

## ALL FOREST HABITATS NARRATIVE

### Habitat description

A plant community extending over a large area and dominated by trees, the crowns of which form an unbroken covering layer or canopy.

### Problems affecting species and habitats

#### Species threats

Respondents ranked the following threats to wildlife in all forest habitats in Indiana:

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

## Appendix F-32: Aggregated Forests

Respondents offered additional threats to wildlife in all forest habitats in Indiana:

- Habitat loss, degradation and fragmentation
  - Fragmentation of forest habitat and loss of farmland habitat to housing
  - Spread of honeysuckle, construction, tree diseases, tree insects and removal of fence rows
  - Serious reduction in timber management and sales on public lands, consequently early successional habitats are disappearing in the forests. Private timber sales and management is too haphazard to replace severe losses of young forests on public lands
  - Lack of periodic vegetative disturbance (man-made or natural every five to 10 years) that adequately opens the forest canopy and is well distributed throughout predominately forested environments, especially in large contiguous forested areas in public ownership. These areas form the heart of residual and current grouse range. Potential habitat on private lands is fragmented due to small ownership and different ownership objectives that does not provide a consistent continuum of acceptable habitat for successful population dispersal. A recent population model analysis based on current habitat conditions and actual grouse population data for Indiana projects that ruffed grouse will potentially disappear as a viable species in much of their current range by 2007. Ruffed grouse population indices are now at the lowest levels recorded in over 40+ years
- Fox squirrels: It might be possible to overharvest fox squirrels in small forest fragments in the northern part of the state but I believe that this too is unlikely
- White-tail deer
  - Captive cervids/genetic contamination
- Brown-headed cowbird nest parasitism
  - Affect cerulean warblers
- Information needs
  - We need to know how the Cerulean Warbler is affected by silviculture and other land management, and how these effect demography
- Lack of public knowledge/information
  - Regarding the importance of disturbances and early successional habitat in forested areas. The lack of early successional habitats in forested areas is causing major declines in the ruffed grouse population.

Respondents listed top threats to wildlife in all forest habitats in Indiana:

- Habitat loss, degradation and fragmentation
  - Habitat losses due to land development
  - Large-scale mortality being reported from wind turbines and other sources is the most threatening issue for some wildlife species
  - For fox squirrels, greatest threats are habitat loss and fragmentation
  - Loss of large blocks of mature forest and increases in forest fragmentation that causes and increase in cowbird nest parasitism and increases edge nest predators (e.g., blue jays). This causes a decrease in recruitment
  - Because the Cerulean Warbler is an area-sensitive species, a loss of large tracts of mature forest on both the breeding and wintering grounds is a critical threat
  - Lack of periodic vegetative disturbance reduces habitat available for ruffed grouse
  - Loss of early successional forest age class

## Appendix F-32: Aggregated Forests

- Adequate habitat (primarily American sycamores along riparian areas) in breeding areas
- Availability and quality of suitable nesting/feeding habitat
- The species is considered a habitat generalist that uses early successional habitats within deciduous forests. With prevailing land management that does not generate early succession habitat (such as maturation of forest on former farm lands), habitat is reduced
- Loss and degradation of breeding and foraging habitats along river corridors and uplands
- Conversion of native communities and habitats for human use cause direct loss of habitats for bobcats and their prey items
- Overpopulation will lead to an unmanageable resource and severe habitat degradation
- Whitetail deer threats
  - Captive cervids contaminate genetic integrity and increase chance of infection for wild deer
  - Trophy mgt & associated leasing will lead to overpopulation and fewer active hunters
  - CWD, EHD and tuberculosis
- Invasive species and its relation to habitat loss/nest predation
  - Cowbird nest parasitism
  - A second top threat is probably loss of nest and nesting females to cats, chipmunks, snakes and other ground predators
- Bobcat threats
  - Direct mortality (incidental take, road-kills, persecution)
  - Habitat loss: Conversion of native communities and habitats for human use cause direct loss of habitats for bobcats and their prey items
- Eastern box turtles
  - Habitat loss
  - Road mortality
  - Human collection
- Lack of information
  - We still have very little information on the Cerulean Warbler. We need to assess basic demography in Indiana and across the breeding range, learn how this species responds to land management, develop an understanding of post-fledging habitat use, and determine the effect of the brown-headed cowbird on this species
  - We also need information about how this species migrates to begin thinking about where not to place such structures. Loss of winter range is a slight concern since we really don't know where they are going
- Low reproductive output
  - Possibly due to poor habitat quality
  - Individual take [by humans] coupled with low reproductive rates pose a serious threat for timber rattlesnakes
- Timber rattlesnake threats:
  - Habitat loss
  - Human persecution
    - Timber rattlesnakes are often killed because they are large venomous snakes
    - There is also a market for some wildlife species in illegal trade.

## Appendix F-32: Aggregated Forests

- Individual take [by humans] coupled with low reproductive rates pose a serious threat for timber rattlesnakes
- Opposition to forest management
  - Preservationist (anti-management folks) and their influence on the politics of timber management and legal management to sound timber/wildlife management activities
- Lack of public outreach
  - Ruffed grouse: Lack of public knowledge/information regarding the importance of disturbances and early successional habitat in forested areas is the main contributing factor to the near extirpation of the ruffed grouse
- Crowned snake threats
  - Habitat destruction and fragmentation
  - Accidental take

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in all forest habitats. Their responses included:

- Yes- it is captured very well.
- Oak-Hickory Forest cover type is not regenerating itself due to the lack of disturbance (fire, even-aged silviculture that is needed to provide suitable conditions for the growth of the shade-intolerant mast-producing oak species. Therefore, wildlife species dependent on the oak-hickory cover type will have a difficult time maintaining current populations over the long term.

