

## BARE DUNES HABITATS NARRATIVE

### Habitat Description

Bare dunes habitats are characterized by bare rock, gravel, sand, silt, clay or other earthen material, with little or no "green" vegetation present. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories.

### Problems affecting species and habitats

#### Species threats

The respondent cited "viable reproductive population size or availability" as a "critical threat" to wildlife in bare dunes habitat in Indiana (not ranked):

The respondent cited the following as "serious threat" to wildlife in bare dunes habitat (not ranked):

- Invasive/non-native species
- Predators (native or domesticated)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Near limits of natural geographic range

The respondent listed the following as "somewhat of a threat" to wildlife in bare dunes habitat (not ranked):

- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed the following as "slight threat" to wildlife in bare dunes habitat in Indiana (not ranked):

- High sensitivity to pollution
- Bioaccumulation of contaminants
- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Small native range (high endemism)
- Large home range requirements

The respondent listed no other threats to wildlife in bare dunes habitat:

The respondent summarized top threats to wildlife in bare dunes habitat in Indiana (not ranked):

- Quality of habitat
- Low population size/edge of range

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

#### Habitat threats

## Appendix F-24: Bare Dunes

The respondent cited the following as “serious threat” to bare dunes habitat in Indiana (not ranked):

- Commercial or residential development (sprawl)
- Counterproductive financial incentives or regulations
- Habitat degradation

The respondent listed the following as “somewhat of a threat” to bare dunes habitat in Indiana (not ranked):

- Invasive/non-native species
- Habitat fragmentation
- Successional change

The respondent listed the following as “slight threat” to bare dunes habitat in Indiana (not ranked):

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

The respondent listed no other threats to bare dunes habitat in Indiana.

The respondent listed top threats to bare dunes habitat in Indiana (not ranked):

- Specific dune habitat configuration
- Threats by gulls and human disturbance

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threat to bare dunes habitat. There were no responses.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

The respondent stated that the current body of science for wildlife in bare dunes habitat in Indiana is adequate.

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

Title = Piping Plover Recovery Plan;  
Author = USFWS;  
Date = unknown;  
Publisher = USFWS

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

#### Habitat research

The respondent stated that the current body of science for bare dunes habitat in Indiana is adequate.

## Appendix F-24: Bare Dunes

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

Title = see previous citation

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

### **Research needs**

#### Species research

The respondent listed no “urgently needed” or “greatly needed” research needs for wildlife in bare dunes habitat in Indiana. The respondent listed the following as “needed” research (not ranked):

- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats
- Population health (genetic and physical)

The respondent listed the following research as “slightly needed” for wildlife in bare dunes habitat in Indiana:

- Distribution and abundance

The respondent listed no other research needs for wildlife in bare dunes habitat in Indiana.

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 bare dunes habitat. There were no responses

#### Habitat research

The respondent listed no “urgently needed” or “greatly needed” research needs for bare dunes habitat in Indiana. The respondent listed the following as “needed” research (not ranked):

- Successional changes
- Distribution and abundance (fragmentation)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of habitat

The respondent listed no other research needs for bare dunes habitat in Indiana.

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

### **Conservation actions necessary**

#### Species actions

## Appendix F-24: Bare Dunes

The respondent listed no conservation efforts that address threats to wildlife in bare dunes habitat in Indiana “very well.” The respondent stated that the following conservation efforts address threats “somewhat” (not ranked):

- Habitat protection
- Population enhancement (captive breeding and release)
- Reintroduction (restoration)
- Threats reduction
- Native predator control
- Exotic/invasive species control
- Regulation of collecting
- Translocation to new geographic range
- Protection of migration routes
- Limiting contact with pollutants/contaminants
- Public education to reduce human disturbance

The respondent listed no other current conservation practices for wildlife in bare dunes habitat in Indiana.

The respondent recommended the following for more effective conservation of wildlife in bare dunes habitat in Indiana (not ranked):

- Protection of potential habitat
- Limiting disturbance by humans and predators if birds ever recolonize Indiana's Lake Michigan shoreline

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

### Habitat actions

The respondent stated that “restrict[ing] public access and disturbance” addresses threats to bare dunes habitat in Indiana “very well.” The following conservation practices address threats to bare dunes habitat in Indiana “somewhat” (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Corridor development/protection
- Pollution reduction
- Protection of adjacent buffer zone
- Land use planning
- Technical assistance
- Cooperative land management agreements (conservation easements)

The respondent cited no other current conservation practices for bare dunes habitat in Indiana.

The respondent recommended “habitat protection and management” for more effective conservation of bare dunes habitat in Indiana.

## Appendix F-24: Bare Dunes

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

### Proposed plans for monitoring

#### Current monitoring

##### Species monitoring

The respondent was aware of no state agency monitoring efforts for wildlife in bare dunes habitat in Indiana.

The respondent was aware of the following monitoring efforts by other organizations for wildlife in bare dunes habitat in Indiana:

- Regional or local year-round monitoring

The respondent listed no "crucial" monitoring efforts by state agencies for conservation of wildlife in bare dunes habitat in Indiana.

The respondent listed no "very crucial" monitoring efforts by other organizations for conservation of wildlife in bare dunes habitat in Indiana. The respondent listed "regional or local year-round monitoring" as "somewhat crucial."

The respondent listed the following regional or local monitoring efforts by state agencies for wildlife in bare dunes habitat in Indiana:

- Awareness of reports by bird watchers

The respondent noted regional or local monitoring by other organizations for wildlife in bare dunes habitat in Indiana:

- Indiana Dunes National Lakeshore biologists stay abreast of sightings along Lake Michigan

The respondent listed the following organizations that monitor wildlife in bare dunes habitat in Indiana (not ranked):

- Bird watchers
- USGS Biologists

The respondent listed the following monitoring technique as "frequently used" for wildlife in bare dunes habitat in Indiana:

- Mark and recapture

The respondent listed the following monitor monitoring techniques as "occasionally used" for wildlife in bare dunes habitat in Indiana:

- Reporting from harvest, depredation or unintentional take (road kill, by-catch)
- Professional survey/census

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- Volunteer survey/census
- Probabilistic sites

The respondent listed the following monitoring techniques as “not used but possible with existing technology and data” for wildlife in bare dunes habitat in Indiana (not ranked):

- Radio telemetry and tracking
- Modeling
- Spot mapping
- Driving a survey route
- Trapping (by any technique)
- Representative sites

The respondent listed no techniques as “not economically feasible” for wildlife in bare dunes habitat in Indiana.

The respondent listed no other monitoring techniques for wildlife in bare dunes habitat in Indiana.

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 bare dunes habitat. There were no responses.

### Habitat inventory and assessment

The respondent was aware of the following inventory and assessment efforts by state agencies and other organizations for bare dunes habitat in Indiana:

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

The respondent listed “occasional regional or local inventory and assessment” by state agencies and other organizations as “somewhat crucial” to conserve bare dunes habitat in Indiana. The respondent listed no methods as “very crucial.”

The respondent listed the following regional or local inventory and assessment by state agencies for bare dunes habitat in Indiana (not ranked):

- Lake Michigan shoreline
- Gibson Lake

The respondent listed this regional or local inventory and assessment by other organizations for bare dunes habitat in Indiana:

- Lake Michigan shoreline

The respondent was not aware of other organizations that conduct inventory and assessments of bare dunes habitat in Indiana.

The respondent did not indicate that any inventory and assessment techniques that are “frequently used.” The respondent listed the following as “occasionally used” (not ranked):

- GIS mapping

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- Aerial photography and analysis

The respondent listed this inventory and assessment technique as “not used but possible with existing technology and data” for bare dunes habitat in Indiana:

- Systematic sampling

The respondent listed no techniques as “not economically feasible” for bare dunes habitat in Indiana.

The respondent noted no other inventory and assessment techniques for bare dunes habitat in Indiana.

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 bare dunes habitat. There were no responses.

## Recommended monitoring

### Species monitoring

The respondent recommended the following monitoring technique for effective conservation of wildlife in bare dunes habitat in Indiana:

- Because the Piping Plover rarely occurs in Indiana, keep track of all reports by birders and have Indiana Dunes personnel systematically survey appropriate habitat along Lake Michigan

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 in bare dunes habitat. There were no responses.

### Habitat inventory and assessment

The respondent recommended this inventory and assessment technique for effective conservation of bare dunes habitat in Indiana:

- Aerial photography and ground visits to determine habitat suitability

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

## BARREN LANDS CLIFFS HABITAT NARRATIVE

### Habitat Description

Barren lands habitats are characterized by bare rock, gravel, sand, silt, clay or other earthen material, with little or no "green" vegetation present. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.

### Problems affecting species and habitats

#### Species threats

Respondents ranked threats to wildlife in barren lands cliffs habitat in Indiana:

Rank	Threats to wildlife in barren lands cliffs habitat
1	Small native range (high endemism)
2	Near limits of natural geographic range
3	Habitat loss (feeding/foraging areas)
4(tie)	Habitat loss (breeding range)
4(tie)	Degradation of movement/migration routes
5(tie)	Disease/parasites (of the species itself)
5(tie)	Viable reproductive population size or availability
6(tie)	Invasive/non-native species
6(tie)	Predators (native or domesticated)
6(tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

Respondents described top threats to wildlife in barren lands cliffs habitat in Indiana (not ranked):

- The green salamander is found only at two sites in Indiana; they are at the edge of the geographic range and are habitat specialists
- The Allegheny woodrat occupies cliffs, caves and other rocky habitats in deciduous forests. When forests become fragmented, several negative impacts to woodrat populations can result
  - Woodrats may have to cross non-forested area to reach preferred feeding areas (i.e. hard mast crops of soft mass – berries, etc.). While doing so, they can become exposed to ubiquitous predators (great horned owls, raccoons)
  - Raccoon densities might be higher in non-forested settings such as farmed areas on top of cliffs, which could expose woodrats to higher levels of raccoon roundworm



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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 barren lands cliffs habitat. There were no responses.

### Habitat threats

Respondents ranked threats to barren lands cliffs habitat in Indiana:

Rank	Threats to barren lands cliffs habitat
1	Habitat fragmentation
2	Habitat degradation
3	Agricultural/forestry practices
4	Commercial or residential development (sprawl)
5	Invasive/non-native species

Respondents listed no additional threats to barren lands cliffs habitat in Indiana.

Respondents described top threats to barren lands cliffs habitat in Indiana (not ranked):

- Habitat loss, degradation and fragmentation due to deforestation around rocky outcrops
- Cliff habitat in general appears somewhat secure except for quarrying operations along the Ohio River. Forested communities in association with cliffs, however, are vulnerable to development, fragmentation, loss of hard mast producing species, etc.

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

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

Respondents stated that the current body of science for wildlife in barren lands cliffs habitat in Indiana is inadequate.

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

Title = Discovery of green salamanders in Indiana and a distributional survey. In Status & Conservation of Midwestern Amphibians;

Author = Robert Madej

Date = 1998;

Publisher = University of Iowa Press, Iowa City

Title = Green salamander: Family plethodontidae, Aneides aeneus Cope and Packard, 1881.;

Author = Pauley, T. K. and M.B. Watson;

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Date = 2005;

Publisher = In: Amphibian Declines: The Conservation Status of United States Species. M. Lannoo, (ed.)

Title = Reassessment of the Allegheny woodrat in Indiana;

Author = Scott Johnson;

Date = 2002;

Publisher = Proceedings of the Indiana Academy of Science 111:56-66.

Title = 2002 Allegheny woodrat monitoring program;

Author = Scott Johnson, Heather Walker, Cassie Conrad, Aaron Holbrook;

Date = 2003;

Publisher = Indiana Department of Natural Resources (internal report)

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

### Habitat research

Respondents stated that the current body of science for barren lands cliffs habitat in Indiana is inadequate.

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

Title = Natural Features of Indiana?;

Author = Alton Lindsey (editor);

Date = 1966;

Publisher = Indiana Academy of Science

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

## Research needs

### Species research

Respondents ranked research needs for wildlife in barren lands cliffs habitat in Indiana:

Rank	Research needs for wildlife in barren lands cliffs habitat
1 (tie)	Threats (predators/competition, contamination)
1 (tie)	Relationship/dependence on specific habitats
1 (tie)	Limiting factors (food, shelter, water, breeding sites)
2	Population health (genetic and physical)

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- 3 Distribution and abundance
- 4 Life cycle

Respondents listed no other research needs for wildlife in barren lands cliffs habitat in Indiana.

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 barren lands cliffs habitat. There were no responses.

### Habitat research

Respondents ranked research needs for barren lands cliffs habitat in Indiana:

Rank	Research needs for barren lands cliffs habitat
1	Distribution and abundance (fragmentation)
1	Relationship/dependence on specific site conditions
2	Threats (land use change/competition, contamination/global warming)
2	Growth and development of individual components of the habitat

Respondents listed no other research needs for barren lands cliffs habitat in Indiana.

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

## **Conservation actions necessary**

### Species actions

Half of respondents stated that "habitat protection" addresses threats to wildlife in barren lands cliffs habitat in Indiana "very well;" the other half indicated "somewhat." Respondents listed no other conservation efforts that address threats to wildlife in this habitat.

Respondents offered no other current conservation practices for wildlife in barren lands cliffs habitat in Indiana, however monitoring population levels and trying to determine factors limiting woodrats have been focus of work.

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

- Green salamander conservation
  - Logging activities should be managed to keep at least 100 meters of buffered forest habitat around rock outcrops and barren lands cliffs, since the main threat to green salamanders is deforestation resulting in loss, degradation or fragmentation of habitat

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- Research: Little is known about population biology, lifespan, mortality rates, dispersal, and colonization of habitats, metapopulation dynamics and extent of arboreal activity
- Allegheny woodrat conservation
  - Research to identify factors that limit woodrat populations
  - Periodic monitoring of extant populations
  - Revisit previously occupied sites to assess recolonization potential

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the effective conservation of wildlife in barren lands cliffs habitat. There were no responses.

### Habitat actions

One of two respondents stated that “habitat protection on public lands” addresses threats to barren lands cliffs habitat in Indiana “very well;” the other stated “somewhat.”

A respondent stated that the following address threats to barren lands cliffs habitat in Indiana “somewhat” (not ranked):

- Habitat protection through regulation
- Protection of adjacent buffer zone
- Restrict public access and disturbance.

Respondents offered no other current conservation practices for barren lands cliffs habitat in Indiana.

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

- Green salamander: Manage logging activities to keep at least 100 meters of buffered forest habitat around rock outcrops and barren lands cliffs
- Woodrat: Encourage retention and development of hard mast trees (oaks, hickories) in close proximity with woodrat cliffs

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the effective conservation of barren lands cliffs habitat. There were no responses.

## **Proposed plans for monitoring**

### **Current monitoring**

#### Species monitoring

Respondents are aware of the following monitoring efforts conducted by state agencies for wildlife in barren cliffs habitat in Indiana (not ranked):

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

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Respondents listed no monitoring efforts by other organizations for wildlife in barren lands cliffs habitat in Indiana.

Respondents listed the following monitoring efforts by state agencies as “very crucial” for conservation of wildlife in barren lands cliffs habitat in Indiana:

Rank	Monitoring by state agencies for wildlife in barren lands cliffs habitat
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring

Respondents listed no monitoring efforts by other organizations as crucial for conservation of wildlife in barren lands cliffs habitat in Indiana.

Respondents listed regional or local monitoring by state agencies for wildlife in barren lands cliffs habitat in Indiana as follows:

- Harrison and Crawford counties

Respondents were not aware or did not list regional or local monitoring by other organizations for wildlife in barren lands cliffs habitat in Indiana.

A respondent listed “Indiana DNR” as organizations that monitor wildlife in barren lands cliffs habitat in Indiana.

The following table reflects the opinions of multiple respondents, thus multiple check marks are possible. Additionally, some of these differences may reflect different taxonomic group bias.

Respondents considered these current monitoring techniques for wildlife in barren lands cliffs habitats in Indiana:

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Rank	Monitoring techniques for wildlife in barren lands cliffs habitat	Used	Not used but possible with existing technology or data
	Mark and recapture	X	X
	Trapping (by any technique)	X	X
	Modeling		X
	Professional survey/census	X	
	Representative sites	X	
	Probabilistic sites	X	

A respondent listed other monitoring techniques for wildlife in barren lands cliffs habitat in Indiana: "Presence/absence of woodrats can be generally determined by searching cliff lines for fresh sign (latrines, food caches, maintained nests) usually in fall. Research underway in other areas to determine if woodrats can be genotyped through scats [sentence fragment]."

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 barren lands cliffs habitat. There were no responses.

### Habitat inventory and assessment

Respondents were not aware of current inventory and assessment efforts by state agencies or other organizations for barren lands cliffs habitat in Indiana.

Respondents did not rate inventory and assessment efforts by state agencies or other organizations as "very crucial" for conservation of barren lands cliffs habitat in Indiana.

A respondent stated that the following inventory and assessment effort by state agencies was "somewhat crucial":

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

A respondent summarized regional or local inventory and assessment of barren lands cliffs habitat in Indiana: "The Division of Nature Preserves might have a decent inventory of cliff habitat in the state. Division of Fish and Wildlife has data for an inventory of cliff habitat occupied by woodrats."

Respondents were not aware of or did not list regional or local inventory and assessment by other organizations for barren lands cliffs habitat in Indiana.

## Appendix F-25: Cliffs

The following table reflects the opinions of multiple respondents, thus multiple check marks are possible. Additionally, some of these differences may reflect different taxonomic group bias.

Respondents considered current inventory and assessment techniques for barren lands cliffs habitat in Indiana as follows. No technique was listed as "frequently used."

Rank	Inventory and assessment techniques for barren lands cliffs habitat	Occasionally used	Not used but possible with existing technology or data	Not economically feasible
	Systematic sampling	X		
	GIS mapping		X	
	Aerial photography and analysis		X	
	Property tax estimates			X
	State revenue data			X
	Regulatory information			X
	Modeling		X	

Respondents offered no other inventory and assessment efforts for barren lands cliffs habitat in Indiana.

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 barren lands cliffs habitat. There were no responses.

## Recommended monitoring

### Species monitoring

Respondents recommended the following monitoring techniques for more effective conservation of wildlife in barren lands cliffs habitat in Indiana (not ranked):

- Systematic surveys in and near rocky outcrops
- Standardized live trapping for two nights is effective to determine distribution and relative abundance
- Search for woodrats' sign at new sites or previously occupied sites to assess recolonization potential

## Appendix F-25: Cliffs

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

### Habitat inventory and assessment

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

- GIS
- Systematic sampling

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 more effective conservation of barren lands cliffs habitat. There were no responses.



## Appendix F-26: Rock Outcrops

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## ALL DEVELOPED LANDS HABITATS NARRATIVE

This habitat narrative is the results of the aggregated data for all developed land sub-habitat types.

### Habitat description

Highly impacted lands, intensively modified to support human habitation, transportation, commerce and recreation.

### Problems affecting species and habitats

#### Species threats

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

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

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- 12 (tie) Specialized reproductive behavior or low reproductive rates
- 13 (tie) Near limits of natural geographic range
- 13 (tie) Large home range requirements
- 14 Small native range (high endemism)

Respondents offered additional threats to wildlife in all developed lands habitats in Indiana (not ranked):

- Genetic pollution due to urbanization and domestication of 'wild' mallards, leading to the hybridization with domestic stock of ducks. This threat constitutes displacement of mallards into undesirable/unnatural areas, creating nuisance problems and genetic integrity concerns
- Canada goose/human conflicts
- Abrupt changes in drainage patterns due to development could affect Kirtland's snakes, which also can be adversely affected by moving, moving or clearing debris
- Tolerance by building managers of nesting sites

Respondents listed top threats to wildlife in all developed lands habitats in Indiana (not ranked):

- Canada geese
  - Overpopulation
  - Aggressive behavior during courtship/nesting
- Migratory habitat loss
- Genetic pollution; population explosions and accompanying diseases; nuisance concerns, etc.
- Urbanization
- Development of drainage areas and flood plains, including development of park-like areas in which natural or man-made cover is removed; habitat fragmentation that disrupts gene flow and recolonization
- Availability of undisturbed nesting sites
- Collisions with buildings, power lines, other structures
- House Sparrow preemption of nests
- Vandalism potential at nesting colonies

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 developed lands habitats. There were no responses.

### Habitat threats

Respondents ranked threats to all developed lands habitats in Indiana:

Rank	Threats to all developed land habitats
1	Commercial or residential development (sprawl)
2 (tie)	Habitat degradation
2 (tie)	Stream channelization
3	Residual contamination (persistent toxins)

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- 4 (tie) Counterproductive financial incentives or regulations
- 4 (tie) Impoundment of water/flow regulation
- 5 Point source pollution (continuing)
- 6 Drainage practices (stormwater runoff)
- 7 Agricultural/forestry practices
- 8 Habitat fragmentation
- 9 Nonpoint source pollution (sedimentation and nutrients)
- 10 (tie) Diseases (of plants that create habitat)
- 10 (tie) Invasive/non-native species
- 11 Climate change
- 12 Successional change
- 13 Mining/acidification

Respondents noted additional threats to all developed lands habitats in Indiana (not ranked):

- Developed land creates a threat to quality habitat for mallards. Mallards in an urban setting face a host of problems for humans and mallards (genetic pollution, nuisance ducks, possible fecal contamination, etc.
- The impact of non-native earthworms should be closely monitored, as the Kirtland's snake's natural diet is believed to be predominantly of earthworms and slugs. The ecological impact of non-native invertebrates has not been adequately studied
- Potential for pollution reducing productivity of aquatic habitats over which cliff swallows feed

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

- Canada geese
- Regulations
- Urban development
- Mallards
  - Urban development creates attractive areas for mallards to become "more domesticated" (i.e., retention/detention ponds)
  - Feeding of birds by people
  - Destruction of beneficial areas for mallards (and other puddle ducks), i.e. wetlands, streams, small ponds, etc. These areas are converted to retention/detention ponds
- Retention ponds
- Development of drainage areas and flood plains, including development of park-like areas in which natural or man-made cover is removed
- Habitat fragmentation that disrupts gene flow and recolonization
- Reduction in quantity and quality of prey populations
- Design of buildings that do not provide nesting ledges
- Changes in design of bridges and causeways to make them less suitable for nest placement

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to all developed lands habitats. There were no responses.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

Thirty-seven percent respondents stated that the current body of science is complete, up to date and extensive or adequate for wildlife in all developed lands habitats in Indiana; sixty-three percent said that it is inadequate or nonexistent.

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

Title = Amphibians and Reptiles of Indiana;  
Author = Sherman A. Minton, Jr.;  
Date = 2001;  
Publisher = Indiana Academy of Sciences

Author = [www.natureserve.org/explorer](http://www.natureserve.org/explorer)

Title = Managing Canada Geese in Urban Environments;  
Author = Arthur E. Smith, Scott R. Craven and Paul D. Curtis;  
Date = 1199;  
Publisher = Cornell Cooperative Extension

Title = Prevention and Control of Wildlife Damage;  
Date = 1994;  
Publisher = University of Nebraska

Title = Conservation Assessment for Kirtland's Snake (*Clonophis kirtlandii*);  
Author = Jonanna Gibson and Bruce Kingsbury;  
Date = 2004;  
Publisher = USDA Forest Service, Eastern Region

Title = Kirtland's Snake;  
Author = [www.natureserve.org](http://www.natureserve.org)

Title = Peregrine Falcon nesting and management in Indiana;  
Author = Castrale, J.S., and A. Parker;  
Date = 1999;  
Publisher = Indiana Audubon Quaterly 77:65-74.

Title = Midwest Peregrine Falcon Restoration - 2004 Annual Report;  
Author = Tordoff, H.B., J.A. Goggin, J.S. Castrale;  
Date = 2004;  
Publisher = The Raptor Center at the Univ. of Minnesota

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

#### Habitat research

## Appendix F-27: Aggregated Developed Lands

Twenty-eight percent respondents stated that the current body of science is complete, up to date and extensive or adequate for all developed lands habitats in Indiana; fifty-seven percent said that it is inadequate or nonexistent.

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

Title = Managing Canada Geese in Urban Environments;  
Author = Arthur E. Smith, Scott R. Craven and Paul D. Curtis;  
Date = 1999;  
Publisher = Cornell Cooperative Extension

Title = Amphibians and Reptiles of Indiana;  
Author = Sherman A. Minton, Jr.;  
Date = 2001;  
Publisher = Indiana Academy of Science

Title = Indiana Heritage Database;  
Author = Indiana Division of Nature Preserves

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

### **Research needs**

#### Species research

Respondents ranked research needs for wildlife in all developed lands habitats in Indiana:

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

Respondents noted other research needs for wildlife in all developed lands habitats in Indiana (not ranked):

- Canada geese
  - Movement pattern of urban Canada geese
  - Affinity for Canada geese hatched in an urban environment to move or migrate back to a similar environment
- Ways to reduce urban populations
- Mallards
  - To determine the genetic integrity of mallards in developed areas

## Appendix F-27: Aggregated Developed Lands

- To determine effective management tools and a management plan of mallards in developed lands

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 developed lands habitats. There were no responses.

### Habitat research

Respondents ranked research needs for all developed lands habitats in Indiana:

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

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

- Ways to exclude geese
- Mallards
  - To determine the long term effects of mallards in developed lands on the overall mallard population
  - To device management tools and concepts to help professionals manage better for mallards in developed lands
- Understand why Kirtland's snakes occur where we are currently finding them. With that information, we can maintain current populations before we determine the feasibility of increasing their numbers and distribution

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

## **Conservation actions necessary**

### Species actions

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

Rank	Conservation efforts for wildlife in all developed lands
------	--

## Appendix F-27: Aggregated Developed Lands

- 1 Protection of migration routes
- 2 Regulation of collecting
- 3 (tie) Population management (hunting, trapping)
- 3 (tie) Food plots
- 3 (tie) Habitat protection
- 4 Public education to reduce human disturbance
- 5 Limiting contact with pollutants/contaminants
- 6 (tie) Population enhancement (captive breeding and release)
- 6 (tie) Reintroduction (restoration)
- 6 (tie) Threats reduction
- 6 (tie) Native predator control
- 6 (tie) Exotic/invasive species control
- 6 (tie) Disease/parasite management
- 6 (tie) Translocation to new geographic range
- 6 (tie) Culling/selective removal
- 6 (tie) Stocking

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

- Bullfrog tadpoles could be introduced into an area as by-product to fish stocking or from released pet tadpoles
- Habitat alteration

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

- I believe large numbers of Canada Geese in urban environments (developed lands) are a real problem. This also is the belief of many Fort Wayne residents. Urban goose-human conflicts are on the rise. Each year the Division of Fish and Wildlife issues more and more egg/nest destruction and trap/transport permits. Urban areas attract geese by offering lakes and ponds, short lush lawns, protection and even those individuals who intentionally feed geese. Effective conservation for urban geese should deal with how to limit numbers through education and habitat modifications. (I.e.: If a retention pond must be constructed, install habitats around the pond that help limit geese. Urban geese can nest in inappropriate sites, demonstrate aggressive behavior, cause damage to lawns, beaches, sidewalks, parking lots, etc.) The best conservation practice is to limit Canada goose numbers in developed land habitats
- Population reduction
- Hunting; habitat alteration
- Removal of habitat in urban zones
- When areas known or suspected to have Kirtland's snakes are threatened with development, seek to have the developer include shrubs and rock features near drainages to provide cover and to reduce mowing in areas Kirtland's snakes are likely to use



## Appendix F-27: Aggregated Developed Lands

- Education/awareness of falcon needs for feeding and nesting
- Continued use of bridge architecture that favors nest placement

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation of wildlife in all developed lands habitats. There were no responses.

