimize such conflicts. This may require citizens who live in areas more likely to encounter bears to take measures such as not feeding bears, securing or removing pet food outdoors, removing or bear-proofing birdfeeders, and securing garbage. Though occurrences of bears may be rare for many years, bears are likely to continue to disperse into Indiana. By removing attractants from backyards, citizens will have more positive experiences with black bears. To report a bear sighting, go to: www.in.gov/dnr/fishwild/8497.htm

Badger

The American badger is a medium-sized, solitary carnivore associated with prairies, meadows, hayfields, and other grassy habitats in the Great Plains region of North America. This stocky member of the weasel family is specialized for digging and living underground. Badgers have low-slung bodies and powerful forelegs with long, heavy claws. This allows them to quickly tunnel through soil and pursue prey such as gophers, ground squirrels, and other small rodents. Badgers are grizzled yellowish-gray in color, with distinctive facial

or stabilizing, including some that were experiencing declines. An example is red fox (*Vulpes vulpes*).

Although not wildlife, house cats, which were added in 2004, were the seventh most commonly sighted species, behind only white-tailed deer, coyotes, fox and gray squirrels, wild turkey, and raccoons.

Fur Harvest And Value

The statewide Fur Harvest and Value Survey is conducted annually by the DFW to monitor the number and value of furbearer pelts purchased by licensed fur buyers. After the close of furbearer harvest seasons, licensed fur buyers are required to report to the DFW the number and average value of furbearer pelts purchased. This provides an economic perspective of trapping and a minimum estimate of harvest during years without a Trapper Survey because fur buyer records are only a fraction of the total harvest.

A total of 36 licensed fur buyers submitted reports after the 2016–17 fur harvest season. Fur buyers purchased 25,594 pelts, equaling a total value of \$108,431. Raccoons and muskrats (*Ondatra zibethicus*) continue to make up the largest portion of pelts purchased.

Muskrats

Muskrats, a species of semi-aquatic rodent, are an integral inhabitant of Indiana’s wetland communities and an important species to licensed trappers. Based on recent declines in abundance throughout the eastern United States, including Indiana, the DFW has been exploring new surveys to better monitor muskrat populations. The first survey, started in January 2018, requires DFW staff to collect sex and age class information from dried muskrat pelts put up by licensed trappers.

Muskrat pelts can be separated into male and female by the presence of visible nipples on female pelts, whereas the priming pattern of the fur distinguishes adult (at least



The fur replacement pattern of adult muskrats is random and patchy (left). Pelts of juvenile muskrats show a distinct lyre-shaped pattern (right).

one year of age) muskrats from juveniles. When a furbearer replaces its summer fur with its thicker winter coat, the change is visible on the skin (or leather) side of the pelt. This pattern is random and patchy in adults, whereas pelts of juveniles show a distinct, lyre-shaped pattern.

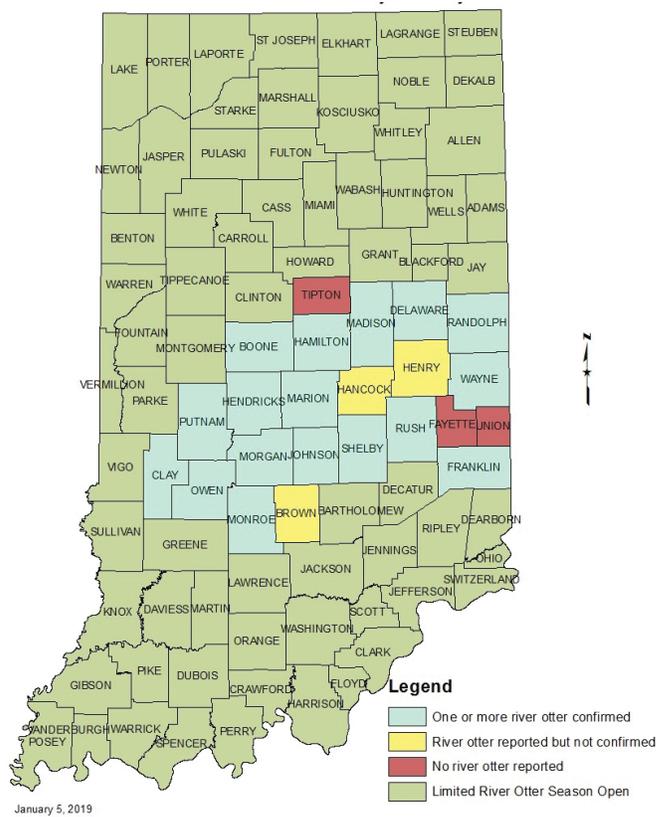
More than 1,600 muskrat pelts were examined at five fur sales in 2018. Information on age and sex ratios collected over the coming years will enable the DFW to watch for warning signs in muskrat reproduction, which can affect populations.

Thank you to the Indiana State Trappers Association, Fur Takers of America Chapter 7, Fur Takers of America Chapter 7B, Fur Takers of America Chapter 7C, Fur Takers of America Chapter 7G and all trappers who brought in muskrat pelts for supporting DFW staff in this effort.

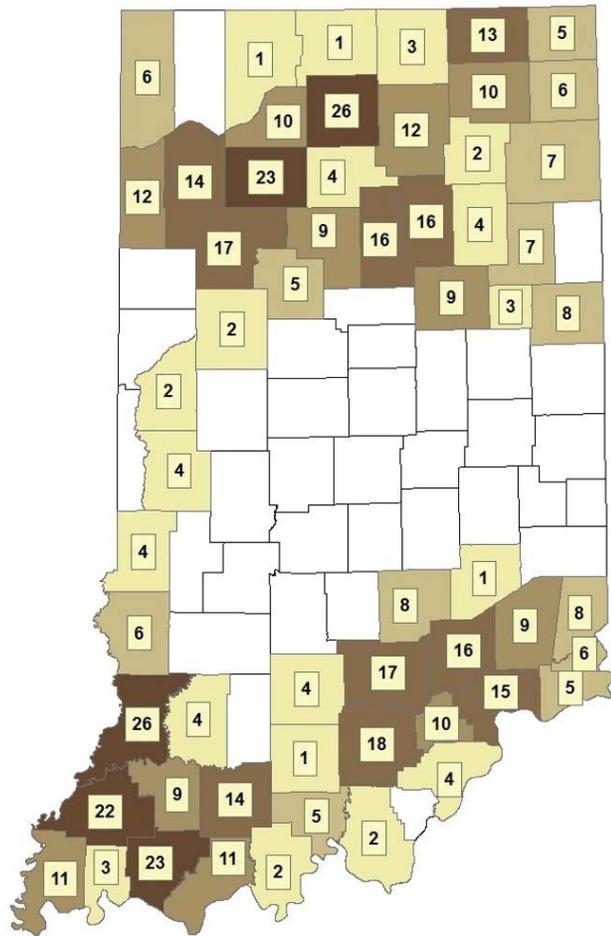
The DFW also worked with Epic Imaging Consultants, from Washington, Indiana to explore the use of unmanned aerial vehicles (i.e., drones) and thermal imagery to survey muskrat houses on public lands. Surveys were attempted in January and April at Goose Pond FWA, but proved unsuccessful for detecting muskrats. Thanks to Epic Imaging Consultants for their work on the pilot endeavor.

River Otter Management

After a highly successful reintroduction of river otter in Indiana in the 1990s, the otter were removed from



Cumulative distribution of river otters in Indiana, as of January 2019. Otters have been confirmed in 86 counties and reported from three others. Only Fayette, Tipton, and Union counties lack reports of river otter.



Distribution of 495 river otters harvested in Indiana during the 2017-18 trapping season. Otters were harvested in 58 of the 66 counties open to otter trapping. The number in each county is the actual number of otters trapped in that county.

the state's endangered species list in 2005. Established and continuously expanding populations allowed for limited harvest, and Indiana's first regulated river otter trapping season began in November 2015.

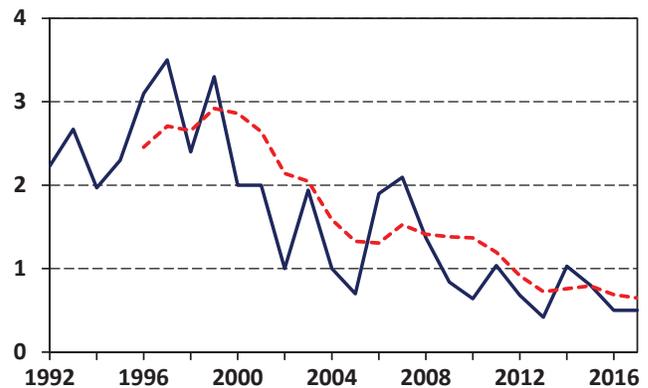
A statewide harvest quota of 600 river otter was set for the 2017–18 season. Otter trapping was open in 66 of Indiana's 92 counties, with a season bag limit of two otters per licensed trapper. Successful trappers were again required to check in their otters through Indiana's online CheckIN game system and deliver the pelt and carcass to a designated check station to obtain a federal CITES tag. Carcasses were collected at check stations, and teeth and reproductive tracts were collected for assessment.

A total of 495 river otters were harvested in the 2017–18 season. Knox and Marshall counties had the highest harvest, 26 otters each. The average age of harvested otter was 1.0. This young average age often suggests populations are still expanding. Analysis of female reproductive tracts collected during the season are ongoing.

Otters have now been confirmed in 86 of Indiana's 92 counties (93%), further supporting the success of the 1990s reintroduction program. Nearly two decades since the last release, otters now inhabit a vast majority of the state of Indiana.

Gray Fox

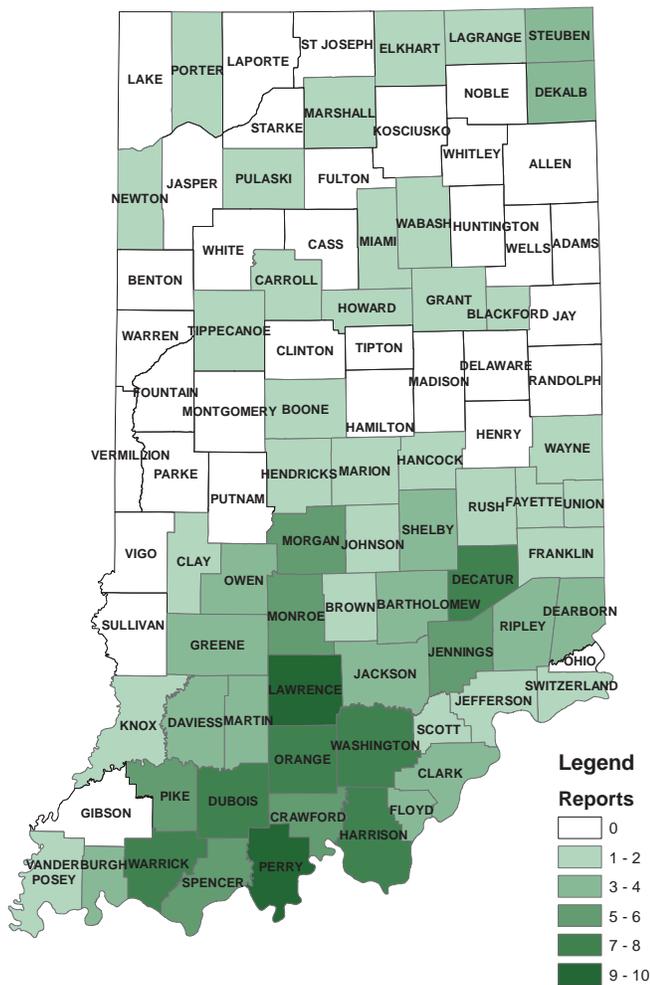
The gray fox is Indiana's only native fox species and is a unique member of the forest wildlife community. Gray fox is the only North American member of the dog family that can climb trees. Surveys such as the Archer Index suggest gray fox populations have been contracting in range and declining in abundance over the last few decades. To assess the species' current distribution in Indiana, DFW staff requested the reporting of sightings of gray foxes through social media and the annual Hunting/Trapping Guide as well as at in-state trapper conventions and rendezvous events in 2017 and 2018. During this period, 179 observations were reported from 58 counties. Gray fox appear most



Number of gray fox observed per 1,000 hours of hunting as reported by Indiana bowhunters from 1992 to 2017. The solid blue line is the annual estimate. The dashed red line denotes the five-year average.



The gray fox will be the subject of a multi-year research project starting in 2020. (Photo by Rick King)



The DFW obtained 179 reports of gray fox from 58 counties in 2017 and 2018.

abundant in southern Indiana and in small pockets in the northern half of the state.

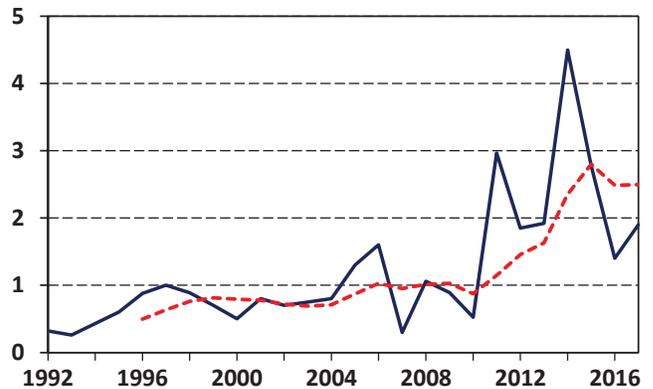
A comprehensive research project on gray foxes that will examine habitat use, survival, cause-specific mortality, diseases, and genetic diversity is slated to begin in 2020.