### Habitat threats

Respondents ranked threats to all forest habitats in Indiana:

Rank	Threats to all forest habitats
1	Commercial or residential development (sprawl)
2	Habitat fragmentation
3	Habitat degradation
4	Agricultural/forestry practices
5	Successional change
6	Invasive/non-native species
7	Counterproductive financial incentives or regulations
8	Diseases (of plants that create habitat)
9	Mining/acidification
10	Stream channelization
11 (tie)	Impoundment of water/flow regulation
11 (tie)	Nonpoint source pollution (sedimentation and nutrients)

## Appendix F-32: Aggregated Forests

- 12 Point source pollution (continuing)
- 13 Residual contamination (persistent toxins)
- 14 Drainage practices (stormwater runoff)

Respondents noted other threats to all forest habitats in Indiana (not ranked):

- Habitat loss, degradation and fragmentation
  - Modern farm practices create large, open, clean fields that leave no habitat
  - Urban spread, construction, clearing for agriculture crops and fence row removal
  - Eastern hardwood forests, including those in Indiana, are relatively young and even-aged with less species diversity, vertical structure, natural canopy gaps, large woody debris, and other structural features than pre-European settlement forests. Suppression of natural disturbances such as fire has resulted in a shift in species composition, structural complexity, and landscape pattern across much of the region. Fire-intolerant species such as sugar maple and American beech have become established at the expense of fire-adapted oak and hickory species, especially after fire control measures were. Before European settlement, fires, beavers, floods and windstorms created extensive openings. The restoration of natural landscapes requires the re-introduction or simulation of these disturbances
  - Although Southeastern crowned snake are is found in conjunction with upland forested habitats in Indiana, this species prefers sand and siltstone glades
- Not clear what is causing decline of the Cerulean Warbler; regionally brood parasitism and forest fragmentation may be negative impacts. It may be possible the species geographic range is shifting (climate?). Exact habitat associations of the species are not known
- Public resistance of timber management: Acceptance of periodic vegetative disturbance is necessary because forest cover across the landscape no longer exists in the same continuum, and natural forces no longer operate (e.g. regional firestorms) as they did prior to settlement. The public needs to accept that man-made disturbances (e.g. even-age timber management) can mimic natural disturbances on a smaller and controlled scale to create a diversity of habitats
- Environmental review process: Excessive environmental review and assessment makes timber management on public lands so costly in agency resources that it is deemed unaffordable within budgeted resources and attracts public ire as being too costly

Respondents listed top threats to all forest habitats in Indiana (not ranked):

- Habitat loss, fragmentation and degradation (loss of breeding, feeding and foraging habitats) due to urban sprawl and development
  - Habitat disturbances affect many species including:
    - Eastern red bat
    - Bobcat
    - Eastern box turtles
    - Cerulean warblers
    - Timber rattlesnakes: Fragmentation allows snakes to become susceptible to human and predator encounters
  - Conversion of habitat to other than pine forests
  - Loss of floodplain sycamores and upland pine forests
  - Loss of cavity trees and harvest of older forests
  - Maturation of existing forest out of young forest age classes

## Appendix F-32: Aggregated Forests

- Affecting migration ranges and movements
  - Fragmentation in farmed/heavily populated regions prevents historical movements from summer to winter ranges
  - Urban sprawl has started to force/interrupt movements and increase accidental mortality; it also increases opportunity to spread disease
- Lack of active habitat management. Management is needed to
  - Open or remove the overhead forest canopy and allow for natural regeneration back into a forest cover
  - Create early successional habitat. Absence of clear-cutting and other disturbances in forests is the major cause of ruffed grouse habitat declines. Forestry practices that do not lead to early successional habitat development are the problem. Grouse and many songbirds need early forest successional stages. Due to the current policies of the USFS and some state properties, the grouse is being “not-managed” to extirpation
- More research needed: We still do not know the specific habitat preferences for some wildlife species. The types of habitats where some of these species were especially abundant in the past (i.e. old-growth bottomland forest) no longer exist. This area needs more research
- Brood parasitism/invasive species
  - Habitat fragmentation creates conditions in which raccoons, blue jays and brown-headed cowbirds can parasitize cerulean warbler nests
- Lack of public understanding and acceptance
  - Of timber management, especially even-age timber management
  - Of vegetative disturbance whether natural or man-made

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to all forest habitats. Their responses included:

- Yes.
- yes

## Additional research and survey efforts

### Current body of research

#### Species research

Fifty-two percent of respondents stated that the current body of science is complete, up to date and extensive or adequate for wildlife in all forest habitats in Indiana. Thirty-nine percent of respondents believe the current body of science is inadequate.

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

Title = Mammals of Indiana;

Author = John Whitaker;

Date = IN Press;

Publisher = IU Press

## Appendix F-32: Aggregated Forests

Title = Nocturnal Behavior of Eastern Red Bats;  
Author = Brianne Everson;  
Date = 2005?;  
Publisher = MS Thesis, Indiana State University (not yet complete)

Title = The bobcat in Illinois;  
Author = Alan Woolf and Clayton Nielsen;  
Date = 2002;  
Publisher = Southern Illinois University Carbondale

Title = Status and management of bobcat in the United States over three decades;  
Author = Woolf, A. and G.F. Hubert, Jr.;  
Date = 1998;  
Publisher = Wildlife Society Bulletin 26:287-293.

Title = White-tailed Deer Ecology and Management;  
Author = Halls, L. K. (editor);  
Date = 1984;  
Publisher = Stackpole Books

Title = IN Mammals;  
Author = Whittaker

Title = White-tailed Deer Ecology & Management;  
Author = Wildlife Management Institute Book;  
Date = 1984;  
Publisher = Stackpole Books

Title = White-tailed Deer Ecology and Management;  
Author = Lowell K. Halls;  
Date = 1984;  
Publisher = Stackpole Books

Title = Mammals of Indiana;  
Author = Russell E. Mumford and John O. Whitaker, Jr.;  
Date = 1982;  
Publisher = Indiana University Press

Title = Gray and Fox Squirrel Management in Indiana;  
Author = John M. Allen;  
Date = 1964;  
Publisher = Indiana Department of Conservation

Title = A long term study of a box turtle (*Terrapene carolina*) population at Allee Memorial Woods, Indiana, with emphasis on survivorship;  
Author = Williams and Parker;  
Date = 1987;  
Publisher = Herpetologica

Title = North American Box Turtles;  
Author = Dodd;  
Date = 2001;  
Publisher = University of Oklahoma Press

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Title = Population status of ruffed grouse in Indiana;  
Author = Steven E. Backs;  
Date = Annual Progress Reports;  
Publisher = Indiana Div. Fish and Wildlife

Title = The historic and present distribution of ruffed grouse in Indiana;  
Author = Steven E. Backs;  
Date = 1984;  
Publisher = Ind. Acad. Sci. 93:161-166.