### Habitat actions

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

Rank	Conservation efforts for all developed lands habitat
1 (tie)	Habitat protection incentives (financial)
1 (tie)	Habitat restoration incentives (financial)
1 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
1 (tie)	Succession control (fire, mowing)
1 (tie)	Land use planning
2	Habitat restoration on public lands
3 (tie)	Corridor development/protection
3 (tie)	Habitat protection on public lands
3 (tie)	Cooperative land management agreements (conservation easements)
3 (tie)	Habitat restoration through regulation
4 (tie)	Managing water regimes
4 (tie)	Protection of adjacent buffer zone
5 (tie)	Restrict public access and disturbance
5 (tie)	Technical assistance
5 (tie)	Habitat protection through regulation
6	Pollution reduction
7	Selective use of functionally equivalent exotic species in place of extirpated natives

Respondents listed additional conservation efforts for all developed lands habitats in Indiana:

- The development and proliferation of stormwater retention ponds

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

- I believe large numbers of Canada Geese in urban environments (developed lands) are a real problem. This also is the belief of many Fort Wayne residents. Urban goose-human conflicts are on the rise. Each year the Division of Fish and Wildlife

## Appendix F-27: Aggregated Developed Lands

issues more and more egg/nest destruction and trap/transport permits. Urban areas attract geese by offering lakes and ponds, short lush lawns, protection and even those individuals who intentionally feed geese. Effective conservation for urban geese should deal with how to limit numbers through education and habitat modifications. (I.e.: If a retention pond must be constructed, install habitats around the pond that help limit geese. Urban geese can nest in inappropriate sites, demonstrate aggressive behavior, cause damage to lawns, beaches, sidewalks, parking lots, etc.) The best conservation practice is to limit Canada goose numbers in developed land habitats

- Landscaping to exclude geese
- Habitat alteration
- Removal of habitat in urban zones
- When areas known or suspected to have Kirtland's snakes are threatened with development, seek to have the developer include shrubs and rock features near drainages to provide cover and to reduce mowing in areas Kirtland's snakes are likely to use
- Education/awareness programs for building managers.
- Critical habitat for cliff swallows is nesting sites; most are on public (DOT) structures (bridges). Much less important is water quality, etc. for feeding areas

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for all developed lands habitats. There were no responses.

## Partner agencies/organizations

The following organizations indicated that they work in Developed lands habitats.

<b>Organization</b>	<b>Percent of time spent in Developed lands habitats</b>
Midwest Peregrine Falcon Recovery Project	70
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	60
American Consulting, Inc.	45
Cordry Sweetwater Conservancy District	45
JFNew and Associates	40
Hoosier Heartland Resource Conservation and Education council	35
Cinergy Corp.	30
MWH Americas, Inc.	30
Lake Lemon Conservancy District	25
Lake Maxinkuckee Environmental Council (LMEC)	25
Northwestern Indiana Regional Planning Commission (NIRPC)	25
Veolia Water Indianapolis, LLC	25
Wabash River Heritage Corridor Commission	25
Earth Source, Inc.	20
EnviroScience Incorporated	20
Indiana Association of Soil and Water Conservation Districts	20

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Indiana Chamber of Commerce	20
Steelheaders of Northwest Indiana (Northwest Indiana Steelheaders)	20
Summit Lake State Park	20
Sierra Club Hoosier Chapter	15
St. Joseph County Soil & Water Conservation District (SWCD)	15
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	15
Arrow Head Country Resource Conservation & Development Area, Inc.	10
Indiana Association of Cities and Towns	10
Indiana Native Plant and Wildflower Society	10
Indiana Quail Unlimited	10
Naval Support Activity Crane	10
Valparaiso Lakes Area Conservancy District	10
Valparasio Chain of Lakes Watershed Group, Inc.	10
St. Joseph River Watershed Initiative	7
Muscatatuck National Wildlife Refuge US FWS	6
Blue Heron Ministries, Inc.	5
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	5
Indiana Environmental Institute	5
Indiana state trappers assoc	5
Indianapolis Power & Light Co.	5
Lost River Conservation Association	5
Northeastern Indiana Trout Association	5
Robert Cooper Audubon Society	5
U.S. Department of Agriculture, Forest Service Hoosier National Forest	5
Division of Fish and Wildlife	2.5
Indiana Division of the Izaak Walton League of America	2
American Society of Landscape Architects, Indiana Chapter	
Federal Highway Administration (FHWA)	
Fur Takers of America	
fur takers of america chapter 7-E north west in.	
Great Lakes Commission	
Indiana Land Resources Council	
Law Enforcement Division, Indiana Department of Natural Resources	

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

## Appendix F-27: Aggregated Developed Lands

Respondents were aware of the following monitoring efforts by state agencies for wildlife in all developed lands habitats in Indiana (not ranked):

- 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

## Appendix F-27: Aggregated Developed Lands

Respondents were aware of the following monitoring efforts by other organizations for wildlife in all developed lands habitats in Indiana (not ranked):

- 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

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

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

Rank	Monitoring efforts by other organizations for conservation of wildlife in all developed lands
1	Regional or local year-round monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring
3	Statewide year-round monitoring

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- 4 Regional or local once-a-year monitoring
- 5 (tie) Occasional regional or local (less than once a year and not regularly scheduled) monitoring
- 5 (tie) Occasional statewide (less than once a year and not regularly scheduled) monitoring
- 6 Statewide once-a-year monitoring

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

- Indiana Division of Fish and Wildlife conducts Canada goose banding yearly. This consists of neck collars and leg bands. Waterfowl surveys are also conducted. Hunter harvests are reported.
- The Wildlife Diversity Section of Indiana Division of Fish and Wildlife coordinates Indiana's North American Amphibian Monitoring and Frog Watch Programs. These two programs collectively are the statewide effort to monitor frog and toad populations in Indiana, including bullfrogs. The data can be analyzed regionally.
- Waterfowl breeding status surveys, population surveys regionally; regional statewide trapping, banding, and recapture efforts
- Citizens and scientists report Kirtland's snake encounters to the Indiana Natural Heritage Database on a sporadic basis. Although sporadic these reports are often sufficient to demonstrate persistent Kirtland's snake occupied sites. However, the environmental parameters of these sites have not been adequately studied or described to reveal important micro-habitat associations
- DNR monitors most nest sites in the state and obtains information from other states

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

- Ducks Unlimited conducts waterfowl surveys
- Breeding and population surveys
- Building managers and volunteers report nesting activity at many nests

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

- U.S. Fish and Wildlife Service
- Indiana Division of Fish and Wildlife
- Ducks Unlimited
- Indiana Division of Parks and Reservoirs
- Waterfowl USA
- Wildlife Diversity Section of the Indiana Division of Fish and Wildlife accepts sighting information as does the Division of Nature Preserves for inclusion in the Heritage Database
- Private companies (NIPSCO, Ispat Inland, building managers)
- Federal Breeding Bird Survey serves this function. It does not focus on suitable habitat; yet, occurrence on these surveys would be tied to nearby presence of this breeding habitat

Respondents considered monitoring techniques for wildlife in all developed lands habitats in Indiana:

## Appendix F-27: Aggregated Developed Lands

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

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

- Aerial surveys
- Bullfrog tadpoles and adults are often recorded during amphibian surveys of particular sites, such as a military base or Superfund sites. Bullfrogs are also encountered and recorded during fish surveys
- A standardized protocol could be developed as suggested by Gibson and Kingsbury 2004. However, a more difficult question might be where should the standardized protocol be implemented to provide an adequate picture of the status of the Kirtland's snake in Indiana
- Surveys for colonies and periodic censuses of nests/populations

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 developed lands habitats. There were no responses.

### Habitat inventory and assessment

## Appendix F-27: Aggregated Developed Lands

Respondents were aware of the following inventory and assessment efforts by state agencies for all developed lands habitats in Indiana (not ranked):

- Occasional statewide (less than once a year and not 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 no inventory and assessment efforts by other organizations for all developed lands habitats in Indiana.

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

Rank	Inventory and assessment by state agencies for conservation of all developed lands habitats
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Statewide annual inventory and assessment
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Statewide once-a-year inventory and assessment

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

Rank	Inventory and assessment by other organizations for conservation of all developed lands habitats
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Statewide once-a-year inventory and assessment

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

- At this time, the habitat characteristics of Kirtland's snakes are not sufficiently defined to be monitored by general habitat measures (such as habitat classification based on remote sensing). More information on Kirtland's snake habitat requirements is needed to



## Appendix F-27: Aggregated Developed Lands

- define a habitat model for this species and to monitor the distribution and abundance of suitable habitat in the state
- Opportunistic statewide determination of potential nest sites in Indiana with the idea of erecting a nest box

Respondents were aware of no regional or local inventory and assessment by other organizations agencies for all developed lands habitats in Indiana. They did not list organizations that monitor this habitat.

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

<b>Inventory and assessment techniques for all developed lands habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	X	--
Aerial photography and analysis	X	X	X
Systematic sampling	--	X	--
Participation in land use programs	--	X	--
Modeling	--	X	--
Voluntary landowner reporting	X	--	--

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

- If there was a significant decline in bullfrog habitat on state owned properties the state would hear about it from frog hunters
- Insufficient data on Kirtland's snake habitat
- Habitat for some wildlife species means suitable nesting sites near water. Volunteer participation in building a database of known breeding colonies and volunteer periodic censusing of colony sizes

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 developed lands habitats. There were no responses.

### **Recommended monitoring** Species monitoring

## Appendix F-27: Aggregated Developed Lands

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

- Neck collars and leg bands; driving surveys
- Population surveys
- Mallards
  - Mark and recapture
  - Modeling to determine population dynamics and evaluate genetic integrity of Mallards in developed lands versus "wild" mallards (i.e., mallards in undeveloped areas)
- Monitoring throughout annual cycle
- I do not believe that an effective nationally or regionally accepted monitoring technique exists. This should be identified as a need in the CWS
- Nest monitoring of all known nests (or representative sample) with two to three visits according to U.S. Fish and Wildlife Service protocol
- Surveys for colonies and periodic censuses of nests/populations

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 in all developed lands habitats. There were no responses.

### Habitat inventory and assessment

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

- Aerial Photography and modeling
- Urban residents could be encouraged to participate in the Frog Watch program
- Aerial spring surveys
- Insufficient data on Kirtland's snake habitat
- Only casual assessment needed
- Habitat for some wildlife species means suitable nesting sites near water. Volunteer participation in building a database of known breeding colonies and volunteer periodic censusing of colony sizes.

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 developed lands habitats. There were no responses.

## DEVELOPED LANDS HABITATS NARRATIVE

### Habitat description

Developed lands habitats are characterized by a high percentage (30 percent or greater) of constructed materials (e.g. asphalt, concrete, buildings, etc).

### Problems affecting species and habitats

#### Species threats

Respondents ranked threats to wildlife in developed lands habitats in Indiana:

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

## Appendix F-28: Developed Lands

A respondent added that threats to wildlife in developed lands habitats in Indiana include genetic pollution due to “urbanization and domestication of ‘wild’ mallards, leading to the hybridization with domestic stock of ducks. This threat constitutes displacement of mallards into undesirable/unnatural areas, creating nuisance problems and genetic integrity concerns.”

Another respondent focused on Canada goose/human conflicts in developed areas.

A third respondent noted that abrupt changes in drainage patterns due to development could affect Kirtland’s snakes, which also can be adversely affected by moving, moving or clearing debris.

Respondents noted top threats to wildlife in developed lands habitats in Indiana (not ranked):

- Overpopulation
- Habitat loss

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

### Habitat threats

Respondents ranked threats to developed lands habitats in Indiana:

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

## Appendix F-28: Developed Lands

Respondents listed additional threats to developed lands habitats in Indiana (not ranked):

- Developed land creates a threat to quality habitat for mallards. Mallards in an urban setting face a host of problems for humans and mallards (genetic pollution, nuisance ducks, possible fecal contamination, etc.
- The impact of non-native earthworms should be closely monitored, as the Kirtland's snake's natural diet is believed to be comprised predominantly of earthworms and slugs. The ecological impact of non-native invertebrates has not been adequately studied

Respondents listed top threats to developed lands habitats in Indiana (not ranked):

- Urban, commercial and residential development (sprawl, destruction of wetland and water habitats, fragmentation, development of drainage areas and flood plains)
  - Allows Canada geese to overpopulate and become nuisances
  - Allows mallards to become more domesticated. People who feed birds is an issue in these settings
  - Respondents placed a large focus on destruction or development of water-based habitats, such as conversion of wetlands to retention ponds, and development of parks resulting in removal of natural cover
  - Fragmentation disrupts gene flow and recolonization
- Regulations (urban development)

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

## Additional research and survey efforts

### Current body of research

#### Species research

One-third of respondents indicated that the current body of science is adequate for wildlife in developed lands habitats in Indiana. Two-thirds indicated that species science is inadequate or non-existent.

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

Title = Amphibians and Reptiles of Indiana;

Author = Sherman A. Minton, Jr.;

Date = 2001;

Publisher = Indiana Academy of Sciences

Author = [www.natureserve.org/explorer](http://www.natureserve.org/explorer)

Title = Managing Canada Geese in Urban Environments;

Author = Arthur E. Smith, Scott R. Craven and Paul D. Curtis;

Date = 1199;

Publisher = Cornell Cooperative Extension

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Title = Prevention and Control of Wildlife Damage;  
Date = 1994;  
Publisher = University of Nebraska

Title = Conservation Assessment for Kirtland's Snake (*Clonophis kirtlandii*);  
Author = Jonanna Gibson and Bruce Kingsbury;  
Date = 2004;  
Publisher = USDA Forest Service, Eastern Region

Title = Kirtland's Snake;  
Author = [www.natureserve.org](http://www.natureserve.org)

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

### Habitat research

Seventeen percent of respondents said that current body of science for developed lands habitats in Indiana is adequate. Fifty percent said that habitat science in inadequate or non-existent. Seventeen percent said marked "unknown," with the added comment that "developed lands is not quality habitat for mallards; therefore, it should not be addressed or perceived as such."

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

Title = Managing Canada Geese in Urban Environments;  
Author = Arthur E. Smith, Scott R. Craven and Paul D. Curtis;  
Date = 1999;  
Publisher = Cornell Cooperative Extension

Title = Amphibians and Reptiles of Indiana;  
Author = Sherman A. Minton, Jr.;  
Date = 2001;  
Publisher = Indiana Academy of Science

Title = Indiana Heritage Database;  
Author = Indiana Division of Nature Preserves

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

## **Research needs**

### Species research

Respondents ranked research needs for wildlife in developed lands habitats in Indiana:

Rank	Research needs for wildlife in developed lands habitats
1	Distribution and abundance

## Appendix F-28: Developed Lands

- 2 (tie) Limiting factors (food, shelter, water, breeding sites)
- 2 (tie) Relationship/dependence on specific habitats
- 3 (tie) Threats (predators/competition, contamination)
- 3 (tie) Population health (genetic and physical)
  
- 4 Life cycle

Other research needs for wildlife in developed lands habitats in Indiana include (not ranked):

- Movement patterns of Canada geese: to understand how geese hatched in an urban environment move or migrate to similar environments
- Ways to reduce urban populations
- Ways to determine genetic integrity of mallards in developed areas and to determine effective management tools/plans for mallards in developed areas

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 developed lands habitat. There were no responses.

### Habitat research

Respondents ranked research needs for developed lands habitats in Indiana:

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

Respondents specified additional research needs for developed lands habitats in Indiana (not ranked):

- Need research on ways to “exclude Canada geese”
- Need to determine long-term effects of mallards in developed lands on overall mallard population. Also need to devise management tools and concepts to help manage mallards in developed lands

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- We need to understand why Kirtland's snakes occur where we currently find them. With that information, we can maintain current populations before we determine the feasibility of increasing their numbers and distribution

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

### Conservation actions necessary

#### Species actions

Respondents ranked conservation efforts that best address threats to wildlife in developed lands habitats in Indiana:

Rank	Conservation efforts for wildlife in developed lands habitats
1	Protection of migration routes
2 (tie)	Habitat protection
2 (tie)	Population management (hunting, trapping)
2 (tie)	Regulation of collecting
2 (tie)	Food plots
3	Public education to reduce human disturbance
4 (tie)	Culling selective removal
4 (tie)	Limiting contact with pollutants/contaminants
4 (tie)	Threats reduction
4 (tie)	Translocation to new geographic range

A respondent listed "habitat alteration" as another current conservation practice for wildlife in developed lands habitats in Indiana.

Respondents recommended the following practices for more effective conservation of wildlife in developed lands habitats in Indiana (not ranked):

- Habitat reduction or alteration
- Hunting and population reduction
- Effective conservation for urban Canada geese should deal with how to limit numbers. Education and habitat modifications are critical. The best conservation practice is to limit Canada goose numbers in developed lands habitats using a partnership of state, municipal and federal government, as well as private landowners
- Bullfrogs are mobile, hearty and a habitat generalist. They are believed to be detrimental to other frogs. They should be monitored as an environmental sentinel
- Mallards in developed lands habitats must be handled in a responsible manner to maintain genetic integrity in more nature or less developed habitats. As the size and distribution of mallards grows, this situation becomes more complex (involving genetic pollution, fecal contamination, habitat loss or destruction, nuisance animal complaints,



## Appendix F-28: Developed Lands

- nutrient loading, etc.) We need proper planning and management of mallards in developed lands, better understanding of mallard and developed lands dynamics, and a reduction of problems and conflicts
- When areas known or suspected to have Kirtland's snakes are threatened with development, work with developers to include shrubs and rock features near drainages to provide cover, and reduce mowing in Kirtland's snake habitat

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

### Habitat actions

Respondents ranked how well the following conservation efforts address threats to developed lands habitats in Indiana:

Rank	Conservation efforts for developed lands habitats
1 (tie)	Succession control (fire, mowing)
1 (tie)	Habitat protection incentives (financial)
1 (tie)	Habitat restoration through regulation
1 (tie)	Habitat restoration incentives (financial)
1 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
1 (tie)	Corridor development/protection
1 (tie)	Cooperative land management agreements (conservation easements)
2 (tie)	Protection of adjacent buffer zone
2 (tie)	Habitat protection through regulation
2 (tie)	Habitat protection on public lands
2 (tie)	Habitat restoration on public lands
3 (tie)	Restrict public access and disturbance
3 (tie)	Managing water regimes
4	Technical assistance
5 (tie)	Pollution reduction
5 (tie)	Selective use of functionally equivalent exotic species in place of extirpated natives

A respondent cited "the development and proliferation of storm water retention ponds" as another current conservation practice for developed lands habitats in Indiana.

## Appendix F-28: Developed Lands

Respondents cited top practices for more effective conservation of developed lands habitats in Indiana (not ranked):

- Habitat alteration and removal (particularly related to Canada geese)
- When areas known or suspected to have Kirtland's snakes are threatened with development, seek to have the developer include shrubs and rock features near drainages to provide cover and to reduce mowing in areas Kirtland's snakes are likely to use.

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

## Partner agencies/organizations

The following organizations indicated that they work in Developed lands habitats.

<b>Organization</b>	<b>Percent of time spent in Developed lands habitats</b>
Midwest Peregrine Falcon Recovery Project	70
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	60
American Consulting, Inc.	45
Cordry Sweetwater Conservancy District	45
JFNew and Associates	40
Hoosier Heartland Resource Conservation and Education council	35
Cinergy Corp.	30
MWH Americas, Inc.	30
Lake Lemon Conservancy District	25
Lake Maxinkuckee Environmental Council (LMEC)	25
Northwestern Indiana Regional Planning Commission (NIRPC)	25
Veolia Water Indianapolis, LLC	25
Wabash River Heritage Corridor Commission	25
Earth Source, Inc.	20
EnviroScience Incorporated	20
Indiana Association of Soil and Water Conservation Districts	20
Indiana Chamber of Commerce	20
Steelheaders of Northwest Indiana (Northwest Indiana Steelheaders)	20
Summit Lake State Park	20
Sierra Club Hoosier Chapter	15
St. Joseph County Soil & Water Conservation District (SWCD)	15
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	15
Arrow Head Country Resource Conservation & Development Area, Inc.	10
Indiana Association of Cities and Towns	10
Indiana Native Plant and Wildflower Society	10

## Appendix F-28: Developed Lands

Indiana Quail Unlimited	10
Naval Support Activity Crane	10
Valparaiso Lakes Area Conservancy District	10
Valparasio Chain of Lakes Watershed Group, Inc.	10
St. Joseph River Watershed Initiative	7
Muscatatuck National Wildlife Refuge US FWS	6
Blue Heron Ministries, Inc.	5
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	5
Indiana Environmental Institute	5
Indiana state trappers assoc	5
Indianapolis Power & Light Co.	5
Lost River Conservation Association	5
Northeastern Indiana Trout Association	5
Robert Cooper Audubon Society	5
U.S. Department of Agriculture, Forest Service Hoosier National Forest	5
Division of Fish and Wildlife	2.5
Indiana Division of the Izaak Walton League of America	2
American Society of Landscape Architects, Indiana Chapter	
Federal Highway Administration (FHWA)	
Fur Takers of America	
fur takers of america chapter 7-E north west in.	
Great Lakes Commission	
Indiana Land Resources Council	
Law Enforcement Division, Indiana Department of Natural Resources	

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents indicated that these monitoring efforts are conducted by state agencies for wildlife in developed lands habitats in Indiana (not ranked):

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

## Appendix F-28: Developed Lands

Respondents indicated that these monitoring efforts are conducted by other organizations for wildlife in developed lands habitats in Indiana (not ranked):

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

## Appendix F-28: Developed Lands

Respondents ranked the importance of monitoring efforts by state agencies for wildlife in developed lands habitats in Indiana:

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

Respondents ranked the importance of monitoring efforts by other organizations for wildlife in developed lands habitats in Indiana:

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

Respondents listed regional or local monitoring efforts by state agencies for wildlife in developed lands in Indiana (not ranked):

- Annual Canada goose banding
- Annual Indiana's North American Amphibian Monitoring and Frog Watch programs
- Regional waterfowl breeding status and population surveys

## Appendix F-28: Developed Lands

- Regional waterfowl trapping, banding and recapture efforts
- Citizens and scientists report Kirtland snake encounters to the Indiana Natural Heritage database sporadically. Environmental parameters of these sites have not been adequately studied or described to reveal important microhabitat associations

Respondents listed regional or local monitoring efforts by other organizations for wildlife in developed lands habitats in Indiana (not ranked):

- Ducks Unlimited waterfowl surveys
- Breeding and population surveys (organization not cited)

Respondents listed organizations involved in monitoring wildlife in developed lands habitats in Indiana (not ranked):

- Indiana Department of Natural Resources (Division of Fish and Wildlife; Division of Parks and Reservoirs; Division of Nature Preserves)
- U.S. Fish and Wildlife Service
- Ducks Unlimited
- Waterfowl USA

Respondents considered current monitoring techniques for wildlife in developed lands habitats in Indiana:

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

## Appendix F-28: Developed Lands

Respondents listed additional monitoring techniques for wildlife in developed lands habitats in Indiana (not ranked):

- Aerial surveys
- Bullfrog tadpoles and adults are often recorded during amphibian surveys of particular site such as military bases or Superfund sites. Bullfrogs also are counted and monitored during fish surveys

A respondent noted: "A standardized protocol could be developed as suggested by Gibson and Kingsbury 2004. However, a more difficult question might be where should standardized protocol be implemented to provide an adequate picture of the status of the Kirtland's snake in Indiana

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 developed lands habitat. There were no responses.

### Habitat inventory and assessment

Twenty percent of respondents were aware of the following inventory and assessment conducted by state agencies for lands habitats in Indiana:

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

Respondents were aware of no other inventory and assessment efforts.

Respondents were not aware of other organizations' habitat inventory and assessment efforts for developed lands habitats in Indiana.

Respondents ranked the importance of inventory and assessment efforts by state agencies for conservation of developed lands habitats in Indiana:

Rank	Monitoring efforts by state agencies for developed lands habitats
1 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
1 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Statewide annual inventory and assessment
2 (tie)	Statewide once a year inventory and assessment

Respondents ranked the following inventory and assessment efforts by organizations as having *equal* importance for conservation of developed lands habitats in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
- Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment

## Appendix F-28: Developed Lands

Respondents listed no regional or local inventory and assessment by state agencies or other organizations for developed lands habitats in Indiana.

A respondent commented: "At this time, the habitat characteristics of Kirtland's snakes are not sufficiently defined as to be monitored by general habitat measures (such as habitat classification based on remote sensing). More information on Kirtland's snake habitats is needed to define a reasonable habitat model for this species and to monitor the distribution and abundance of suitable habitat in the state.

Respondents considered current inventory and assessment techniques for developed lands habitats in Indiana:

<b>Inventory and assessment techniques for developed lands habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology or data</b>	<b>Not economically feasible</b>
GIS mapping	X	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	--	X	X
Participation in landuse programs	--	X	--
Modeling	--	X	--
Voluntary landowner reporting	X	--	--

A respondent cited feedback from frog hunters as an additional inventory and assessment technique for developed lands habitats in Indiana: "If there was a significant decline in bullfrog habitat on state-owned properties, the state would hear about it from frog hunters."

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 developed lands habitat. There were no responses.

### **Recommended monitoring** Species monitoring

Respondents recommended the following monitoring techniques for wildlife in developed lands habitats in Indiana (not ranked):

- Neck collars, leg bands and driving surveys
- Population surveys



## Appendix F-28: Developed Lands

- Mark and recapture
- Modeling to determine population dynamics and genetic integrity of mallards in developed lands vs. wild mallards. Monitoring throughout annual cycle

A respondent noted: "I do not believe that an effective nationally or regionally accepted monitoring technique exists. This should be identified as a need in the CWS."

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 developed lands habitat. There were no responses.

### Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for developed lands habitats in Indiana (not ranked):

- Aerial monitoring, photography and spring surveys
- Urban residents could be encouraged to participate in Frog Watch program

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 developed lands habitat. There were no responses.

## Appendix F-29: Golf Courses

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## INDUSTRIAL LANDS HABITAT NARRATIVE

### Habitat description

Industrial lands habitats are characterized by a high percentage (30 percent or greater) of constructed materials such as asphalt, concrete, buildings, etc. Industrial lands habitat includes infrastructure such as roads, railroads and all highly developed areas not classified as High Intensity Residential, that comprises areas where people reside in large numbers.

### Problems affecting species and habitats

#### Species threats

The respondent listed no "critical threat" or "serious threat" for wildlife in industrial lands habitat in Indiana. Listed as "somewhat of a threat" are (not ranked):

- High sensitivity to pollution
- Bioaccumulation on contaminants
- Diseases/parasites (of the species itself)
- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

The respondent listed the following as "slight threat" for wildlife in industrial land habitat in Indiana (not ranked):

- Predators (native or domesticated)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Viable reproductive population size or availability
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed "[lack of] tolerance by building managers of nesting sites" as an additional threat to wildlife in industrial lands habitat in Indiana.

The respondent listed top threats to wildlife in industrial lands habitat in Indiana as (not ranked):

- Availability of undisturbed nesting sites
- Collisions with buildings, power lines and other structures

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

#### Habitat threats

The respondent listed no "critical threat" or "serious threat" for industrial lands habitat in Indiana. The respondent listed "residual contamination (persistent toxins)" as "somewhat of a threat." The respondent listed as "slight threat" (not ranked):

- Commercial or residential development (sprawl)
- Habitat degradation

## Appendix F-30: Industrial Lands

- Stream channelization
- Agricultural/forestry practices
- Point source pollution (continuing)

The respondent listed no additional threats for industrial lands habitat in Indiana.

The respondent listed top threats for industrial lands habitat in Indiana (not ranked):

- Reduction in quality and quantity of prey populations
- Design of buildings that do not provide nesting ledges

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to industrial lands habitats. There were no responses.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

The respondent said that the body of science for wildlife in industrial lands habitat in Indiana is complete, up-to-date and extensive.