Bobcat

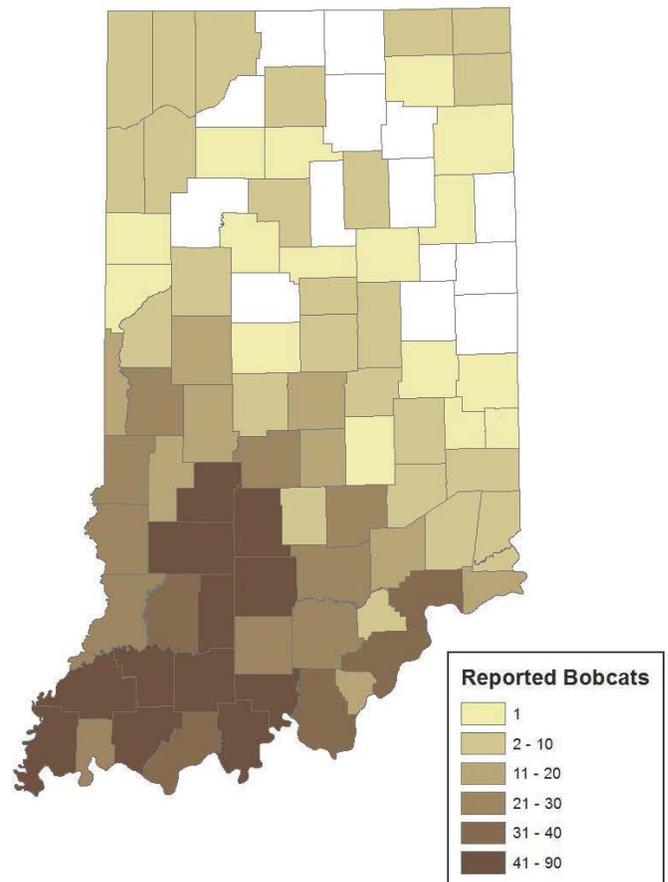
Bobcats (*Lynx rufus*) were never completely eliminated from or reintroduced into Indiana. Populations always persisted where habitat was suitable. In the 1990s, DFW biologists began to document a gradual increase in distribution and abundance. In the last decade, bobcat populations have expanded markedly, as demonstrated by information obtained through the Archer Index, Snapshot Indiana, and the Bobcat Mortality Survey. DFW staff also collect observations of bobcats reported by the public.

Since the late 1980s, the DFW has recorded the number and location of bobcat mortalities reported annually in Indiana. Reports include bobcats that have been struck by vehicles or found dead of unknown causes,

as well as those accidentally killed in traps legally set for other furbearers. The number of mortalities has steadily increased since the mid-2000s, although there were fewer reported in 2016 and 2017, when staff vacancies hindered data collection. Bobcat mortalities are reported most often in fall and winter months and



Number of bobcats observed per 1,000 hours of hunting as reported by Indiana bowhunters from 1992 to 2017. The solid blue line is the annual estimate. The dashed red line denotes the five-year average.



Distribution of 806 confirmed bobcat mortalities reported in Indiana from 1993 to 2018.



A trail camera from Snapshot Indiana captured this image of an adult bobcat in Greene County.



A male northern bobwhite at Prophetstown State Park.

occur primarily in southern counties. Since this survey began, bobcat mortalities have been confirmed in 58 of 92 counties (63%) and have helped document range expansion in Indiana. Sightings of bobcat have now been documented in 78 Indiana counties.

SMALL GAME

Northern Bobwhite Whistle Call Counts

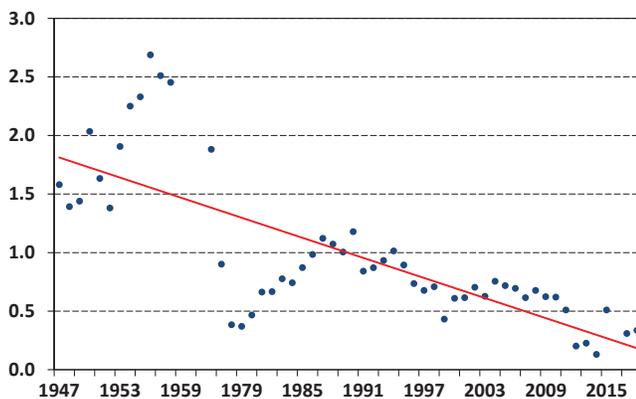
Northern bobwhite are a common gamebird in early successional habitats throughout the Midwest, Southwest, and eastern United States. Early successional habitats require periodic disturbances such as prescribed fire to maintain suitable vegetative structure for nesting and brood rearing. An early successional shrub component is also important for winter survival.

Maintaining complex vegetation communities is immensely important to sustaining local bobwhite populations; however, widespread changes in land cover from agricultural intensification, urban sprawl, and fewer vegetative disturbances have resulted in sharp declines in bobwhite populations throughout their

range. They are considered extirpated from Pennsylvania and trending in that direction in Ohio. Indiana has seen similar declines, but populations have remained at harvestable levels.

Since 1956, the DFW has conducted annual whistle call counts of bobwhites to monitor changes in relative abundance along roadside routes. In 2018, staff and volunteers conducted 63 surveys throughout Indiana, counting 369 whistling bobwhites along all routes combined. This produced an average of 5.94 males/route (range: 0–40), which is slightly higher than the average number heard in 2017 (4.75 males/route).

Although long-term declines in the whistle call index are expected, and mirror national trends, those during the last 10 years are concerning. Without meaningful efforts to improve habitat conditions at large scales, northern bobwhite show little sign of recovering to levels observed in the 1950s. Because 96% of Indiana is in private ownership, increasing landowner participation in management practices to create and maintain early successional habitats is essential to reversing Indiana's bobwhite population trends.

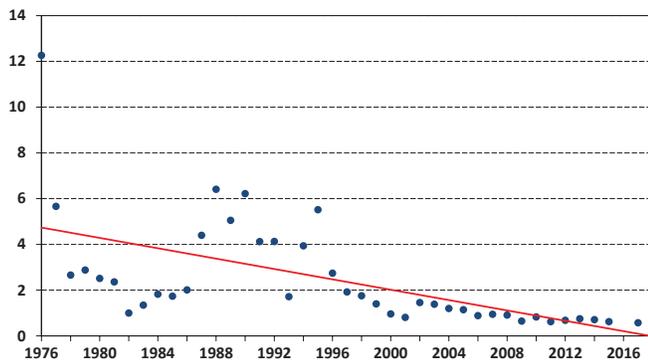


Statewide average number of whistling bobwhite heard per stop in Indiana, 1947–2018. The solid red line represents a significant decline in bobwhite abundance during this period.

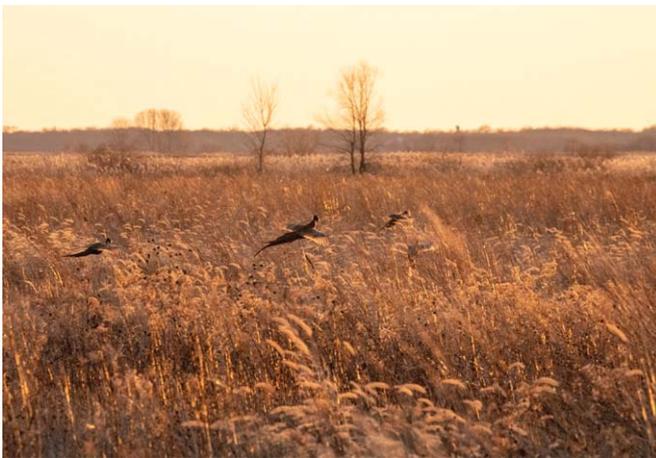
Ring-Necked Pheasants Crowding Counts

The ring-necked pheasant (*Phasianus colchicus*) is an introduced species to the United States. It is native to East Asia. Pheasants proved well adapted to the agricultural landscape of the U.S., where year-round food and cover were plentiful in fencerows, fallow fields, field borders, and crop residues.

The interactions of habitat with landscape and weather characteristics are important factors that influence pheasant populations. Fluctuations in abundance appear closely related to habitat quality and availability, which are driven by agriculture and land management practices through the Conservation Reserve Program (CRP). Nationally, since the late 1980s, farming intensity has increased, while enrollment in CRP has decreased. This has caused pheasant populations to decline.



Average number of crowing male pheasants heard per stop in Indiana, 1976–2018. The solid red line represents a significant decline in pheasant abundance during this period.



A group of ring-necked pheasants flush from cover during a hunt in Newton County.

Despite such sustained declines, ring-necked pheasants remain an important gamebird among upland and small game hunters in the Great Plains and Midwestern states. Each year, an estimated two million hunters pursue pheasants throughout the country. Because of the birds' economic and social importance, starting in 1976 the DFW has conducted annual spring crowing counts to monitor pheasant populations and, if necessary, adjust harvest regulations.

Between April 24 and May 10, 2018, DFW staff and volunteers recorded 205 different cock pheasants on 18 routes in 21 counties. Surveyors heard an average of 8.2 cocks/route, a 29% decline from the previous 2017 survey (11.6 cocks/route). The 10-year and long-term trends both suggest declines greater than 50% in statewide abundance. Pheasant numbers have decreased by more than 85% in the years since the DFW began conducting crowing counts in 1976.

The long-term decline in Indiana's ring-necked pheasant population is likely due to loss of habitat. What remains supports fewer pheasants and reduces

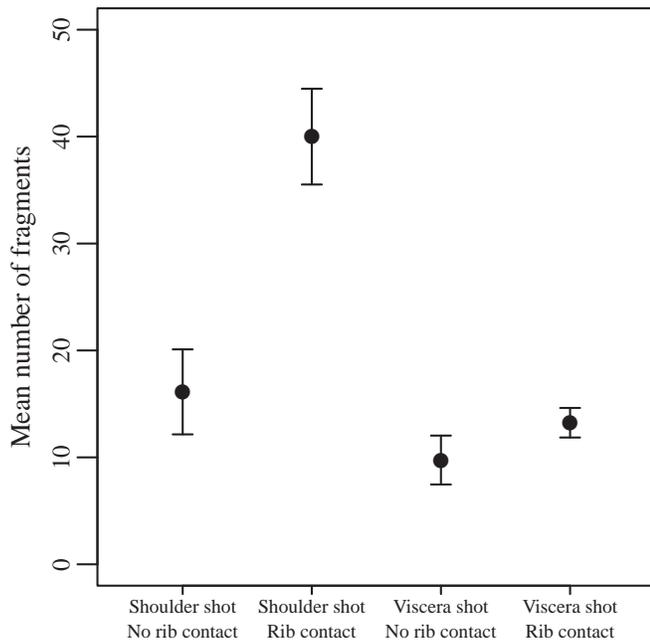
adult and chick survival. Winter survival may decline if escape cover from extreme weather and predators is unavailable. To illustrate, much of the observed decline in 2018 could be attributed to a few counties in northwest Indiana (e.g., Benton, Warren) that experienced disastrous flooding in early spring. Available habitat and reproduction may have been limited as a result, emphasizing the need to buffer the impacts of weather on reproduction and survival through habitat conservation.

Demographics such as reproduction and survival are best mitigated through habitat management at large scales. Because about 96% of Indiana is privately owned, effective pheasant conservation will require the provision of habitats on private lands. Fortunately, Indiana landowners may take advantage of several federal programs through the CRP, administered by the U.S. Department of Agriculture's Farm Service Agency and offered through the DFW's Private Lands Program. Currently, there are three CRP practices available to landowners to create and enhance habitat for upland game, songbirds, and pollinators. Filter strips (CP21), wildlife buffers (CP33), and State Acres for Wildlife Enhancement (CP38) reduce soil erosion and improve water quality, as well as providing nesting and winter cover for ring-necked pheasants and other grassland-dependent wildlife.

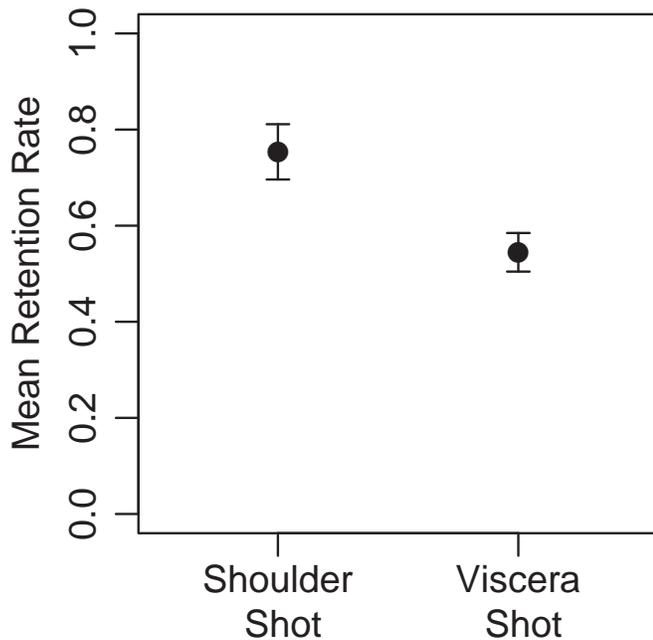
Lead Fragmentation

The toxic effects of lead have been recognized and documented since the 19th century. They include non-lethal human health concerns such as deleterious effects on fertility and cognition. Hunters who harvest game using projectiles containing lead may unknowingly subject themselves and possibly others to the metal via the eating of wild game meat. Most research has focused on the effects of high-powered rifle bullets; low-velocity ammunition had received little attention. Until recently, deer in Indiana were harvested using low-velocity, primitive-type weapons. Therefore, it is important for hunters to be aware of and understand how to reduce their risk of lead exposure.

To assess these concerns, Wildlife Science staff radiographed 43 harvested deer. This determined the number and size of lead fragments in visceral and muscle tissue, and their distance from the entry wound. Fragmentation patterns differed significantly between deer that were shot in the shoulder and the thoracic cavity, and between shots that contacted bone and those that did not. On average, 61% of all fragments were retained in muscle tissue; this number increased to 75% when deer were shot in the shoulder, where muscle tissue and bone are more dense. Deer that were shot in the shoulder area had a higher proportion of small (less than 1 mm) fragments. Overall, most fragments traveled less than four inches from entry wounds, through muscle tissue. Those



Average number of lead fragments in radiographs by shot placement and whether the projectile contacted a rib bone. Significantly more lead fragments were found in deer that were shot in the shoulder rather than broadside (i.e., viscera), and in which the projectile contacted a rib.



The average proportion, or retention rate, of lead fragments was about 30% higher when deer were shot in the shoulder rather than broadside (i.e., viscera). When deer are harvested from a projectile that enters the shoulder, more lead fragments are found in the muscle tissue, which may pose greater health risks.

distances were considerably shorter than those from lead particles from most high-powered rifles.

Hunters who use low-velocity primitive firearm types to harvest deer can take several precautions against ingesting lead. Shot placement reduces the amount of lead in game meat, as does washing and rinsing the general vicinity of the entry wound. Two simple strategies can greatly reduce or eliminate the potential for lead consumption: discard any meat within a four-inch radius of the entry wound, or switch to non-toxic ammunition types to entirely eliminate the risk of lead exposure.