Title = Ruffed Grouse Restoration in IN;  
Author = Steve Backs;  
Date = 1984;  
Publisher = N. Central Section of the Wildlife Soc.

Title = Characteristics of Drumming Habitat of Grouse in IN;  
Author = Backs, Kelly, Major, Miller;  
Date = 1984;  
Publisher = Proceedings of Indiana Academy of Science: 94:227-230

Title = Atlas of Breeding Birds in Indiana;  
Author = Castrale, Hopkins, and Keller;  
Date = 1998;  
Publisher = Indiana Department of Natural Resources

Title = Breeding Bird Atlas of Indiana;  
Author = Castrale, J.S., E. Hopkins, C. Keller;  
Date = 1988;  
Publisher = IDNR

Title = BNA Account - Yellow-throated Warbler;  
Author = G.A. Hall;  
Date = 1996;  
Publisher = American Ornithologists' Union

Title = Atlas of Breeding Birds in Indiana;  
Author = Castrale, Hopkins, and Keller;  
Date = 1998;  
Publisher = Indiana Department of Natural Resources

Title = Cerulean Warbler MS Thesis;  
Author = Kirk Roth;  
Date = 2004;  
Publisher = Ball State University

Title = Cerulean Warbler MS Thesis;  
Author = Cindy Basile;  
Date = 2002;  
Publisher = Ball State University

Title = Habitat Selection and Territory Size of Cerulean Warblers in Southern Indiana;  
Author = Cynthia M. Basile;  
Date = 6/02;  
Publisher = N/A

## Appendix F-32: Aggregated Forests

Title = Master's Thesis (Title Unknown);  
Author = Kirk Roth;  
Date = 6/2004

Title = Habitat selection and reproductive success of Cerulean Warblers in Southern Indiana;  
Author = Kamal Islam and Kirk L.Roth;  
Date = December 2004;  
Publisher = Department of Biology Technical Report No. 4, Ball State University, submitted to U.S. Fish & Wildlife Service, Fort Snelling, MN

Title = Relative abundance and habitat selection of Cerulean Warblers in Southern Indiana;  
Author = Kamal Islam and Cynthia Basile;  
Date = December 2002;  
Publisher = Department of Biology Technical Report No. 1, Ball State university, final report submitted to U.S. Fish & Wildlife Service, Fort Snelling, MN

Title = Spatial Ecology of the Timber Rattlesnake in south central Indiana;  
Author = Walker and Kingsbury;  
Date = 2000;  
Publisher = Masters Thesis, IPFW

Author = Gibson and Kingsbury;  
Date = 2003;  
Publisher = Masters Thesis, IPFW

Title = Breeding Bird Atlas of Indiana;  
Author = Castrale, Hopkins, Keller;  
Date = 1988;  
Publisher = IDNR

Title = BNA Account - Pileated Woodpecker;  
Author = E.L. Bull and J.A. Jackson;  
Date = 1995;  
Publisher = American Ornithologists' Union

Title = Eastern Towhee, Birds of North American account #262;  
Author = Greenlaw, J.S.;  
Date = 1996;  
Publisher = The Birds of North America, Inc.

Title = Decline of the Rufous-sided Towhee in the eastern United States;  
Author = Hagan, J.M.;  
Date = 1993;  
Publisher = Auk 110:863-874.

Title = Atlas of Breeding Birds of Indiana;  
Author = Castrale, JS., E Hopkins, C Keller;  
Date = 1988;  
Publisher = IDNR

Title = BNA Account - Red-shouldered Hawk;  
Author = ST Crocoll;  
Date = 1994;  
Publisher = American Ornithologists' Union

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Title = Amphibians and Reptiles of Indiana;  
Author = Minton;  
Date = 2001;  
Publisher = Indiana Academy of Science

Title = Snakes of the United States and Canada;  
Author = Ernst and Ernst;  
Date = 2003;  
Publisher = Smithsonian Institute

Title=The Birds of North America  
Author=P.B. Hamel  
Date=2000  
Publisher=The Birds of North America, Inc., Philadelphia

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of research for wildlife in all forest habitats. Their responses included:

- Yes

### Habitat research

Forty-three percent of respondents stated that the current body of science is complete, up to date and extensive or adequate for all forest habitats in Indiana. Forty-four percent of respondents believe the current body of science is inadequate or nonexistent.

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

Title = Natural Heritage of Indiana;  
Author = Marion Jackson;  
Date = 1999;  
Publisher = IU Press

Title = Nocturnal Behavior of Eastern Red Bats;  
Author = Brianne Everson;  
Date = 2005?;  
Publisher = Unpublished MS Thesis (should be complete by May 2005)

Title = The bobcat in Illinois;  
Author = Alan Woolf and Clayton Nielsen;  
Date = 2002;  
Publisher = Southern Illinois University Carbondale

Title = White-tailed Deer Ecology and Management;  
Author = Halls, L. K. (editor);  
Date = 1984;  
Publisher = Stackpole Books

Title = White-tailed Deer Ecology and Management;  
Author = Lowell K. Halls;  
Date = 1984;  
Publisher = Stackpole Books

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Title = Statewide Forest Inventory;  
Author = ?;  
Date = periodic;  
Publisher = US Forest Service/IDNR

Title = Indiana Natural Heritage Data Center;  
Publisher = unpublished data

Title = The Natural Regions of Indiana;  
Author = Homoya, Abrell, Aldrich, and Post;  
Date = 1985;  
Publisher = Indiana Academy of Science

Title = Indiana Natural Heritage Data Center Community Classifications;  
Publisher = Unpublished Data

Title = The Natural Regions of Indiana;  
Author = Homoyo, Abrell, Aldrich, and Post;  
Date = 1985;  
Publisher = Indiana Academy of Science

Title = Cerulean Warbler MS Thesis;  
Author = Kirk Roth;  
Date = 2004;  
Publisher = Ball State University

Title = Cerulean Warbler MS Thesis;  
Author = Cindy Basile;  
Date = 2002;  
Publisher = Ball State University