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

Title = Peregrine Falcon nesting and management in Indiana;  
Author = Castrale, J.S., and A. Parker;  
Date = 1999;  
Publisher = Indiana Audubon Quaterly 77:65-74.

Title = Midwest Peregrine Falcon Restoration - 2004 Annual Report;  
Author = Tordoff, H.B., J.A. Goggin, J.S. Castrale;  
Date = 2004;  
Publisher = The Raptor Center at the Univ. of Minnesota

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

#### Habitat research

The respondent said that the body of science for industrial lands habitat in Indiana is complete, up-to-date and extensive.

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

Title = see previous citations

## Appendix F-30: Industrial Lands

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

### **Research needs**

#### Species research

The respondent indicated no “urgently needed” or “greatly needed” research for wildlife in industrial lands habitat in Indiana. The respondent listed the following “needed” research:

- Threats (predators/competition, contamination)

The respondent listed the following as “slightly needed” research for wildlife in industrial land habitat in Indiana (not ranked):

- Life cycle
- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)
- Relationship/dependence on specific habitats
- Population health (physical and genetic)

The respondent indicated no other research needs for wildlife in industrial lands habitat in Indiana.

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 industrial lands habitats. There were no responses.

#### Habitat research

The respondent indicated no “urgently needed” or “greatly needed” research for industrial lands habitat in Indiana. The respondent listed the following “needed” research (not ranked):

- Threats (land use change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions

The respondent listed the following as “slightly needed” research for industrial lands habitat in Indiana:

- Distribution and abundance (fragmentation)

The respondent indicated no other research needs for industrial lands habitat in Indiana.

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

### **Conservation actions necessary**

#### Species actions

From a list of options, the respondent indicated that the following conservation efforts address threats to wildlife in industrial lands habitats in Indiana “very well” (not ranked):

- Regulation of collecting
- Limiting contact with pollution/contaminants
- Public education to reduce human disturbance

## Appendix F-30: Industrial Lands

According to the respondent, the following conservation efforts address threats to wildlife in industrial lands habitats “somewhat” (not ranked):

- Habitat protection
- Population enhancement (captive breeding and release)
- Reintroduction (restoration)
- Threats reduction
- Disease/parasite management
- Translocation to new geographic range
- Protection of migration routes

The respondent cited no other current conservation practices for wildlife in industrial lands habitat in Indiana.

The respondent listed “education/awareness needs for feeding and nesting” as a specific, recommended practice for more effective conservation of wildlife in industrial lands habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife in industrial lands habitats. There were no responses.

### Habitat actions

The respondent indicated that the following conservation efforts address threats to industrial lands habitat in Indiana “very well” (not ranked):

- Artificial habitat creation
- Pollution reduction
- Technical assistance

According to the respondent, the following conservation efforts address threats to industrial lands habitat in Indiana “somewhat” (not ranked):

- Habitat protection through regulation
- Corridor development/protection
- Protection of adjacent buffer zone
- Restrict public access and disturbance
- Cooperative land management agreements (conservation easements)

The respondent listed no other current conservation practices for industrial lands habitat in Indiana.

The respondent listed “education/awareness programs for building managers” as a specific, recommended practice for more effective conservation of industrial lands habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for industrial lands habitats. There were no responses.

## **Proposed plans for monitoring**

## Current monitoring

### Species monitoring

The respondent indicated that the following monitoring efforts for wildlife in industrial lands habitat in Indiana are conducted by state agencies (not ranked):

- Statewide year-round monitoring
- Statewide once-a-year monitoring

The respondent indicated that the following monitoring efforts are conducted by other organizations for wildlife in industrial lands habitat in Indiana (not ranked):

- Statewide year-round monitoring
- Statewide once-a-year monitoring

The respondent listed no “very crucial” monitoring efforts by state agencies for conservation of wildlife in industrial lands habitat in Indiana. The respondent listed as “somewhat crucial” (not ranked):

- Statewide year-round monitoring
- Statewide once-a-year monitoring

The respondent listed no “very crucial” monitoring efforts by other organizations for conservation of wildlife in industrial lands habitat in Indiana. The respondent listed as “somewhat crucial” (not ranked):

- Statewide year-round monitoring
- Statewide once-a-year monitoring

The respondent listed the following regional or local monitoring efforts by state agencies for wildlife in industrial lands habitat in Indiana:

- DNR monitors most nest sites in the state and obtains information about others

The respondent listed the following regional or local monitoring efforts by other organizations for wildlife in industrial land habitat in Indiana:

- Building managers and volunteers report nesting activity at many nests

The respondent listed the following organizations that monitor wildlife in industrial lands habitat in Indiana (not ranked):

- NIPSCO
- Ispat Island
- Building managers

The following table reflects the opinions of multiple respondents, thus multiple check marks are possible. Additionally, some of these differences may reflect different taxonomic group bias.

The respondent cited the following monitoring techniques for wildlife in industrial lands habitat in Indiana:

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

The respondent cited no other monitoring techniques for wildlife in industrial lands habitat in Indiana.

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 industrial lands habitats. There were no responses.

Habitat inventory and assessment

The respondent listed the following inventory and assessment efforts by state agencies for industrial lands habitat in Indiana:

- Occasional statewide (less than once-a-year and not regularly scheduled) inventory

The respondent noted no inventory and assessment efforts by other organizations for industrial lands habitat in Indiana.

The respondent listed no crucial efforts by state agencies or other organizations for conservation of industrial lands habitat in Indiana.



## Appendix F-30: Industrial Lands

The respondent cited the following methods for regional or local inventory and assessment by state agencies for industrial lands habitat in Indiana:

- Opportunistic statewide determination of potential nest sites in Indiana with the idea of erecting a nest box

The respondent noted no regional or local inventory or assessment by other organizations for industrial lands habitat in Indiana.

The respondent listed no organizations involved with inventory or assessment for industrial lands habitat in Indiana.

From a list of possible inventory and assessment techniques for industrial lands habitat in Indiana, the respondent listed "GIS mapping", "aerial photography and analysis" and "voluntary landowner reporting" as "occasionally used." Nothing was noted as "frequently used." The respondent listed "systematic sampling" and "modeling" as methods that are "not used but possible with existing technology and data."

The respondent listed no other inventory and assessment techniques for industrial lands habitat in Indiana.

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 industrial lands habitats. There were no responses.

### **Recommended monitoring** Species monitoring

The respondent recommended the following monitoring technique for effective conservation of wildlife in industrial lands habitat in Indiana:

- Nest monitoring of all known nests (or representative sample) with two to three visits according to USFWS protocol

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 in industrial lands habitats. There were no responses.

### Habitat inventory and assessment

The respondent recommended that "casual assessment" is the recommended inventory and assessment technique for effective conservation of industrial lands habitat in Indiana.

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 industrial lands habitats. There were no responses.

## ROADS/RAILS/BRIDGES HABITAT NARRATIVE

### Habitat description

Roads/bridges/trails habitats are characterized by a high percentage (30 percent or greater) of constructed materials such as asphalt, concrete, buildings, etc. It includes infrastructure such as roads, railroads and all highly developed areas not classified as High Intensity Residential that comprises areas where people reside in large numbers.

### Problems affecting species and habitats

#### Species threats

The respondent listed no "critical threat" or "serious threat" for wildlife in roads/rails/bridges habitat in Indiana. The respondent listed "invasive/non-native species" as "somewhat of a threat."

The respondent listed as "slight threat" (not ranked):

- Predators (native or domesticated)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Habitat loss (breeding range)
- Near limits of natural geographic range

The respondent listed no additional threats to wildlife in road/rails/bridges habitat in Indiana.

The respondent listed top threats to wildlife in roads/rails/bridges habitat in Indiana (not ranked):

- House sparrow preemption of nests
- Vandalism potential at nesting colonies

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

#### Habitat threats

The respondent listed no "critical" or "serious threats" for roads/rails/bridges habitat in Indiana.

The respondent listed as "slight threat" (not ranked):

- Habitat degradation
- Agricultural/forestry practices
- Residual contamination (persistent toxins)
- Point source pollution (continuing)
- Drainage practices (stormwater runoff)

The respondent listed the following threat to roads/rails/bridges habitat in Indiana:

- Potential for pollution reducing productivity of aquatic habitats over which Cliff Swallows feed

The respondent listed a top threat for roads/rails/bridges habitat in Indiana as:

## Appendix F-31: Roads/Rails/Bridges

- Changes in design of bridges and causeways to make them less suitable for nest placement

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

## Additional research and survey efforts

### Current body of research

#### Species research

The respondent said that the body of science for wildlife in roads/rails/bridges habitat in Indiana is inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of wildlife in roads/rails/bridges habitats in Indiana.

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

#### Habitat research

The respondent said that body of science for roads/bridges/trails habitat in Indiana is inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of roads/rails/bridges habitats in Indiana.

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

### Research needs

#### Species research

The respondent indicated no “urgently needed” or “greatly needed” research for wildlife in roads/rails/bridges habitat in Indiana. The respondent did indicate the following research was “needed” (not ranked):

- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)

The respondent listed the following as “slightly needed” for wildlife in roads/rails/bridges habitat in Indiana (not ranked):

- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats
- Population health (genetic and physical)

The respondent cited no other research needs for wildlife in roads/rails/bridges habitat in Indiana.

## Appendix F-31: Roads/Rails/Bridges

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 road/rails/bridges habitat. There were no responses.

### Habitat research

The respondent indicated no urgent or greatly needed research for roads/rails/bridges habitat in Indiana. The respondent did indicate the following research was “needed” (not ranked):

- Distribution and abundance (fragmentation)
- Relationship/dependence on specific site conditions

The respondent listed the following research as “slightly needed” for roads/rails/bridges habitat in Indiana:

- Threats (land use change/competition, contamination/global warming)

The respondent cited no other research needs for roads/rails/bridges habitat in Indiana.

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

## **Conservation actions necessary**

### Species actions

From a list of potential conservation efforts, the respondent indicated that “habitat protection” addresses threats to wildlife in roads/rails/bridges habitat in Indiana “very well.” The following efforts address threats “somewhat” (not ranked):

- Exotic/invasive species control
- Disease/parasite management

The respondent noted no other conservation practices for wildlife in roads/rails/bridges habitat in Indiana.

The respondent recommended “continued use of bridge architecture that favors nest placement” as a practice that would provide more effective conservation of wildlife in roads/rails/bridges habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife in road/rails/bridges habitat. There were no responses.

### Habitat actions

From a list of potential efforts, the respondent indicated that the following conservation efforts address threats to roads/rails/bridges habitat in Indiana “very well” (not ranked):

- Habitat restoration on public lands
- Artificial habitat creation
- Restrict public access and disturbance

## Appendix F-31: Roads/Rails/Bridges

According to the respondent, the following address threats "somewhat" (not ranked):

- Habitat protection through regulation
- Habitat restoration through regulation
- Pollution reduction

The respondent noted no other conservation practices for roads/rails bridges habitat in Indiana.

The respondent listed the following as a specific, recommended practice for more effective conservation of roads/bridges/rails habitat in Indiana:

- Critical habitat for Cliff Swallows is nesting sites, most are on public (DOT) structures (bridges). Much less important is water quality, etc., for feeding areas

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

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

The respondent indicated that the following monitoring efforts are conducted by state agencies for wildlife in roads/bridges/rails habitat in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) monitoring

The respondent indicated that the following monitoring efforts are conducted by other organizations for wildlife in roads/bridges/rails habitat in Indiana:

- Statewide once-a-year monitoring

The respondent indicated that there are no crucial monitoring efforts by state agencies or other organizations for conservation of wildlife in roads/bridges/rails habitat in Indiana. The respondent was not aware of any monitoring efforts by any state or organizational entity for wildlife in roads/bridges/rails habitat in Indiana.

The respondent listed the following organizations that monitor wildlife in roads/rails/bridges habitat in Indiana:

- Federal Breeding Bird Survey serves this function, but does not focus on suitable habitat. Yet, occurrence on these surveys would be tied to nearby presence of this breeding habitat

The respondent cited the following monitoring techniques for wildlife in roads/rails/bridges habitats in Indiana are "not used by possible with existing technology or data" (not ranked):

- Driving a survey route
- Professional survey/census
- Volunteer survey/census
- Representative sites

## Appendix F-31: Roads/Rails/Bridges

The respondent listed no techniques as “frequently used,” “occasionally used” or “not economically feasible.”

The respondent recommended the following techniques for wildlife in roads/rails/bridges habitat:

- Surveys for colonies and periodic censuses of nests/populations

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 road/rails/bridges habitat. There were no responses.

### Habitat inventory and assessment

The respondent is not aware of current inventory and assessment efforts by state agencies or other organizations for roads/bridges/rails habitat in Indiana. The respondent listed no crucial efforts by state agencies or other organizations for conservation of roads/bridges/rails habitat in Indiana. The respondent is not aware of state agencies or other organizations that perform inventory and assessment for roads/bridges/rails habitat in Indiana.

The respondent listed “GIS mapping” and “systematic sampling” as inventory and assessment techniques that are “not used but possible with existing technology and data” for roads/bridges/rails habitat in Indiana. The respondent listed “aerial photography and analysis” as “not economically feasible.” The respondent listed no techniques that are “frequently used” or “occasionally used.”

The respondent listed the following inventory and assessment technique for roads/rails/bridges habitat in Indiana:

- Primarily suitable nesting sites near water define habitat for some wildlife species. Volunteer participation in building a database of known breeding colonies and volunteer periodic censusing of colony sizes

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 road/rails/bridges habitat. There were no responses.

## **Recommended monitoring**

### Species monitoring

The respondent recommended the following monitoring technique for effective conservation of wildlife in roads/rails/bridges habitats in Indiana:

- Surveys for colonies and periodic censuses of nests/populations

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 in road/rails/bridges habitat. There were no responses.

### Habitat inventory and assessment

The respondent recommended the following inventory and assessment technique for roads/rails/bridges habitat in Indiana:

## Appendix F-31: Roads/Rails/Bridges

- Primarily suitable nesting sites near water define habitat for some wildlife species. Volunteer participation in building a database of known breeding colonies and volunteer periodic censusing of colony sizes

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 road/rails/bridges habitat. There were no responses.

## 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

## Appendix F-32: Aggregated Forests

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



## Appendix F-32: Aggregated Forests

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

## Appendix F-32: Aggregated Forests

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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

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:

<b>Rank</b>	<b>Monitoring efforts by state agencies for conservation of wildlife in all forest habitats</b>
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:

<b>Rank</b>	<b>Monitoring efforts by other organizations for conservation of</b>
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

## Appendix F-32: Aggregated Forests

- 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)

## Appendix F-32: Aggregated Forests

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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

- 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

## Appendix F-32: Aggregated Forests

- 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

## FOREST HABITAT 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 forest habitats in Indiana:

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

Respondents offered additional threats to wildlife in forest habitats in Indiana (not ranked):

- Captive cervids/genetic contamination from farmed white-tails
- Fragmentation of forest habitat and loss of farmland habitat to housing/construction
- The spread of bush honeysuckles

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- Tree diseases
- Tree insects
- Removal of fence rows
- 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

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

- Deer: Diseases/genetic integrity
  - Captive cervids contaminate genetic integrity and increase chance of infection for wild deer
  - CWD, EHD and tuberculosis would be devastating to a deer herd of our density
- Overpopulation will lead to an unmanageable resource and severe habitat degradation
- Habitat fragmentation and destruction
- Invasive species and its relation to habitat loss
- Loss of migration habitat: The large-scale mortality reported about wind turbines and other sources is the most threatening issue for avian wildlife. 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 don't know where they are going
- Fox squirrels: The two greatest threats to fox squirrels are overall loss of habitat and fragmentation of remaining forest tracts
- Bobcat: Threats to bobcat populations are human related factors such as direct mortality (incidental take, road kills and persecution) and habitat loss. Conversion of native communities and habitats for human use cause direct loss of habitats for bobcats and prey
- Box turtles: Top threats to Eastern box turtle are habitat loss, road mortality and human collection

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

- I would say so. I don't know about fox squirrels, it seems like they like fragmented parcels.

### Habitat threats

Respondents ranked threats to forest habitats in Indiana:

Rank	Threats to forest habitats
1	Commercial or residential development (sprawl)
2	Habitat fragmentation
3	Habitat degradation
4	Invasive/non-native species
5	Agricultural/forestry practices
6 (tie)	Diseases (of plants that create habitat)
6 (tie)	Counterproductive financial incentives or



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- regulations
- 7 Nonpoint source pollution (sedimentation and nutrients)
- 8 Successional change
- 9 (tie) Residual contamination (persistent toxins)
- 9 (tie) Point source pollution (continuing)
- 10 (tie) Mining/acidification
- 10 (tie) Drainage practices (stormwater runoff)

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

- Modern farm practices: the creation of large open, clean farm fields leaves no habitat for deer or many other mammals, clearing for crops, fence row removal
- Urban spread
- Construction

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

- Loss of habitat/habitat degradation/habitat fragmentation (urban sprawl, development, farming practices)
  - Interrupts movements from summer to winter ranges
  - Forces unnatural movement
  - Increases accidental mortality
  - Creates opportunity to spread disease
  - Loss of foraging ability

Respondents noted that biggest threats to bobcats, box turtles and fox squirrels are habitat loss and fragmentation due to commercial development and agricultural practices.

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

- Good. I wonder if successional changes will be a bigger player as we see our forest lands changing in species composition. I.E. the loss of Oak/Hickory in the Hoosier National Forest.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

Fifty-one percent of respondents stated that the current body of science for wildlife in forest habitats in Indiana is adequate, complete, up-to-date and extensive. Thirty-eight percent of respondents said that it is inadequate.

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

Title = Mammals of Indiana;

Author = John Whitaker;

Date = IN Press;

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Publisher = IU Press

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;

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Publisher = University of Oklahoma Press

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

- Yes but I think there is some information out there on the Wild Turkey that could be included.

### Habitat research

Over ten percent of respondents stated that the current body of science for forest habitats in Indiana is Complete, up to date and extensive, a third indicated that it was Adequate, over twenty percent responded that it was inadequate, and twenty percent responded other including "Unknown" and "I am not sure on the habitat's body of science... I would assume complete and up to date".

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of 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

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

- More needs to be done.

## Research needs

### Species research

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

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

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

- White-tailed deer:
  - A deer harvest analysis and modeling program/baseline life history data
  - CWD (all aspects)
  - The aging techniques (tooth wear) 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 of age
  - 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 high fragmentation of forest tracts in Indiana (especially northern Indiana) I believe that dispersal distance is a critical area of research. I also would like to see a research project that evaluates the amount of harvest pressure can be sustained by isolated metapopulations of squirrels

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 forest habitats. Their responses included:

- This looks like a very small scope of critters. We need to be more broad.

### Habitat research

Respondents ranked research needs for forest habitats in Indiana:

Rank	Research needs for forest habitats
1	Distribution and abundance (fragmentation)

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- 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

A respondent noted additional research need for forest habitats in Indiana:

- Research needs explore the effects of land development

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

- Yes-this is important. Our forest lands are just as important as wetlands. We just do not seem to sell that value the same.

## Conservation actions necessary

### Species actions

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

Rank	Conservation efforts for wildlife in forest habitats
1	Protection of migration routes
2 (tie)	Population management (hunting, trapping)
2 (tie)	Food plots
2 (tie)	Regulation of collecting
3	Habitat protection (use below for details)
4 (tie)	Disease/parasite management
4 (tie)	Public education to reduce human disturbance
4 (tie)	Exotic/invasive species control
4 (tie)	Threats reduction
4 (tie)	Limiting contact with pollutants/contaminants
4 (tie)	Culling/selective removal

Respondents noted other current conservation practices for wildlife in forest habitats in Indiana:

- Deer contraceptives: Currently not used due to efficacy and economical reasons

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

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- Woodland habitat protection/control forest habitat fragmentation
- Study migration routes to protect habitats
- Protect corridors between fragments
- Population management via hunting
- Ban cervid farming and canned hunting
- Invasive species control
- Preserve large continuous blocks of forest habitat and prohibit collection of box turtles
- Attempt to lower meso predator numbers and protect nest cavities

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

- yes

### Habitat actions

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

Rank	Conservation efforts for forest habitats
1	Habitat protection incentives (financial)
2 (tie)	Habitat protection through regulation
2 (tie)	Habitat restoration on public lands
2 (tie)	Corridor development/protection
3	Land use planning
4	Habitat restoration incentives (financial)
5	Habitat protection on public lands
6 (tie)	Habitat restoration through regulation
6 (tie)	Technical assistance
6 (tie)	Cooperative land management agreements (conservation easements)
6 (tie)	Succession control (fire, mowing)
6 (tie)	Protection of adjacent buffer zone
6 (tie)	Pollution reduction
6 (tie)	Restrict public access and disturbance
6 (tie)	Managing water regimes

Respondents listed other current conservation practices for forest habitats in Indiana:

- Restriction of motorized access into habitat

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

- Habitat protection and management
  - Preservation of forest and agricultural landscapes
  - Protect large blocks of natural communities and habitats
  - Manage forests to provide early/mid successional stage habitats
- Habitat restoration
- Legislation to protect habitat
- Create corridors between forest tracts
- Provide financial incentives to protect or create forest habitat

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

- We need to educate the publics on the importance of their forest resources. They need to be managed not protected.

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

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

- 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

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

- Statewide once-a-year 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 forest habitats in Indiana:

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



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but still regularly scheduled) monitoring

- 6 (tie) 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 forest habitats in Indiana:

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

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

- Statewide basis (Bloomington DNR office)
- State parks
- Nature preserves
- Select urban areas
- State deer check stations
- Hunter harvest data on state fish and wildlife properties
- Population trends can be assessed via animals submitted to state rabies lab
- IDNR is monitoring box turtles in Martin, Brown and Morgan counties
- Red bats are monitored as part of regular bat sampling at Indianapolis International Airport, Camp Atterbury and Newport Chemical Depot
- Ongoing ecological studies of bobcats in southwestern Indiana, primarily Greene, Lawrence and Martin counties
- Small game harvest questionnaire is only survey agency conducts to monitor Indiana fox squirrel population. Survey is conducted only in odd years

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

- Some municipalities
- University properties
- Purdue University
- Beverly Shores
- U.S. National Lakeshore

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- Wesselman Woods (Evansville)
- Private groups have helped with counts in some state parks

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

- Universities
- Indiana State University
- Wildlife biologists at military bases
- Indiana Division of Fish and Wildlife
- IDNR does maintain records, databases, etc. regarding reports of bobcats throughout the state. 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 for information regarding bobcat sightings, road-kills, and incidental captures, etc. It is one of the few means of monitoring low-density and wide-ranging species such as the bobcat

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

Monitoring techniques for wildlife in forest habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	X	X	--
Modeling	X	X	--
Coverboard routes	--	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	X
Mark and recapture	X	X	X
Professional survey/census	X	X	X
Volunteer survey/census	X	X	X
Trapping (by any technique)	X	X	--
Representative sites	X	X	--
Probabilistic sites	X	X	--

Respondents noted no other monitoring techniques for wildlife in forest habitats in Indiana.

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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 forest habitats. Their responses included:

- yes

### Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for forest habitats in Indiana (not ranked):

- 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
- 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 forest habitats in Indiana (not ranked):

- 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 forest habitats in Indiana:

<b>Rank</b>	<b>Inventory and assessment for conservation of forest habitats by state agencies</b>
1 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment

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- 3 (tie) Regional or local year-round inventory and assessment
- 3 (tie) Regional or local once-a-year inventory and assessment
- 4 Statewide once-a-year inventory and assessment
- 5 Statewide annual inventory and assessment

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

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

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

- State forests
- Nature preserves
- Division of Forestry (keeps track of changes in forest cover)
- IDNR
- I suspect that most, if not all, public properties in the state (Hoosier National Forest, Crane NSWC, state forests, state 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

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

- Beverly Shores
- National Lakeshore
- Hoosier National Forest
- Wesselman Woods (Evansville)
- Local planning boards monitor land use in most localities
- Indiana GAP project categories land use cover types from landsat imagery. I assume that the change in cover types is being calculated over a specified period of time

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

- Universities
- Purdue University
- In addition to state and federal agencies, I suspect Indiana Hardwood Lumberman's Association or other private groups may monitor forested lands, particularly those in private ownership
- I would assume that TNC, IDNR and other federal agencies monitor these habitats
- Indiana GAP Project

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

<b>Inventory and assessment techniques for forest habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	--	--
Aerial photography and analysis	X	X	--
Systematic sampling	X	--	X
Property tax estimates	X	--	--
Regulatory information	X	--	--
Participation in land use programs	X	--	--
Modeling	X	X	--
Voluntary landowner reporting	X	--	--

Respondents listed no additional inventory and assessment techniques for forest habitats in Indiana.

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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 forest habitats. Their responses included:

- yes

### **Recommended monitoring**

#### Species monitoring

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

- Reporting from harvest, depredation, or unintentional take
- Modeling (White-tailed Deer Ecology and Management, Lowell K. Halls)
- Collection of harvest data from mandatory check stations
- We need make sure someone continues to examine all animals submitted for rabies testing
- 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
- 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
- Bobcats: Some form of questionnaire or survey that is sent to trappers, hunters and 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
- Box turtle: I would recommend long-term surveys and radio-telemetry of box turtle. 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

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 in forest habitats. Their responses included:

- yes

#### Habitat inventory and assessment

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

- GIS mapping and aerial photo analysis
  - 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 a 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
- Statewide habitat mapping is needed (and mostly available if you know who to ask)
- Property tax assessments can be used as a proxy as well

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- Collect hunter data from DNR properties and private land hunters
- Universities keep record of habitat loss and habitat fragmentation

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 forest habitats. Their responses included:

- Yes

Technical experts and conservation organizations offered the following additional comments:

- We have to increase the level of awareness and importance of our forest habitats within the publics.

## Appendix F-34: Deciduous

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.



## EARLY FOREST STAGE HABITATS

### Habitat description

Early stage forests are typified by tree seedlings (less than 1-inch diameter breast height (dbh) and tree saplings (greater than 1-inch dbh but less than 5-inch dbh). The tree species often occur in combination with non-arborescent woody shrubs and perennial herbs/forbs.

### Problems affecting species and habitats

#### Species threats

The respondent ranked threats to wildlife in early forest stage habitats in Indiana:

Rank	Threats to wildlife in early forest stage habitats in Indiana
1 (tie)	Habitat loss (breeding range)
1 (tie)	Habitat loss (feeding/foraging areas)
2 (tie)	Viable reproductive population size or availability
2 (tie)	Small native range (high endemism)
3	Predators (native or domesticated)
4 (tie)	Specialized reproductive behavior or low reproductive rates
4 (tie)	Genetic pollution (hybridization)
5 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
5 (tie)	Near limits of natural geographic range
6	Diseases/parasites (of the species itself)
7 (tie)	Large home range requirements
7 (tie)	Regulated hunting/fishing pressure (too much)
7 (tie)	Invasive/non-native species
8	Bioaccumulation of contaminants

Respondents noted other threats to wildlife in early forest stage habitats in Indiana (not ranked):

- Loss of early successional forest age class
  - Lack of periodic vegetative disturbance (man-made or natural every 5 to 10 years) that adequately opens the forest canopy, especially in contiguous forests under 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. This situation does not provide a continuum of acceptable habitat for successful grouse population dispersal. A recent population model projects that ruffed grouse will potentially disappear as a viable species in much of

## Appendix F-35: Early Forest Stage

their current range by 2007. Ruffed grouse population indices are now at the lowest levels recorded in over 40+ years

- Lack of public knowledge/information regarding the importance of disturbances and early successional habitat in forested areas. This is the main contributing factor to the near extirpation of the ruffed grouse.

Respondents noted top threats to wildlife in early forest stage habitats in Indiana (not ranked):

- Loss of early successional forest age class (see Q8 for possible reasons)
- Preservationist (anti-management) influences on politics of timber management and legal challenges to sound timber/wildlife management activities
- Lack of public knowledge/information regarding the importance of disturbances and early successional habitat in forested areas.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in early forest stage habitats. There were no responses.