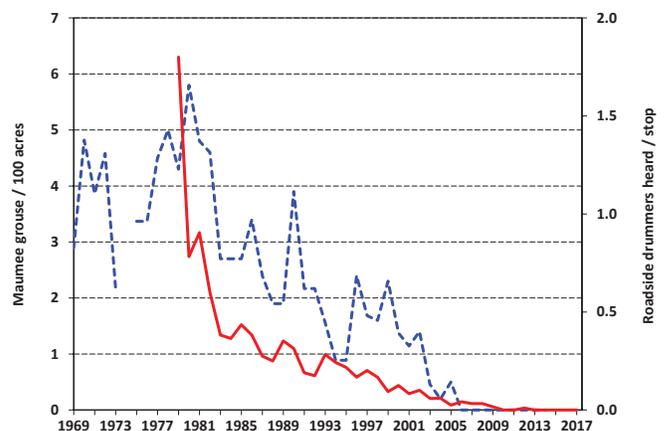
RUFFED GROUSE & WILD TURKEY

Ruffed Grouse Population Status

The distribution of ruffed grouse (*Bonasa umbellus*) in Indiana has historically fluctuated with changing land use. Grouse require young hardwood forests (0–20 years old), composed of dense seedling to sapling-size trees and shrubs. In 1931, ruffed grouse were found in only 12 Indiana counties. After reforestation, natural range expansion, and a successful restoration program, grouse were found to occupy 41 counties by 1983. This was their largest distribution in Indiana since 1856.

Ruffed grouse have declined steadily in Indiana during the last 30 years. Their populations are now at less than 1% of their levels during the peak years of 1979–1981. They occurred in less than 1% of the 2005–2010 Breeding Bird Atlas blocks, compared to 10% for those same blocks from the 1985–1990 atlas. By 2008, ruffed grouse were thought to persist in 10–13 of the 41 counties they occupied in 1983. The hunting season was suspended in 2015 due to declining populations caused by a lack of young forest habitat.

Ruffed grouse populations are surveyed annually by roadside counts of drumming males in early April and



Indices of ruffed grouse populations in Indiana, 1969–2018. Annual results of roadside drumming surveys are represented by the solid red line. Maumee grouse density is depicted by the dashed blue line.

from published observation reports. No grouse were heard on 14 roadside routes (15 stops/route) in 2018. This is the sixth consecutive year in which no grouse were heard, and only one has been heard in the last eight years. The five-year (2014–2018) average drumming index is 0.0, compared to 1.16 during the peak years of 1979–1981. No confirmed observations of grouse from web sites (Breeding Bird Surveys, e-Bird, Christmas Bird Counts) or agency personnel were received outside of the limited grouse range in 2018. There was also no increase in observations within this range, compared to the numbers from previous years.

The Appalachian subspecies of the ruffed grouse (*B. u. monticola*) is also found in Indiana. It is morphologically unique from other subspecies and physiologically adapted to southern latitudes of the birds' continental distribution. Populations of this subspecies have disappeared from Illinois and portions of Missouri, Kentucky, Tennessee and Arkansas, with major declines in abundance elsewhere.

Ruffed grouse are a “flagship” or “coal mine canary” species of young forests, a habitat type that is rapidly disappearing from Indiana and the eastern United States. The lack of early successional forests has, in part, caused declines in abundance of wildlife species that use habitats requiring periodic vegetation disturbances. The annual rate of decline for early succession woodland and young forests in the eastern United States is 3%, which is only 5.5% of what it was in 1950. This decline is expected to continue. Without natural or anthropogenic disturbances, oak-hickory forests that produce hard and soft mast and invertebrate foods important to wildlife will be replaced by shade-tolerant species such as sugar maple (*Acer saccharum*). This change in forest type change will dramatically influence populations of ruffed grouse and other wildlife species of conservation concern.

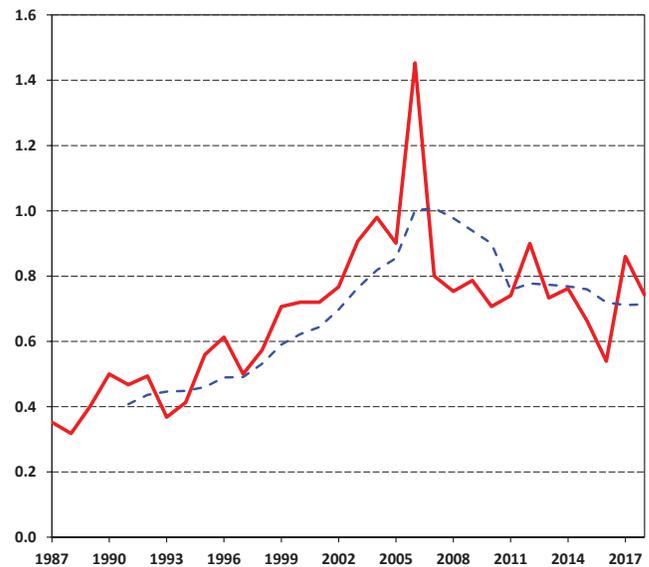
Wild Turkey Population Status

Downward trends in summer brood production of wild turkeys after the post-restoration era have become an increasing concern in the eastern United States, including Indiana. From 1993 to 2015, DNR biologists and conservation officers annually recorded observations of wild turkey hens and poults, including hens without poults, during July and August. The summer brood Production Index (PI) is the total poults/total adult hens compiled into one index from these observations. The PI is an accurate index of production because it counts all hens observed, including those without poults. A chronic bias in these data is the tendency of observers to more readily report hens with poults than hens without poults (barren hens), which produces a higher PI than actually occurred. The PI is often higher in August than in July due to “gang” brood behavior, when several broods and hens without broods combine into a single brood flock.

In 2016, a new web-based brood reporting system



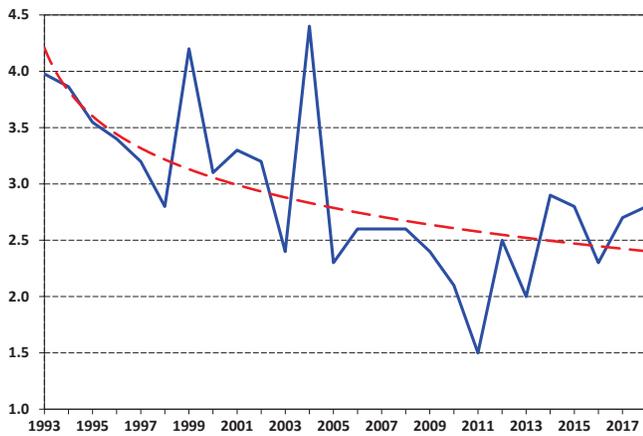
A wild turkey hen with six nearly grown poults searches for insects along the border of a grassy field. (Photo by Grace Johnston)



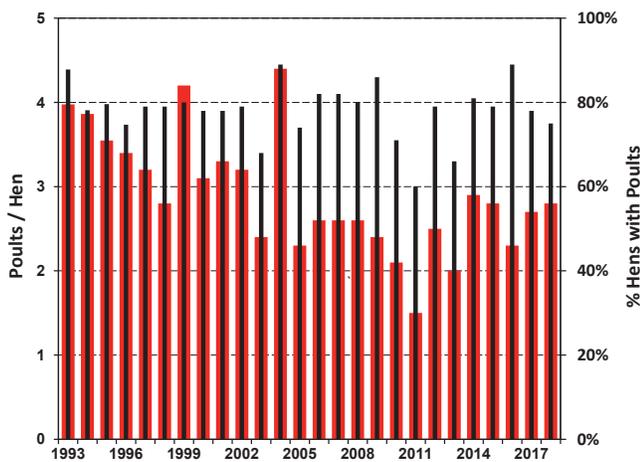
Average number of gobblers heard per stop during roadside surveys in Indiana from 1987 to 2018. Annual results are shown by the solid red line. The dashed blue line depicts the five-year moving average.

began using online data-entry software. This system facilitates reporting of turkey observations by natural resource agency personnel and interested members of the public during the summer months. The addition of public observations could lead to greater coverage and more observations. Instructions for reporting turkey observations were developed and promoted through agency communications, including a “Wanted Poster” available online as a letter-size cardstock poster or wallet-size cards.

In 2018, a total of 678 usable observations of at least one wild turkey was received from 278 participants



Average number of wild turkey poults per adult hen observed during the summer brood season from 1993 to 2018. Annual results are represented by the solid blue line. The dashed red line depicts logarithmic scale values.



Average number of wild turkey poults per hen (wide orange bars) and percentage of hens observed with poults (narrow black bars) from 1993 to 2018.

during the July (61% of observation) and August reporting period. These figures represent a 30% decline in total observations and a 56% decrease in the number of participants from 2017, which also negated the increases in both categories from 2016 to 2017. Observations from non-DNR personnel accounted for 65% of the reports. All observations totaled 5,423 turkeys (1,434 hens, 3,989 poults; compared to 2,069 hens and 5,590 poults in 2017) from 527 brood sightings in 2018 (compared to 747 in 2017). The 2018 statewide PI was 2.8 poults:hen, with 75% of the hens observed with at least one poul. This figure is 4% higher than the 2.7 PI in 2017, but not different from 2.5 PI of the previous five years (2013–2017).

The average PI has progressively declined from 3 to 4 in the early 1990s; to about 2 from 2005 through 2013, with some signs of recovery to around 2.5 in recent

years. The downward trend in the PI is indicative of a turkey population that has transitioned from one with geometric growth during restoration to an established population with stable annual production and growth rates. Regional production is viewed cautiously because of the scarcity of brood reports in portions of the state that traditionally have high spring harvests, such as southeast Indiana. Considerable effort to solicit more participation is needed to reach a minimum goal of 3,000 brood reports evenly distributed across the state. Other potential biases in brood detection among regions include differences in vegetation, road density, and topography.

Roadside gobbler counts are conducted annually from late March to April to monitor the relative abundance of wild turkey populations in areas surveyed. Routes consist of 15 stops on 10-20 miles of rural roadways. Routes are driven at least twice, in opposite directions, and the highest gobbler count heard per stop is used to determine the Gobbling Index (GI). These counts are not indicative of trends in abundance because weather conditions may affect results and 2-year-old gobblers (a product of summer production two years prior) are disproportionately more vocal. The GI, however, does provide insight into long-term population trends and information to compare areas to one another.

The number of male wild turkeys heard gobbling

INDIANA DNR FISH & WILDLIFE





to count turkeys and
help us learn about summer
wild turkey brood production.



DNR
Indiana Department of Natural Resources



Wildlife
Indiana Department of Natural Resources

report here:
wildlife.IN.gov/8641.htm

This poster was used to promote the reporting of wild turkey broods using a web-based system.

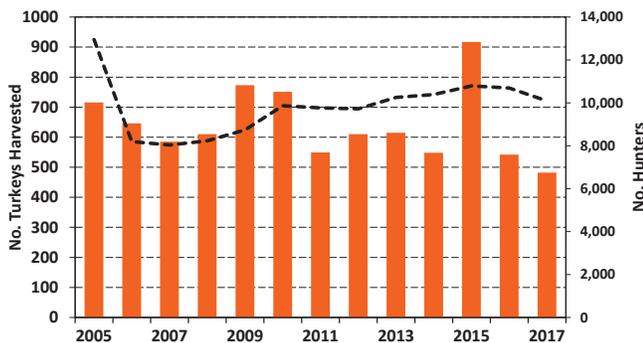
along 14 roadside routes during April 5–19, 2018, was 0.74 gobblers per stop. This value is 14% less than that heard in 2017 (0.86) but did not differ from the five-year mean of 0.71. Fewer gobblers were heard on nearly all routes except for the LaGrange-Steuben route that increased substantially (+256%) and positively influenced the overall GI. The five-year moving average shows an overall increase from 1987 through 2006, followed by a general decrease.

Fall 2017–18 Wild Turkey Harvest

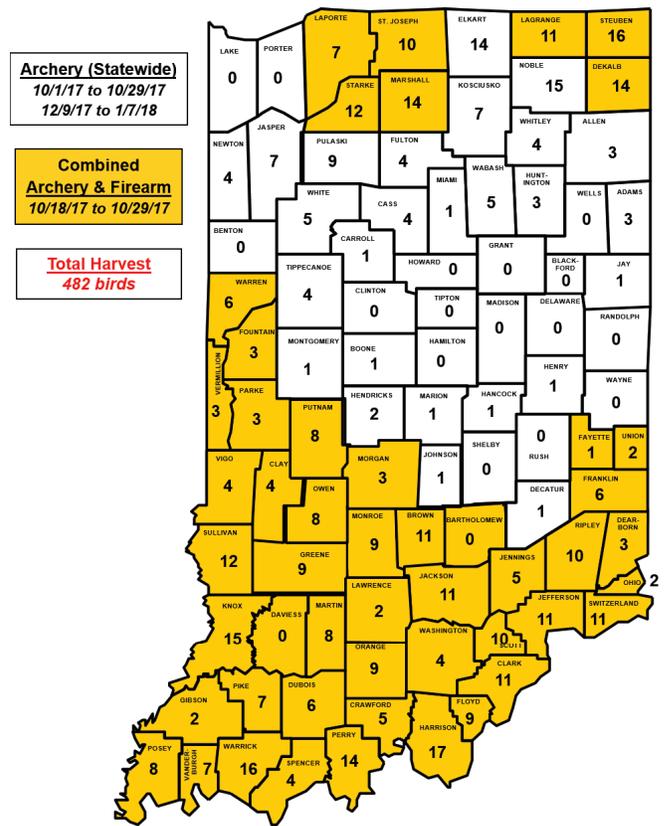
Hunters harvested 482 wild turkeys during the 13th fall turkey hunting season, 60 fewer birds (11%) than were harvested in 2016–17, and the lowest fall harvest since the 2005 inception of fall turkey hunting in Indiana. Fifty-one percent of the harvest occurred during the combined shotgun and archery portion of the season, with archery hunters taking 62% of the total harvest.

Adult birds accounted for 78% of the harvest, producing a juvenile-to-adult ratio of 1:3.5. Adult females composed the largest proportion (41%) of the harvest, followed by adult males (37%). The proportion of adults in the fall harvest was relatively high, likely due to poor summer brood production, hunter selection for larger adult birds, and age determination errors. Ninety-four percent of the harvest occurred on privately owned lands. No counties had harvests of 20 or more birds, compared to five in 2016–17. The following 11 counties, however, had fall harvests of at least 12 birds: Harrison (17); Steuben and Warrick (16); Knox and Noble (15); DeKalb, Elkhart, Marshall, and Perry (14); and Starke and Sullivan (12). Compared to 2016–17, a total of 37 counties had reduced harvests, 33 had increased harvests, and 22 experienced no change. No birds were harvested in 19 counties.

The statewide fall-to-spring harvest proportion was 4% due to the fall season’s conservative structure and lower hunter interest; the proportion by county ranged from 0% to 25%. The decline in harvest and hunter success rate was likely influenced by several factors. The 2017–18 fall harvest was the lowest in Indiana. This figure came only two years after the highest harvest (917



Number of wild turkeys harvested (orange bars) and number of hunters (black dashed line) during fall hunting seasons in Indiana from 2005 to 2018.