Title = The natural regions of Indiana; Author = Homoya, M.A., D.B. Abrell, J.R. Aldrich, and T.W. Post;  
Date = 1985;  
Publisher = Proceedings of the Indiana Academy of Science 94:245-268

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of research for all forest habitats. Their responses included:

- Yes

## Research needs

### Species research

Respondents ranked research needs for wildlife in all forest habitats in Indiana:

Rank	Research needs for wildlife in all forest habitats
1	Threats (predators/competition, contamination)
2	Relationship/dependence on specific habitats

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- 3 Distribution and abundance
- 4 Population health (genetic and physical)
- 5 Limiting factors (food, shelter, water, breeding sites)
- 6 Life cycle

Respondents noted additional research needs for wildlife in all forest habitats in Indiana:

- White-tailed deer
  - A deer harvest analysis and modeling program
  - Baseline life history data
  - CWD all aspects
  - Aging techniques (tooth wear) that biologists use were developed in New York and may not be accurate for deer of the Midwest. My personal experience with deer of known ages indicates that wear is less than the aging charts we currently use. Additional local research needs to be done if we are interested in accurately aging deer over 2 1/2 years
  - Research needs explore the role of age and social structure in deer herd health.
- Bats: We desperately need to know how bats interact with each other in terms of competition
- Fox squirrels
  - Due to the high fragmentation of forest tracts in Indiana (especially northern Indiana) dispersal distance is a critical area of research
  - Research that evaluates the amount of harvest pressure can be sustained by isolated metapopulations of squirrels
- Cerulean warblers: Effects of forestry practices on demography and presence and absence of cerulean warblers (TNC) proposed study
- Ruffed grouse
  - Whether the distribution of early successional habitat is now so poor and low (as are ruffed grouse populations) that the disappearance of ruffed grouse from local areas now expand into a more regional or complete extinction
- Eastern towhee: Population trends, habitat needs and threats are not well defined for Indiana. The documented population declines in databases such as the Breeding Bird Surveys are poorly explained
- General life history information is needed for the Southeastern crowned snake in Indiana. Due to this species secretive nature, little is known about Indiana's populations

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wildlife in all forest habitats. Their responses included:

- I think there are further research needs for Indiana bat. The current federal timber harvesting guidelines are extremely limiting to protect the species, but there seems to be very little science behind the guidelines. It is unclear if they will in fact help the population. Should these guidelines be extended to private forests, there will be little opportunity for timber harvests, especially the types needed to create early successional habitat. We need to determine to what degree Indiana bat habitat is harmed by "normal" forest management practices and whether the guidelines will in fact help the species.

## Appendix F-32: Aggregated Forests

### Habitat research

Respondents ranked research needs for all forest habitats in Indiana:

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

Respondents noted additional research needs for all forest habitats in Indiana (not ranked):

- Cerulean warblers: Effects of forestry practices on cerulean warblers presence or absence and on demography
- Eastern towhee: Relationship between towhee occupancy and habitat age is not explicitly well studied here

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for all forest habitats. Their responses included:

- Yes

### **Conservation actions necessary**

#### Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in all forest habitats in Indiana:

Rank	Conservation efforts for wildlife in forest habitats
1 (tie)	Habitat protection
1 (tie)	Protection of migration routes
2	Population management (hunting, trapping)
3	Food plots
4	Regulation of collecting
5	Threats reduction
6 (tie)	Native predator control
6 (tie)	Disease/parasite management
6 (tie)	Limiting contact with pollutants/contaminants

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- 6 (tie) Public education to reduce human disturbance
- 6 (tie) Culling/selective removal
- 6 (tie) Exotic/invasive species control

Respondents noted additional conservation efforts for all wildlife in all forest habitats in Indiana (not ranked):

- White-tailed deer
  - Contraceptives currently are not used due to efficacy and economical reasons
- Ruffed grouse:
  - Instead of the word "protection" perhaps "enhancement" would be a better choice, as "protection" of habitat for ruffed grouse requires active vegetative management. While hunting is not responsible for declining population trends, and hunting pressure is self-limiting/regulated by diminishing returns, the question does eventually come (with the continuous decline of habitat and subsequently low populations). One must ask if there is an available surplus or are we shooting the last grouse in an area that was doomed anyway due to the lack of habitat
  - What is needed is habitat management in the form of producing early successional forest stages in large tracts throughout the forested regions of the state, especially on public lands. If this is not provided, the grouse will soon be extirpated
- Education of public to reduce losses due to exotic predators such as cats

Respondents recommended these practices for more effective conservation of all wildlife in all forest habitats in Indiana (not ranked):

- White-tailed deer
  - Population management via hunting
  - Ban cervid farming and canned hunting
  - Woodland habitat protection
- Habitat protection and management
  - Control of forest fragmentation
  - Eastern box turtles: Preserve large continuous blocks of forested habitat and nest cavities
  - Fox squirrels: Protect existing forest tracts and maintain or creating corridors between fragments
  - Increasing the area of mature forest and decrease fragmentation. The conservation of existing forestland is also critical
  - Active timber management, especially on the larger blocks of public forest lands, especially those timber management practices that remove at least 75 percent of the overhead canopy
  - Ruffed grouse: Immediate production of early successional stages of vegetation on public lands. Forestry practices such as clear-cutting and certain select cutting methods are needed to provide the habitat that is essential to returning ruffed grouse populations to earlier levels
  - Eastern towhee
    - Prescription burning to maintain sparse understory in mature pine forests may potentially help this species, for example on DNR lands.
      - Rodewald, P.G., J.H. Withgott, and K.G. Smith. 1999. Wildlife. In *The Birds of North America*, No. 438 (A. Poole and F. Gill, eds.). *The Birds of North America, Inc.*, Philadelphia, PA