### Habitat threats

The respondent ranked threats to early forest stage habitats in Indiana:

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

Again, respondents indicated that other, top threats to early forest stage habitats in Indiana is lack of periodic vegetative disturbance in forested areas to maintain early forest stage habitat,

## Appendix F-35: Early Forest Stage

especially in the large contiguous forested areas of the state in public ownership. (See Q8 and Q9 for more information.)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to early forest stage habitats. There were no responses.

### **Additional research and survey efforts**

#### **Current body of research**

##### Species research

Two-thirds of respondents indicated that the current body of research for wildlife in early forest stage habitats in Indiana is adequate. A third indicated that research is complete, up to date and extensive.

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

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

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 early forest stage habitats. There were no responses.

##### Habitat research

Two thirds of respondents indicated that research for early forest stage habitats in Indiana is adequate. A third of respondents indicated that research is inadequate.

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

Title = Statewide Forest Inventory;

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Author = ?;

Date = periodic;

Publisher = US Forest Service/IDNR

Title = same as earlier

Author = same as earlier

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 early forest stage habitats. There were no responses.

### Research needs

#### Species research

Respondents ranked research needs for wildlife in early forest stage habitats in Indiana:

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

A respondent listed other research needs for wildlife in early forest stage habitats in Indiana (not ranked):

- Whether distribution of early successional habitat is now so poor and low that the disappearance of ruffed grouse from local areas will expand into a regional or complete extinction

A respondent stated, "We don't need more research. We need habitat management for early successional forest species, including but not limited to the ruffed grouse."

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 early forest stage habitats. There were no responses.

#### Habitat research

Respondents ranked research needs for early forest stage habitats in Indiana:

Rank	Research needs for early forest stage habitats
1	Distribution and abundance (fragmentation)

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- 2 Successional changes
- 3 Relationship/dependence on specific site conditions
- 4 (tie) Growth and development of individual components of the habitat
- 4 (tie) Threats (land use change/competition, contamination/global warming)

A respondent commented on other research needs for early forest stage habitats in Indiana: “We do not need research on grouse habitat. We know what they need, it just needs to be provided before the ruffed grouse is extirpated.”

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

### Conservation actions necessary

#### Species actions

Respondents ranked how well conservation efforts address threats to wildlife in early forest stage habitats in Indiana:

Rank	Conservation efforts for wildlife in early forest stage habitats in Indiana
1 (tie)	Habitat protection
1 (tie)	Population management (hunting, trapping)
2	Public education to reduce human disturbance

A respondent commented on current conservation practices for wildlife in early forest stage habitats in Indiana. The respondent indicated that “habitat enhancement” is needed, rather than protection. The respondent stated that, “ruffed grouse requires active vegetative management. While hunting is not responsible for the declining population trends and hunting pressure is self-limiting/regulated by diminishing returns, the question does eventually come to the point (with the continuous decline of habitat and subsequently low populations) where 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.”

Respondents recommended the following conservation practices to enhance wildlife in early forest stage habitats in Indiana (not ranked):

- Active timber management, especially on the larger blocks of public forest lands; timber management practices that remove at least 75 percent of the overhead canopy
- Production of early successional stages of vegetation on public lands using practices such as clear-cutting and certain select cutting methods

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for wildlife in early forest stage habitats. There were no responses.

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### Habitat actions

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

<b>Rank</b>	<b>Conservation efforts for early forest stage habitats</b>
<b>1 (tie)</b>	Habitat restoration through regulation
<b>1 (tie)</b>	Habitat restoration on public lands
<b>1 (tie)</b>	Habitat restoration incentives (financial)
<b>1 (tie)</b>	Succession control (fire, mowing)
<b>2 (tie)</b>	Land use planning
<b>2 (tie)</b>	Corridor development/protection
<b>3 (tie)</b>	Cooperative land management agreements (cooperative easements)
<b>3 (tie)</b>	Habitat protection through regulation
<b>3 (tie)</b>	Habitat protection on public lands
<b>3 (tie)</b>	Habitat protection incentives (financial)
<b>3 (tie)</b>	Technical assistance
<b>3 (tie)</b>	Protection of adjacent buffer zone

Respondents noted other current conservation practices for early forest stage habitats in Indiana:

- Some states mandate that a certain percentage of public lands be maintained in early successional and transitional forest types

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

- Active timber management that removes at least 75 percent of the existing forest canopy on a portion of the forested landscape every 5 to 10 years on an 80- to 120-year rotation is needed
- Educate the public to understand that habitat management is necessary 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 conservation practices for early forest stage habitats. There were no responses.

## **Proposed plans for monitoring**

### **Current monitoring**

#### Species monitoring

Respondents indicated that the following monitoring efforts are conducted by state agencies for wildlife in early forest stage habitats in Indiana (not ranked):

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- Statewide once-a-year monitoring
- Regional or local once-a-0year monitoring

Respondents indicated that the following monitoring efforts are conducted by other organizations for wildlife in early forest stage habitats in Indiana (not ranked):

- Statewide once-a-year 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 in conserving wildlife in early forest stage habitats in Indiana:

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

Respondents ranked monitoring efforts by other organizations based on their importance in conserving wildlife in early forest stage habitats in Indiana:

Rank	Monitoring efforts by other organizations for wildlife in early forest stage habitats
1 (tie)	Regional or local year-round monitoring conducted by state agencies
1 (tie)	Regional or local once-a-year monitoring conducted by state agencies
2	Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies
3	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies

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

- Roadside spring drumming survey (drumming indices) conducted in primarily in south-central Indiana
- Activity center counts on the 900-acre Maumee Grouse Study Area in Jackson/Brown counties

Respondents listed the following regional or local monitoring efforts by other organizations for wildlife in early forest stage habitats in Indiana (not ranked):

- Incidental observations on Christmas Bird Counts (extremely minor)
- Species occurrence noted during the Statewide Breeding Bird Atlas Project (only one ever done).

Respondents listed organizations involved in monitoring wildlife in early forest stage habitats in Indiana (not ranked):

- Audubon Society
- Indiana Department of Natural Resources

Respondents considered monitoring techniques for wildlife in early forest stage habitats in Indiana as follows:

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



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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 early forest stage habitats. There were no responses.

### Habitat inventory and assessment

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

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

Respondents indicated that no inventory and assessment efforts are conducted by other organizations for early forest stage habitats in Indiana.

Respondents ranked inventory and assessment efforts by state agencies based on their importance to conserving early forest stage habitats in Indiana:

<b>Rank</b>	<b>Inventory and assessment efforts by state agencies for early forest stage habitats</b>
<b>1</b>	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations
<b>2</b>	Statewide annual inventory and assessment conducted by other organizations
<b>3 (tie)</b>	Statewide once-a-year inventory and assessment conducted by other organizations
<b>3 (tie)</b>	Regional or local year-round inventory and assessment conducted by other organizations
<b>3 (tie)</b>	Regional or local once-a-year inventory and assessment conducted by other organizations
<b>3 (tie)</b>	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations
<b>4</b>	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations
<b>5</b>	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by other

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organizations

One-third of respondents *equally* ranked the following inventory and assessment efforts by other organizations as “slightly crucial” to conserving early forest stage habitats in Indiana:

- Statewide annual inventory and assessment
- Statewide once-a-year 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
- 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 listed regional or local inventory and assessment efforts for early forest stage habitats in Indiana:

- The Continuous Statewide Forest Inventory jointly conducted by the US Forest Service and the Indiana Div. of Forestry, IDNR

Respondents listed no habitat inventory and assessment efforts or organizations involved in monitoring for early forest stage habitats in Indiana.

Respondents considered the following inventory and assessment techniques for early forest stage habitats in Indiana:

<b>Inventory and assessment techniques for early forest stage habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	--	X	--
Aerial photography and analysis	--	X	--
Systematic sampling	X	--	--
Participation in land use programs	X	X	--
Modeling	X	--	--
Voluntary landowner reporting	--	X	--

## Appendix F-35: Early Forest Stage

Respondents listed no other inventory and assessment efforts for early forest stage habitats in Indiana.

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 early forest stage habitats. There were no responses.

### **Recommended monitoring**

#### Species monitoring

Respondents recommended the following monitoring techniques for wildlife in early forest stage habitats in Indiana (not ranked):

- Spring drumming routes used nationally for spring breeding trend data
- On particular or "study areas," complete spring drumming counts for accurate breeding densities
- Hunter bag 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 early forest stage habitats. There were no responses.

#### Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for early forest stage habitats in Indiana (not ranked):

- Statewide Forest Inventory
- GIS and current aerial photos

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 early forest stage habitats. There were no responses.

## EVERGREEN FOREST HABITATS

### Habitat description

Evergreen forests are areas dominated by trees where 75 percent or more of the tree species maintain their leaves all year. The canopy is never without green foliage.

### Problems affecting species and habitats

#### Species threats

The respondent listed no “critical threat” or “serious threat” to evergreen forest wildlife in Indiana. The respondent listed the following as “somewhat of a threat” (not ranked):

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

The respondent listed the following as a “slight threat” for wildlife in evergreen forest habitats in Indiana (not ranked):

- Predators (native or domesticated)
- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Small native range (high endemism)
- Near limits of natural geographic range
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed no other threats to evergreen forest wildlife in Indiana.

The respondent indicated that the top threat to evergreen forest wildlife in Indiana is the “potential habitat loss due development and lack of management.”

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

#### Habitat threats

The respondent listed no threats to evergreen forest habitats in Indiana as critical or serious. The respondent listed the following as “somewhat of a threat” (not ranked):

- Commercial or residential development (sprawl)
- Habitat fragmentation
- Successional change

The respondent listed the following as “slight threat” for evergreen forest habitats in Indiana (not ranked):

- Diseases (of plants that create habitat)
- Habitat degradation
- Agricultural/forestry practices
- Mining/acidification

The respondent listed no other threats to evergreen forest habitats in Indiana.

## Appendix F-36: Evergreen

The respondent listed top threats to wildlife in evergreen forest habitats in Indiana as (not ranked):

- Conversion of habitat to other than pine forests
- Lack of active habitat management as the top two threats to evergreen forest habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to evergreen forest habitats. There were no responses.

## Additional research and survey efforts

### Current body of research

#### Species research

The respondent listed "Breeding Bird Atlas and Breeding Bird Survey data" as the current body of science on evergreen forest wildlife in Indiana. No indication about the completeness of this research was given.

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

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

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science on wildlife in evergreen forest habitats. There were no responses.

#### Habitat research

The respondent indicated that the current body of science on evergreen forest habitats in Indiana is inadequate.

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

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

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science on evergreen forest habitats. There were no responses.

### Research needs

#### Species research

## Appendix F-36: Evergreen

The respondent did not list any research efforts as “urgently needed” or “greatly needed” for wildlife in evergreen forest habitats in Indiana. The respondent listed the following research as “needed” (not ranked):

- Life cycle
- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats
- Population health (genetic and physical)

The respondent did not list other research needs for wildlife in evergreen forest habitats in Indiana.

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 evergreen forest habitats. There were no responses.

### Habitat research

The respondent did not list any research for evergreen forest habitats in Indiana as “urgently needed” or “greatly needed.” The respondent listed as the following research as “needed” (not ranked):

- Successional changes
- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research for evergreen forest habitats. There were no responses.

## **Conservation actions necessary**

### Species actions

The respondent did not indicate that any of the listed conservation efforts address threats to evergreen forest wildlife in Indiana “very well.” The respondent stated that the following conservation effort addresses threats to wildlife “somewhat:”

- Habitat protection

The respondent did not list any other current conservation practices for wildlife in evergreen forest habitats in Indiana.

The respondent recommended the following for more effective conservation of wildlife in evergreen forest habitats in Indiana: “Prescribed burning to maintain sparse understory in mature pine forests may potentially help evergreen forest wildlife species, for example on DNR lands.”

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife in evergreen forest habitats. There were no responses.

## Appendix F-36: Evergreen

### Habitat actions

The respondent indicated “selective use of functionally equivalent exotic species in place of extirpated natives” addresses threats to evergreen forest habitats in Indiana “very well.” the respondent stated that the following address threats to evergreen forest habitats in Indiana “somewhat” (not ranked):

- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration on public lands
- Succession control (fire, mowing)

The respondent did not note other current conservation practices for evergreen forest habitats in Indiana.

The respondent recommended the following for more effective conservation of evergreen forest habitats in Indiana: “Prescribed burning to maintain sparse understory in mature pine forests may potentially help evergreen forest habitat. Rodewald et al. 1999. Pine Warbler in Birds of North America.”

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for evergreen forest habitats. There were no responses.

## **Proposed plans for monitoring**

### **Current monitoring**

#### Species monitoring

The respondent was aware of this monitoring effort by state agencies for wildlife in evergreen forest habitats in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent considered this effort to be “somewhat crucial” for conservation of wildlife in evergreen forest habitats in Indiana. No other monitoring efforts by state agencies were considered crucial.

The respondent was aware of this monitoring effort by other organizations for wildlife in evergreen forest habitats in Indiana:

- Statewide once-a-year monitoring

The respondent considered this effort to be “somewhat crucial” for conservation of wildlife in evergreen forest habitats in Indiana. No other monitoring efforts by other organizations were considered crucial.

The respondent noted no regional or local monitoring by state agencies or organizations for wildlife in evergreen forest habitats in Indiana.

The respondent indicated that the following organizations are involved in evergreen forest wildlife monitoring in Indiana (not ranked):

## Appendix F-36: Evergreen

- DNR Division of Fish and Wildlife
- USGS Breeding Bird Survey

The respondent indicated that the following techniques are “frequently used” to monitor evergreen forest wildlife in Indiana:

- Driving a survey route
- Volunteer survey/census

The respondent was not aware of other monitoring techniques for wildlife in evergreen forest habitats in Indiana.

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 evergreen forest habitats. There were no responses.

### Habitat inventory and assessment

The respondent was not aware of inventory and assessment efforts by state agencies or other organizations for evergreen forest habitats in Indiana.

The respondent could not rate the importance of inventory and assessment efforts conducted by state agencies and other organizations for evergreen forest habitats in Indiana.

The respondent was not aware of regional or local inventory and assessment conducted by state agencies and other organizations for evergreen forest habitats in Indiana. The respondent did not know organizations that conducted this inventory and assessment for evergreen forest habitats in Indiana.

The respondent was unaware of the use or feasibility of inventory and assessment techniques for evergreen forest habitats in Indiana.

The respondent did not list other inventory and assessment techniques for evergreen forest habitats in Indiana.

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 evergreen forest habitats. There were no responses.

## **Recommended monitoring**

### Species monitoring

The respondent recommended the following monitoring technique for effective conservation of wildlife in evergreen forest habitats in Indiana:

- Sampling of mature pine forest habitat to better determine distribution



## Appendix F-36: Evergreen

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 in evergreen forest habitats. There were no responses.

### Habitat inventory and assessment

The respondent recommended the following inventory and assessment technique for effective conservation of evergreen forest habitats in Indiana:

- Statewide inventory and mapping of mature pine forest communities to determine more accurate potential distribution of pine warbler. The respondent suggested "Flora of Indiana" by Charles Deam 1940 and unpublished data/files from Division of Forestry as reference

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 evergreen forest habitats. There were no responses.

## FLOODPLAIN FORESTS HABITAT NARRATIVE

### Habitat description

Floodplain forests are a transitional habitat between the river or stream and upland and serve as a wildlife corridor between habitats.

### Problems affecting species and habitats

#### Species threats

The respondent did not indicate any "critical" or "serious threat" to floodplain forest wildlife in Indiana. The respondent noted the following as "somewhat of a threat" (not ranked):

- Invasive/non-native species
- Predators (native or domesticated)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent noted the following as a "slight threat" to wildlife in floodplain forest habitats in Indiana (not ranked):

- High sensitivity to pollution
- Dependence on other species (mutualism, pollinators)
- Species overpopulation
- Near limits of natural geographic range
- Viable reproductive population size or availability

The respondent noted no additional threats to wildlife in floodplain forest habitats in Indiana.

The respondent noted that "adequate habitat (primarily American sycamores along riparian areas) in breeding areas" is the top threat to wildlife in floodplain forest habitats in Indiana.

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

- Channelization of rivers is also a threat to wildlife.  
Loss of habitat for nesting wood ducks. Habitat is used by migrating waterfowl.
- No! Uncontrolled timber cutting and no effort given to reforestation of tree species after repeated high grading of the timber resource for the past 100 plus years. Continued high threat preventing reestablishment of any floodplain forest resembling natural species composition of past conditions.

#### Habitat threats

The respondent did not indicate any "critical" or "serious threat" to floodplain forest habitats in Indiana. The respondent noted the following as "somewhat of a threat" (not ranked):

- Commercial or residential development (sprawl)

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- Counterproductive financial incentives or regulations
- Habitat fragmentation
- Successional change
- Stream channelization
- Impoundment of water/flow regulation
- Agricultural/forestry practices

The respondent listed the following as a “slight threat” to floodplain forest habitats in Indiana (not ranked):

- Invasive/non-native species
- Nonpoint source pollution (sedimentation and nutrients)
- Diseases (of plants that create habitat)
- Habitat degradation
- Point source pollution (continuing)
- Mining/acidification
- Drainage practices (stormwater runoff)

The respondent noted no additional threats to floodplain forest habitats in Indiana.

The respondent noted that the top threat to floodplain forest habitats in Indiana is “loss of floodplain sycamores and “upland pine forests.”

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

- No. Threats to this habitat are continuing unabated based on uncontrolled market conditions dictating timber practices. No forethought or management of this habitat type.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

The respondent indicated that the current body of science for wildlife in floodplain forest habitats in Indiana is adequate.

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

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

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

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

- No. There have to be more studies such as Hurley's, "Factors Influencing Habitat Selection by Breeding Birds of Floodplain Communities in Southern Indiana." completed for IU in 2001. Has anyone simply taken the time to compile a list of Research Studies completed by universities in Indiana?

### Habitat research

The respondent indicated that the current body of science for floodplain forest habitats in Indiana is adequate.

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

Title = see previous citations

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

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

- Yes.

## **Research needs**

### Species research

The respondent indicated that no research is "urgently needed" or "greatly needed" for wildlife in floodplain forest habitats in Indiana. The respondent indicated that the following research is "needed" (not ranked):

- Life cycle
- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats

The respondent indicated that the following research is "slightly needed" for wildlife in floodplain forest habitats in Indiana (not ranked):

- Distribution and abundance
- Population health (genetic and physical)

## Appendix F-37: Floodplain Forests

The respondent listed no other research needs for wildlife in floodplain forest habitats in Indiana.

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 floodplain forest habitats. Their responses included:

- No. Research is always needed. Who knows right now the impact of cowbird parasitism on cerulean warblers? Who can identify the best floodplain forest with the largest or most productive cerulean warbler population? What is the composition of the best production floodplain forest in Indiana? Can we manage to make long term improvements to floodplain forests for cerulean production? What long term studies are being done to monitor the population dynamics of a particular cerulean population? Much more needs to be known about what is happening in regards to indicator species populations in relation to habitat changes.

### Habitat research

The respondent listed no research as “urgently needed” or “greatly needed” for floodplain forest habitats in Indiana. The respondent listed the following as “needed” research (not ranked):

- Distribution and abundance (fragmentation)
- Threats (landuse change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of habitat

The respondent listed research about “successional changes” as “slightly needed” for floodplain forest habitats in Indiana.

The respondent listed no other research needs for floodplain forest habitats in Indiana.

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

- Yes, this is a good start. We need to establish long-term studies of a representative sample of this habitat type to know how it is changing and what is changing it.

## **Conservation actions necessary**

### Species actions

The respondent indicated that none of the listed conservation efforts address threats to floodplain forest wildlife in Indiana “very well.” The respondent indicated that the following efforts address threats “somewhat” (not ranked):

- Habitat protection
- Threats reduction
- Regulation of collecting
- Protection of migration routes

The respondent noted no other conservation practices for wildlife in floodplain forest habitats in Indiana.

## Appendix F-37: Floodplain Forests

The respondent recommended “conservation of habitats” for more effective conservation of wildlife in floodplain forest habitats in Indiana.

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

- No, more emphasis needs to be placed on restoration and purposeful management of this habitat.

### Habitat actions

The respondent indicated that none of the listed conservation efforts address threats to floodplain forest habitats in Indiana “very well.” The respondent noted that the following efforts address threats “somewhat” (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration through regulation
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Corridor development/protection
- Managing water regimes
- Pollution reduction
- Protection of adjacent buffer zone
- Restrict public access and disturbance
- Landuse planning
- Technical assistance
- Cooperative land management agreements (conservation easements)

The respondent noted no other current conservation practices for floodplain forest habitats in Indiana.

The respondent recommended “incentives to conserve floodplain forests” for more effective conservation of floodplain forest habitats in Indiana.

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

- Work can also be done on Private Lands.
- No, need more education efforts with real world examples of best management practices to provide convincing evidence that management pays dividends in the long run. Publicity of these long term study sites is needed to invoke interest by those willing to learn good stewardship.

## **Proposed plans for monitoring**

## Appendix F-37: Floodplain Forests

### Current monitoring

#### Species monitoring

The respondent was aware of the following monitoring efforts by state agencies for wildlife in floodplain forest habitats in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent indicated that this effort was “somewhat crucial” for conservation of wildlife in floodplain forest habitats in Indiana.

The respondent was aware of the following efforts by other organizations for wildlife in floodplain forest habitats in Indiana:

- Statewide once-a-year monitoring

The respondent listed this monitoring effort as “very crucial” for conservation of wildlife in floodplain forest habitats in Indiana.

The respondent indicated that the following regional or local monitoring efforts by state agencies are conducted for wildlife in floodplain forest habitats in Indiana:

- Periodic statewide Breeding Bird Atlas

The respondent indicated that the following regional or local monitoring efforts by other organizations are conducted for wildlife in floodplain forest habitats in Indiana (not ranked):

- Federal Breeding Bird Survey statewide
- Statewide May Day Bird Counts
- Summer Bird Counts

The respondent indicated that the following participate in monitoring floodplain forest wildlife in Indiana (not ranked):

- Bird watchers
- U.S. Geological Survey
- Volunteers

The respondent indicated that the following monitoring techniques are “frequently used” for wildlife in floodplain forest habitats in Indiana (not ranked):

- Driving a survey route
- Volunteer survey/census

The respondent noted that the following monitoring techniques are “occasionally used” for wildlife in floodplain forest habitats in Indiana (not ranked):

- Spot mapping
- Mark and recapture
- Professional survey/census
- Representative sites
- Probabilistic sites

The respondent indicated that the following monitoring techniques are “not used but possible with existing technology and data” for wildlife in floodplain forest habitats in Indiana (not ranked):

- Radio telemetry and tracking
- Trapping (by any technique)

## Appendix F-37: Floodplain Forests

The respondent noted no other monitoring techniques for wildlife in floodplain forest habitats in Indiana.

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 floodplain forest habitats. Their responses included:

- Yes.

### Habitat inventory and assessment

The respondent was aware of no inventory and assessment efforts by state agencies for floodplain forest habitats in Indiana.

The respondent indicated, "periodic statewide (less than once a year but still regularly scheduled) inventory and assessment by state agencies is "somewhat crucial" for conservation of floodplain forest habitats in Indiana.

The respondent was aware of "periodic statewide (less than once a year but still regularly scheduled) inventory and assessment" conducted by other organizations for floodplain forest habitats in Indiana; the respondent listed this as "somewhat crucial" for conservation of these habitats in Indiana. No monitoring efforts were considered "very crucial."

The respondent listed no regional or local inventory and assessment by state agencies for floodplain forest habitats in Indiana.

The respondent listed the following regional or local inventory and assessment by other organizations for floodplain forest habitats in Indiana:

- Statewide aerial imagery of habitats in Indiana

The respondent listed no organizations that conduct inventory and assessments for floodplain forest habitats in Indiana.

The respondent listed no inventory and assessment techniques that are "frequently used" for floodplain forest habitats in Indiana. The respondent listed as "occasionally used" (not ranked):

- GIS mapping
- Aerial photography and analysis
- Modeling

The respondent listed the following as "not used but possible with existing technology or data:"

- Systematic sampling

The respondent listed no other inventory and assessment techniques for floodplain forest habitats in Indiana.



## Appendix F-37: Floodplain Forests

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 floodplain forest habitats. Their responses included:

- No, systematic sampling of model sites is needed as a reference for other similar areas in the state. The Division of Forestry could manage this sampling over a long term study period of 50 years with wildlife habitat monitoring needs identified by the Division of F&W.

### **Recommended monitoring**

#### Species monitoring

The respondent recommended “roadside surveys, canoe surveys, local and more intensive studies” for more effective conservation of wildlife in floodplain forests habitats in Indiana.

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

- Yes, purposeful and planned monitoring efforts are needed. Model sampling guidelines with workshops to birding groups to assist in the conduct of these surveys would increase buying and recruit necessary volunteer manpower to get results.

#### Habitat inventory and assessment

The respondent recommended “aerial imagery of riparian and pine habitats coupled with habitat modeling” for more effective conservation of floodplain forest habitats in Indiana.

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

- No, this is just a big view of what is down there. We need on-site inspections and plant inventories, abundance ratings etc. so we have some idea of what is there for the wildlife species present or desired.

## FOREST WETLAND HABITATS NARRATIVE

### Habitat description

An area characterized by woody vegetation over 20 feet tall, where soil is at least periodically saturated with or covered by water.

### Problems affecting species and habitats

#### Species threats

The respondent listed the following as "somewhat of a threat" to wildlife in forested wetland habitats in Indiana (not ranked):

- Invasive/non-native species
- Predators (native or domesticated)
- Habitat loss (breeding range, feeding/foraging areas)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed the following as "slight threat" (not ranked):

- Species overpopulation
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Near limits of natural geographic range
- Viable reproductive population size or availability

The respondent listed no threats as "critical" or "serious."

The respondent offered no additional threats to wildlife in forested wetland habitats in Indiana.

The respondent listed top threats to wildlife in forested wetland habitats in Indiana:

- Adequate habitat (primarily American sycamores along riparian areas) in breeding areas

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

- Loss of habitat threatens wood duck nesting.  
Important area for migrating waterfowl.
- No. Forested wetlands comprise more than 60% of all wetland acreage in Indiana, and support dozens of species of birds, mammals, reptiles, and amphibians. To include only two species in the guild for this habitat type makes the evaluation incomplete at best. A more appropriate guild would include species representatives of the variety of forested wetland types found in the state, including flatwoods, forested swamp, forested fen, wet floodplain forest, and wet-mesic floodplain forest. Since forested wetlands show the greatest percentage loss of all wetland types, the lack of "critical" or "serious" threats to the species inhabiting them hardly seems accurate. Birds of forested wetlands typically make up a sizable percentage of the top species of management concern for organizations such as Partners in Flight, making the conservation of forested wetlands critical. To consider the top threat to wildlife in forested wetlands an inadequate number of sycamores along riparian areas is to virtually ignore the importance of forested wetlands to a host of wildlife species

## Appendix F-38: Forested Wetlands

and the serious continued threats to those species due to loss and degradation of habitat through piecemeal clearing, drainage, and subsequent fragmentation.

### Habitat threats

The respondent listed the following as “somewhat of a threat” to forested wetland habitats in Indiana (not ranked):

- Commercial or residential development (sprawl)
- Counterproductive financial incentives or regulations
- Habitat fragmentation
- Successional change
- Stream channelization
- Impoundment of water/flow regulation
- Agricultural/forestry practices
- Mining/acidification

The respondent listed the following as “slight threat” (not ranked):

- Invasive/non-native species
- Nonpoint source pollution (sedimentation or nutrients)
- Diseases (of plants that create habitat)
- Habitat degradation
- Point source pollution
- Drainage practices (stormwater runoff)

The respondent listed no threats as “critical” or “serious.”