County distribution of the 482 wild turkeys harvested during the 2017–18 fall season.

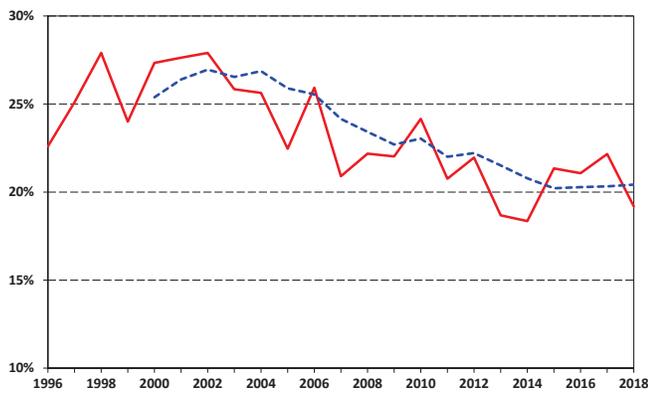
birds) in 2015–16. At that time, five days of firearms hunting, including a second weekend, had been added to the northern counties. That factor may have attracted more hunters who dissipated after that first year.

Interest in fall turkey hunting in Indiana remains relatively low compared to that of the spring season. Fall participation and hunter success is often influenced by brood production during the preceding summer. Brood production has been declining in Indiana since 2005, especially along southern and west-central river drainages, coinciding with the start of fall turkey hunting. An estimated 10,088 hunters participated in the 2017–18 fall season and had an estimated success rate of 5%. Despite increases in hunting opportunity, participation has yet to return to the high level in the first “novelty” season of 2005.

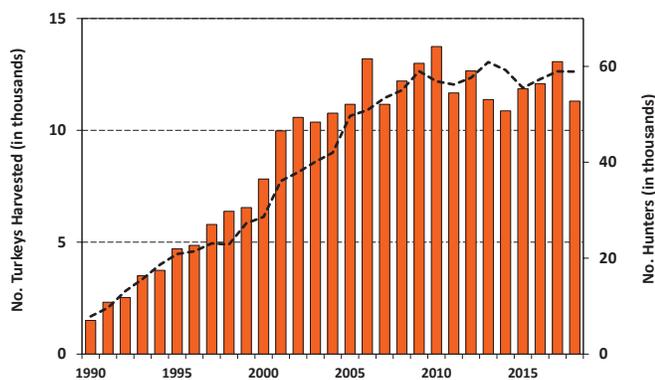
Spring 2018 Wild Turkey Harvest

Hunters harvested 11,306 wild turkeys during the 2018 (49th) spring wild turkey season, as reported to the CheckIN-Game harvest reporting system. The total harvest was 13% less than the 2017 harvest of 13,069 birds. All regions of the state had proportional decreases in harvest, ranging from 6% in the north to 25% in southcentral Indiana.

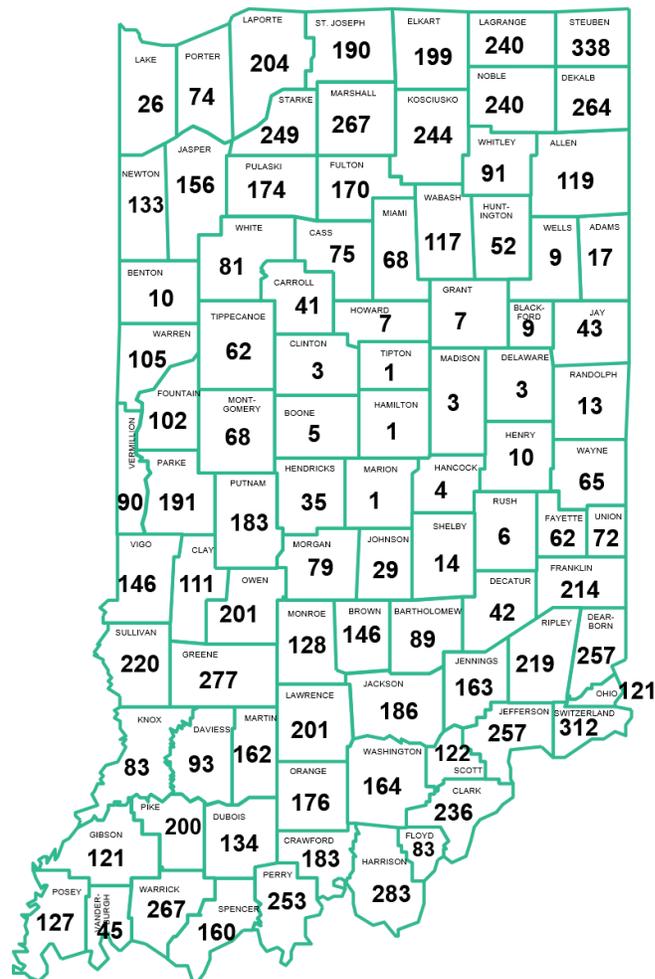
At least one turkey was harvested in each of Indiana’s 92 counties in 2018. Harvest exceeded 200 birds



Trends in spring wild turkey hunting success from 1996 to 2018. Annual success is represented by the solid red line. The dashed blue line depicts the five-year moving average.



Number of wild turkeys harvested (orange bars) and number of hunters (black dashed line) during spring hunting seasons in Indiana from 1990 to 2018.



County distribution of the 11,306 wild turkeys harvested during the 2018 spring season.

in 22 counties, compared to 30 counties in 2017. Harvests increased from 2017 in 23 counties, decreased in 65 counties, and remained unchanged in four. The 10 leading counties were Steuben (338 birds), Switzerland (312), Harrison (283), Greene (277), Marshall (267), Warrick (267), DeKalb (264), Dearborn (257), Jefferson (257), and Perry (253).

A total of 1,097 birds (10%) were taken during the youth-only weekend. Fifty-seven percent of the regular season harvest (10,209 birds) was taken in the first five days of the 19-day season, with 37% occurring on the three weekends. Resident spring turkey licensees harvested 44% of the birds, followed by Lifetime (32%), Youth (13%), license exempt Landowners/Military (7%), and Non-Resident spring turkey licensees (4%). Ninety-two percent of the birds were harvested on privately owned lands.

Age distribution was 15% juvenile gobblers (1-year-old birds or "jakes"), 38% were 2-year-olds, and 47% were 3 years of age or older. The 15% juvenile proportion was a slight increase from the record low of

13% in 2017, yet still below the 10-year average (20%). This age structure reflects variation in brood production from 2014 to 2017 and the greater vulnerability of adult gobblers to harvest. Summer brood production in 2016 was poor in many regions of the state, particularly in southern Indiana, which had a slight improvement in 2017. The shift toward older age classes began about 10-12 years ago, when summer brood production declined from high levels during Indiana's wild turkey restoration era (1956–2004) to a post-restoration norm of low brood productivity and declining or stabilized harvests. The average proportion of juveniles in Indiana's spring harvest from 1988 to 2005 was 28%; it has since declined to 18%.

The low proportion of juveniles in the 2017 and 2018 harvests raises concern for future hunter success and satisfaction. It suggests progressively fewer 2-year-old gobblers in spring harvests that are lower than the current 10-year average (48%). Two-year-old gobblers are the most active gobbler cohort and generally the most vulnerable to harvest. A change in the



Turkey hunters took 11,096 gobblers during the 2018 spring season, which represented 98% of the total harvest.

age structure would likely diminish hunter success and satisfaction unless annual production improves. The higher harvest rates for adult gobblers, however, may be offset by greater recruitment of juveniles into adult age classes, allowing for a sustainable level of harvest. More important, the low proportion of juveniles in spring harvests also suggests a comparable decrease in the proportion of the more productive adult hen cohort that could influence production and statewide population levels for several years, even if weather and habitat conditions are conducive to poult survival.

Annual spring harvests have stabilized at 11,000 to 12,000 birds since the peak harvest in 2010 (13,742 birds). During this time, the number of hunters afield ranged from 56,000 to 61,000, with success rates from 18 to 24%. The 2018 harvest appeared to be another fluctuation around a new normal, lower level after restoration. Hunter success and harvest levels, however, may not accurately reflect trends in wild turkey abundance unless hunter effort is taken into account. Additionally, the influence of annual summer production on turkey harvests has created uncertainty regarding sustainable harvest levels and future management strategies. The higher proportion of adult gobblers in recent spring harvests was welcomed by hunters, but continued low proportion of juveniles raised concerns about harvest trends and hunter success in the coming years.

WATERFOWL

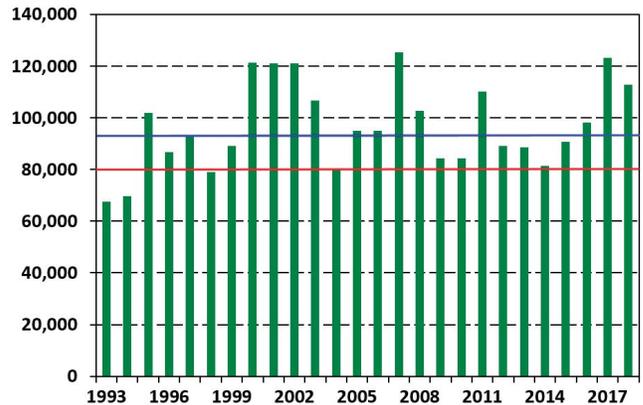
Waterfowl Population Surveys

The DFW performs many surveys to monitor the distribution and abundance of waterfowl in

Indiana. During the April breeding season, statewide helicopter surveys are used to estimate the breeding population of Canada geese, mallard, blue-winged teal (*Anas discors*), and mute swan (*Cygnus olor*). Wood duck breeding populations are not estimated because they nest in tree cavities not visible from a helicopter.

Indiana breeding population estimates for 2018 were 112,800 Canada geese, 43,724 mallards, and 4,519 blue-winged teal. Mute swan populations are rarely estimated from data collected during flights. The distribution of the birds on the landscape is so scattered that it is difficult to get a reliable estimate using our random plot method. Instead, the DFW works with USDA-Wildlife Services to determine mute swan abundance in Indiana, which was 1,122 birds in 2018.

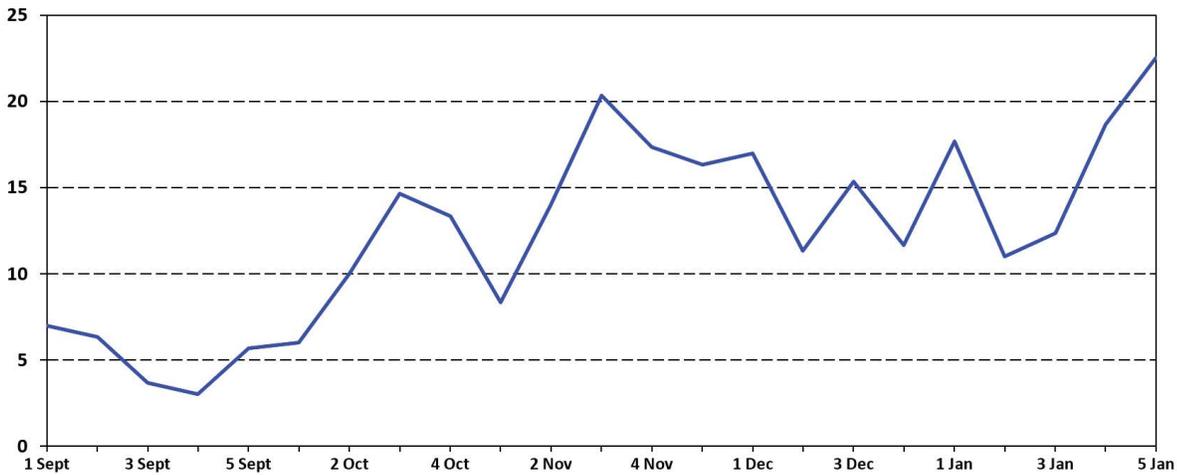
Since 1986, weekly waterfowl surveys have been conducted from the last week in August through



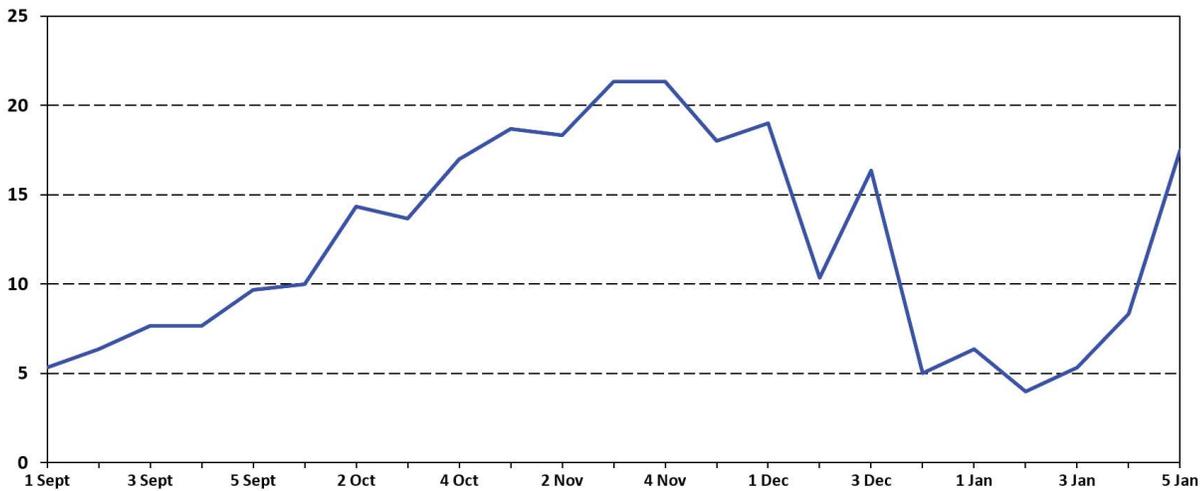
Estimates of the breeding Canada goose population in Indiana from 1993 to 2018. The red (lower) horizontal line represents the state goal of 80,000. The blue (upper) horizontal line represents the average population estimate during the entire period (96,818 geese).