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- The major need is regional land management plans that retain young forest age classes and mixes of habitats within regional landscapes
- Invasive species/predator control
  - Eastern box turtles: Attempt to lower meso predator numbers
    - Eastern towhee: Second practice may be exotic plant control. Garlic mustard and Amur honeysuckle have the ability to change vegetative structure of ground and understory layers. As ground nester and ground forager, towhees could be affected, but this is unstudied
- Care should be taken in approving wind turban power stations because of the large direct take associated with these structures. We also need some studies of these power stations in this section of the Midwest (Indiana, Ill, OH)
- Restrictions and regulations
  - Eastern box turtles: prohibit collection by humans
- Research
  - Cerulean warblers
    - We desperately need to learn how silvicultural activities and land management affect this species. Are there silvicultural activities (such as single-tree selection) that actually improve cerulean warbler habitat?
    - Additional research (nest productivity, annual monitoring of populations to assess trends in population numbers)
  - Studies of migration routes are needed so these areas can be protected
  - Research of general life history requirements
- Public education
- Incentives to conserve wooded riparian corridors and responsible forestry practices

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

- Yes

### Habitat actions

Respondents ranked conservation efforts by how well they address threats to all forest habitats in Indiana:

Rank	Conservation efforts for all forest habitats
1	Selective use of functionally equivalent exotic species in place of extirpated natives
2	Land use planning
3	Habitat protection on public lands
4	Habitat restoration on public lands
5 (tie)	Succession control (fire, mowing)
5 (tie)	Corridor development/protection

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- 5 (tie) Habitat protection incentives (financial)
- 6 Habitat restoration through regulation
- 7 (tie) Habitat protection through regulation
- 7 (tie) Habitat restoration incentives (financial)
- 7 (tie) Restrict public access and disturbance
- 8 Cooperative land management agreements (conservation easements)
- 9 (tie) Pollution reduction
- 9 (tie) Protection of adjacent buffer zone
- 9 (tie) Technical assistance
- 9 (tie) Managing water regimes

Respondents listed other conservation efforts for all forest habitats in Indiana (not ranked):

- Restrict motorized access into habitat
- There are few if any “current conservation practices being implemented for ruffed grouse. That is the major problem with critically low population levels
- Some states have policies and regulations that specifically mandate that a certain percentage of public lands will be maintained in early successional and transitional forest types

Respondents recommended the following practices for more effective conservation of all forest habitats in Indiana (not ranked):

- Restrictions and regulations
  - Restrict housing development in forested areas
  - Legislation to protect habitat
- Create incentives for establishing new, forested areas and protecting of existing ones
  - Incentives to conserve wooded riparian corridors.
- Habitat protection, restoration and management
  - Of forest and agricultural landscapes
  - Protect large blocks of natural communities and habitats
  - Manage forested lands to provide early- to mid-successional stage habitats
  - Create corridors between forest tracts
  - On public and private land
  - Promote older growth forests on public and private land
  - Due to natural succession and the reduction of natural disturbance, sugar maple and American beech are increasing in stand density and basal area at the expense of the oak-hickory overstory throughout many of the forests in the state. A shift in forest composition from oak-hickory to maple-beech dominated forests has implications for many wildlife species. This shift could result in a reduction of species richness and abundance within forest bird communities and may negatively influence the cerulean warbler. Differences in foliage and bark structure may affect arthropod (spiders and related species) availability for this species. And, the short-petioled leaves and furrowed bark of oak trees compared to maples may provide better foraging opportunities for these birds

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- Active timber management that removes at least 75 percent of existing forest canopy every five to 10 years on an 80- to 120-year rotation (depending on site constraints and management objectives) using even-age timber management techniques primarily
  - Implement forestry practices that will benefit early successional species including gray fox, bobcat and woodcock, as well as ruffed grouse
  - Potentially prescribed burning on public lands to maintain mature forests with sparse understory. (Rodewald et al. 1999. Pine Warbler in Birds of North America 16)
  - Incentives to conserve floodplain forests
  - Encouragement of forest management plans that retains / creates mix of young and older forest should retain towhees in regional avifaunas. Forest habitat restoration provides habitat in early stages. Encouragement of forest management plans that retains / creates mix of young and older forest should retain towhees in regional avifaunas. Forest habitat restoration provides habitat in early stages
- Land use planning
  - Conduct additional research
    - For cerulean warblers, research is needed on nest productivity and annual monitoring of populations to assess trends
  - Public outreach and education
    - Educate the public to understand that habitat management in this day and age is necessary if we are to provide habitat for specialist species whose populations are in peril

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the effective conservation of all forest habitats. Their responses included:

- Yes

## Partner agencies/organizations

The following organizations indicated that they work in Forest habitats.

Organization	Percent of time spent in Forest habitats
Indiana Forest Industry Council (IFIC)	100
Indiana Forestry and Woodland Owners Association	100
Indiana Forestry Educational Foundation	100
Central Indiana Land Trust	90
The Indiana Audubon Society	90
Naval Support Activity Crane	80
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	~75-80
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)	70
National Wild Turkey Federation	70

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U.S. Department of Agriculture, Forest Service Hoosier National Forest	65
Whitewater Valley Land Trust, Inc.	60
NICHES Land Trust	50
Indiana Dunes National Lakeshore	45
Tippecanoe Audubon Society	40
Hoosier Heartland Resource Conservation and Education council	35
Red-tail Conservancy, Inc.	33
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	31
ACRES, Inc.	30
Arrow Head Country Resource Conservation & Development Area, Inc.	30
Big Oaks National Wildlife Refuge, USFWS	30
Clark's Valley Land Trust	30
DNR Division of Nature Preserves	30
Indiana Native Plant and Wildflower Society	30
Lincoln Hills RC&D	30
Merry Lea Environmental Learning Center of Goshen College	30
Muscatatuck National Wildlife Refuge US FWS	30
Sycamore Land Trust	30
Robert Cooper Audubon Society	28
Hoosier Environmental Council	25
Indian Deer Hunters Association	25
Sassafras Audubon Society	25
Trillium Land Conservancy, Inc.	25
Dunes-Calumet Audubon Chapter	20
Patoka River National Wildlife Refuge & Management Area	20
The Nature Conservancy	20
Hoosier Conservation Alliance	15
Mason & Hanger Corp. Newport Chemical Depot	15
Blue Heron Ministries, Inc.	10
Cinergy Corp.	10
Ducks Unlimited, Inc.	10
Earth Source, Inc.	10
Indiana Association of Soil and Water Conservation Districts	10
Indiana Quail Unlimited	10
JFNew and Associates	10
Lost River Conservation Association	10
MWH Americas, Inc.	10
Northern Indiana Public Service Company (NIPSCO) a Subsidiary of NiSource	10
Save the Dunes Conservation Fund	10
Summit Lake State Park	10