The respondent noted no additional threats to forested wetland habitats in Indiana.

The respondent listed top threats to forested wetland habitats in Indiana:

- Loss of floodplain sycamores and upland pine forests

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

- Again, to consider the dominant wetland type in Indiana with the highest level of loss to be without critical or serious threats completely misses the mark. Many of the threats listed above should be considered critical or serious threats, including habitat fragmentation (through clearing, drainage, development), stream maintenance/channelization, and acid mine drainage or other contaminants.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

The respondent stated that the current body of science is adequate for wildlife in forested wetland habitats in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of wildlife in forested wetland habitats in Indiana.

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

- No. Very little species-specific research on wildlife of forested wetlands in Indiana.

Appropriate papers include:

Knutson, M.G., J.P. Hoover, and E.E. Klaas. 1996. The importance of floodplain forests in the conservation and management of neotropical migratory birds in the Midwest. Pages 168-188 in Thompson, F.R., editor. Management of Midwestern Landscapes for the Conservation of Neotropical Migratory Birds. USDA NC Forest Exp. Stat. Gen. Tech. Rep NC-187.

### Habitat research

The respondent stated that the current body of science is adequate for forested wetland habitats in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of forested wetland habitats in Indiana.

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

- No. Appropriate titles include:

Roberts, S.D. and R.A. Rathfon, editors. 1994. Management of forested wetland ecosystems in the Central Hardwood Region. Purdue University FNR 151.

Stauffer, D.F. and L.B. Best. 1980. Habitat selection by birds of riparian communities: Evaluating the effects of habitat alterations. J. Wildl. Manage. 44(1): 1-15.

Twedt, D.J. et.al. 2002. Avian response to bottomland hardwood reforestation: The first 10 years. Restoration Ecol. 10(4): 645-655.

U.S. Fish and Wildlife Service. 1990. Regional Wetlands Concept Plan. Region 3.

Indiana DNR. 1996. Indiana Wetlands Conservation Plan.

Gosselink, J.G., et. al. 1990. Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems. Lewis Publ. 708 pp.

## **Research needs**

### Species research

The respondent listed the following research as "needed" for wildlife in forested wetland habitats in Indiana (not ranked):

- Life cycle
- Limiting factors (food, shelter, water, breeding sites)

## Appendix F-38: Forested Wetlands

- Relationship/dependence on specific habitats

The respondent listed the following as “slightly needed” research (not ranked):

- Distribution and abundance
- Threats (predators/competition, contamination)
- Population health (genetic and physical)

The respondent listed no research as “urgently needed” or “greatly needed.”

The respondent noted no other research needs for wildlife in forested wetland habitats in Indiana.

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 forested wetlands habitats. Their responses included:

- How species respond to habitat fragmentation will be one of the major research needs in the future.

### Habitat research

The respondent listed the following research as “needed” for forested wetland habitats in Indiana (not ranked):

- Distribution and abundance (fragmentation)
- Relationship/dependence on specific site conditions

The respondent listed the following research as “slightly needed” (not ranked):

- Successional changes
- Threats (land use change/competition, contamination/global warming)
- Growth and development of individual components of the habitat

The respondent listed no research as “urgently needed” or “greatly needed.”

The respondent noted no additional research needs for forested wetland habitats in Indiana.

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

- See above

## **Conservation actions necessary**

### Species actions

The respondent ranked the following conservation efforts that address threats to wildlife in forested wetland habitats in Indiana:

<b>Rank</b>	<b>Conservation efforts for wildlife in forested wetland habitats</b>
1	Habitat protection

## Appendix F-38: Forested Wetlands

- 2 (tie) Threats reduction
- 2 (tie) Regulation of collecting
- 2 (tie) Protection of migration routes

The respondent noted no other conservation practices for wildlife in forested wetland habitats in Indiana.

The respondent recommended these no additional practices for more effective conservation of wildlife in forested wetland habitats in Indiana.

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

- Habitat Protection on Public and Private Lands.

### Habitat actions

The respondent stated that the following conservation efforts address threats to forested wetland habitats in Indiana “somewhat” well (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration through regulation
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Corridor development/protection
- Pollution reduction
- Protection of adjacent buffer zone
- Restrict public access and disturbance
- Technical assistance
- Cooperative land management agreements (conservation easements)

The respondent listed no additional current conservation practices for forested wetland habitats in Indiana.

The respondent recommended the following conservation practices for more effective conservation of forested wetland habitats in Indiana:

- Conservation of habitats

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for forested wetlands habitats. Their responses included:

- Habitat restoration on private lands through programs such as the WRP, CRP, and Partners for Fish and Wildlife is one of the best ways to generate a net gain in forested wetland habitat.

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

The respondent was aware of the following monitoring efforts by state agencies for wildlife in forested wetland habitats in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent was aware of the following monitoring efforts by other organizations for wildlife in forested wetland habitats in Indiana:

- Statewide once-a-year monitoring

The respondent listed the following monitoring efforts by state agencies as “somewhat crucial” for conservation of wildlife in forested wetland habitats in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent listed the following monitoring efforts by other organizations as “somewhat crucial” for conservation of wildlife in forested wetland habitats in Indiana:

- Statewide once-a-year monitoring

The respondent listed regional or local monitoring by state agencies for wildlife in forested wetland habitats in Indiana:

- Periodic statewide Breeding Bird Atlas

The respondent listed regional or local monitoring by other organizations for wildlife in forested wetland habitats in Indiana (not ranked):

- Federal Breeding Bird Survey statewide
- Statewide May Day bird counts
- Summer bird counts

The respondent listed organizations that monitor wildlife in forested wetland habitats in Indiana (not ranked):

- Birdwatchers
- USGS
- Volunteers

The respondent considered monitoring techniques for wildlife in forested wetland habitats in Indiana:

Monitoring techniques for wildlife in forested wetland habitats	Used	Not used but possible with existing	Not used and not possible with existing technology

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		technology and data	and data
Radio telemetry and tracking	--	X	--
Spot mapping	X	--	--
Driving a survey route	X	--	--
Reporting from harvests, depredation, or unintentional take	--	--	X
Mark and recapture	X	--	--
Professional survey/census	X	--	--
Trapping (by any technique)	X	--	--
Representative sites	X	--	--

The respondent noted no other monitoring techniques for wildlife in forested wetland habitats in Indiana.

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 forested wetlands habitats. There were no responses.

### Habitat inventory and assessment

The respondent was aware of no inventory and assessment efforts by state agencies for forested wetland habitats in Indiana.

The respondent was aware of the following inventory and assessment effort by other organizations for forested wetland habitats in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent listed the following inventory and assessment efforts by state agencies as "somewhat crucial" for conservation of forested wetland habitats in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent listed no inventory and assessment efforts by other organizations that are crucial for conservation of forested wetland habitats in Indiana.



## Appendix F-38: Forested Wetlands

The respondent listed no regional or local inventory and assessment by state agencies for forested wetland habitats in Indiana.

The respondent listed the following regional or local inventory and assessment by other organizations agencies for forested wetland habitats in Indiana:

- Statewide aerial imagery of habitat in Indiana

The respondent listed no organizations that monitor forested wetland habitats in Indiana.

The respondent considered inventory and assessment techniques for forested wetland habitats in Indiana:

<b>Inventory and assessment techniques for forested wetland habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	--	--
Aerial photography and analysis	X	--	--
Systematic sampling	--	X	--

The respondent listed no additional inventory and assessment techniques for forested wetland habitats in Indiana.

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 forested wetlands habitats. There were no responses.

### **Recommended monitoring**

#### Species monitoring

The respondent recommended the following monitoring techniques for effective conservation of wildlife in forested wetland habitats in Indiana (not ranked):

- Roadside surveys
- Canoe surveys
- Local more intensive studies

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 in forested wetlands habitats. There were no responses.

#### Habitat inventory and assessment

## Appendix F-38: Forested Wetlands

The respondent recommended the following inventory and assessment techniques for effective conservation of forested wetland habitats in Indiana:

- Aerial imagery of riparian and pine habitats coupled with habitat modeling

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 forested wetlands habitats. There were no responses.

Technical experts and conservation organizations offered the following additional comments:

- From the comments it sounds like only one person has made any recommendations for this habitat. I think it would be beneficial to get feedback from more than one person.
- Difficulty in separating Forested Wetlands, Floodplain Wetlands, and Riparian Forests.....many individual sites are all three, and little overlap in species composition, threats, or conservation measures.

## MATURE/HIGH CANOPY FOREST HABITAT NARRATIVE

### Habitat description

Typical dominant overstory vegetation is composed primarily of sawtimber sized trees (greater than 9" dbh in softwoods and 11" dbh in hardwoods). The forest canopy is usually higher than in previous stages and predominantly closed with occasional canopy gaps. Older forests that are selectively harvested will usually remain in the Mature/High Canopy condition after harvest while those areas that are clear cut or contain regeneration openings will revert back to the Early Forest Stage.

### Problems affecting species and habitats

#### Species threats

Respondents ranked the following threats to wildlife in mature/high canopy forest habitat in Indiana:

Rank	Threats to wildlife in mature/high canopy forest habitat	Score
1	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)	4.75
2 (tie)	Habitat loss (breeding range)	4.60
2 (tie)	Habitat loss (feeding/foraging areas)	4.60
3	Viable reproductive population size or availability	4.00
4	Specialized reproductive behavior or low reproductive rates	3.60
5	Predators (native or domesticated)	3.00
6	Small native range (high endemism)	2.60
7	Large home range requirements	2.40
8	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)	2.33
9	Invasive/non-native species	2.25
10	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)	2.20
11 (tie)	Bioaccumulation of contaminants	2.00
11 (tie)	Diseases/parasites (of the species itself)	2.00
12	Unregulated collection pressure	1.80
13 (tie)	Dependence on other species (mutualism, pollinators)	1.50
13 (tie)	High sensitivity to pollution	1.50

## Appendix F-39: Mature or High Canopy Stage

14	Near limits of natural geographic range	1.40
15	Genetic pollution (hybridization)	1.20

Respondents offered additional threats to wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Brown-headed cowbird nest parasitism
  - In cerulean warbler habitat
- Need to know how the Cerulean Warbler is affected by silviculture and other land management, how these affect demography

Respondents listed top threats to wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Species parasitism/predators
  - Cowbird nest parasitism
  - Increase edge nest predators (e.g. blue jays)
  - Nest predation
- 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
  - Habitat fragmentation may exacerbate both of these.
  - Loss of contiguous blocks of mature forest
- Low reproductive output
  - Possibly 'sink' populations due to poor habitat quality
- Timber rattlesnake threats
  - Habitat loss
  - Human persecution: Timber rattlesnakes are often killed because they are large venomous snakes. There is also a market for this species in illegal trade. Individual take coupled with low reproductive rates pose a serious threat for this species.

A respondent noted, "We need to assess basic demography in Indiana and across the breeding range, learn how the Cerulean Warbler responds to land management, develop an understanding of post-fledging habitat use, and determine the effect of the brown-headed cowbird on this species."

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in mature/high canopy forest habitats. There were no responses.

### Habitat threats

Respondents ranked threats to mature/high canopy forest habitat in Indiana:

Rank	Threats to mature/high canopy forest habitat
------	--

## Appendix F-39: Mature or High Canopy Stage

- 1 (tie) Habitat fragmentation
- 1 (tie) Commercial or residential development (sprawl)
  - 2 Agricultural/forestry practices
  - 3 Habitat degradation
  - 4 Successional change
  - 5 Invasive/non-native species
  - 6 Counterproductive financial incentives or regulations
  - 7 Diseases (of plants that create habitat)
- 8 (tie) Stream channelization
- 8 (tie) Climate change
- 8 (tie) Mining/acidification
  - 9 Nonpoint source pollution (sedimentation and nutrients)
- 10 (tie) Residual contamination (persistent toxins)
- 10 (tie) Point source pollution (continuing)
  - 11 Impoundment of water/flow regulation
  - 12 Drainage practices (stormwater runoff)

Respondents noted additional threats to mature/high canopy forest habitat in Indiana (not ranked):

- Human disturbance
  - Has affected age and species diversity (trees are even-aged and young, with less species diversity, vertical structure, natural canopy gaps, large woody debris and other structural features than pre-European settlement forests)
  - Has resulted in extirpated flora and fauna
- Suppression of natural disturbances (fire, beaver, floods)
  - Results in shift of wildlife species composition, structural complexity and landscape pattern
  - Fire-intolerant species such as sugar maple and American beech have become established at expense of fire-adapted oak and hickory species
  - Restoration of natural landscapes needs reintroduction or simulation of these disturbances
- 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. It is not clear what is optimal habitat in Indiana.

Respondents listed top threats to mature/high canopy forest habitat in Indiana (not ranked):

- Habitat loss and fragmentation
  - Fragmentation of canopied forest habitats

## Appendix F-39: Mature or High Canopy Stage

- Predators/parasitism
- Cerulean warblers threats
  - Habitat loss and fragmentation
    - Fragmentation may allow predators and parasitism to occur by cowbirds, blue jays and raccoons due to fragment size. Fragmentation of forest in Indiana especially in predominately agricultural landscapes has resulted in small patches of forest surrounded by open habitat that cowbirds require for feeding and nest searching
    - Dependence on large tracts of mature deciduous forests, make the species especially sensitive to continuing forest fragmentation and isolation
  - Predators and parasitism
    - By brown-headed cowbirds (brood parasitism)
    - By blue jays (nest predation)
    - Raccoons (nest predation)
- Timber rattlesnake threats
  - Habitat loss and fragmentation: Rattlesnakes need large continuous blocks of forest habitat)
  - Predation/human disturbance: When habitat is loss or fragmented, rattlesnakes become susceptible to human and predator encounters

A respondent noted, "We still do not know the specific habitat preferences for this species. The types of habitats where these species were especially abundant in the past (i.e. old-growth bottomland forest) no longer exist. This area needs more research."

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to mature/high canopy forest habitats. There were no responses.

## Additional research and survey efforts

### Current body of research

#### Species research

All respondents stated that the current body of science is inadequate for wildlife in mature/high canopy forest habitat in Indiana.

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

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-39: Mature or High Canopy Stage

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

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in mature/high canopy forest habitats. There were no responses.

### Habitat research

Twenty percent of respondents stated that the current body of science is adequate for mature/high canopy forest habitat in Indiana, while 80 percent said that it is inadequate or nonexistent.

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

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

## Appendix F-39: Mature or High Canopy Stage

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for mature/high canopy forest habitats. There were no responses.

### Research needs

#### Species research

Respondents ranked research needs for wildlife in mature/high canopy forest habitat in Indiana:

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

A respondent noted another research need for wildlife in mature/high canopy forest habitat in Indiana:

- Effects of forestry practices on demography and presence and absence of cerulean warblers (TNC) proposed study

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 mature/high canopy forest habitats. There were no responses.

#### Habitat research

Respondents ranked research needs for mature/high canopy forest habitat in Indiana:

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

A respondent noted an additional research need for mature/high canopy forest habitat in Indiana:



## Appendix F-39: Mature or High Canopy Stage

- Effects of forestry practice on cerulean warblers presence or absence and on demography

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for mature/high canopy forest habitats. There were no responses.

## Conservation actions necessary

### Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in mature/high canopy forest habitat in Indiana:

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

Respondents noted no other current conservation practices for wildlife in mature/high canopy forest habitat in Indiana.

Respondents recommended these practices for more effective conservation of wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Habitat protection/restoration/acquisition
  - Increase area of mature, old growth, contiguous forests
  - Reduce fragmentation of forest blocks
- Public education
- More research needed for 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)
    - Hamel, P.B. 2000. Cerulean Warbler (*Dendroica cerulea*). In *The Birds of North America*, no. 511 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia.
    - Islam, K. and K.L. Roth. 2004. Habitat Selection and Reproductive Success of Cerulean Warblers in Southern Indiana. Final report submitted to U.S. Fish and Wildlife Service, Fort Snelling, MN, December 2002. Department of Biology Technical Report No. 4, Ball State University, Muncie, Indiana 51pp.
    - Islam, K. and C. Basile. 2002. Relative abundance and habitat selection of

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- Cerulean Warblers in Southern Indiana. Final report submitted to U.S. Fish and Wildlife Service, Fort Snelling, MN, December 2002. Department of Biology Technical Report No. 1, Ball State University, Muncie, Indiana 76pp.

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

- Also, increase the use even-aged management silviculture techniques to promote the regeneration of shade-intolerant oak species in order to sustain the oak-hickory forest cover type on the landscape.

### Habitat actions

Respondents ranked conservation efforts by how well they address threats to mature/high canopy forest habitat in Indiana:

Rank	Conservation efforts for mature/high canopy forest habitat
1	Restrict public access and disturbance
2	Habitat protection on public lands
3 (tie)	Habitat restoration on public lands
3 (tie)	Cooperative land management agreements (conservation easements)
3 (tie)	Habitat restoration through regulation
4	Land use planning
5 (tie)	Technical assistance
5 (tie)	Corridor development/protection
5 (tie)	Habitat protection incentives (financial)
5 (tie)	Protection of adjacent buffer zone
5 (tie)	Habitat protection through regulation
5 (tie)	Habitat restoration incentives (financial)
5 (tie)	Pollution reduction
5 (tie)	Succession control (fire, mowing)

Respondents listed no other current conservation practices for mature/high canopy forest habitat in Indiana.

Respondents recommended the following practices for more effective conservation of mature/high canopy forest habitat in Indiana (not ranked):

- Habitat protection and restoration on public and private land
  - Promote older growth/mature forest components

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- Land use planning
- Additional research needed for cerulean warblers (nest productivity, annual monitoring of populations to assess trends)

A respondent commented on habitat related to cerulean warblers, "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."

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of mature/high canopy forest habitats. There were no responses.

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Statewide once-a-year monitoring
- Periodic statewide (less than once a year but still regularly scheduled) monitoring
- Occasional statewide (less than once a year and not regularly scheduled) monitoring
- 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 were aware of the following monitoring efforts by other organizations for wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Statewide once-a-year monitoring
- Periodic statewide (less than once a year but still regularly scheduled) monitoring
- Occasional statewide (less than once a year and not regularly scheduled) monitoring
- 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 mature/high canopy forest habitat in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in mature/high canopy forest habitat
------	--

- |   |                                  |
|---|----------------------------------|
| 1 | Statewide once-a-year monitoring |
|---|----------------------------------|

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

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Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in mature/high canopy forest habitat in Indiana:

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

Respondents listed regional or local monitoring by state agencies for wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- 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 through DNR determines statewide distribution periodically. Does not produce quantitative measure of population size. 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
- IDNR has monitored timber rattlesnake in Brown, Monroe and Morgan counties

Respondents listed regional or local monitoring by other organizations for wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Cerulean warblers
  - Audubon Society supports May Day count throughout state which 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

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- 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
- Ball State 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 staff
- The USFS has contracted out survey work in the southern portions of the Hoosier National Forest

Respondents listed organizations that monitor wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- U.S. Fish and Wildlife Service
  - Big Oaks National Wildlife Refuge
- IDNR (Breeding Bird Atlas project)
- The Nature Conservancy
- Audubon
- American Bird Conservancy
- MAPS program (Point Reyes Bird Observatory)
- Local bird clubs
- Natural Resources Conservation Service (WRP program monitoring)
- USDA Forest Service, Hoosier National Forest
- U.S. Geological Survey (roadside bird surveys)
- 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

Respondents considered monitoring techniques for wildlife in mature/high canopy forest habitat in Indiana:

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

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

Respondents noted other monitoring techniques for wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- Nest monitoring, territory mapping, 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 mature/high canopy forest habitats. There were no responses.

### Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for mature/high canopy forest habitat in Indiana (not ranked):

- Occasional statewide (less than once a year and not 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 mature/high canopy forest habitat in Indiana (not ranked):

- Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
- Regional or local once-a-year 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 mature/high canopy forest habitat in Indiana:

Rank	Inventory and assessment by state agencies for conservation of mature/high canopy forest habitat
1 (tie)	Statewide annual inventory and assessment
1 (tie)	Statewide once-a-year inventory and assessment
1 (tie)	Regional or local once-a-year inventory and assessment
2	Regional or local year-round inventory and assessment
3	Periodic statewide (less than once a year but

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- still regularly scheduled) inventory and assessment
- 4 Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
  - 5 (tie) Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
  - 5 (tie) Occasional regional or local (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 mature/high canopy forest habitat in Indiana:

Rank	Inventory and assessment by other organizations for conservation of mature/high canopy forest habitat
1 (tie)	Statewide once-a-year inventory and assessment
1 (tie)	Regional or local once-a-year inventory and assessment
2	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
3 (tie)	Statewide annual inventory and assessment
3 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
4 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
4 (tie)	Regional or local year-round inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for mature/high canopy forest habitat in Indiana:

- The state examines habitat on state properties periodically and uses GAP and other habitat modeling programs to assess forest habitats

Respondents listed regional or local inventory and assessment by other organizations agencies for mature/high canopy forest habitat in Indiana (not ranked):



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- TNC, USFWS and USDA Forest Service uses habitat models to examine forest habitat in Indiana (Hoosier National Forest and Big Oaks National Wildlife Refuge)
- 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

Respondents listed organizations that monitor mature/high canopy forest habitat in Indiana (not ranked):

- INDNR
- USFWS
- USDA Forest Service
- TNC
- Cornell Lab of Ornithology
- 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

Respondents considered inventory and assessment techniques for mature/high canopy forest habitat in Indiana:

<b>Inventory and assessment techniques for mature/high canopy forest habitat</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	--	--
Aerial photography and analysis	X	--	--
Systematic sampling	X	--	--
Modeling	X	--	--
Voluntary landowner reporting	X	--	--

Respondents listed additional inventory and assessment techniques for mature/high canopy forest habitat 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

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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 mature/high canopy forest habitats. There were no responses.

### **Recommended monitoring**

#### Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in mature/high canopy forest habitat in Indiana (not ranked):

- A study that experimentally tests how forest management influences demography and presence and absence. Some wildlife species need basic life history studied, too
- Cerulean warblers
  - 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
  - Nest search and monitoring to assess productivity to determine if Indiana has a 'source' or 'sink' population of cerulean warblers (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)
- Roadside bird surveys on selected routes maximizing forest habitats
- Repeated point count surveys in representative forest sites
- Timber rattlesnakes
  - 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

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effect conservation of wildlife in mature/high canopy forest habitats. There were no responses.

#### Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of mature/high canopy forest habitat in Indiana (not ranked):

- GIS modeling, photo analysis and intensive study to determine habitat quality (source vs. sink)
- Cerulean warblers

## Appendix F-39: Mature or High Canopy Stage

- 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
- Systematic sampling/survey techniques to locate warblers (Hutto et al. 1986. Auk 103:593-602)
- Habitat association studies to determine which habitat types used/ preferred in Indiana

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 effect conservation of mature/high canopy forest habitats. There were no responses.

## OLD FOREST STAGE HABITATS NARRATIVE

### Habitat description

Old forest stage is typified with main overstory canopy trees that are relatively old and relatively large for the represented species on that site. Old forest is comprised of a significant number of standing snags and downed logs. More frequent and larger canopy gaps occur as older trees die and the gaps revert to the early forest stage.

### Problems affecting species and habitats

#### Species threats

The respondent did not indicate any “critical threat” or “serious threat” to wildlife in old forest stage habitats in Indiana. The respondent listed the following as “somewhat of a threat” (not ranked):

- Invasive/non-native species
- Habitat loss (breeding range, feeding/foraging areas)
- Large home range requirements
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

The respondent listed the following as “slight threat” to wildlife in old forest stage habitats in Indiana (not ranked):

- Predators (native or domesticated)
- Species overpopulation
- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Viable reproductive population size or availability
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed no additional threats to wildlife in old forest stage habitats in Indiana.

The respondent commented that availability and “quality of suitable nesting/feeding habitat” is the top threat to wildlife in old forest stage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in old forest stage habitats. There were no responses.

#### Habitat threats

The respondent did not indicate any “critical threat” or “serious threat” to old forest stage habitats in Indiana. The respondent listed the following as “somewhat of a threat” (not ranked):

- Commercial or residential development (sprawl)
- Counterproductive financial incentives or regulations
- Invasive/non-native species
- Habitat fragmentation
- Habitat degradation
- Impoundment of water/flow regulation
- Agricultural/forestry practices

## Appendix F-40: Old Forest Stage

The respondent listed the following as “slight threat” to old forest stage habitats in Indiana:

- Successional change
- Stream channelization
- Mining/acidification

The respondent noted no additional threats to old forest stage habitats in Indiana.

The respondent commented that “loss of cavity trees and harvest of older forests” is a top threat to old forest stage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to old forest stage habitats. There were no responses.

## Additional research and survey efforts

### Current body of research

#### Species research

The respondent indicated that the current body of science for wildlife in old forest stage habitats is adequate.

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

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

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

#### Habitat research

The respondent indicated that the current body of science for old forest stage habitats is adequate.

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

Title = see previous citations

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

## **Research needs**

### Species research

The respondent did not list any research needs for old forest stage wildlife in Indiana as “urgently needed” or “greatly needed.” The respondent stated that the following research is “needed” (not ranked):

- Life cycle
- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats
- Population health (genetic and physical)

The respondent listed no other research needs for wildlife in old forest stage habitats in Indiana.

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 old forest stage habitats. There were no responses.

### Habitat research

The respondent did not list any research needs for old forest stage habitats in Indiana as “urgently needed” or “greatly needed.” The respondent stated that the following research is “needed” (not ranked):

- Successional changes
- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of habitat

The respondent listed no other research needs for old forest stage habitats in Indiana.

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

## **Conservation actions necessary**

### Species actions

The respondent did not indicate any efforts that address threats to old forest stage wildlife in Indiana “very well.” The following addresses threats to wildlife “somewhat” (not ranked):

- Habitat protection
- Threats reduction
- Regulation of collecting

The respondent listed no other current conservation practices for wildlife in old forest stage habitats in Indiana.

## Appendix F-40: Old Forest Stage

The respondent recommended “conservation of forests and wise timber management emphasizing older forests” as specific practices for more effective conservation of old forest stage wildlife in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife in old forest stage habitats. There were no responses.

### Habitat actions

The respondent did not indicate any efforts that address threats to old forest stage habitats in Indiana “very well.” The following address threats “somewhat” (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Corridor development/protection
- Protection of adjacent buffer zone
- Restrict public access and disturbance
- Land use planning
- Technical assistance
- Cooperative land management agreements (conservation easements)

The respondent listed no other current conservation practices for old forest stage habitats in Indiana.

The respondent recommended “incentives to preserve forests” and “use good timber management practices” as specific practices for more effective conservation of old forest stage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for old forest stage habitats. There were no responses.

## **Proposed plans for monitoring**

### **Current monitoring**

#### Species monitoring

The respondent was aware of the following monitoring of old forest stage wildlife in Indiana conducted by state agencies:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent was aware of the following monitoring of old forest stage wildlife in Indiana conducted by other organizations:

- Statewide once-a-year monitoring

## Appendix F-40: Old Forest Stage

The respondent considered no monitoring techniques for wildlife in old forest stage habitats in Indiana as “very crucial.” The respondent considered Statewide once a year monitoring by other organizations to be “somewhat crucial” and Occasional statewide (less than once a year and not regularly scheduled) monitoring by other organizations “slightly crucial” for wildlife in old forest stage habitats in Indiana:

The respondent indicated that the following monitoring by state agencies takes place for wildlife in old forest stage habitats in Indiana:

- Breeding Bird Atlas – statewide

The respondent indicated that the following monitoring by other organizations takes place for wildlife in old forest stage habitats in Indiana (not ranked):

- Federal Breeding Bird Surveys – statewide
- Regional May Day Bird Counts
- Summer Bird Counts
- Christmas Bird Counts

The respondent indicated that the following entities participate in monitoring old forest stage wildlife in Indiana (not ranked):

- U.S. Geological Survey
- Birding groups
- National Audubon Society

The respondent indicated that “driving survey routes” and “volunteer census/surveys” are “frequently used” monitoring techniques for old forest wildlife in Indiana.