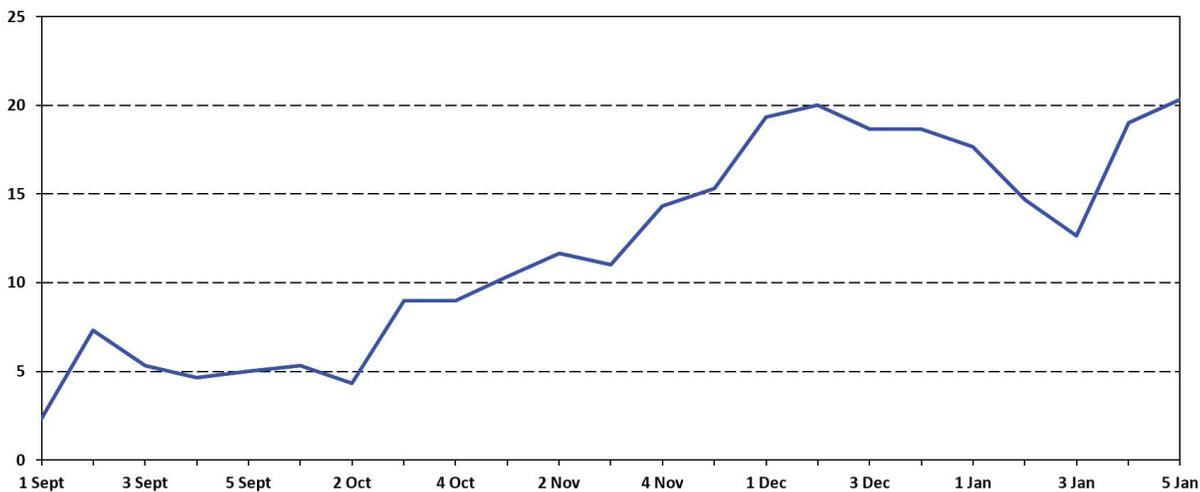
Mallards are the most numerous duck in North America, and in Indiana's harvest.



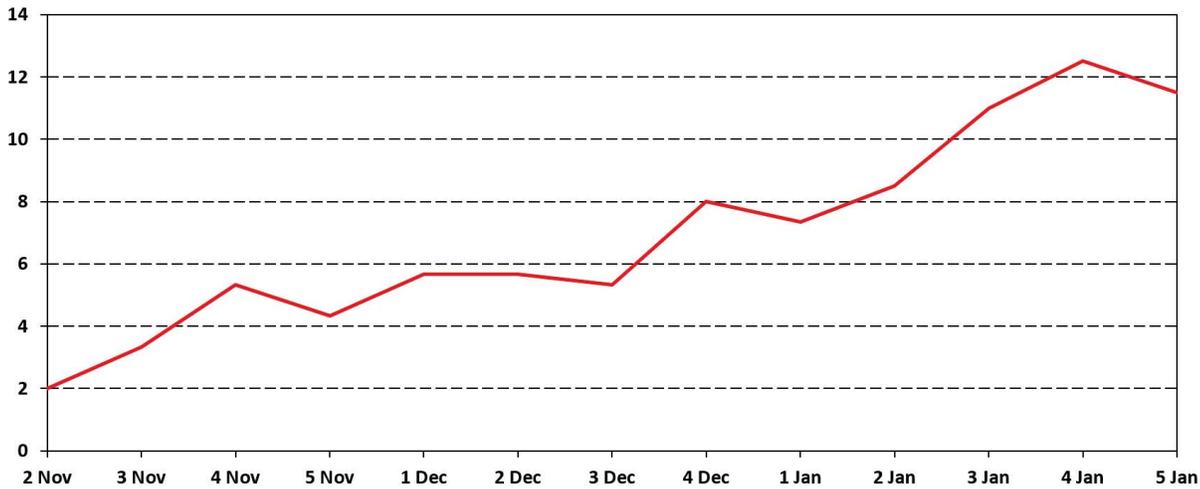
Average migration for all ducks in the Central Zone during the 2015–17 seasons. The x-axis represents the week of the month, not the date. The y-axis represents rank. The survey occurs for 23 consecutive weeks. The week with the highest count of ducks has a rank of 23. The week with the lowest count has a rank of 1.



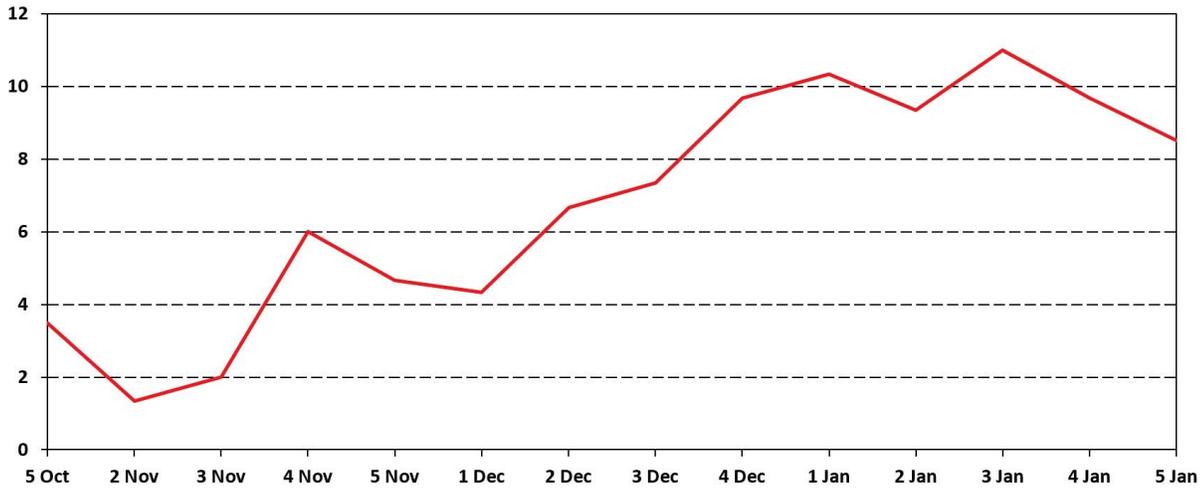
Average migration for all ducks in the North Zone during the 2015–17 seasons. The x-axis represents the week of the month, not the date. The y-axis represents rank. The survey occurs for 23 consecutive weeks. The week with the highest count of ducks has a rank of 23. The week with the lowest count has a rank of 1.



Average migration for all ducks in the South Zone during the 2015–17 seasons. The x-axis represents the week of the month, not the date. The y-axis represents rank. The survey occurs for 23 consecutive weeks. The week with the highest count of ducks has a rank of 23. The week with the lowest count has a rank of 1.



Average migration for all ducks on the lower Wabash River, from its confluence with the Ohio River upstream to Terre Haute, during the 2015–17 seasons. The x-axis represents the week of the month, not the date. The y-axis represents rank. The survey occurs for 13 consecutive weeks. The week with the highest count of ducks has a rank of 13. The week with the lowest count has a rank of 1.



Average migration for all ducks on the section of the West Fork White River from Martinsville downstream to Elnora during the 2015–17 seasons. The x-axis represents the week of the month, not the date. The y-axis represents rank. The survey occurs for 13 consecutive weeks. The week with the highest count of ducks has a rank of 13. The week with the lowest count has a rank of 1.

the end of January on selected State and federal properties throughout Indiana. These data allow the DFW to monitor yearly and long-range migration timing and distribution as birds move through the state. This information is used to set annual waterfowl season parameters in each waterfowl hunting zone to maximize local hunting opportunities while peak migration is occurring.

In 2012, waterfowl biologists began conducting weekly helicopter surveys of the lower Wabash, White and Ohio rivers from November through January. These flights provide information about winter waterfowl usage on Indiana’s major river systems. The 2017–18 season was the sixth for the Wabash surveys

and the fifth for the West Fork of the White River. Due to low waterfowl densities, surveys of the Ohio River were discontinued after the first year.

The survey route follows the Wabash River from its confluence with the Ohio River upstream to Fairbanks Landing FWA at the Sullivan-Vigo county line. The West Fork of the White River is flown from the State Road 39 bridge in Martinsville, downstream to the State Road 58 bridge that is west of Elnora. The ditches and marshes around Gibson Generating Station, including Gibson Lake and Cane Ridge WMA, are also flown. This is an important area for wintering waterfowl, especially mallard, snow goose (*Chen caerulescens*), and Ross’s goose (*C. rossii*).

Waterfowl Banding

Canada geese and wood ducks are migratory waterfowl that breed statewide in Indiana. Both are abundant and widely sought by waterfowl hunters.

Each year, DFW staff capture members of each species for banding. Geese are captured during their flightless period in the last two weeks of June using funnel traps on dry land. Wood ducks are captured



Canada geese are banded in June, when they are flightless. During early summer, it is very easy to distinguish between adult and juvenile geese.

using baited live traps. The birds are removed from the traps, their age and sex are determined, and a uniquely numbered aluminum band is attached to one leg of each bird.

Data from the banded birds are submitted to the U.S. Geological Survey Bird Banding Laboratory in Maryland, which maintains the data from all banded migratory birds nationwide. Anyone who harvests, sees, or finds a banded migratory bird is encouraged to report the band number by visiting reportband.gov. Information from bird band recovery is critical to waterfowl harvest management. The data are used to calculate survival and harvest rates, as well as to determine movement patterns.

In 2018, a total of 2,618 Canada geese were banded on private and public lands in Indiana. Unlike in the prior three years, the goal of banding 2,000 geese was reached. A total of 205 wood ducks were banded. That number was well short of the annual goal (1,285 ducks) and short of last year's total (331). Water conditions were good during wood duck banding in 2018 at most banding locations but staffing capacity partially contributed to banding fewer ducks than usual.

WHITE-TAILED DEER Deer Management In Indiana

The DFW monitors and manages Indiana's deer herd using a combination of population indices. Indices are measures that represent what the population is doing (i.e., increasing, decreasing, remaining stable), although they do not calculate the actual size of the population. Indices for deer management include the number of deer harvested annually, the amount of crop damage reported by landowners, and the number of deer-vehicle collisions reported to the Indiana Department of Transportation. Individually, these factors are not useful, but collectively, they illustrate trends in the deer population over time.

The DFW examines these trends over five- to 10-year periods. Information was also collected from surveys of hunters and landowners, and used to determine public opinion regarding the health, status,



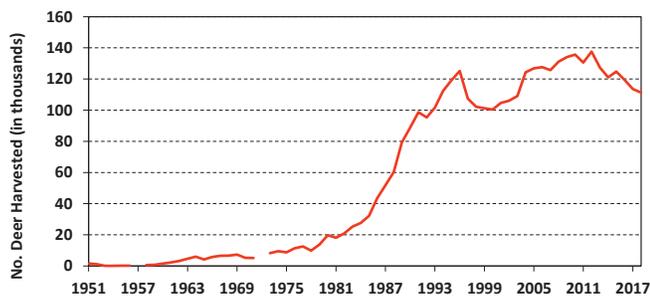
An adult doe and her two offspring, as captured by a Snapshot Indiana trail camera in Carroll County.

and management of Indiana's deer population. Both population indices and public opinion information are used to guide management strategies for the statewide deer population.

The Deer Management Survey (DMS) was created in 2018 to evaluate hunter and public opinions about deer management in Indiana. The DMS was emailed to 269,783 hunters and non-hunters who had purchased a hunting and/or fishing license using the DNR's electronic system. A total of 23,283 responses (8.6%) were received, and participants completely finished 12,659 surveys. Partial data were collected from an additional 10,624 surveys. Final results from the first DMS will be available in the 2018 Deer Report.

2018–19 Deer Harvest

The 2018–19 deer hunting season ran from September 15, 2018 through January 31, 2019. There were four statewide seasons: Youth (Sep. 29–30), Archery (Oct. 1–Jan. 6), Firearms (Nov. 17–Dec. 2), and Muzzleloader (Dec. 8–23). In addition, a Special



The annual number of deer harvested during hunting seasons in Indiana, 1951–2018. The numbers from 1993 through 2018 include deer that were harvested in State Park deer reduction hunts.



Hunters harvested 47,256 antlered deer, comprising 42% of the statewide total, during the 2018–19 Indiana deer hunting season.

Antlerless Firearms season was available from December 26 to January 6 in 24 counties, and a Deer Reduction Zone season was available from September 15 to January 31 in designated areas of 26 counties. A total of 111,251 deer were harvested during the 2018–19 season. This figure included 47,256 antlered deer and 63,995 antlerless deer. This year’s harvest was 2% less than the 2017–18 harvest.

Deer Damage Control Program

The DFW’s deer damage control program addresses the immediate damage that deer pose to private properties, primarily those of farmers. The program is designed to resolve localized, short-term problems. It is not a tool to control deer populations on a large scale.

The program allows for the removal of deer outside the hunting season only when damage exceeds \$500 or there is a threat from disease, and non-lethal measures would not be practical. The DFW responds to landowner complaints by conducting an on-site inspection and providing appropriate technical advice. If non-lethal methods, such as fencing or repellants, are deemed ineffective or inappropriate for the situation, the DFW may issue a deer damage control permit.

The permit requires any antlers to be removed and be provided to DNR Law Enforcement or other approved DNR personnel.

A total of 277 permits were issued in 2018. An average of 16.6 deer were authorized to be taken on each permit, but only an average of 6.8 deer were actually taken on 257 permits. Statewide, 1,737 deer were taken, representing 1.6% of the total number of deer harvested by hunters in 2018–19 and taken on damage permits.

Soybeans and corn were reported as the most frequently damaged crop. The program provided 316 deer, which were donated to families in need. Eight deer were taken on four permits issued to landowners due to concerns about transmission of disease to livestock.

Community Hunting Access Program

The DFW created the Community Hunting Access Program (CHAP) in 2017 to provide hunting opportunities for white-tailed deer in urban areas and to help reduce deer-human conflicts. The program offers community partners financial and technical assistance to administer hunting programs in their communities. In 2018, all five CHAP applications received were approved, but two applicants later withdrew. Collectively, the five approved communities were eligible to receive an estimated maximum \$157,000 over the two-year agreement cycle (\$78,500 annually). An estimated 2,610 acres were made available for hunter access through this program.

Participating communities are encouraged to hire and work closely with certified CHAP Hunt Coordinators (CHCs). The DFW provides a training program for CHCs. It teaches how to administer community hunts, manage hunters, and navigate the application process as a community representative. Additional information about CHAP is available at wildlife.IN.gov/9420.htm.

WILDLIFE HEALTH

One Health

The Wildlife Health Program, now in its second year, approaches disease concerns from a One Health perspective. This concept is commonly referred to in veterinary medicine, public health, and, increasingly, in conservation. One Health acknowledges the interconnectedness of animal (both domestic and wild), human, and ecosystem health. If the health of any one of these three elements is out of balance, the health of the other elements cannot be optimized. A multidisciplinary approach and working closely with multiple partners is needed to improve the health of all three.