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U.S. Fish and Wildlife Service - Indiana Private Lands Office	10
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	10
Valparasio Chain of Lakes Watershed Group, Inc.	10
Wawasee Area Conservancy Foundation, Inc.	10
St. Joseph River Watershed Initiative	7
Division of Fish and Wildlife	6
American Consulting, Inc.	5
Ducks Unlimited	5
EnviroScience Incorporated	5
Indiana Division of the Izaak Walton League of America	5
Indiana state trappers assoc	5
Indianapolis Power & Light Co.	5
Sierra Club Hoosier Chapter	5
Veolia Water Indianapolis, LLC	5
Wabash River Heritage Corridor Commission	5
St. Joseph County Soil & Water Conservation District (SWCD)	3
Federal Highway Administration (FHWA)	
fur takers of america chapter 7-E north west in.	
American Society of Landscape Architects, Indiana Chapter	
Central Hardwoods Joint Venture/American Bird Conservancy	
Fur Takers of America	
Indiana Land Resources Council	
Law Enforcement Division, Indiana Department of Natural Resources	
National Audubon Society - Indiana Important Bird Areas Program (IBA)	
USDA Natural Resources Conservation Service	

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in all forest habitats in Indiana:

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

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Respondents were aware of the following monitoring efforts by other organizations for wildlife in all forest habitats in Indiana:

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

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in all forest habitats in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in all forest habitats
1	Statewide once-a-year monitoring
2	Regional or local once-a-year monitoring
3	Occasional statewide (less than once a year and not regularly scheduled) monitoring
4	Periodic statewide (less than once a year but still regularly scheduled) monitoring
5	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
6	Statewide year-round monitoring
7	Regional or local year-round monitoring
8	Occasional regional or local (less than once a year and not regularly scheduled) monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in all forest habitats in Indiana:

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

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- 6 Periodic statewide (less than once a year but still regularly scheduled) monitoring
- 7 Regional or local year-round monitoring
- 8 Statewide year-round monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in all forest habitats in Indiana (not ranked):

- Indiana Division of Fish and Wildlife
  - On a statewide basis
  - State deer check stations
  - Hunter harvest data on state fish and wildlife areas
  - Small game harvest questionnaire is the only survey the agency conducts to monitor Indiana fox squirrel population. The survey is only conducted in odd years
- Indiana state parks and nature preserves
- Selected urban areas
- Red bats: Are monitored as part of regular bat sampling that occurs at Indianapolis International Airport, Camp Atterbury and Newport Chemical Depot. Also population trends can be assessed via animals submitted to state rabies lab
- Bobcats: Ongoing ecological studies in southwest Indiana, primarily Lawrence, Greene and Martin counties)
- Box turtles: Are being monitored in Martin, Brown and Morgan counties
- Local breeding bird surveys done on state properties and private land. State cooperates in national breeding bird survey. State biologists also survey in local habitats (e.g., Patoka River)
- Indiana Breeding Bird Atlas project
  - Cerulean warblers: BBA survey through IDNR determines statewide distribution periodically. Does not produce quantitative measure of population size. These are not tied to this habitat type but frequency of other cerulean warbler habitats in the BBS coverage is so low so most data refer to this habitat. Statewide BBA survey was done in the 1980s and is being redone now
- Timber rattlesnake: IDNR monitors in Brown, Monroe and Morgan counties
- Ruffed grouse: Eight roadside spring drumming surveys (drumming indices) conducted primarily in south central Indiana. Activity Center counts on the 900 acre Maumee Grouse Study Area in Jackson and Brown counties
- In southern Indiana in the unglaciated forested region
- Towhees and summer birds: State DNR nongame bird program coordinates publication of summer bird count that generates some data on towhee numbers (along with all other summer birds. No analysis is done, however)

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Respondents listed regional or local monitoring by other organizations for wildlife in all forest habitats in Indiana (not ranked):

- Some municipalities and university properties
- Purdue University, Beverly Shores, U.S. National Lakeshore, Wesselman woods (Evansville)
- Private groups have helped with counts in some state parks
- Cerulean warblers
  - Audubon supports May Day count that detects cerulean warblers. TNC is working on developing a research project in the state for ceruleans
  - BBS routes provide some information for this species. However, most routes are located along roads and do not adequately monitor interior forest species such as the cerulean
  - Hoosier National Forest conducts breeding bird point counts each year along points located in interior forest blocks or varying fragment size. Although the cerulean is not the focus of this study, data is collected on its occurrence
  - Cornell Lab of Ornithology collects data on the cerulean warbler for their program "Birds in Forested Landscapes." I am unsure whether data has been collected and submitted in Indiana
  - Ball State University has been conducting studies on the Hoosier National Forest and Big Oaks National Wildlife Refuge for cerulean warblers. Currently, students from this university are working in conjunction with the Hoosier National Forest
  - USGS roadside Breeding Bird Survey. These are not tied to this habitat type, but frequency of the other cerulean habitats in the BBS coverage is low so most data refer to this habitat
- USDA Forest Service has contracted out survey work in the southern portions of the Hoosier National Forest
- Incidental observations on Christmas Bird Counts (extremely minor)
- Federal Breeding Bird Survey statewide
- Statewide and Regional May Day Bird Counts
- Summer Bird Counts
- Christmas Bird Counts
- Eastern towhees: Other bird monitoring efforts that collect data nationwide generate information on eastern towhees. These include Breeding Bird Surveys, Christmas Bird Counts (towhees are rare in winter, though) and Cornell nest record program. Hoosier National Forest conducts breeding bird monitoring on the forest since 1991
- Statewide Breeding Bird Survey. Periodic area surveys in the Hoosier National Forest
- The Nature Conservancy occasionally monitors

Respondents listed organizations that monitor wildlife in all forest habitats in Indiana (not ranked):