The respondent listed the following techniques as “occasionally used” (not ranked):

- Modeling
- Spot mapping
- Professional survey/census
- Representative sites
- Probabilistic sites

The respondent listed “radio telemetry/tracking” and “mark and recapture” as “not currently used but possible with existing technology and data” for wildlife in old forest stage habitats in Indiana.

The respondent listed no other monitoring techniques for wildlife in old forest stage habitats in Indiana.

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 old forest stage habitats. There were no responses.

### Habitat inventory and assessment

The respondent was aware of no inventory and assessment (statewide, local or regional) conducted by state agencies for old forest stage habitats in Indiana; therefore, no efforts are considered crucial. The respondent was aware of the following conducted by other organizations, and considered it “somewhat crucial” for old forest stage habitats in Indiana:



## Appendix F-40: Old Forest Stage

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent indicated that other organizations conduct the following inventory and assessment technique for old forest stage habitats in Indiana:

- Periodic aerial imaging

The respondent indicated that the following organizations might conduct inventory and assessment for old forest stage habitats in Indiana (not ranked):

- U.S. Department of Agriculture
- U.S. Geological Survey

The respondent indicated that no inventory and assessment techniques for old forest stage habitats in Indiana are “frequently used.” The respondent stated that these techniques are “occasionally used:”

- GIS mapping
- Aerial photography and analysis
- Systematic mapping
- Participation in landuse programs
- Modeling

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 old forest stage habitats. There were no responses.

## **Recommended monitoring**

### Species monitoring

The respondent recommended “annual statewide breeding bird surveys by federal agencies” to monitor wildlife in old forest stage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques needed for wildlife in old forest stage habitats. There were no responses.

### Habitat inventory and assessment

The respondent recommended “aerial imaging and modeling” to assess and inventory old forest stage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques needed for old forest stage habitats. There were no responses.

## Appendix F-41: Pole Stage

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## PRE-FOREST STAGE HABITATS NARRATIVE

### Habitat description

This is the initial stage as an area begins to revert from a cleared condition to forest. It is typified with annual/ perennial herbs, forbs and grasses with some shrubs and intolerant tree seedlings.

### Problems affecting species and habitats

#### Species threats

The respondent listed the following as “serious threat” to wildlife in pre-forest stage habitats in Indiana (not ranked):

- Invasive/non-native species
- Predators (native or domesticated)

The respondent listed the following as “somewhat of a threat” to wildlife (not ranked):

- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

The respondent listed the following as “slight threat” to wildlife (not ranked):

- High sensitivity to pollution
- Bioaccumulation of contaminants
- Diseases/parasites (of the species itself)

The respondent offered no additional threats to wildlife in pre-forest stage habitats in Indiana.

The respondent listed top threats to wildlife in pre-forest stage habitats in Indiana:

- The eastern towhee 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. A second top threat is loss of nest and nesting females to cats, chipmunks, snakes and other ground predators

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in pre-forest stage habitats. There were no responses.

#### Habitat threats

The respondent listed the following as “serious threat” to pre-forest stage habitats in Indiana (not ranked):

- Commercial or residential development (sprawl)
- Successional change
- Agricultural/forestry practices

The respondent listed the following as “somewhat of a threat” (not ranked):

- Invasive/non-native species
- Habitat fragmentation
- Habitat degradation

## Appendix F-42: Pre-Forest Stage

The respondent listed no "critical threat" or "slight threat" to pre-forest stage habitats in Indiana.

The respondent noted no additional threats to pre-forest stage habitats in Indiana.

The respondent listed top threats to pre-forest stage habitats in Indiana (not ranked):

- Urban development and sprawl
- Maturation of existing forest out of young forest age classes

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to pre-forest stage habitats. There were no responses.

## Additional research and survey efforts

### Current body of research

#### Species research

The respondent stated that the current body of science is adequate for wildlife in pre-forest stage habitats in Indiana.

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

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.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in pre-forest stage habitats. There were no responses.

#### Habitat research

The respondent stated that the current body of science is inadequate for pre-forest stage habitats in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of pre-forest stage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for pre-forest stage habitats. There were no responses.

## Appendix F-42: Pre-Forest Stage

### Research needs

#### Species research

The respondent listed the following research as “greatly needed” for wildlife in pre-forest stage habitats in Indiana (not ranked):

- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats

The respondent listed the following research as “needed” (not ranked):

- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)

The respondent listed the following research as “slightly needed:”

- Life cycle

The respondent listed no research as “urgently needed” for wildlife in pre-forest stage habitats in Indiana.

The respondent noted additional research needs for wildlife in pre-forest stage habitats in Indiana:

- The eastern towhee is a well-known, fairly common species. The general life-history literature is extensive. Population trends, habitat needs and threats are not well defined for Indiana. Documented population declines in databases such as the Breeding Bird Surveys are poorly explained.

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 pre-forest stage habitats. There were no responses.

#### Habitat research

The respondent listed research as “urgently needed” for pre-forest stage habitats in Indiana:

- Successional changes

The respondent listed research as “greatly needed:”

- Distribution and abundance (fragmentation)

The respondent listed research as “needed:”

- Threats (land use change/competition, contamination/global warming)

The respondent listed research as “slightly needed:”

- Relationship/dependence on specific site conditions

The respondent noted additional research needs for pre-forest stage habitats in Indiana:

- The 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 pre-forest stage habitats. There were no responses.

### Conservation actions necessary

## Appendix F-42: Pre-Forest Stage

### Species actions

The respondent stated that the following conservation efforts address threats to wildlife in pre-forest stage habitats in Indiana “somewhat” well (not ranked):

- Food plots
- Exotic/invasive species control
- Public education to reduce human disturbance

The respondent did not indicate that any conservation efforts address threats to wildlife “very well.”

The respondent noted additional conservation practices for wildlife in pre-forest stage habitats in Indiana:

- Education of public to reduce losses due to exotic predators such as cats probably is important to some local populations

The respondent recommended these practices for more effective conservation of wildlife in pre-forest stage habitats in Indiana (not ranked):

- Regional land management plans to retain young forest age classes and mixes of habitats within regional landscapes
- 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

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in pre-forest stage habitats. There were no responses.

### Habitat actions

The respondent indicated that the following conservation efforts address threats to pre-forest stage habitats in Indiana “very well” (not ranked):

- Succession control (fire, mowing)
- Land use planning

The respondent stated that the following conservation efforts address threats “somewhat” well (not ranked):

- Habitat restoration on public lands
- Protection of adjacent buffer zone

The respondent listed no other current conservation practices for pre-forest stage habitats in Indiana.

The respondent recommended the following practices for more effective conservation of pre-forest stage habitats in Indiana:

- Encouragement of forest management plans that retain/creates a mix of young and older forest should retain towhees in regional avifaunas. Forest habitat restoration provides habitat in early stages

## Appendix F-42: Pre-Forest Stage

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of pre-forest stage habitats. There were no responses.

### Proposed plans for monitoring

#### Current monitoring

##### Species monitoring

The respondent was aware of the following monitoring efforts by state agencies for wildlife in pre-forest stage habitats in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent was aware of the following monitoring efforts by other organizations for wildlife in pre-forest stage habitats in Indiana (not ranked):

- Statewide once-a-year monitoring
- Periodic statewide (less than once a year but still regularly scheduled) monitoring
- Regional or local once-a-year monitoring
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring

The respondent listed the following monitoring efforts by state agencies as “somewhat crucial” for conservation of wildlife in pre-forest stage habitats in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent listed the following monitoring efforts by other organizations as “very crucial” for conservation of wildlife in pre-forest stage habitats in Indiana (not ranked):

- Statewide once-a-year monitoring
- Regional or local once-a-year monitoring
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring

The respondent listed regional or local monitoring by state agencies for wildlife in pre-forest stage habitats in Indiana (not ranked):

- Statewide breeding bird atlas efforts are coordinated by IDNR. This atlas effort was done in the 1980s, and is being redone now.
- IDNR nongame bird program coordinates publication of a summer bird count that generates data on towhee numbers (along with all other summer birds). No analysis is done, however

The respondent listed regional or local monitoring by other organizations for wildlife in pre-forest stage habitats in Indiana (not ranked):

- Other bird monitoring efforts that collect data nationwide generate information on eastern towhees:
  - Breeding Bird Surveys
  - Christmas Bird Counts (towhees are rare in winter, though)
  - Cornell nest record program
  - The Hoosier National Forest conducts breeding bird monitoring on the forest since 1991

## Appendix F-42: Pre-Forest Stage

The respondent listed organizations that monitor wildlife in pre-forest stage habitats in Indiana (not ranked):

- USGS coordinates Breeding Bird Survey
- National Audubon Society coordinates Christmas Bird Counts
- Cornell's Laboratory of Ornithology collects nest records
- Federal agencies monitor lands they manage within the state (e.g., Hoosier National Forest)

The respondent considered monitoring techniques for wildlife in pre-forest stage habitats in Indiana:

Monitoring techniques for wildlife in pre-forest stage habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Spot mapping	X	--	--
Driving a survey route	X	--	--
Mark and recapture	--	X	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--

The respondent noted other no monitoring techniques for wildlife in pre-forest stage habitats in Indiana.

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 pre-forest stage habitats. There were no responses.

### Habitat inventory and assessment

The respondent was aware of the following inventory and assessment efforts by state agencies and other organizations for pre-forest stage habitats in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent was unaware of the importance these efforts for conservation of pre-forest stage habitats in Indiana.

The respondent listed regional or local inventory and assessment by state agencies for pre-forest stage habitats in Indiana (not ranked):

- Forest inventory plots in established forest management lands give some information on trends in early succession habitat
- Analysis of remote sensing data can provide some trend information where young forest classes can be mapped



## Appendix F-42: Pre-Forest Stage

The respondent added, "I am unaware of any regular coordinated effort by state or other agencies to monitor young forest age classes." The respondent referred readers to the above response regarding other inventory and assessment efforts or organizations that do them.

The respondent considered inventory and assessment techniques for pre-forest stage habitats in Indiana:

<b>Inventory and assessment techniques for pre-forest stage habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	--	--
Aerial photography and analysis	--	X	--
Modeling	X	--	--

The respondent listed no additional inventory and assessment techniques for pre-forest stage habitats in Indiana.

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 pre-forest stage habitats. There were no responses.

### **Recommended monitoring** Species monitoring

The respondent recommended the following monitoring techniques for effective conservation of wildlife in pre-forest stage habitats in Indiana (not ranked):

- Primary technique used is point counts of singing birds in breeding season, either by roadside counts (Breeding Bird Survey) or set survey points (e.g., Hoosier National Forest monitoring)
- Roadside surveys 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

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 in pre-forest stage habitats. There were no responses.

### Habitat inventory and assessment

The respondent recommended the following inventory and assessment techniques for effective conservation of pre-forest stage habitats in Indiana (not ranked):

## Appendix F-42: Pre-Forest Stage

- 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

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 pre-forest stage habitats. There were no responses.

## RIPARIAN WOODED CORRIDOR/STREAMS FOREST HABITATS NARRATIVE

### Habitat description

Forests associated with river and stream banks. Often utilized as travel corridors by wildlife and affects in-stream habitat.

### Problems affecting species and habitats

#### Species threats

The respondent listed the following as “serious threat” to wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

The respondent listed the following as “somewhat of a threat” to wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- High sensitivity to pollution
- Bioaccumulation of contaminants
- Predators (native or domesticated)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed the following as “slight threat” to wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Species overpopulation
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Large home range requirements
- Viable reproductive population size or availability

The respondent listed no “critical threat” to wildlife in this habitat.

The respondent offered no additional threats to wildlife in riparian wooded corridors/streams forest habitats in Indiana.

The respondent listed top threats to wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Loss and degradation of breeding and foraging habitats along river corridors and uplands

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in riparian wooded corridors/streams forest habitats. There were no responses.

#### Habitat threats

The respondent listed “serious threats” to riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Commercial or residential development (sprawl)

## Appendix F-43: Riparian Wooded Corridors/Streams

- Habitat fragmentation
- Habitat degradation
- Stream channelization

The respondent listed the following as “somewhat of a threat” to riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Counterproductive financial incentives or regulations
- Nonpoint source pollution (sedimentation and nutrients)
- Impoundment of water/flow regulation
- Agricultural/forestry practices
- Residual contamination (persistent toxins)
- Mining/acidification

The respondent listed the following as “slight threat” to riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Successional change
- Point source pollution (continuing)

The respondent listed no “critical threat” to these habitats.

The respondent noted no additional threats to riparian wooded corridors/streams forest habitats in Indiana.

The respondent listed top threats to riparian wooded corridors/streams forest habitats in Indiana:

- Loss and degradation of breeding and foraging habitats along river corridors and uplands

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to riparian wooded corridors/streams forest habitats. There were no responses.

## Additional research and survey efforts

### Current body of research

#### Species research

The respondent stated that the current body of science is adequate for wildlife in riparian wooded corridors/streams forest habitats in Indiana.

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

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

## Appendix F-43: Riparian Wooded Corridors/Streams

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in riparian wooded corridors/streams forest habitats. There were no responses.

### Habitat research

The respondent stated that the current body of science is adequate for riparian wooded corridors/streams forest habitats in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of riparian wooded corridors/streams forest habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for riparian wooded corridors/streams forest habitats. There were no responses.

## **Research needs**

### Species research

The respondent stated that the following research is “needed” for wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Life cycle
- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats
- Population health (genetic and physical)

The respondent noted no additional research needs for wildlife in riparian wooded corridors/streams forest habitats in Indiana.

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 riparian wooded corridors/streams forest habitats. There were no responses.

### Habitat research

The respondent stated that the following research is “needed” for riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Successional changes
- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of the habitat

The respondent noted no additional research needs for riparian wooded corridors/streams forest habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for riparian wooded corridors/streams forest habitats. There were no responses.

## Conservation actions necessary

### Species actions

The respondent stated that the following conservation efforts address threats to wildlife in riparian wooded corridors/streams forest habitats in Indiana “somewhat” well (not ranked):

- Habitat protection (use below for details)
- Threats reduction
- Regulation of collecting
- Protection of migration routes
- Limiting contact with pollutants/contaminants
- Public education to reduce human disturbance

The respondent did not list any efforts that addressed threats “very well.”

The respondent noted no other current conservation practices for wildlife in riparian wooded corridors/streams forest habitats in Indiana.

The respondent recommended these practices for more effective conservation of wildlife in riparian wooded corridors/streams forest habitats in Indiana:

- 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 of wildlife in riparian wooded corridors/streams forest habitats. There were no responses.

### Habitat actions

The respondent stated that the following conservation efforts “somewhat” address threats to riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration through regulation
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Corridor development/protection
- Pollution reduction
- Protection of adjacent buffer zone
- Restrict public access and disturbance
- Land use planning
- Technical assistance
- Cooperative land management agreements (conservation easements)

The respondent listed no other current conservation practices for riparian wooded corridors/streams forest habitats in Indiana.

The respondent recommended the following practices for more effective conservation of riparian wooded corridors/streams forest habitats in Indiana.

## Appendix F-43: Riparian Wooded Corridors/Streams

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of riparian wooded corridors/streams forest habitats. There were no responses.

### Proposed plans for monitoring

#### Current monitoring

##### Species monitoring

The respondent were aware of the following monitoring efforts by state agencies for wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

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

The respondent were aware of the following monitoring efforts by other organizations for wildlife in riparian wooded corridors/streams forest habitats in Indiana:

- Statewide once-a-year monitoring
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring

The respondent ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in riparian wooded corridors/streams forest habitats in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in riparian wooded corridors/streams forest habitats
1	Occasional statewide (less than once a year and not regularly scheduled) monitoring
2	Occasional regional or local (less than once a year and not regularly scheduled) monitoring

The respondent ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in riparian wooded corridors/streams forest habitats in Indiana:

Rank	Monitoring efforts by other organizations for conservation of wildlife in riparian wooded corridors/streams forest habitats
1 (tie)	Statewide once-a-year monitoring
1 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring

The respondent listed regional or local monitoring by state agencies for wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Statewide Breeding Bird Atlas
- Periodic local studies in southern Indiana

## Appendix F-43: Riparian Wooded Corridors/Streams

The respondent listed regional or local monitoring by other organizations for wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- Statewide Breeding Bird Atlas
- Periodic local studies in Hoosier National Forest

The respondent listed organizations that monitor wildlife in riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- USGS
- Universities

The respondent considered monitoring techniques for wildlife in riparian wooded corridors/streams forest habitats in Indiana:

Monitoring techniques for wildlife in riparian wooded corridors/streams forest habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	--
Modeling	X	--	--
Spot mapping	--	X	--
Driving a survey route	X	--	--
Mark and recapture	X	--	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	X	--	--
Representative sites	X	--	--

The respondent noted no other monitoring techniques for wildlife in riparian wooded corridors/streams forest habitats in Indiana.

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 riparian wooded corridors/streams forest habitats. There were no responses.

### Habitat inventory and assessment

The respondent was not aware of inventory and assessment efforts by state agencies for riparian wooded corridors/streams forest habitats in Indiana. Therefore, the respondent found no state agency efforts to be crucial for habitat conservation and could not name agencies involved in monitoring.



## Appendix F-43: Riparian Wooded Corridors/Streams

The respondent was aware of the following inventory and assessment efforts by other organizations for riparian wooded corridors/streams forest habitats in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent listed these efforts as “somewhat crucial” for habitat conservation.

The respondent listed regional or local inventory and assessment by other organizations agencies for riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- USFS
- USDA statewide (respondent unsure)

The respondent listed organizations that monitor riparian wooded corridors/streams forest habitats in Indiana (not ranked):

- USFS
- USDA (respondent unsure)

The respondent considered inventory and assessment techniques for riparian wooded corridors/streams forest habitats in Indiana:

<b>Inventory and assessment techniques for riparian wooded corridors/streams forest habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	--	--
Aerial photography and analysis	X	--	--
Systematic sampling	X	--	--
Participation in land use programs	X	--	--
Modeling	X	--	--
Voluntary landowner reporting	X	--	--

The respondent listed no additional inventory and assessment techniques for riparian wooded corridors/streams forest habitats in Indiana.

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 riparian wooded corridors/streams forest habitats. There were no responses.

### **Recommended monitoring** Species monitoring

## Appendix F-43: Riparian Wooded Corridors/Streams

The respondent recommended the following monitoring techniques for effective conservation of wildlife in riparian wooded corridors/streams forest habitats in Indiana:

- Road/streamside surveys in appropriate habitat

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 in riparian wooded corridors/streams forest habitats. There were no responses.

### Habitat inventory and assessment

The respondent recommended the following inventory and assessment techniques for effective conservation of riparian wooded corridors/streams forest habitats in Indiana:

- Aerial imagery coupled with modeling

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 riparian wooded corridors/streams forest habitats. There were no responses.

## Appendix F-44: Suburban

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## UPLAND FOREST HABITATS NARRATIVE

### Habitat description

*Upland forest habitats* are areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25 to 100 percent of the cover. Upland forest habitats include the following sub-habitat types:

- *Deciduous forest habitats* are dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.
- *Evergreen forest habitats* are dominated by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.
- *Mixed forest habitats* are dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

### Problems affecting species and habitats

#### Species threats

The respondent listed the following as “serious threat” to wildlife in upland forest habitats in Indiana (not ranked):

- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Small native range (high endemism)
- Near limits of natural geographic range

The respondent listed the following as “somewhat of a threat:”

- Specialized reproductive behavior or low reproductive rates

The respondent listed the following as “slight threat” (not ranked):

- Predators (native or domesticated)
- Unregulated collection pressure
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

The respondent listed no “critical threat” to wildlife in upland forest habitats in Indiana.

The respondent noted no additional threats to wildlife in upland forest habitats in Indiana.

The respondent listed top threats to wildlife in upland forest habitats in Indiana:

- Crowned snake: Little is known about the crowned snake in Indiana. Top threats include (not ranked):
  - Habitat destruction
  - Habitat fragmentation
  - Accidental take

## Appendix F-45: Upland

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

### Habitat threats

The respondent listed the following as “serious threat” to upland forest habitats in Indiana:

- Invasive/non-native species

The respondent listed the following as “somewhat of a threat” (not ranked):

- Habitat fragmentation
- Successional change

The respondent listed no “critical threat” or “slight threat” to upland forest habitats in Indiana.

The respondent noted no additional threats to upland forest habitats in Indiana.

The respondent listed top threats to upland forest habitats in Indiana (not ranked):

- Invasive species encroachment
- Habitat destruction

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to upland forest habitats. There were no responses.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

The respondent stated that the current body of science is inadequate for wildlife in upland forest habitats in Indiana.

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

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

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

## Appendix F-45: Upland

### Habitat research

The respondent was unaware of the current body of science for upland forest habitats in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of upland forest habitats in Indiana.

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

### **Research needs**

#### Species research

The respondent listed the following research as “urgently needed” for wildlife in upland forest habitats in Indiana:

- Distribution and abundance

The respondent listed the following research as “greatly needed:”

- Population health (genetic and physical)

The respondent listed the following research as “needed” (not ranked):

- Life cycle
- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)

The respondent listed the following research as “slightly needed:”

- Relationship/dependence on specific habitats

The respondent noted other research needs for wildlife in upland forest habitats in Indiana:

- General life history 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 upland forest habitats. There were no responses.

### Habitat research

The respondent did not answer questions regarding research needs for upland forest habitats in Indiana.

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

### **Conservation actions necessary**

#### Species actions

The respondent ranked conservation efforts by how well they address threats to wildlife in upland forest habitats in Indiana:

## Appendix F-45: Upland

Rank	Conservation efforts for wildlife in upland forest habitats
------	---

- |         |  |
|---------|--|
| 1       | Habitat protection (use below for details) |
| 2 (tie) | Exotic/invasive species control            |
| 2 (tie) | Regulation of collecting                   |

The respondent noted no other current conservation practices for wildlife in upland forest habitats in Indiana.

The respondent recommended these practices for more effective conservation of wildlife in upland forest habitats in Indiana:

- For the Southeastern crowned snake:
  - Habitat protection
  - Research of general life history requirements

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife in upland forest habitats. There were no responses.

### Habitat actions

The respondent did not answer questions about conservation efforts for upland forest habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for upland forest habitats. There were no responses.

## **Proposed plans for monitoring**

### **Current monitoring**

#### Species monitoring

The respondent was aware of the following monitoring efforts by state agencies for wildlife in upland forest habitats in Indiana:

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

The respondent was aware of no monitoring efforts by other organizations for wildlife in upland forest habitats in Indiana.

The respondent listed the following monitoring efforts by state agencies and other organizations as "somewhat crucial" for conservation of wildlife in upland forest habitats in Indiana (not ranked):

- 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

## Appendix F-45: Upland

The respondent listed regional or local monitoring by state agencies for wildlife in upland forest habitats in Indiana:

- IDNR occasionally monitors this species (crowned snake)

The respondent listed regional or local monitoring by other organizations for wildlife in upland forest habitats in Indiana:

- TNC occasionally monitors this species (crowned snake)

The respondent listed no organizations that monitor wildlife in upland forest habitats in Indiana.

The respondent considered monitoring techniques for wildlife in upland forest habitats in Indiana:

Monitoring techniques for wildlife in upland forest habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Modeling	--	X	--
Coverboard routes	--	X	--
Spot mapping	--	X	--
Driving a survey route	--	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	--	X	--
Mark and recapture	--	X	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	--	X	--
Representative sites	--	X	--
Probabilistic sites	--	X	--

The respondent noted no other monitoring techniques for wildlife in upland forest habitats in Indiana.

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 upland forest habitats. There were no responses.

### Habitat inventory and assessment



## Appendix F-45: Upland

The respondent was aware of the following inventory and assessment efforts by state agencies for upland forest habitats in Indiana (not ranked):

- Statewide annual 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

The respondent was not aware of inventory and assessment efforts by other organizations for upland forest habitats in Indiana. Therefore the respondent did not rank any organizational efforts.

The respondent listed the following inventory and assessment efforts by state agencies as “somewhat crucial” for conservation of upland forest habitats in Indiana:

- Statewide annual inventory and assessment

The respondent listed regional or local inventory and assessment by state agencies for upland forest habitats in Indiana:

- I am not sure how often state agencies survey crowned snake habitat. IDNR – Division of Nature Preserves monitors these habitats

The respondent listed organizations that monitor upland forest habitats in Indiana:

- IDNR – Division of Nature Preserves
- TNC

The respondent listed “systematic sampling” as a “frequently used” inventory and assessment technique for upland forest habitats in Indiana. The respondent did not comment on other level of use and feasibility for other inventory and assessment techniques.

The respondent listed additional inventory and assessment techniques for upland forest habitats in Indiana:

- I believe 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 upland forest habitats. There were no responses.

## **Recommended monitoring**

### Species monitoring

The respondent recommended the following monitoring techniques for effective conservation of wildlife in upland forest habitats in Indiana:

- I would recommend the use of professional surveys and test the effectiveness of cover objects for trapping Southeastern crowned snake.

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 in upland forest habitats. There were no responses.

### Habitat inventory and assessment

## Appendix F-45: Upland

The respondent recommended no inventory and assessment techniques for effective conservation of upland forest habitats in Indiana.

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 upland forest habitats. There were no responses.

## Appendix F-46: Urban

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## GENERALIST HABITAT NARRATIVE

### Problems affecting species and habitats

#### Species threats

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

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

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

- Urban sprawl
- Although not habitat specific, the inability to responsibly and proactively manage coyotes, raccoons and opossums according to the wildlife conservation model, as opposed to reactive measures through nuisance practices, is a concern regarding conservation of these species. This concern applies across the landscape, not just in urban and suburban environments

## Appendix F-47: Generalist

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

- Coyotes are highly adaptable and seemingly expanding their numbers across the state. People are generally “anti-coyote,” fearing predation on pets, livestock and wildlife
- Exclusion of maternity colonies from buildings
- Although not habitat specific, the inability to responsibly and proactively manage coyotes, raccoons and opossums according to the wildlife conservation model, as opposed to reactive measures through nuisance practices, is a concern regarding conservation of these species. This concern applies across the landscape, not just in urban and suburban environments
- Build-up of dense, urban development around roost location without adequate greenspace for foraging

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

### Habitat threats

Respondents ranked threats to generalist habitat in Indiana:

Rank	Threats to generalist habitat
1	Counterproductive financial incentives or regulations
2	Commercial or residential development (sprawl)
3	Habitat degradation
4 (tie)	Successional change
4 (tie)	Agricultural/forestry practices
5 (tie)	Nonpoint source pollution (sedimentation and nutrients)
5 (tie)	Residual contamination (persistent toxins)
5 (tie)	Point source pollution (continuing)
6	Habitat fragmentation
7	Stream channelization
8	Mining/acidification
9	Invasive/non-native species

Respondents noted no other threats to generalist habitat in Indiana. A respondent noted, “The participant has to speculate about the meaning of successional change. Is a ‘change’ an increase or decrease in early successional habitats? Climate change also is speculative. Agriculture/forestry practices may have different effects. Grouping these practices into a single category does not appropriately represent each individual practice.”

A respondent listed top threats to generalist habitat in Indiana (not ranked):

- Urban sprawl
- Agriculture/forestry practices

## Appendix F-47: Generalist

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

### **Additional research and survey efforts**

#### **Current body of research**

##### Species research

Thirty-four percent of respondents stated that the current body of science for wildlife in generalist habitat in Indiana is complete, up to date and extensive or adequate. Seventeen percent of respondents said that it is inadequate.