One Health acknowledges that diseases do not recognize local, state, national, or international boundaries. Awareness of global health concerns and proactive measures are needed to fully protect health in Indiana. One Health also recognizes that diseases do not always

respect species barriers. Some diseases can be transmitted between animals and people, and the health of any one species cannot be effectively managed without consideration of the health of other species. Clean air, clean water, and clean soil promote the health and quality of life of both humans and animals. Our work reflects our belief in the importance to Indiana of the health of all three elements: animal, human, and ecosystem. Several examples of ongoing health projects and disease concerns across a variety of Indiana wildlife species follow.

Freshwater Mussel Health

Freshwater mussels are some of the state's most imperiled species and, because of their remarkable filtering capability, they are critical in maintaining water quality in Indiana rivers and streams. Mussel die-offs are increasingly recognized across their range in the United States and globally. Fortunately, no mussel die-offs have been documented in Indiana. Rarely



Obtaining baseline information on the health of two common and native mussels, the plain pocketbook (*Lampsilis cardium*; top) and fatmucket (*L. silquoidea*; bottom), are the subject of a new project in 2019.

are the causes of a die-off identified. Die-offs are often presumed to be due to contaminants, and professional wildlife health managers are becoming concerned that infectious disease may also play a role.

Because little is known regarding the health of the state's diverse mussel species, wildlife health staff have developed plans to improve the capacity to respond in the event of a die-off in Indiana. The project will begin to establish a database of normal parameters for mussel health and provide insight into the role environmental conditions have on mussel health. The project will also contribute to public health by examining antimicrobial resistance of bacteria in the waterways. This collaborative study began in summer 2019.

Salamander Chytrid Disease

Salamander chytrid disease is caused by a recently discovered fungus, *Batrachochytrium salamandrivorans* (*Bsal*), that infects the skin of salamanders and newts. First described in 2013, it has caused mass



Scientists are researching different salamanders to see which species are especially vulnerable to *Bsal*. The eastern newt (*Notophthalmus viridescens*), which occurs throughout much of Indiana, has shown lethal responses when exposed to *Bsal* in laboratory studies.

die-offs in the Netherlands. Believed to be of Asian origin, *Bsal* has since been documented elsewhere in Europe, including Belgium and Germany. It is related to the chytrid fungus, *B. dendrobatidis* (*Bd*), that has caused population declines in frog and toad species across the globe. While *Bd* is present in the United States, including Indiana, *Bsal* is not known to occur in North America. There is significant concern among wildlife health managers and researchers that *Bsal* will be introduced through the import of amphibians for research or the pet trade. Once here, its' effects could be devastating because there are so many susceptible salamander populations in the U.S.

In 2016 and 2017, the DFW contributed to national *Bsal* surveillance efforts coordinated by the National Wildlife Health Center in Wisconsin. Fortunately, all animals tested across the country were negative for *Bsal*. To be prepared for the likelihood of the introduction of this disease to North America, the DFW continues its support of regional and national *Bsal* research, including species susceptibility testing, disease management strategy investigation, pet store surveillance, and human dimension surveys.

Continued vigilance is needed to protect Indiana's wild amphibians, and preventing the introduction of diseases is always more effective than responding to outbreaks. Thus, it is important that people never intentionally release pet amphibians into the wild because they could be a source of *Bsal* infection that could infect wild populations. Since 2017, the DFW has required researchers who request permits for fieldwork with reptiles and amphibians in Indiana to follow published biosecurity and decontamination guidelines to minimize the chance of spreading infectious diseases between sites.

Skeletochronology In Eastern Hellbenders

The DFW, in collaboration with Purdue University and several Indiana zoos, continued the captive-rearing program for the endangered eastern hellbender with the release of 39 individuals into the Blue River in southern Indiana in 2018.

To advance our knowledge of this charismatic species and improve its management in the wild, the DFW partnered with the Purdue College of Veterinary Medicine and the Animal Disease Diagnostic Laboratory on a pilot study to use skeletochronology to determine the age of hellbenders. This technique correlates the number of growth lines identified through microscopic examination of bone sections to an individual animal's known age, similar to aging a tree by counting its rings seen in cross-section. This information could inform conservation efforts through understanding the age structure of hellbender populations in the wild.

Based on findings from this pilot study, skeletochronology shows promise for aging hellbenders. Plans are to continue this research in the future to test and refine the ability to identify hellbenders of a wider range of ages.

The pilot study was conducted primarily by a Purdue veterinary student under the mentorship and guidance of the DNR's state wildlife veterinarian and a Purdue University veterinary pathologist. Funding was provided by the Boehringer-Ingelheim Veterinary Scholars Program. The program's mission is to provide an opportunity to introduce first- and second-year veterinary medical students to biomedical research. It was rewarding for the wildlife health program to be able to collaborate to provide such an opportunity and benefit from the student's efforts. The program includes a national symposium, funded by the National Institutes of

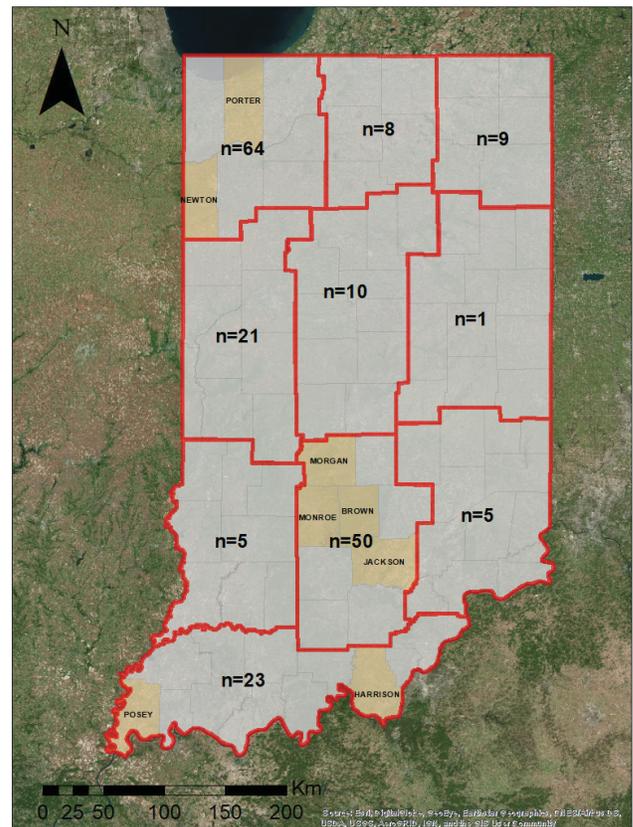


Identifying aging eastern hellbenders by examining the number of growth lines in their bones was the topic of a pilot study between Purdue University and the DFW in 2018. (photo by Rod Williams)

Health, where research is presented and experiences are shared among the veterinary scholars and faculty.

Snake Fungal Disease

Snake fungal disease (SFD), caused by the fungus *Ophidiomyces ophiodiicola*, is an emerging fungal disease first identified in Indiana in 2017 as part of



Number of snakes sampled for ophidiomycosis by Indiana region in 2017 and 2018. Positive samples were detected in the eight counties that are shaded orange.

a three-year State Wildlife Grant surveillance project contracted to the University of Illinois. In the first two years, 22 species have been sampled, and the causative fungus has been identified in swabs taken from the skin of 19 of 196 snakes tested (11 in 2017; eight in 2018). The overall prevalence is 9.7%. Species that tested positive were the northern watersnake (*Nerodia sipedon*), racer (*Coluber constrictor foxii*), queen snake (*Regina septemvittata*), red-bellied snake (*Farancia abacura*), Kirtland's snake (*Clonophis kirtlandii*), bull-snake (*Pituophis catenifer sayi*) and milksnake (*Lampropeltis triangulum*). SFD has been detected in eight Indiana counties: Brown, Harrison, Jackson, Monroe, Morgan, Newton, Porter, and Posey. All but two of the 19 positive snakes were from southern Indiana.

Field work will continue in 2019 with the goal of sampling at least 300 snakes. The potential negative impact this disease may have on populations of Indiana's endangered snakes, such as the eastern massasauga (*Sistrurus catenatus*) is unknown. Protecting populations of predators such as snakes is important in maintaining balanced rodent populations and potentially in decreasing the risk of disease transmission from rodents to other species.

Avian Cholera

Avian cholera is an infectious disease of birds caused by *Pasteurella multocida* bacteria. Infections in waterfowl can often result in the deaths of thousands of birds, and outbreaks occur regularly in some parts of the country.

Indiana documented its first outbreak of avian cholera in Gibson County in early December 2017. In response, the DFW and federal and private partners increased surveillance of waterfowl populations statewide and carefully removed and disposed of carcasses at the affected sites in Gibson County through mid-March 2018. The primary purpose of these efforts was to reduce bacterial contamination of the environment and decrease the risk of transmission to other birds in this area, particularly whooping cranes and raptors.

About 700 total birds were found dead in association with the outbreak in Indiana, with the vast majority being snow geese. Tens to hundreds of thousands of snow geese and other waterfowl are found at these sites during winter, so the incidence of disease appeared to be very low, with no population level effects expected. Concurrent avian cholera outbreaks were identified in other Mississippi Flyway states (Arkansas, Illinois, Kentucky, Missouri, and Tennessee) and Pacific Flyway states (Utah, California) in 2017 and 2018.

Rabies

Rabies is a deadly viral disease that affects the nervous system of many mammal species. It is most often transmitted by animal bites. Testing of wildlife for rabies is conducted by the Indiana State Department of Health's (ISDH) rabies lab in cases of known or suspect-

ed human or domestic animal exposure. Submitted bats have continued to test positive on occasion. Thirteen of 552 (2.36%) bats tested were positive for rabies in 2018, whereas 14 of 425 (3.29%) of bats tested were positive in 2017. From 2012 through 2016, 3.7% of the 1,945 bats submitted to the ISDH rabies lab tested positive.

Of terrestrial wildlife, the last rabies-positive skunk in Indiana was identified in 2004, the last rabies-positive fox was identified in 1990, and the last rabies-positive raccoon was identified in 1979.

White-Nose Syndrome

Winter bat surveys were conducted in 15 hibernacula during January and February 2018. Counts of Indiana bats and little brown bats decreased marginally from 2016, while populations of big brown bats and tri-colored bats increased marginally.

All four species have declined since the first detection of WNS in Indiana in 2011. Little brown bats and tri-colored bats have been hit especially hard, experiencing declines in abundance of about 90%. Recently, winter populations generally appear to be stabilizing, although multiple tri-colored bats with visible signs of WNS infection were observed during the 2018 surveys.

Swabs for WNS surveillance were not collected from bats or cave surfaces in 2018. Data collection for the continental study of the geographic distribution, spread, and transmission of WNS concluded in 2016, and results were published in 2017.

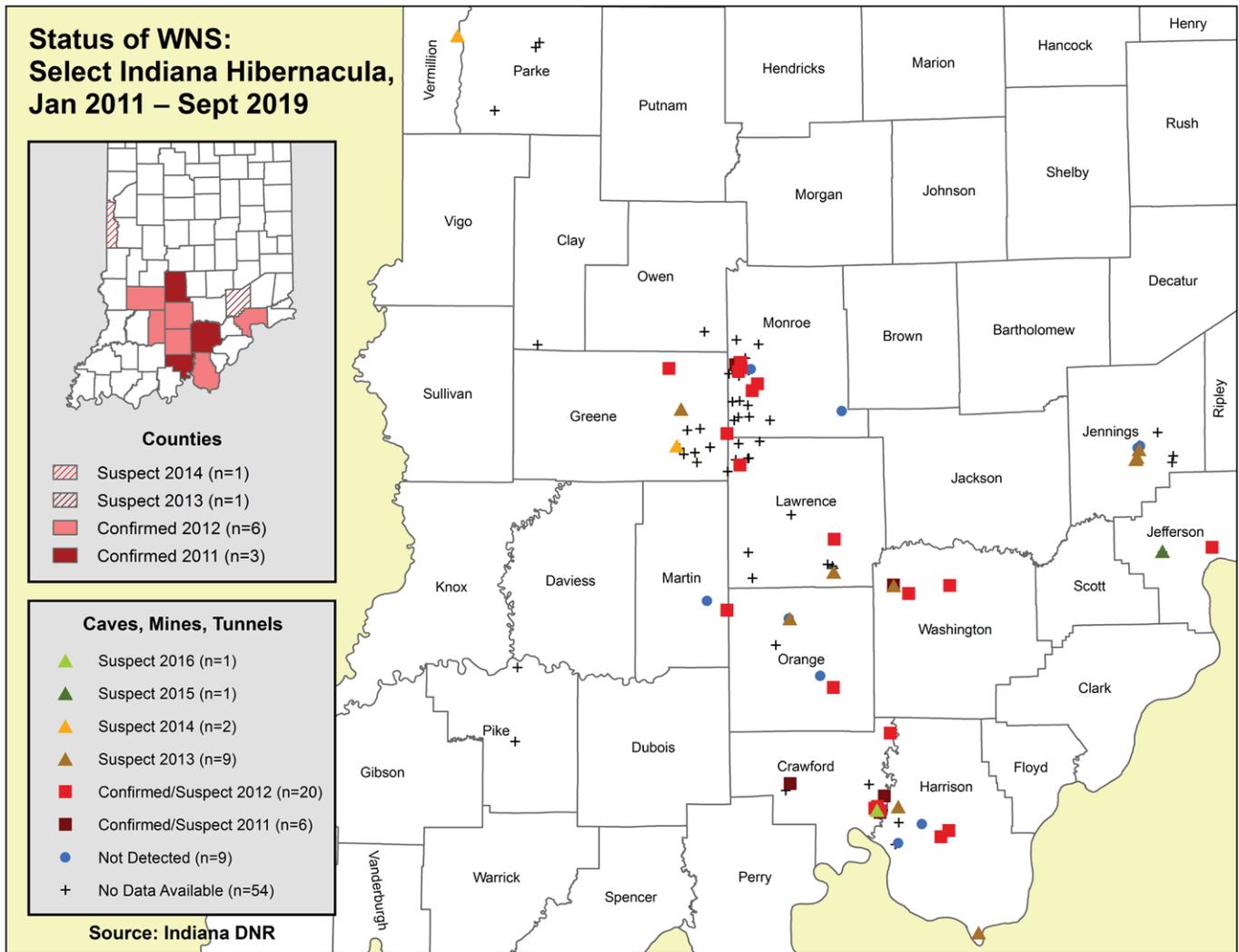
West Nile Virus In Squirrels

The DFW received an unusually high number of reports of neurologic squirrels from the public from May to July 2018. Clinical signs in adult squirrels included circling before collapsing and dying, seizures, lack of balance, falling out of trees, and aggression. In July, a neurologic squirrel reported as circling frantically was submitted in July and tested positive for West Nile Virus (WNV). This is the first known documentation of this disease in squirrels in Indiana, though it is frequently reported as a cause of abnormal behavior and mortality in gray and fox squirrels elsewhere.