- Universities
  - Ball State University
    - Department of Biology has been monitoring Cerulean Warbler populations at Big Oaks National Wildlife Refuge, Hoosier National Forest, and Yellowwood and Morgan-Monroe state forests during the last five years
  - Purdue University
  - Indiana State University
- Bobcats: IDNR does maintain records and databases regarding reports of bobcats. These reports are, for the most part, unsolicited and obtained as they become available. It is not a regular, routine survey, but more of a clearinghouse regarding bobcat sightings, road-kills, and incidental captures, etc. This is one of the few means of monitoring low-density and wide-ranging species such as the bobcat

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- Wildlife biologists at military bases
- Indiana Division of Fish and Wildlife
  - Breeding Bird Atlas project
- The Nature Conservancy
- National Audubon Society
  - Coordinates Christmas bird counts
- American Bird Conservancy
- MAPS program (Point Reyes Bird Observatory)
- Local bird clubs, bird watchers, volunteers
- NRCS (thru WRP program monitoring)
- U.S. Geological Survey
  - Coordinates breeding bird surveys
- Cornell's Laboratory of Ornithology collects the nest records
- Federal agencies do monitoring on lands they manage
  - U.S. Fish and Wildlife Service (Big Oaks National Wildlife Refuge)
  - USDA Forest Service (Hoosier National Forest)

Respondents considered monitoring techniques for wildlife in all forest habitats in Indiana:

Monitoring techniques for wildlife in all forest habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	X	X	X
Modeling	X	X	--
Coverboard routes	--	X	X
Spot mapping	X	X	--
Driving a survey route	X	X	X
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	X	--
Mark and recapture	X	X	X

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Professional survey/census	X	X	X
Volunteer survey/census	X	X	X
Trapping (by any technique)	X	X	X
Representative sites	X	X	--
Probabilistic sites	X	X	--

Respondents noted other monitoring techniques for wildlife in all forest habitats in Indiana (not ranked):

- Nest monitoring, territory trapping, call playback and color banding
- Point count surveys

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in all forest habitats. Their responses included:

- Not familiar with it but seems reasonable.

## Appendix F-32: Aggregated Forests

### Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for all forest habitats in Indiana:

- Statewide annual inventory and assessment
- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
- Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
- Regional or local year-round inventory and assessment
- Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

Respondents were aware of the following inventory and assessment efforts by other organizations for all forest habitats in Indiana”

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of all forest habitats in Indiana:

<b>Rank</b>	<b>Inventory and assessment by state agencies for conservation of all forest habitats</b>
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2	Statewide once-a-year inventory and assessment
3	Regional or local once-a-year inventory and assessment
4	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
5	Regional or local year-round inventory and assessment
6	Occasional regional or local (less than once a

## Appendix F-32: Aggregated Forests

- year and not regularly scheduled) inventory and assessment
- 7 Statewide annual inventory and assessment
- 8 Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of all forest habitats in Indiana:

Rank	Inventory and assessment by other organizations for conservation of all forest habitats
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2	Statewide once-a-year inventory and assessment
3	Regional or local once-a-year inventory and assessment
4	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
5	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
6	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
7	Regional or local year-round inventory and assessment
8	Statewide annual inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for all forest habitats in Indiana (not ranked):

- State forests
- Nature preserves
- IDNR
- Forestry division keeps track of changes in forest cover
- Most, if not all, public properties in the state (Hoosier National Forest, Crane NSWC, state forests, reservoirs, etc.) periodically inventory and assess forested habitats under their jurisdiction. Commercial timbered lands are probably also inventoried on a regular basis. The Nature Conservancy may also have access to data
- The state examines habitat on state properties periodically and uses GAP and other habitat modeling programs to assess forest habitats
- The Continuous Statewide Forest Inventory jointly conducted by the USDA Forest Service and the Indiana Division of Forestry

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- Forest inventory plots in established forest management lands give some information on trends in early succession habitat. But I am unaware of any regular coordinated effort by state or other agencies to monitor young forest age classes. Analysis of remote sensing data can provide some trend information where young forest classes can be mapped
- I am not sure how often state agencies survey crowned snakes habitat. Indiana Division of Nature Preserves monitors these habitats

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

- Beverly Shores, U.S. National Lakeshore, Hoosier National Forest, Wesselman Woods (Evansville)
- Local planning boards monitor land use in most localities
- Indiana GAP project categorizes land use cover types from Landsat imagery. I assume that the change in cover types is being calculated over a specified period of time
- The Nature Conservancy, U.S. Fish and Wildlife Service and USDA Forest Service use habitat models to examine forest habitat in Indiana (Hoosier National and Big Oaks National Wildlife Refuge)
- Cerulean warblers
  - Hoosier National Forest and Ball State University are collecting data on habitat use by cerulean warblers on the northern portion of the Forest
  - Cornell's "Birds in Forested Landscapes" collects some data on habitat use. I am not sure if data has been submitted from Indiana
- Statewide aerial imagery of habitats in Indiana
- U.S. Geological Survey

Respondents listed organizations that monitor all forest habitats in Indiana (not ranked):

- State Universities
  - Purdue University
  - Ball State University (Department of Biology has been monitoring Cerulean Warbler populations at Big Oaks National Wildlife refuge, Hoosier national Forest, and Yellowwood and Morgan-Monroe state forests during the last 5 years)
- In addition to state and federal agencies, I suspect Indiana Hardwoods Lumberman Association or other private groups may monitor forested lands, particularly those in private ownership
- The Nature Conservancy
- IDNR
  - Division of Nature Preserve
- Indiana GAP Project
- USDA Forest Service
- U.S. Fish and Wildlife Service
- The Nature Conservancy
- Cornell Lab of Ornithology
- U.S. Geological Survey

Respondents considered inventory and assessment techniques for all forest habitats in Indiana:

Inventory and assessment techniques for all forest habitats	Used	Not used but possible	Not economically feasible
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## Appendix F-32: Aggregated Forests

		with existing technology and data	
GIS mapping	X	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	X	X	X
Property tax estimates	X	--	--
Regulatory information	X	--	--
Participation in land use programs	X	X	--
Modeling	X	X	--
Voluntary landowner reporting	X	X	--

Respondents listed additional inventory and assessment techniques for all forest habitats in Indiana (not ranked):