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

Title = Mammals of Indiana;  
Author = Mumford/Whitaker;  
Date = 1982;  
Publisher = IU Press

Title = Ecology of coyotes as influenced by landscape fragmentation;  
Author = Todd Attwood;  
Date = May 2002;  
Publisher = Purdue University

Title = Mammals of Indiana;  
Author = John Whitaker;  
Date = 2005 (currently in press);  
Publisher = IU Press

Title = Foraging-habitat selection by bats at an urban-rural interface: comparison between a successful and a less successful species.;  
Author = Duchamp, Sparks, Whitaker;  
Date = 2004;  
Publisher = Canadian Journal of Zoology

Title = Raccoon density, home range, and habitat use on south-central Indiana farmland.;  
Author = Larry Lehman;  
Date = 1984;  
Publisher = IDF&W

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

##### Habitat research

Forty percent of respondents stated that the current body of science for generalist habitat in Indiana is complete, up to date and extensive or adequate. The remainder of respondents couldn't judge the status and marked "unknown."

## Appendix F-47: Generalist

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

Title = Natural Heritage of Indiana;  
Author = MT Jackson;  
Publisher = IU Press

Title = Indiana GAP data;  
Date = Unpublished available form ISU dept of Geography

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

### Research needs

#### Species research

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

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

Respondents noted no other research needs for wildlife in generalist habitat in Indiana.

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 generalist habitat. There were no responses.

#### Habitat research

Respondents ranked research needs for generalist habitat in Indiana:

Rank	Research needs for generalist habitat
1	Threats (land use change/competition, contamination/global warming)
2	Successional changes

Respondents noted no additional research needs for generalist habitat in Indiana.

## Appendix F-47: Generalist

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

### Conservation actions necessary

#### Species actions

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

Rank	Conservation efforts for wildlife in generalist habitat
1	Culling/selective removal
2 (tie)	Regulation of collecting
2 (tie)	Habitat protection
3	Population management (hunting, trapping)
4	Food plots

Respondents noted no other current conservation practices for wildlife in generalist habitat in Indiana.

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

- Although not habitat specific, outreach programs are needed to effectively and accurately educate citizens about game and nongame, the wildlife conservation model (for both) and the need for effective coyote, raccoon and opossum management programs
- Protect bats as part of historic home preservation
- Research into how to allow peaceful and safe coexistence between bats and homeowners

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

#### Habitat actions

Respondents were aware of the following conservation efforts “somewhat” addressing the threats to generalist habitat in Indiana:

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration through regulation
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Corridor development/protection
- Protection of adjacent buffer zone
- Cooperative land management agreements (conservation easements)
- Restrict public access and disturbance



## Appendix F-47: Generalist

- Technical assistance

Respondents listed no other current conservation practices for generalist habitat in Indiana; they provided no recommendations for more effective conservation of this habitat.

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

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

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

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

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

- Occasional statewide (less than once a year and not 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 generalist habitat in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in generalist habitat
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
2	Statewide once-a-year monitoring

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

Rank	Monitoring efforts by other organizations for conservation of wildlife in generalist habitat
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## Appendix F-47: Generalist

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

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

- Coyote
  - Fur harvest report
  - Small game harvest questionnaires
- Bats
  - State rabies lab
  - DNR monitoring records for mist net captures
- Indiana Division of Fish and Wildlife: Population monitoring efforts at state, regional and local levels are occurring to obtain annual population trends, but they are not habitat specific, nor do they encompass all habitat types associated with generalist species

Respondents listed regional or local monitoring by other organizations for wildlife in generalist habitat in Indiana:

- Indiana State University by John O. Whittaker (Public survey soliciting information on known bat populations)

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

- Indiana Division of Fish and Wildlife. IDF&W uses professional, road-kill surveys to monitor annual population trends at the state, regional and local scales. However, monitoring is not a means to associate opossum and raccoon activity with particular habitats, as inferred in the questionnaire
- Farm Bureau and other agricultural groups might do informal monitoring, but if so, it would be to prove that there are too many

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

Monitoring techniques for wildlife in generalist habitat	Used	Not used but possible	Not economically feasible
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Appendix F-47: Generalist

		with existing technology and data	
Radio telemetry and tracking	X	--	--
Modeling	--	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	--	--
Mark and recapture	--	X	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	X	--	--

Respondents noted other monitoring techniques for wildlife in generalist habitat in Indiana (not ranked):

- Coyote
  - Howling counts
  - Reports of coyote depredation on pets or livestock
- Indiana Division of Fish and Wildlife uses professional survey/census to monitor annual population trends, but it is not means to associate raccoon activity within all generalist habitat types

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 generalist habitat. There were no responses.

Habitat inventory and assessment

Respondents were aware of no following inventory and assessment efforts by state agencies and other organizations for generalist habitat in Indiana.

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of generalist habitat in Indiana:

Rank	Inventory and assessment by state agencies for conservation of generalist habitat.
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment

## Appendix F-47: Generalist

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

Respondents listed no inventory and assessment efforts by other organizations as important to generalist habitat in Indiana.

Respondents did not offer regional or local inventory and assessment by state agencies or other organizations; they did not list organizations that monitor generalist habitat in Indiana.

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

<b>Inventory and assessment techniques for generalist habitat</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	--	X	--
Aerial photography and analysis	--	X	--
Systemic sampling	--	X	--
Participation in land use programs	X	--	--
Modeling	--	X	--
Voluntary landowner reporting	X	X	--

## Appendix F-47: Generalist

Respondents listed no additional inventory and assessment techniques for generalist habitat in Indiana.

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 generalist habitat. There were no responses.

### **Recommended monitoring**

#### Species monitoring

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

- Harvest information
- Depredation information
- Indiana Division of Fish and Wildlife uses harvest reports and professional surveys. However, these techniques are not habitat specific, nor do they cover the full spectrum of habitats associated with generalist species
- Bats
  - Mark-recapture monitoring of representative colonies across the state
  - Survey a sample of Indiana residents every 10 years as to whether they have bats in their homes. (Followup affirmative responses with a visit to confirm 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 in generalist habitat. There were no responses.

#### Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of generalist habitat in Indiana:

- GIS mapping and aerial photography

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 generalist habitat. There were no responses.

## ALL GRASSLAND HABITATS NARRATIVE

This habitat narrative is the results of the aggregated data for all grassland sub-habitat types.

### Habitat description

Open area dominated by grass species, for example, prairies or reclaimed minelands.

### Problems affecting species and habitats

#### Species threats

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

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

## Appendix F-48: Aggregated Grasslands

Respondents offered additional threats to wildlife in all grassland habitats in Indiana (not ranked):

- Changes in burrowing crayfish or rodent populations that would impact the availability of burrows
- Introduction of fish into formally fishless breeding waters
- Development of barriers between the crayfish frog's burrow and breeding waters
- Cold wet weather when first litters appear (late March and early April)
- Cottontail rabbits
  - Agricultural policy, i.e., production without supply side considerations, influence availability of the habitats
  - Cottontails are a game species and utilized heavily as a recreational resource, and therefore a luxury. The tradeoff is that the American public wants beef, corn and related foodstuffs at a low cost. The cottontail will not prevail here as being necessary under those societal needs
  - Habitat loss to natural succession is a critical threat to cottontail populations in Indiana
- Impacts of herbicides and pesticides drifting over from nearby agricultural lands is unknown
- Mowing in June, July and August
- Early harvesting of hay crops
- Fire suppression is a major threat to many, many species in the state. Savannah habitats are seriously degraded because fire suppression has allowed shade tolerant species to dominate the understory, changing the open savannah structure into a dense forest with an impenetrable understory. Fire keeps the structure open and results in a varied mosaic of habitats, including fire killed trees that provide both food and shelter

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

- Habitat loss, degradation, fragmentation
  - Land use changes or other factors that impact the availability and persistence of suitable burrows
  - Loss of habitat, plus people trying to remove them from their lawns and gardens
  - Loss of grasslands, and grassland ground squirrel populations
  - Habitat loss to uncontrolled vegetative succession is a serious threat
  - Habitat loss due to agricultural practices
  - Short-tailed shrew: Habitat loss in this relatively specialized habitat is the primary threat to the short-tailed shrew. Early successional grassland habitats provide marginal habitat requirements for this specialized species. The short-tailed shrew is an insectivore/vermivore. Early successional grassland habitat occurs in abandoned land associated with either agricultural, industrial or urban land uses. Only in isolated situations do grasslands develop as a dominant habitat type in Indiana. Most grasslands will eventually be dominated by shrub or tree cover. By definition early successional grassland habitat is a temporary habitat type
  - Loss of quality nesting and brood habitat
  - Lack of large areas in native grass
  - Habitat loss due to fire suppression

## Appendix F-48: Aggregated Grasslands

- Redheaded woodpecker: This species is more of an obligate to open areas with scattered dead trees than most Indiana species. Outright loss of this habitat configuration is probably the leading threat
- Crayfish frog
  - Introduction of fish into formally fishless breeding waters
  - Development of barriers between the crayfish frog's burrow and breeding waters
- Agricultural policy/loss of farm programs
  - Bobwhite quail
    - The primary threat is the loss of these farm programs
    - An additional threat would be the loss or shortening of the primary nesting season dates established by USDA
- Farm practices
  - Habitat loss due to agricultural practices
  - Bobwhite quail: Mowing or haying during the quail nesting season would be allowed on enrolled acreage if these dates were eliminated or shortened.
  - Timing and frequency of haying, as well as the cover type (alfalfa) can negatively affect nest success and limit productivity
  - Mowing grasslands
  - Invasive/non-native vegetative species such as fescue do not provide cover, nutrition and are thought to be toxic
  - Fire suppression
- Domestic predators
  - Habitat loss and fragmentation create small, isolated patches where nest predation and brood parasitism tend to increase
- Specialized habitat
  - Short-tailed shrew: Habitat loss in this relatively specialized habitat is the primary threat to the short-tailed shrew. Early successional grassland habitats provide marginal habitat requirements for this specialized species
- Disease
  - Redheaded woodpecker: West Nile Virus is probably currently the second greatest threat
- Small population size and low reproductive rate
  - Most known populations seem to occur at such low densities that mating seems a remote possibility. All problems associated with small population size and low reproductive rate seem likely to plague the Ornate box turtle. Most populations seem likely to be in a slow-motion death spiral at the moment

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 grasslands habitats. Their responses included:

- The greatest threat to grassland birds nesting in Indiana would be losing these reclaimed mineland grasslands to housing developments, golf courses and industrial development.

### Habitat threats



## Appendix F-48: Aggregated Grasslands

Respondents ranked threats to all grassland habitats in Indiana:

Rank	Threats to all grassland habitats
1 (tie)	Habitat degradation
2	Successional change
3	Agricultural/forestry practices
4	Commercial or residential development (sprawl)
5	Habitat fragmentation
6	Counterproductive financial incentives or regulations
7	Invasive/non-native species
8	Residual contamination (persistent toxins)
9	Mining/acidification
10	Point source pollution (continuing)
11	Climate change
12	Nonpoint source pollution (sedimentation and nutrients)
13	Drainage practices (stormwater runoff)
14	Diseases (of plants that create habitat)
15	Stream channelization
16	Impoundment of water/flow regulation

Respondents noted additional threats to all grassland habitats in Indiana (not ranked):

- Badgers: Mowing or burning for aesthetic purposes such that badger prey population or badger cover are diminished
- No financial incentive to develop/maintain/manage these habitats
- Bobwhite quail: If the farm bill programs (e.g. CRP) were to be eliminated the negative effects on Indiana's northern bobwhite population would be substantial
- Red-headed woodpecker: Loss of disturbance regimes that maintained the open structure of savannahs and swamp forests where the red-headed woodpecker resides
- Fire suppression is the major threat. Lack of fire also results in an increase of shade-tolerant invasive species like garlic mustard and Asian bush honeysuckle, further degrading the savannah habitat

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

- Agricultural practices
  - Cattle grazing, farming, and development activities that affect the persistence of burrows in formally flooded or moist grasslands
  - Invasion of early successional grasslands by tall fescue

## Appendix F-48: Aggregated Grasslands

- Another threat is early mowing or haying during the primary nesting season. These activities are not currently allowed until after July 15 but mowing during late July and early August still destroys some nests and young
- Conversion of hayfields to row crop
- Habitat loss and fragmentation
  - Draining of breeding ponds, ditches; introducing fish into breeding waters
  - Loss of grasslands, and grassland ground squirrel populations
  - Due to agricultural practices
  - Due to urban sprawl/conversion to urban cover types
  - Conversion of savannah to development uses
  - Fragmentation and small habitat size – most habitats are small remnants of native grassland, surrounded by either agriculture or fire-suppressed oak savannah. Habitat size needs to be expanded at sites which support seemingly salvageable populations of the Ornate box turtle
- Successional change/fire suppression
  - Results in habitat degradation as grasslands are invaded by woody vegetation
  - Fire suppression is resulting in successional change to more shade-tolerant forests. Forestry practices are not emphasizing the need for fire in savannah areas enough
- Exotic/invasive species
  - Fescue invasion
  - Much potentially suitable habitat has been lost through succession to exotic species and oak woodland. This turtle requires expansive open grassland. Lack of habitat management, or in the case of invasive species, because of the purposeful introduction of invasive shrubs, has resulted in open native grassland being lost to shrub land and oak woodland
- Agricultural policy
- Competing products (food)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to all grasslands habitats. There were no responses.

## Additional research and survey efforts

### Current body of research

#### Species research

Thirty-three percent respondents stated that the current body of science is adequate for wildlife in all grassland habitats in Indiana; sixty-seven percent stated that it is inadequate or nonexistent.

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

Title = Amphibians and reptiles of Indiana;  
Author = Sherman A. Minton, Jr.;  
Date = 2001;

## Appendix F-48: Aggregated Grasslands

Publisher = Indiana Academy of Sciences

Author = [www.natureserve.org/explorer](http://www.natureserve.org/explorer)

Title = Mamm. IN;  
Author = M & W 1982

Title = Mammals of the Eastern United States;  
Author = J.O. Whitaker, Jr. and W. J. Hamilton, Jr.;  
Date = 1998;  
Publisher = Cornell University Press

Author = [www.natureserve.org/explorer](http://www.natureserve.org/explorer)

Title = Mammals of Indiana;  
Author = Mumford;  
Date = ?;  
Publisher = ?

Title = Mammals of the Great Lake States;  
Author = ?;  
Date = ?;  
Publisher = ?

Title = Mammals of IN;  
Author = Russel Mumford & John Whitaker Jr;  
Date = 1982;  
Publisher = IN Universty Press

Title = Reduction in the Eastern Limit of the Range of the Franklin's Ground Squirrel;  
Author = Scott Johnson and Jane Choromanski-Norris;  
Date = 1992;  
Publisher = American Midland Naturalist 128:325-331.

Title = Franklin's Ground Squirrel in Illinois: A Declining Prairie Mammal?;  
Author = Jason Martin, Edward Heske, Joyce Hofman;  
Date = 2003;  
Publisher = American Midland Naturalist 150:130-138.

Title = A 14-year study of BLARINA BREVICAUDA in east-central Illinois.;  
Author = Getz, L. L.;  
Date = 1989;  
Publisher = J. Mammalogy 70:58-66.

Title = Blarina bravicauda;  
Author = George, S. B., J. R. Choate, and H. H. Genoways;  
Date = 1986;  
Publisher = Mammalian Species 261:1-9

Title = Population Ecology and Harvest of the Cottontail Rabbit;  
Author = Heraold A. Demaree, Jr;  
Date = 1978;

Title = Population ecology and harvest of the cottontail rabbit on the Pigeon River fish and wildlife area, 1962-1970;

## Appendix F-48: Aggregated Grasslands

Author = Harold Demaree Jr.;  
Date = 1978;  
Publisher = Indiana Division of Fish and Wildlife

Title = HESPS in mine land MS Thesis;  
Author = Travis Devault;  
Date = 2000;  
Publisher = Indiana State Univ

Title = Forest and Grassland Bird Productivity;  
Author = Robb et. al.;  
Date = 1998;  
Publisher = USFWS internal report

Title = Atlas of Breeding Birds of Indiana;  
Author = J.S. Castrale, E.M. Hopkins, & C.E. Keller;  
Date = 1998;  
Publisher = IDNR

Title = Effects of management practices on grassland birds: Bobolink;  
Author = Dechant, J.A., M.L. Sondreal, D.H. Johnson, L.D. Igl, C.M. Goldade, A.L. Zimmerman and B.R. Euliss;  
Date = 2001;  
Publisher = Northern Prairie Wildlife Research Center

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

Title = BNA Account - Savannah;  
Author = Wheelwright and Rising;  
Date = 1993;  
Publisher = American Ornithologists' Union

Title = Red-headed Woodpecker (*Melanerpes erythrocephalus*). In *The Birds of North America*, No. 518;  
Author = Smith, K. G., J. H. Withgott, and P. G. Rodewald.;  
Date = 2000;  
Publisher = The Birds of North America, Inc., Philadelphia, PA.

Title = 1998. Atlas of Breeding Birds of Indiana Atlas of Breeding Birds of Indiana;  
Author = Castrale, John S., Edward M. Hopkins, and Charles E. Keller.;  
Date = 1998;  
Publisher = Indiana Department of Natural Resources

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

- Also, see list of literature references pertaining to reclaimed minelands, habitat fragmentation and brown-headed cowbird parasitism.

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### Habitat research

Forty-two percent of respondents stated that the current body of science is adequate for all grassland habitats in Indiana; fifty-four percent stated that it is inadequate or nonexistent.

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

Title = Mammals of Indiana;  
Author = Mumford/Whitaker;  
Date = 1982;  
Publisher = IU Press

Title = A4-year study study of BLARINA BREVICAUDA un east-central Illinois;  
Author = Getz, L. L.;  
Date = 1989;  
Publisher = J. Mammalogy 70:58-66.

Title = Strip mine grassland birds;  
Author = Travis Devault;  
Date = 2000;  
Publisher = Indiana State Univ.

Title = Vegetation management practices on conservation reserve program fields to improve northern bobwhite habitat quality;  
Author = Greenfield, K. C.; W. B. Burger Jr.; M. J. Chamberlain, E. W. Kurzejeski;  
Date = 2002;  
Publisher = Wildlife Society Bulletin

Title = Surviving where ecosystems meet: ecotonal animal communities of midwestern oak savannas and woodlands;  
Author = Temple, Stanley A.;  
Date = 1998;  
Publisher = Transactions of the Wisconsin Academy of Sciences, Arts and Letters 86: 206-222

Title = Savannas, barrens, and rock outcrop plant communities of North America;  
Author = Anderson, Roger C., Fralish, James S. , and Baskin, Jerry M.;  
Date = 1999;  
Publisher = Cambridge University Press

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

### **Research needs**

#### Species research

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

Rank	Research needs for wildlife in all grassland habitats
1	Limiting factors (food, shelter, water, breeding sites)

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- 2 Threats (predators/competition, contamination)
- 3 Relationship/dependence on specific habitats
- 4 Population health (genetic and physical)
- 5 Distribution and abundance
- 6 Life cycle

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

- Some wildlife species are in great need of study on all aspects of its ecology
- We need more information on the reproduction of some wildlife species in various habitats
- Badgers: The relationship between badgers and land use and soil type, especially soil types that support borrows both for the badger and its prey
- Cottontail rabbits: Determine what affect feral cats have on a local cottontail population
- I would like to see some research to determine the extent to which mowing and haying negatively impact production following the end of the primary nesting season (as defined by the USDA). Following July 15 in Indiana landowners can mow or hay there enrolled lands. I believe a substantial proportion of bobwhites are still nesting at that time
- How to reduce clean farming and increasing field size
- Detailed demographic data need to be gathered and the effects of habitat structure and fragmentation on those demographic parameters understood

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 grasslands habitats. There were no responses.

### Habitat research

Respondents ranked research needs for all grassland habitats in Indiana:

Rank	Research needs for all grassland 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

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### 5 Growth and development of individual components of the habitat

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

- Crawfish frogs: Habitat needs to be adequately described
- Additional information on all phases of the biology of some wildlife species would be helpful. However, some are in no current danger
- Badgers: The difference between native, warm-season-grass/native for grasslands; planted, non-native, cool-season grasslands and CRP grasslands relative to suitability for badgers
- Seeding mixtures and mid-contract management activities currently utilized on Farm Bill lands need to be evaluated to determine their value to bobwhite nesting and brood rearing
- How to create and maintain quality grassland habitat on a permanent basis
- Timing and frequency of haying and other agricultural disturbances
- Relationship of fire to habitat structure needs to be better elucidated

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

## Conservation actions necessary

### Species actions

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

Rank	Conservation efforts for wildlife in grassland habitats
1	Population management (hunting, trapping)
2	Public education to reduce human disturbance
3	Exotic/invasive species control
4	Protection of migration routes
5 (tie)	Food plots
5 (tie)	Threats reduction
6	Habitat protection
7 (tie)	Regulation of collecting
7 (tie)	Native predator control
7 (tie)	Limiting contact with pollutants/contaminants

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Respondents noted other current conservation practices for wildlife in all grassland habitats in Indiana (not ranked):

- Crawfish frog: Study burrow-making crayfish and their burrows
- Saving grassland (and woodland) will help this animal
- Vegetative succession control/fire management
- Cottontail rabbits: Provide additional habitats through programs, agricultural and other. Rabbits are a byproduct of the economy. The more human needs placed on the landscape the less amount of by products will be produced. If we select for beef and corn there will be less rabbits. By selecting for, you simultaneously select against something else
- Restoration of native grasslands, and increased enrollment in Conservation Reserve Program provide refuges from agricultural disturbances (provided the proper vegetation structure is maintained)
- Water level management in swamp forests

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

- Crawfish frog: Promote non-disturbance in known crawfish frog habitat
- Identify breeding sites and protect the sites from disturbance and the introduction of fish
- Conservation and restoration of ground squirrel and pocket gopher populations
- Limit human access to all parts of large grasslands
- Protect, conserve and restore early successional habitat
  - Promote early succession associated with structure similar to *L. japonica*
  - The best strategy would be to protect as much early successional habitat as possible but that habitat must be manipulated periodically to set back natural succession
  - Manage lands for early successional grassland habitat - would require land use change every three to five years
  - Long-term fire management of existing savannah sites
  - Restoration of grassland habitats adjacent to known population sites would be a great start. Restoration could involve creation of native grassland system from adjacent agricultural fields, with the restoration designed to create habitat specifically for this and other species
  - Restoration of oak savannah at known sites would involve opening the canopy in oak woodlands to ~50 percent cover and control of invasive exotic shrubs. This would restore connectivity between potentially occupied habitat patches at larger public lands, and expand potential habitat
- Require mid-contract management (e.g. disking or burning) between three to five years after establishment on all Farm Bill acreage planted to grasses



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

- Non-native vegetation including tall fescue, smooth brome, orchard grass and Japanese brome was used successfully for nesting. The size of the reclaimed minelands and isolation from forested habitat apparently accounted for a reduced level of brown-headed cowbird parasitism and high nesting use and success.

### Habitat actions

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

<b>Rank</b>	<b>Conservation efforts for all grassland habitats</b>
1	Habitat restoration incentives (financial)
2	Habitat protection on public lands
3	Cooperative land management agreements (conservation easements)
4	Habitat restoration on public lands
5	Selective use of functionally equivalent exotic species in place of extirpated natives
6	Corridor development/protection
7	Land use planning
8	Restrict public access and disturbance
9	Habitat restoration through regulation
9 (tie)	Technical assistance
10	Habitat protection incentives (financial)
11	Habitat protection through regulation
12	Succession control (fire, mowing)
13 (tie)	Protection of adjacent buffer zone
13 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
13 (tie)	Managing water regimes
13 (tie)	Pollution reduction

Respondents listed other current conservation practices for all grassland habitats in Indiana (not ranked):

- Strip spraying/interseeding
- Preventing early mowing and haying of CRP land or other habitat

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

- Crawfish frog: Public ownership (purchase) of known crawfish frog habitat and maintenance of the hydrology of the site and associated breeding waters
- Prescribed burning/manage for early successional habitats
  - Grasslands often have to be maintained by fire. Control-burns are becoming more difficult to conduct due to lack of trained personnel, restricted burn windows, and encroaching development. Grassland management difficulties need to be addressed
  - Prescribed burning, because it is useful in controlling vegetative succession. Uncontrolled vegetative succession eventually excludes rabbits and makes future management difficult due to concerns for the Indiana Bat. (Stribling, H.L. and Speake, D. W. 1991. Responses of Bobwhite Quail and Eastern Cottontail Rabbit Populations to Prescribed Burning, Cover Enhancement and Food Plots. Alabama Game & Fish Division/Auburn University
  - To maintain cottontail rabbit habitat
  - Early successional grassland habitat maintenance would require restart succession in areas. Disturbance of a magnitude to create bare ground, such as a complete burn, plowing, etc. would be required to accomplish this goal
- Making mid-contract management mandatory on enrolled acreage
- Control invasives: Get rid of the invasive species degrading savannah habitats, including those invasive species deliberately plant by wildlife agencies
- Prevent early mowing/haying
  - Provide incentives to prevent landowners from haying or grazing during the breeding season
- Landowner education and outreach
  - Educate landowners about the importance of their land to the persistence of the species
- Purchase remnant savannahs, restore savannahs that have undergone succession to forest or have been farmed

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

- Purchase of fee title or easement rights by the State is the last hope to preserve significant grassland habitat for grassland and savanna nesting birds.

### Partner agencies/organizations

The following organizations indicated that they work in Grassland habitats.