Epizootic Hemorrhagic Disease

Epizootic hemorrhagic disease (EHD) is caused by a virus spread to white-tailed deer by the biting midge *Culicoides variipennis* in Indiana. Often worse in drought years, outbreaks tend to occur in approximately five-year cycles. Although the DFW received sporadic reports of mortality in white-tailed deer in 2018, no cases of EHD were confirmed in Indiana.

Localized mortality in deer from EHD can occur at any time, even if there is not a significant outbreak. The last major outbreak of EHD in Indiana occurred in 2012, with a less widespread, but significant, outbreak in 2013. There is no treatment for this disease in wild deer, but some individuals may survive infection and develop resistance.



Status of WNS in select bat hibernacula in Indiana from January 2011 to September 2019.

Chronic Wasting Disease

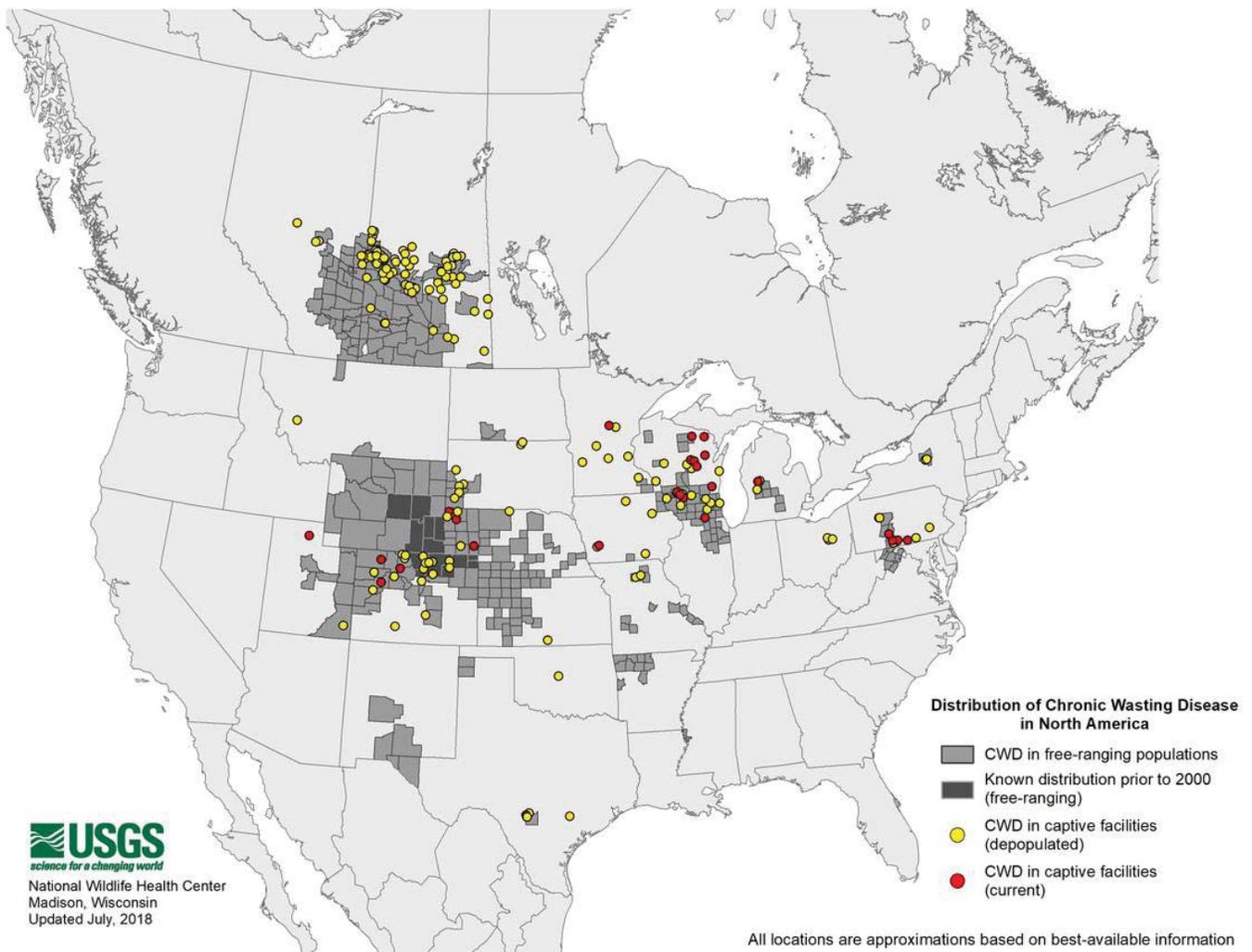
Chronic wasting disease (CWD) is a fatal neurodegenerative disease that affects members of the cervid family, including white-tailed deer, mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), moose (*Alces alces*), and reindeer (*Rangifer tarandus*). CWD is in a class of prion-caused diseases known as transmissible spongiform encephalopathies (TSE). CWD was first detected in 1967 in captive mule deer at a Colorado research facility, and as of early 2019, it had been found in wild and captive cervids in 26 states, three Canadian provinces, Norway, South Korea, and Finland. The disease continues to spread geographically in the U.S. The Indiana DNR works with state and regional partners to coordinate approaches to prevent and manage this disease, which remains one of the most challenging and consequential in wildlife health management in North America.

Despite ongoing CWD-related research, there remains no effective cure or vaccine for the disease, and it is always fatal to the infected cervid. It attacks the

animal's brain and causes behavioral changes, excessive salivation, and loss of appetite. Eventually, CWD leads to progressive loss of body condition and death. It has a long incubation period that averages from 18 to 24 months between infection and clinical signs. Infected animals often appear healthy in the early stages of CWD. However, in advanced stages, they become emaciated, may lose fear of humans, stand with legs wide apart, and hold their head and ears low. CWD prions shed in the secretions of infected animals may persist in the environment for many years.

Each year since 2002, DNR has collected tissue samples statewide from hunter-harvested and road-killed deer to test for CWD. Sick deer reported by citizens are also tested.

In 2018, 756 hunter-harvested deer, 180 road-killed deer, 26 targeted deer, and seven deer found dead were tested for CWD. Surveillance was focused in northeast and northwest Indiana due to detections of CWD in neighboring Illinois and Michigan, 25 and 35 miles from the border, respectively. Farmed deer have



Distribution of CWD in North America, July 2018.

tested positive for CWD in Ohio, but CWD has not yet been detected in farmed or wild deer in Kentucky.

Since surveillance began in Indiana in 2002, DFW biologists have tested tissues from more than 20,000 deer, all of which have tested negative for CWD. The best chance for effective management of CWD is to detect it early when prevalence is low. For this reason, the public is encouraged to report any deer they observe that appear sick. Hunters are also encouraged to submit their deer harvested within CWD surveillance zones for testing. Hunters outside of those zones may submit samples to the Animal Disease Diagnostic Laboratory at Purdue University for CWD testing for a fee.

Bovine Tuberculosis

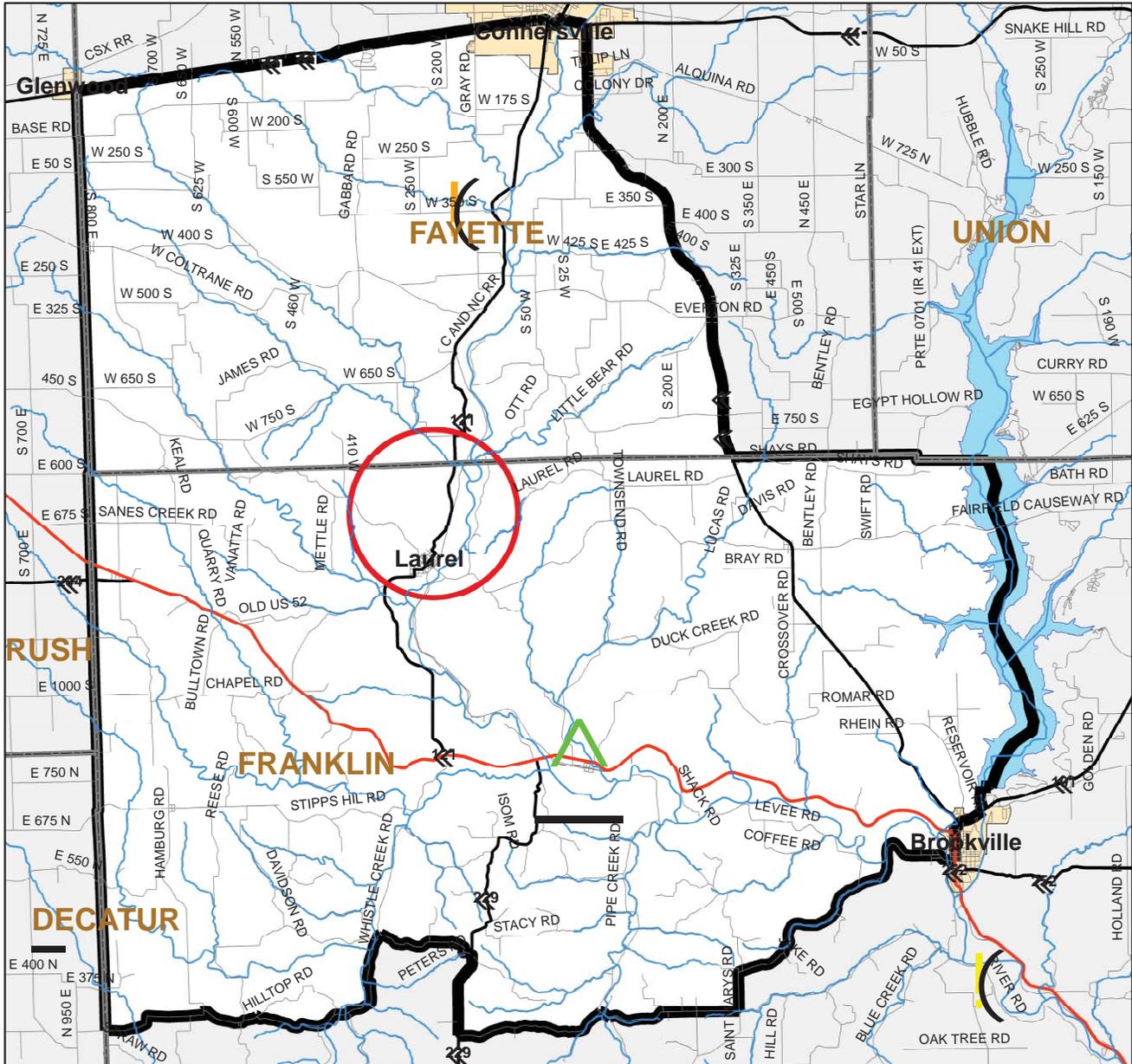
Bovine tuberculosis (bTB) is a contagious, chronic disease caused by the bacterium *Mycobacterium bovis*. It typically infects the lungs but may spread to other organs and can infect many mammal species, including humans. If infection becomes established in white-tailed deer, those deer can act as reservoir hosts, and

the existence of multiple reservoir hosts can make eradication of bTB difficult.

The DFW and other state and federal partners test wild white-tailed deer for bTB because it was found in cattle in Franklin County in 2008, 2009, and 2016, and in Dearborn County in 2011. The disease was also detected in captive deer from a farm in Franklin County in 2009. Between 2009 and early 2017, a total of 3,524 wild white-tailed deer were sampled in the bTB surveillance zones. None of those deer tested positive for the disease.

In 2016, bTB was detected in a second Franklin County cattle farm. Resident wildlife were removed from the farm, and one deer and one raccoon tested positive for bTB. Both infections were determined to have been spillover events from livestock. In response, the DFW initiated more intensive bTB surveillance during the 2016–17 and 2017–18 deer hunting seasons in portions of Fayette, Franklin and Dearborn counties.

A total of 2,047 hunter-harvested deer were sampled during the 2016–17 season. All of those deer tested



Div of Fish & Wildlife, Oct. 2018

Drop-Off Locations 2018 (Call for Hours)

-  Mustin's Taxidermy & Processing
1660 W 350 S, Connersville, IN 47331; 765-825-5943
-  Hunters Choice Deer Processing
6164 Highland Center Rd, Brookville, IN 47012; 765-647-0916
-  bTB Surveillance Zone
-  Focal bTB Surveillance Zone



CHECK STATION - Whitewater Canal State Historic Site maintenance facility

 19083 Clayborn St, Metamora, IN 47030

HOURS OF OPERATION
Saturdays and Sundays
Nov. 3 through Dec. 23
9:00 A.M. - 6:00 P.M.

Voluntary bTB surveillance zone established in Franklin and Fayette counties for the 2018-19 deer hunting season.

negative for bTB. In December 2016, however, bTB was identified on a third cattle farm in Franklin County. Resident wildlife on this farm were also removed, and one raccoon tested positive for bTB; it too was demonstrated to be spillover from livestock to wildlife. A total of 541 hunter-harvested deer were sampled during the 2017–18 season. None of those deer tested positive for bTB. In the 2018-19 season, 177 deer were tested from the area. All of those deer were negative. However, one raccoon removed from the most recently detected positive cattle farm did test positive.

These results suggest that, through the 2018–19 hunting season, the prevalence of bTB in wild deer within the Franklin County surveillance zone has remained at levels that are difficult to detect, likely very low to non-existent. The Indiana DNR will continue to support state and federal efforts for eradication of this serious and economically important disease from Indiana.

Wildlife Health Application

The DFW has begun the development of a wildlife health application to track wildlife health outcomes, manage wildlife health samples and results, and track and notify people and organizations associated with wildlife health cases. The web-based application will be designed to allow reporting of an observation of a sick animal by the public to allow for a more timely and effective response from staff. The first phase of this project is expected to be completed in time to manage sample collection for Indiana’s fall 2019 CWD surveillance of hunter-harvested deer.