- Samples at known nest sites are compared with random sites at Big Oaks National Wildlife Refuge
- There have been several master's degree projects on habitat selection for the Cerulean Warbler in Indiana. These studies have collected the following information on habitat use: diameter at breast height (DBH) and identification of tree species in a nested plot at the center of a territory, number of saplings (trees <3cm DBH), number and DBH of standing dead trees (snags), canopy cover, ground cover, canopy height, percent canopy coverage and ground cover, canopy height, and vertical stratification of foliage
- This habitat "siltstone glade in upland forest" is monitored through surveys performed in this habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for all forest habitats. Their responses included:

- Yes

### **Recommended monitoring** Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in all forest habitats in Indiana (not ranked):

- Reporting from harvest, depredation or unintentional take
  - Collection of harvest data from mandatory check stations
  - Hunter bag surveys
- Modeling (White-tailed Deer Ecology and Management, Lowell K. Halls)
- We need make sure someone continues to examine all animals submitted for rabies testing

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- Bats: A regular monitoring program (using traps, echolocation calls, and mist nets) for bats should be initiated on a statewide basis. This should be a combined effort by IDNR, universities, and private organizations
- Bobcats
  - Continued documentation of sightings, road-kills, and accidental captures. Obtain pertinent biological data from recovered specimens such as age and reproductive parameters (pregnancy rate, litter size). These data could be used to model populations or build life tables in future years
  - Some form of questionnaire or survey that is sent to trappers, hunters, professional resource managers could also be useful. The Indiana Bowhunter Survey is a good example although reporting rates for bobcats are so low they may not be effective to detect changes and monitor trends
- Eastern box turtle: Long-term surveys and radio-telemetry. Surveys would include mark recapture methods
- Fox squirrels
  - A hunter report card sent out to dedicated squirrel hunters would be a useful tool to provide an index to the fox squirrel population.
  - I would also like to see a radio-telemetry project in northern Indiana to document fox squirrel dispersal between forest tracts. Another objective of this proposed radio-telemetry project would be to evaluate the possibility of overharvesting fox squirrel metapopulations
- Cerulean warbler research
  - A study that experimentally tests how forest management influences demography and presence and absence. This species needs basic life history studied, too.
  - We would benefit from obtaining basic demography data on this species. Mist netting is not particularly feasible because the species stays so high in the canopy. Due to the difficulty of locating nests of ceruleans and of capturing adults, especially females, determination of reproductive success is problematic. Assessing survivorship of eggs, nestlings, and fledglings is also difficult. Until such reproductive success and survivorship information is available, the dynamics of populations will continue to be unknown
  - Point counts, spot mapping, and territory mapping provide important information about ceruleans. Banding individual birds could supply information on site fidelity and survivorship
  - Regular monitoring of migratory stopover and winter habitats will also be an important part of the conservation of the cerulean warbler
  - Roadside bird surveys on selected routes maximizing forest habitats
  - Repeated point count surveys in representative forest sites
  - Professional survey/census to locate cerulean warblers
  - Nest search and monitoring to assess productivity to determine if Indiana has a 'source' or 'sink' population
  - Hutto, R.L., S.M. Pletschett, and T.P. Hendricks. 1986. A fixed-radius point-count method for nonbreeding and breeding season use. *Auk* 103:593-602
- I would recommend the use of radio-telemetry, mark recapture techniques, and transect surveys. Due to the cryptic nature of these snakes, locating individuals without the help of telemetry is extremely difficult. Many studies conducted locally and nationally have included telemetry in their methods

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- Ruffed grouse
  - Spring drumming routes are used nationally for spring breeding trend data. On particular “study areas”, complete spring drumming counts for accurate breeding densities. Assumes a low number of non-drumming males and requires at least three opportunities, on good mornings, to hear a drumming bird in any portion of the study area
- Sampling mature pine forest habitat to better determine distribution
- Roadside surveys, canoe surveys; local, more intensive studies
- Federal Breeding Bird Surveys annually statewide
- Eastern towhees:
  - Primary technique used is point counts of singing birds in breeding season, either by roadside counts (BBS) or set survey points (e.g., Hoosier National Forest monitoring). Roadside surveys probably are most effective because towhees are edge/early successional species, using habitats found near roads
  - Long-term banding programs (e.g., MAPS) provide demographic information not gained with other monitoring, but are more intensive
- I would recommend the use of professional surveys and test the effectiveness of cover objects for “trapping” some wildlife species

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife for all forest habitats. Their responses included:

- Yes.

### Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of all forest habitats in Indiana (not ranked):

- GIS, aerial survey, mapping and modeling
  - Habitat modeling
  - Mapping and aerial photo analysis
  - Statewide habitat mapping is needed (and mostly available if you know who to ask)
  - GIS is a logical tool to inventory and assess all aspects of forested habitats in Indiana (species composition, age and size class, ownership, management regime, etc.). It would be nice to have GIS coverage of rock outcrops in the state to supplement forest data
  - I would recommend a GIS analysis that examines changes in land use over the last 30+ year period
  - GIS modeling, and intensive study to determine habitat quality (source vs. sink)
  - Statewide inventory and mapping of mature pine forest communities to determine more accurate potential distribution of pine warbler. References suggested would be Flora of Indiana by Charles Deam 1940 and unpublished data/files from Division of Forestry
  - Aerial imagery of riparian and pine habitats coupled with habitat modeling
  - GIS mapping can certainly generate amounts and trends of habitat if forest type and age are mapped. Aerial photography can be used when young age classes appear distinct from other habitat classes

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- Property tax assessments can be used as a proxy as well
- Collect hunter data from DNR properties and private land hunters
- Universities keep record of habitat loss and habitat fragmentation
- Cerulean warblers
  - A crucial piece of habitat data for the cerulean warbler is the size and distribution of canopy gaps within territories. At this point, researchers have not determined an effective means to quantify this data
  - Another important habitat inventory would be looking at landscape characteristics of cerulean occurrence and distribution in relation to forest fragmentation. Monitoring should incorporate the occurrence of the species in relation to landscape characteristics such as proportion of agricultural use, tract size and shape, and amount of edge
  - Habitat association studies to determine which habitat types used/ preferred in Indiana
  - Systematic sampling/survey techniques to locate cerulean warblers (Hutto et al. 1986. Auk 103:593-602)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of all forest habitats. Their responses included:

- Yes