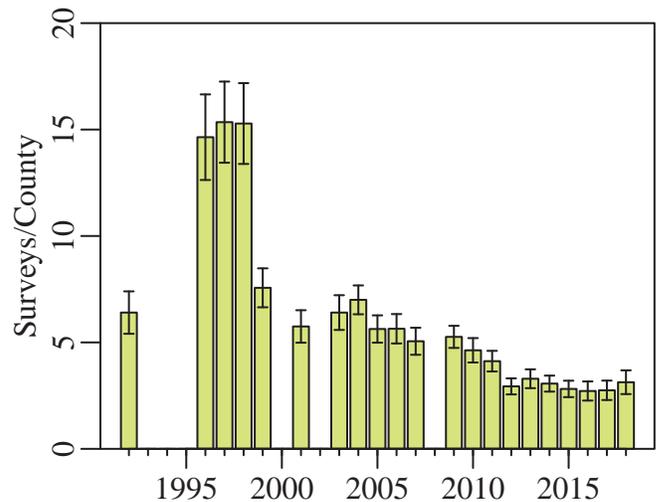
WILDLIFE DATA ANALYTICS

Archer Index Participation And Behavior

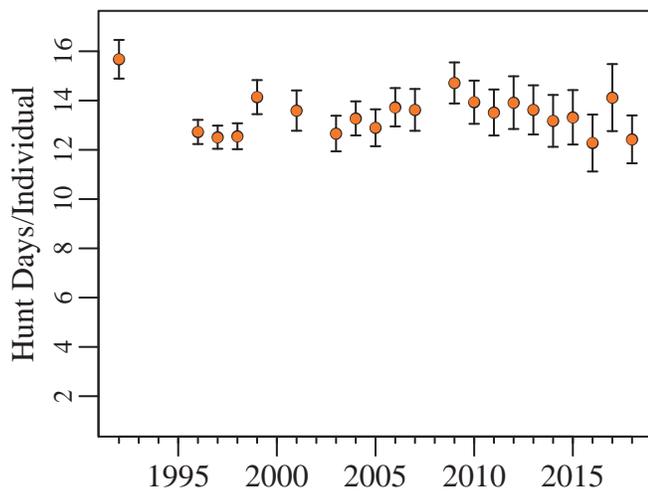
In 1992, the DFW piloted a survey to collect observations of wildlife from voluntary bowhunters across the

state. The Archer Index has continued since with few interruptions and is an inexpensive means of monitoring trends in wildlife populations. It also offers insights into changes in human behavior, such as survey participation and hunting activity over time.

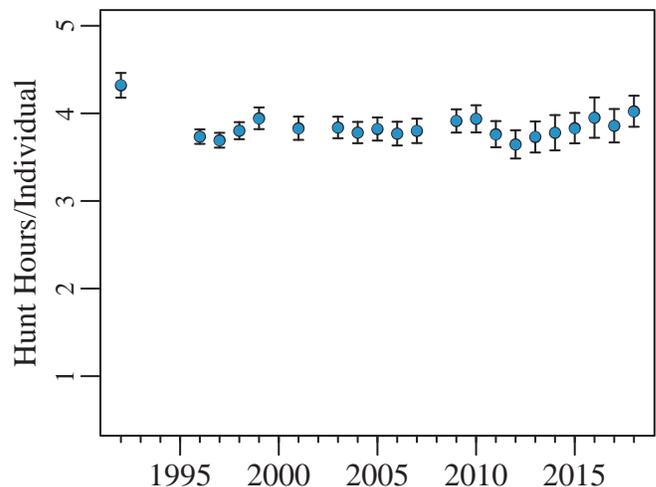
Archer Index survey returns peaked in the mid-1990s and then fell steeply. This includes both the total number of surveys, which dropped from an annual high of 992 in 1997, to a low of 186 in 2016, and the total number of observations, which fell from an annual high of 20,016 in 1995, to a low of 2,902 in 2016. These trends were driven by declining



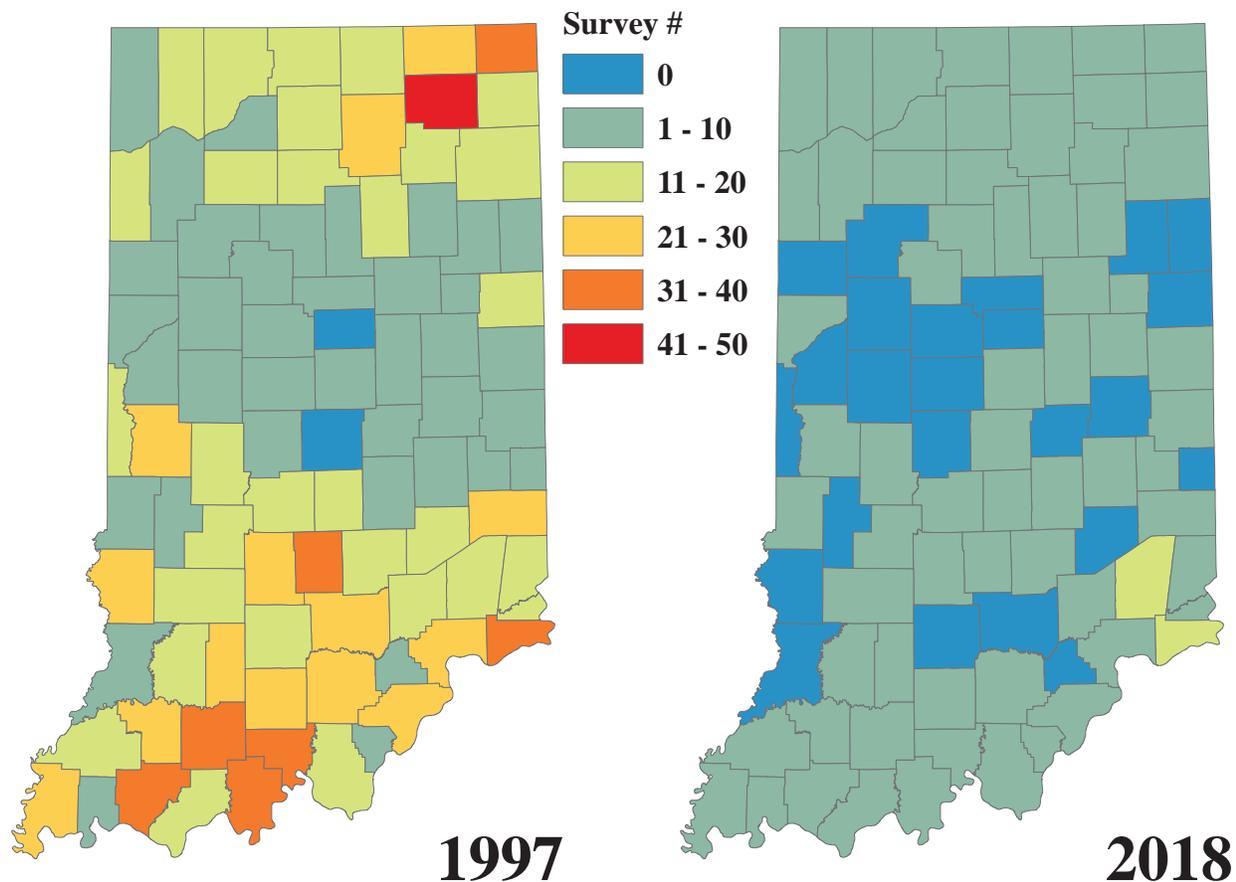
The average number of Archer Index surveys returned per county (with 95% confidence intervals) from 1992 to 2018. The survey was not completed in 1993, 1994, and 2008. The survey was completed in 1995, 2000, and 2002, but the number of individual survey returns was not recorded.



The average number of days hunted per individual (with 95% confidence intervals) by participants in the Archer Index survey from 1992 to 2018.



The average number of hours hunted per day (with 95% confidence intervals) by participants in the Archer Index survey from 1992 to 2018.



The number of Archer Index surveys returned in each county in 1997, at the peak of survey returns, and in 2018.

participant recruitment and dwindling return rates. Survey numbers have rallied slightly during the last two archery seasons, but the overall decline in returns has led to gaps in coverage that could jeopardize the ability to monitor populations statewide.

Although participation has fallen, the average number of days hunting (13.32), hunting hours (50.45), and hours per hunt (3.83) has changed little over time. Such behavioral consistency is surprising considering the corresponding decrease in hunting licenses over the same period. Whether this pattern of behavioral consistency holds for all Indiana bowhunters is unknown because Archer Index participants may represent a particularly dedicated group of hunters. Although the number of surveys has declined over time, it is encouraging that the number of observation hours per participant has remained relatively stable.

These results suggest that considerable effort is needed to maintain citizen participation over a sustained period. Maps of survey coverage will help target areas to recruit future participants. Various methodological and technological solutions that would increase participation and improve overall data quality are also under consideration. Such changes would help

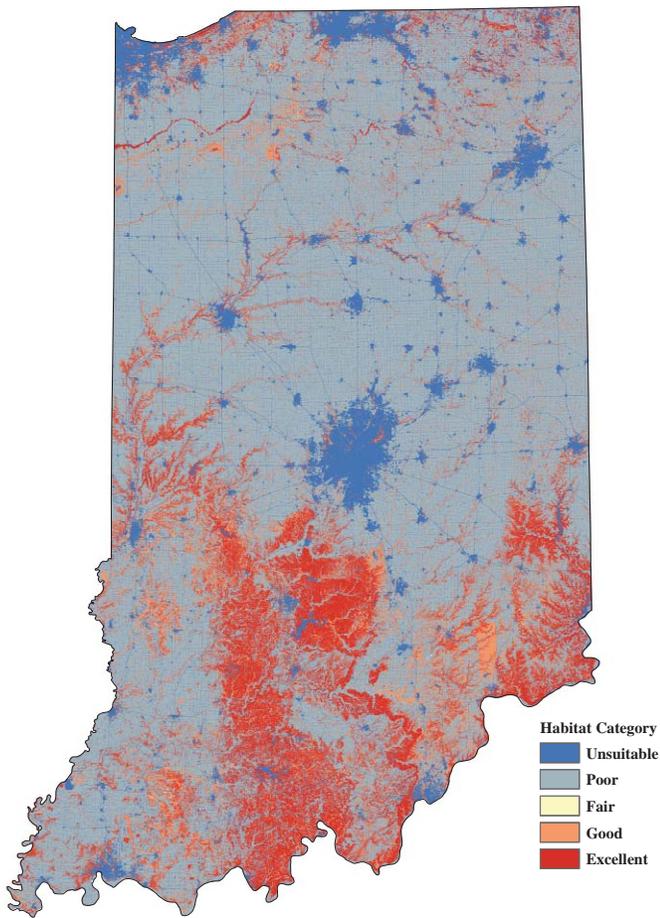
ensure the Archer Index remains a valuable source of information about Indiana’s wildlife populations for years to come.

Mapping Black Bear Habitat

Since the species first confirmed report in Indiana in more than a century in spring 2015, sightings of black bears have become more common in Indiana. To better understand their potential distribution, a map of habitat suitability for black bears in Indiana was developed. This map can serve as a management tool for the species because black bears are likely to continue to expand their range into Indiana and use available habitat.

Because there are few records of black bears in Indiana, it was not practical to develop a habitat model from verified locations. Instead, a layer of habitat suitability was developed using past studies of black bear habitat use. Peer-reviewed manuscripts were examined to find evidence of consistent habitat associations, and these validated relationships were then used to construct a suitability surface.

This map shows that that the majority of suitable bear habitat in Indiana occurs in the southern



Habitat suitability map for black bears in Indiana.

portion of the state. The information presented in this map can be used to focus future education and surveillance efforts.

Wildlife Information System

The Wildlife Science Unit collects an abundance of data from both short-term research projects and long-term population monitoring programs. If these data are not properly managed, there is risk of losing valuable information over time. One of the first priorities for the new Wildlife Data Analytics program is to build an integrated Wildlife Information System that will collect, organize, and store data generated by DFW’s Wildlife Section.

Development of this system is an ongoing project that involves examining existing data sources, converting them into compatible formats, developing applications for data collection that maximize efficiency and minimize opportunities for error, and storing data in a series of secured relational databases. These efforts will decrease the risk of data loss in the event of technological failure and employee turnover. Ultimately, integrating the data streams of the multiple wildlife programs will serve to better inform the

management of Indiana’s wildlife populations.

Each wildlife program will have its place in the Wildlife Information System. The first to be developed is a wildlife health application. It will track wildlife health outcomes, manage wildlife health samples from initiation to storage, manage supply inventory, and store and link associated documents. This application is essential to meet the growing needs of the Wildlife Health program and is expected to be operational by fall 2019 to streamline CWD surveillance efforts.

WILD PIGS

Wild pigs (*Sus scrofa*), a non-native and invasive species, were intentionally and illegally released in two regions of southern Indiana in the early 1990s. Genetic analyses linked these pigs to sources in Louisiana and possibly Mississippi. Morphologically, wild pigs exhibit features of Eurasian or Russian boar hybrids rather than those of feral swine of domestic origin. Ongoing DNA profiling of existing populations shows promise as a forensic tool for law enforcement to determine the origin of new populations and as a means to evaluate eradication success.

Control of wild pig populations in Indiana was previously conducted through unrestricted shooting. However, combined with recreational sport hunting, this approach not only proved ineffective in controlling populations, but also can often encourage illegal release of more pigs to expand hunting opportunities. In 2014, Congress approved \$20 million over five years to control and eliminate wild pigs, with emphasis directed at emerging populations in the Midwest. USDA-Wildlife Services (USDA-WS) hired professional technicians in each state to work with State and federal agencies and cooperating landowners to carry out control techniques such as trapping, snaring, aerial shooting, and selective night shooting. Such methods must be tailored to conditions in the Midwest, where relatively low pig populations, abundant food resources, and winter conditions present challenges not likely faced in southern states. Additionally, landowners must learn to integrate multiple control methods and develop patience to capture complete pig sounder groups (i.e., adult sows and their progeny) for effective removal.

In 2018, USDA-WS technicians removed 77 wild pigs (compared to 226 in 2017 and 130 in 2016) in Indiana. Most pigs (n = 49; 64%) were removed through trapping. Selective night shooting and aerial shooting removed 18 and 10 additional pigs, respectively. Tissue samples were collected and submitted to USDA-WS for disease testing (classical swine fever, toxoplasmosis; 18 samples) and genetic DNA profiling (28 samples).

Shortly before the November 2018 deer firearms season, six or seven free-ranging pigs were observed in northwest Indiana that were traced back to an apparent escape or abandonment of domestic pigs in Illinois. At least two pigs were killed on a Fish and

Wildlife Area by agency personnel; another was taken by a nearby landowner. No further reports of free-ranging pigs in the area has occurred since.

The proliferation of free-ranging pot-bellied or “Heritage” pig reports in Indiana has become more of an administrative nuisance and unnecessary waste of limited personnel investigation time. Most pot-bellied, Heritage and related hybrid pigs appear to be abandoned, escaped or poorly confined pets or hobby animals. Free-ranging swine of any origin can damage native fauna and flora, their habitats, water resources and personal property, and can generally be shot on sight in Indiana with landowner permission. Over the last decade, several pot-bellied or Heritage hybrid pigs have been removed from DNR properties.