Organization	Percent of time spent in Grassland habitats
Blue Heron Ministries, Inc.	40
Merry Lea Environmental Learning Center of Goshen College	35
Red-tail Conservancy, Inc.	33

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Big Oaks National Wildlife Refuge, USFWS	30
DNR Division of Nature Preserves	30
Dunes-Calumet Audubon Chapter	30
Indiana Grand Kankakee Marsh Restoration Project	30
Indiana Native Plant and Wildflower Society	30
Indiana Quail Unlimited	30
U.S. Fish and Wildlife Service - Indiana Private Lands Office	30
NICHES Land Trust	25
Northern Indiana Public Service Company (NIPSCO) a Subsidiary of NiSource	25
Pheasants Forever Inc.	25
Sassafras Audubon Society	25
Trillium Land Conservancy, Inc.	25
Indiana Dunes National Lakeshore	20
Lincoln Hills RC&D	20
Patoka River National Wildlife Refuge & Management Area	20
Summit Lake State Park	20
The Nature Conservancy	20
Cinergy Corp.	15
Ducks Unlimited, Inc.	15
Mason & Hanger Corp. Newport Chemical Depot	15
South Bend-Elkhart Audubon Society	10-15
Earth Source, Inc.	10
Indiana Association of Soil and Water Conservation Districts	10
JFNew and Associates	10
MWH Americas, Inc.	10
Northwestern Indiana Regional Planning Commission (NIRPC)	10
Save the Dunes Conservation Fund	10
Sycamore Land Trust	10
The Indiana Audubon Society	10
U.S. Department of Agriculture, Forest Service Hoosier National Forest	10
Wawasee Area Conservancy Foundation, Inc.	10
Indian Deer Hunters Association	10
St. Joseph River Watershed Initiative	7
Division of Fish and Wildlife	6
ACRES, Inc.	5
Central Indiana Land Trust	5
Ducks Unlimited	5
Hoosier Environmental Council	5
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)	5
Indiana state trappers assoc	5
Lost River Conservation Association	5

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Robert Cooper Audubon Society	5
Sierra Club Hoosier Chapter	5
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	5
Veolia Water Indianapolis, LLC	5
Whitewater Valley Land Trust, Inc.	5
St. Joseph County Soil & Water Conservation District (SWCD)	4
Indiana Division of the Izaak Walton League of America	3
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	1
Federal Highway Administration (FHWA)	?
American Society of Landscape Architects, Indiana Chapter	
Central Hardwoods Joint Venture/American Bird Conservancy	
Crooked Creek Conservation & Gun Club, Inc.	
Fur Takers of America	
Indiana Beef Cattle Association	
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 grassland habitats in Indiana (not ranked):

- 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

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

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

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- 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 grassland habitats in Indiana:

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

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

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

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

- Crawfish frogs: Statewide within the range of crawfish frogs: Indiana Amphibian Monitoring Program (IAMP) part of the North American Amphibian Monitoring Program and Frog Watch are conducted annually during the crawfish frog breeding season. The data can be analyzed regionally
- Badgers: Indiana Division of Fish and Wildlife and the Division of Nature Preserves maintain data on the occurrence location of road-kill, accidentally trapped or other verified human encounters with badgers
- Cottontail rabbits: Indiana Division of Fish and Wildlife logged rabbit sightings during quail whistle counts in the past
- DNR property harvest data
- Annual small game survey of licensed hunters
- Indiana Division of Fish and Wildlife conducts a biennial mailing survey to small game hunters to estimate harvest. Additionally, the division conducts an annual spring whistle counts to provide an index to the spring breeding population. However, neither of these methods focus directly on Farm Bill habitats
- Interlake Property, Division of Outdoor Recreation ownership
- Surveys on state properties and through efforts such as the Breeding Bird Atlas project
- IDNR's Nongame and Endangered Species Program

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

- The Breeding Bird Atlas survey
  - Is conducted by the National Audubon Society and observers counts the number of bobwhites seen along with other bird species. This survey is not directly focuses on Farm Bill habitats
  - BBS routes and work done on strip-mined lands in southwest Indiana, and Big Oaks National Wildlife Refuge
  - BBS routes are scattered throughout the state depending on volunteer participation
  - Includes routes that incorporate sites occupied by the redheaded woodpecker. This annual survey will therefore potentially count redheaded woodpeckers at a few sites yearly
- Local intensive surveys, nest monitoring or mark-recapture studies
- May Day Bird Counts and Summer Bird Counts

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

- Cottontail rabbits: The biennial small game harvest survey is the only method currently being used by the Division of Fish and Wildlife to monitor the statewide rabbit population

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- Breeding Bird Survey
  - Conducted by National Audubon Society
  - Conducted by U.S. Geological Survey Bird Banding Lab
- USDA Forest Service
- Indiana Division of Fish and Wildlife
- The Nature Conservancy
- U.S. Fish and Wildlife Service
- Indiana Academy of Science
- National Audubon Society/local chapters
- Universities such as Purdue University conduct local-level research projects
- U.S. Geological Survey
  - In Porter, Indiana has conducted studies of oak savannah birds, including the Red-headed Woodpecker
  - Breeding Bird Survey
- Birding organizations

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

Monitoring techniques for wildlife in grassland habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	X
Modeling	X	X	X
Coverboard routes	X	X	--
Spot mapping	X	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
Professional survey/census	X	X	X

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

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

- Sampling for eggs or larva
- Nest monitoring
- Distance sampling

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 grasslands habitats. Their responses included:

- Merry Lea Environmental Learning Center of Goshen College is a bird banding station in support of the nationwide MAPS program. (Monitoring Avian Productivity and Survivorship)

### Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for all grassland habitats in Indiana (not ranked):

- 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
- 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 were aware of the following inventory and assessment efforts by other organizations for all grassland habitats in Indiana (not ranked):

- Statewide annual inventory and assessment
- Statewide once-a-year 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
- 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



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- 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 grassland habitats in Indiana:

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

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

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

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- 3 (tie) Statewide 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 once-a-year inventory and assessment
- 6 Regional or local year-round inventory and assessment

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

- Crawfish frogs: Habitat is not well understood and is not currently being inventoried to my knowledge. Grasslands may be monitored by not all grasslands are crawfish frog habitat
- Badgers
  - Purdue University and NRCS keep track of grasslands created as part of the Farm Bill programs. There are also occasional statewide assessments of grassland as part of remote-sensing, GIS based studies such as the GAP Analysis
  - Division of Nature Preserves keeps track of good examples of remnant native grassland. I am not sure any of these agencies collect the grassland habitat data specifically for badgers but other agencies applied the information to badgers
- DNR property evaluations
- Interlake Property
- Habitats on state areas are occasionally surveyed for quality and quantity
- Annual and 5-year-census, county-level reports of acreage planted to various hay cover types and acreage harvested
- Indiana Division of Nature Preserves has inventoried habitats across the state over the past three decades. Savannas mainly occur in the northern third of the state

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

- Farm Bill/CRP type inventories but none specifically for cottontail rabbits
- Farm Service Agency keeps track of the location and acreage associated with each contract
- USFWS, USFWS, TNC, Indiana State University have surveyed quality and quantity of habitats for HESP's
- Statewide aerial imagery of habitats, land uses
- In the northern third of the state

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

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- I am not aware of any scheduled monitoring of early successional habitat in Indiana. I would suspect that one of the universities has remotely sensed data but their objective probably isn't specifically to monitor early successional habitat
- Bobwhite quail
  - Indiana Division of Fish and Wildlife will initiate some type of bobwhite monitoring program to determine the success of the newest continuous CRP practice (CP33)
  - Farm Service Agency monitors acreage and location of tracts enrolled in each USDA program
  - Natural Resource Conservation Service provides technical support or administers most farm programs and I believe they conduct regular inspections
- IDNR, USDA, USFS, TNC, Indiana State University
- USDA National Agricultural Statistics Service for Indiana <http://www.nass.usda.gov/in/>

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

<b>Inventory and assessment techniques for all grassland habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	X	X	--
Property tax estimates	--	X	X
State revenue data	--	X	X
Regulatory information	X	X	X
Participation in land use programs	X	X	X
Modeling	X	X	X
Voluntary landowner reporting	X	X	X

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

- Bobwhite quail: I recently correlated the number of acres enrolled in USDA programs with our annual bobwhite whistle indices on a statewide scale. I am planning on modeling regional bobwhite indices and USDA idled acreage

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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 grasslands habitats. There were no responses.

### Recommended monitoring

#### Species monitoring

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

- Crawfish frogs: More intensive call surveys and larva surveys, especially to determine how far the adults are traveling to deposit their eggs
- If we wanted to survey some wildlife species, I would develop a system counting hills
- Badgers: Continue to monitor road-kills, accidental captures and other verified sightings. Review this data and, if warranted, (a number of verified sightings near grassland habitat) attempt a telemetry and tracking study
- Trapping and visual surveys
  - Cottontail rabbits
    - McWheter, Gary Randolph, 1991, Estimating Abundance of Cottontail Rabbits using live trapping and visual surveys, Master's thesis, University of Tennessee
    - An analysis of vegetative structure by specie or species group in early successional habitats and then correlated with selected early successional species would be relevant
    - I would like to see a rural mail carrier survey initiated that would be useful for monitoring rabbits and several other wildlife species. Another method to monitor rabbit populations would be to include rabbit observations on the division's annual bobwhite whistle counts
  - Bobwhite quail
    - To monitor bobwhite populations specifically in Farm Bill habitats
      - A random sample of contracts and conducting flushing transects
      - Have hunters complete "report cards" when hunting on Farm Bill acreage
      - Request that landowners conduct whistle counts on their enrolled lands each spring
    - Fall Covey counts
- Professional and volunteer survey and census
- Point counts
  - During breeding season
  - Conduct point counts on private lands. If possible estimate nest success too
  - Point counts in potential habitats using distance sampling. This technique is relatively simple to implement and provides density information rather than an index. Observers count birds from points randomly located in the studied habitat and measure or estimate distance to observed birds. Calculation of density from the data, however, does require some technical expertise (Buckland, S. T., D. R. Anderson, et al (2001). Introduction to distance sampling. Oxford, UK, Oxford University Press)
- Establish more Breeding Bird Survey routes <http://www.pwrc.usgs.gov/bbs/>

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- Roadside surveys; spot-mapping on smaller areas
- I'm not sure if a salvageable population exists in the State of Indiana. It would be critical to survey known populations to determine population structure, density and potential for recruitment. This information could then be used to plan and implement a conservation effort geared towards this 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 grasslands habitats. There were no responses.

### Habitat inventory and assessment

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

- Crawfish frog habitat: May be described by a combination of hydrology, soil type, proximity to breeding waters and vegetation. These factors should be investigated to develop a model for crawfish frog habitat
- Monitoring larger grasslands in Indiana (both native and man-made) such as grassland created by strip mining
- Cottontail rabbits: Are a mid to late early successional habitat resident. We do not know the amount of structure required to maintain optimum populations. We don't know what an optimum population is! We do know that it cycles but we don't know why
- The best habitat inventory technique would be creating a GIS with Landsat data from different time periods
- Flush counts or more intensive whistle counts on farm program lands would be a useful method of evaluating their quality when compared to the same indices on non-Farm Bill lands
- Grassland mapping by major plant species type
- GIS mapping and participation in land use programs (CRP)
- Survey of hay harvest dates and frequencies each year
- Aerial imagery couple with modeling

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 all grasslands habitats. There were no responses.

Technical experts and conservation organizations offered the following additional comments:

- Make sure "savanna" (no "h") is spelled correctly in any official publications
- No comments were received on reclaimed mine lands, even though they represent the largest remaining grasslands in the state, and have been shown through recent research to be highly important to many grassland birds. They also represent the best chance in Indiana to protect and manage large blocks of grassland habitat, and many are being parceled out and sold as small tracts. This is a significant omission in the conservation plan for grassland habitats for Indiana.

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## GRASSLAND HABITATS NARRATIVE

### Habitat description

Open area dominated by grass species, for example, prairies or reclaimed minelands.

### Problems affecting species and habitats

#### Species threats

Respondents ranked the following threats to wildlife in grassland habitats in Indiana:

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

A respondent offered an additional threat to wildlife in grassland habitats in Indiana:

- Crawfish frog

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- Changes in burrowing crawfish or rodent populations that would impact the availability of burrows
- Introduction of fish into formally fishless breeding waters
- Development of barriers between crawfish frog burrows and breeding waters

Respondents listed top threats to wildlife in grassland habitats in Indiana (not ranked):

- Crawfish frog
  - Land use changes or other factors that impact the availability and persistence of suitable burrows
  - Introduction of fish into formally fishless breeding waters
  - Development of barriers between crawfish frog burrows and breeding waters
- Habitat loss and fragmentation
  - Loss of habitat is probably the only threat to this species, plus people trying to remove them from lawns and gardens
  - Loss of grasslands
- Loss of grassland ground squirrel populations

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

- Loss of grassland
  - breeding sites for Mallards and Blue-winged Teal

### Habitat threats

Respondents ranked threats to grassland habitats in Indiana:

Rank	Threats to grassland habitats
1 (tie)	Commercial or residential development (sprawl)
1 (tie)	Habitat fragmentation
2	Agricultural/forestry practices
3	Habitat degradation
4	Successional change
5 (tie)	Counterproductive financial incentives or regulations
5 (tie)	Residual contamination (persistent toxins)
6	Mining/acidification
7	Invasive/non-native species
8 (tie)	Stream channelization
8 (tie)	Impoundment of water/flow regulation
8 (tie)	Point source pollution (continuing)
8 (tie)	Drainage practices (stormwater runoff)



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### 9 Nonpoint source pollution (sedimentation and nutrients)

Respondents noted additional threats to grassland habitats in Indiana:

- Mowing or burning for aesthetic purposes so that badger prey population or badger cover are diminished

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

- Crawfish frog habitat:
  - Cattle grazing, farming, and development activities that affect the persistence of burrows in formally flooded or moist grasslands
  - Draining of breeding ponds and ditches
  - Introduction of fish into breeding waters
- Loss of grasslands and grassland ground squirrel populations
- Fragmentation of habitat

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

- Mowing and burning are essential parts of the grassland habitat. Burning of the grassland is a natural process.

## Additional research and survey efforts

### Current body of research

#### Species research

Twelve percent respondents stated that the current body of science is adequate for wildlife in grassland habitats in Indiana; eight-seven percent said that it is inadequate or nonexistent.

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

Title = Amphibians and reptiles of Indiana;

Author = Sherman A. Minton, Jr.;

Date = 2001;

Publisher = Indiana Academy of Sciences

Author = [www.natureserve.org/explorer](http://www.natureserve.org/explorer)

Title = Mamm. IN;

Author = M & W 1982

Title = Mammals of the Eastern United States;

Author = J.O. Whitaker, Jr. and W. J. Hamilton, Jr.;

Date = 1998;

Publisher = Cornell University Press

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Author = www.natureserve.org/explorer

Title = Mammals of Indiana;  
Author = Mumford;  
Date = ?;  
Publisher = ?

Title = Mammals of the Great Lake States;  
Author = ?;  
Date = ?;  
Publisher = ?

Title = Mammals of IN;  
Author = Russel Mumford & John Whitaker Jr;  
Date = 1982;  
Publisher = IN Universty Press

Title = Reduction in the Eastern Limit of the Range of the Franklin's Ground Squirrel;  
Author = Scott Johnson and Jane Choromanski-Norris;  
Date = 1992;  
Publisher = American Midland Naturalist 128:325-331.

Title = Franklin's Ground Squirrel in Illinois: A Declining Prairie Mammal?;  
Author = Jason Martin, Edward Heske, Joyce Hofman;  
Date = 2003;  
Publisher = American Midland Naturalist 150:130-138.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in grasslands habitat. Their responses included:

- Ducks, Geese, and Swans of North America  
Bellrose, 1976

### Habitat research

Thirty-three percent respondents stated that the current body of science is adequate for grassland habitats in Indiana; sixty-seven percent said that it is inadequate or nonexistent.

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

Title = Mammals of Indiana;  
Author = Mumford/Whitaker;  
Date = 1982;  
Publisher = IU Press

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

## Appendix F-49: Grasslands

### Research needs

#### Species research

Respondents ranked research needs for wildlife in grassland habitats in Indiana:

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

Respondents noted other research needs for wildlife in grassland habitats in Indiana (not ranked):

- The species is in great need of study on all aspects of its ecology
- We need more information on the reproduction of this species in various habitats
- Badgers: The relationship between badgers and land use/soil types that support burrows both for badgers and prey

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 grasslands habitat. There were no responses.

#### Habitat research

Respondents ranked research needs for grassland habitats in Indiana:

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

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

## Appendix F-49: Grasslands

- Crawfish frog: Frog habitat needs to be adequately described
- Additional information on all phases of biology of this species would be helpful
- Badgers: The difference between native, warm-season grasses/native forbs grasslands; planned, non-native, cool-season grasslands; and CRP grasslands relative to suitability for badgers

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

## Conservation actions necessary

### Species actions

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

Rank	Conservation efforts for wildlife in grassland habitats
1	Population management (hunting, trapping)
2 (tie)	Habitat protection
2 (tie)	Regulation of collecting
2 (tie)	Exotic/invasive species control

Respondents noted other current conservation practices for wildlife in grassland habitats in Indiana (not ranked):

- Study burrow making crawfish and their burrows
- Saving grassland and woodland will help this animal

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

- Crawfish frog
  - Promote non-disturbance in known crawfish frog habitat
  - Identification of breeding sites and protect sites from disturbance and introduction of fish
- Save natural habitats
- Conservation and restoration of ground squirrel and pocket gopher populations. Limit human access to all parts of large grasslands

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

## Appendix F-49: Grasslands

### Habitat actions

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

<b>Rank</b>	<b>Conservation efforts for grassland habitats</b>
1 (tie)	Succession control (fire, mowing)
1 (tie)	Habitat protection on public lands
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Habitat restoration through regulation
2 (tie)	Habitat restoration on public lands
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Habitat protection through regulation
2 (tie)	Corridor development/protection
2 (tie)	Protection of adjacent buffer zone
2 (tie)	Restrict public access and disturbance
2 (tie)	Cooperative land management agreements (conservation easements)

Respondents listed no other current conservation practices for grassland habitats in Indiana.

Respondents recommended the following practices for more effective conservation of grassland habitats in Indiana:

- Crawfish frog
  - Public ownership (purchase) of known crawfish frog habitat
  - Maintenance of hydrology of sites and associated breeding waters
- Grasslands often have to be maintained by fire. Controlled burns are becoming more difficult due to lack of trained personnel, restricted burn windows and encroaching development. Grassland management difficulties need to be addressed

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

### **Partner agencies/organizations**

**The following organizations indicated that they work in Grassland habitats.**

<b>Organization</b>	<b>Percent of time spent in Grassland habitats</b>
<b>Blue Heron Ministries, Inc.</b>	<b>40</b>
<b>Merry Lea Environmental Learning Center of Goshen College</b>	<b>35</b>
<b>Red-tail Conservancy, Inc.</b>	<b>33</b>

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<b>Big Oaks National Wildlife Refuge, USFWS</b>	<b>30</b>
<b>DNR Division of Nature Preserves</b>	<b>30</b>
<b>Dunes-Calumet Audubon Chapter</b>	<b>30</b>
<b>Indiana Grand Kankakee Marsh Restoration Project</b>	<b>30</b>
<b>Indiana Native Plant and Wildflower Society</b>	<b>30</b>
<b>Indiana Quail Unlimited</b>	<b>30</b>
<b>U.S. Fish and Wildlife Service - Indiana Private Lands Office</b>	<b>30</b>
<b>NICHES Land Trust</b>	<b>25</b>
<b>Northern Indiana Public Service Company (NIPSCO) a Subsidiary of NiSource</b>	<b>25</b>
<b>Pheasants Forever Inc.</b>	<b>25</b>
<b>Sassafras Audubon Society</b>	<b>25</b>
<b>Trillium Land Conservancy, Inc.</b>	<b>25</b>
<b>Indiana Dunes National Lakeshore</b>	<b>20</b>
<b>Lincoln Hills RC&amp;D</b>	<b>20</b>
<b>Patoka River National Wildlife Refuge &amp; Management Area</b>	<b>20</b>
<b>Summit Lake State Park</b>	<b>20</b>
<b>The Nature Conservancy</b>	<b>20</b>
<b>Cinergy Corp.</b>	<b>15</b>
<b>Ducks Unlimited, Inc.</b>	<b>15</b>
<b>Mason &amp; Hanger Corp. Newport Chemical Depot</b>	<b>15</b>
<b>South Bend-Elkhart Audubon Society</b>	<b>10-15</b>
<b>Earth Source, Inc.</b>	<b>10</b>
<b>Indiana Association of Soil and Water Conservation Districts</b>	<b>10</b>
<b>JFNew and Associates</b>	<b>10</b>
<b>MWH Americas, Inc.</b>	<b>10</b>
<b>Northwestern Indiana Regional Planning Commission (NIRPC)</b>	<b>10</b>
<b>Save the Dunes Conservation Fund</b>	<b>10</b>
<b>Sycamore Land Trust</b>	<b>10</b>
<b>The Indiana Audubon Society</b>	<b>10</b>
<b>U.S. Department of Agriculture, Forest Service Hoosier National Forest</b>	<b>10</b>
<b>Wawasee Area Conservancy Foundation, Inc.</b>	<b>10</b>
<b>Indian Deer Hunters Association</b>	<b>10</b>
<b>St. Joseph River Watershed Initiative</b>	<b>7</b>
<b>Division of Fish and Wildlife</b>	<b>6</b>
<b>ACRES, Inc.</b>	<b>5</b>
<b>Central Indiana Land Trust</b>	<b>5</b>
<b>Ducks Unlimited</b>	<b>5</b>
<b>Hoosier Environmental Council</b>	<b>5</b>
<b>IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)</b>	<b>5</b>
<b>Indiana state trappers assoc</b>	<b>5</b>
<b>Lost River Conservation Association</b>	<b>5</b>

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<b>Robert Cooper Audubon Society</b>	<b>5</b>
<b>Sierra Club Hoosier Chapter</b>	<b>5</b>
<b>US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)</b>	<b>5</b>
<b>Veolia Water Indianapolis, LLC</b>	<b>5</b>
<b>Whitewater Valley Land Trust, Inc.</b>	<b>5</b>
<b>St. Joseph County Soil &amp; Water Conservation District (SWCD)</b>	<b>4</b>
<b>Indiana Division of the Izaak Walton League of America</b>	<b>3</b>
<b>Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)</b>	<b>1</b>
<b>Federal Highway Administration (FHWA)</b>	<b>?</b>
<b>American Society of Landscape Architects, Indiana Chapter</b>	
<b>Central Hardwoods Joint Venture/American Bird Conservancy</b>	
<b>Crooked Creek Conservation &amp; Gun Club, Inc.</b>	
<b>Fur Takers of America</b>	
<b>Indiana Beef Cattle Association</b>	
<b>Law Enforcement Division, Indiana Department of Natural Resources</b>	
<b>National Audubon Society - Indiana Important Bird Areas Program (IBA)</b>	
<b>USDA Natural Resources Conservation Service</b>	

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

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

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

Respondents were aware of no monitoring efforts by other organizations for wildlife in grassland habitats in Indiana.

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

<b>Rank</b>	<b>Monitoring efforts by state agencies for conservation of wildlife in grassland habitats</b>	<b>Score</b>
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring	3.00

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2 (tie)	Statewide year-round monitoring	2.50
2 (tie)	Statewide once-a-year monitoring	2.50
2 (tie)	Regional or local year-round monitoring	2.50
2 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring	2.40
3	Periodic regional or local (less than once a year but still regularly scheduled) monitoring	2.20
4 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring	2.20
4 (tie)	Regional or local once-a-year monitoring	2.20



## Appendix F-49: Grasslands

Respondents listed no monitoring efforts by other organizations as crucial for conservation of wildlife in grassland habitats in Indiana. Respondents listed no organizations that monitor wildlife.

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

- Crawfish frogs: Indiana Amphibian Monitoring Program (IAMP) -- part of the North American Amphibian Monitoring Program and Frog Watch -- conduct annual monitoring during crawfish frog breeding season. This happens statewide throughout the crawfish frog range. The data can be analyzed regionally
- Badgers: Indiana Division of Fish and Wildlife and Division of Nature Preserves maintain data on the occurrence location of road-kill, accidentally trapped or other verified human encounters with badgers

Respondents considered monitoring techniques for wildlife in grassland habitats in Indiana:

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

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

- Sampling for eggs or larva

## Appendix F-49: Grasslands

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 grasslands habitat. There were no responses.

### Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for grassland habitats in Indiana (not ranked):

- Occasional statewide (less than once a year and not 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 grassland habitats in Indiana:

- Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment

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

<b>Rank</b>	<b>Inventory and assessment by state agencies for conservation of grassland habitats</b>
1 (tie)	Statewide annual inventory and assessment
1 (tie)	Regional or local year-round inventory and assessment
2	Statewide once-a-year inventory and assessment
3 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
3 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
4 (tie)	Regional or local once-a-year inventory and assessment
4 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

## Appendix F-49: Grasslands

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

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

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

- Crawfish frog habitat is not well understood and is not currently being inventoried. Grasslands may be monitored but not all grasslands are crawfish frog habitat
- Purdue University and NRCS keep track of grasslands created as part of Farm Bill programs. There are also occasional statewide assessments of grassland as part of remote sensing, GIS based studies such as GAP Analysis. Division of Nature Preserves also keeps track of good examples of remnant native grassland. I am not sure any of these agencies collect the grassland habitat data specifically for badgers but other agencies applied the information to badgers

Respondents listed no regional or local inventory and assessment by other organizations agencies for grassland habitats in Indiana. Respondents listed no organizations that monitor grassland habitats.

## Appendix F-49: Grasslands

Respondents considered inventory and assessment techniques for grassland habitats in Indiana:

<b>Inventory and assessment techniques for grassland habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology and data</b>	<b>Not economically feasible</b>
GIS mapping	X	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	--	X	--
Property tax estimates	--	X	--
State revenue data	--	X	--
Regulatory information	--	X	--
Participation in land use programs	--	X	--
Modeling	--	X	X
Voluntary landowner reporting	--	X	--

Respondents listed no additional inventory and assessment techniques for grassland habitats in Indiana.

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 grasslands habitat. There were no responses.

### **Recommended monitoring**

#### Species monitoring

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

- Crawfish frogs: More intensive call surveys and larva surveys, especially to determine how far adults travel to deposit their eggs
- Develop a system counting hills
- Badgers: Continue to monitor road kills, accidental captures and other verified sightings. Review this data and if warranted (a number of verified sightings near grasslands habitat), attempt a telemetry and tracking study

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 in grasslands habitat. There were no responses.

#### Habitat inventory and assessment

## Appendix F-49: Grasslands

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

- Crawfish frog habitat includes a combination of hydrology, soil type, proximity to breeding waters and vegetation. These factors should be investigated to develop a model for crawfish frog habitat
- Monitoring larger grasslands in Indiana (native and man-made) such as the grasslands created by strip mining. Especially monitor the quality and quantity of these areas

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 grasslands habitat. There were no responses.

Technical experts and conservation organizations offered the following additional comments:

- Grasslands are important to many songbirds. Need more input about songbird use of grasslands.

## EARLY SUCCESSIONAL GRASSLAND HABITATS NARRATIVE

### Habitat description

These habitats are composed primarily of grasses and other early successional non-woody vegetation. Relatively frequent disturbances are required for their maintenance.

### Problems affecting species and habitats

#### Species threats

Respondents ranked the following threats to wildlife in early successional grassland habitats in Indiana:

Rank	Threats to wildlife in early successional grassland habitats
1	Habitat loss (breeding range)
2	Habitat loss (feeding/foraging areas)
3	Invasive/non-native species
4 (tie)	Predators (native or domesticated)
4 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
5	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
6 (tie)	Viable reproductive population size or availability
6 (tie)	Diseases/parasites (of the species itself)
7 (tie)	Regulated hunting/fishing pressure (too much)
7 (tie)	Unregulated collection pressure
8	Bioaccumulation of contaminants

Respondents offered additional threats to wildlife in early successional grassland habitats in Indiana (not ranked):

- Cold wet weather when first litters appear (late March and early April)
- Cottontail rabbits:
  - Numbers are proportional to available habitats. To increase or decrease in number depends on available habitats.
  - Agricultural policy, i.e. production without supply side considerations influence the availability of the habitats.
  - The tradeoff concerning the cottontail is that we, the American public, want beef, corn and related foodstuffs at a low cost. The cottontail will not prevail here as being necessary under those societal needs

## Appendix F-50: Early Successional Areas

- Habitat loss to natural succession is a critical threat to cottontail populations in Indiana

Respondents listed top threats for wildlife in early successional grassland habitats in Indiana (not ranked):

- Invasive/non-native vegetative species such as fescue do not provide cover, nutrition and are thought to be toxic
- Habitat loss to uncontrolled vegetative succession/agriculture
- Agricultural policy
- Domestic predators
- Short-tailed shrew: Habitat Loss in this relatively specialized habitat is the primary threat to the short-tailed shrew. Early successional grassland habitats provide marginal habitat requirements for this specialized species. The short-tailed shrew is an insectivore/vermivore. Early successional grassland habitat occurs in abandoned land associated with either agricultural, industrial or urban land uses. Only in isolated situations do grasslands develop as a dominant habitat type in Indiana. Most grasslands will eventually be dominated by shrub or tree cover. By definition, early successional grassland habitat is a temporary habitat type.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats for wildlife in early successional grassland habitat. There were no responses.

### Habitat threats

Respondents ranked threats to early successional grassland habitats in Indiana:

<b>Rank</b>	<b>Threats to in early successional grassland habitats</b>
1 (tie)	Commercial or residential development (sprawl)
1 (tie)	Habitat degradation
2	Successional change
3	Invasive/non-native species
4 (tie)	Habitat fragmentation
4 (tie)	Agricultural/forestry practices
5 (tie)	Counterproductive financial incentives or regulations
5 (tie)	Nonpoint source pollution (sedimentation and nutrients)
6 (tie)	Drainage practices (stormwater runoff)
6 (tie)	Stream channelization

Respondents noted additional threats to early successional grassland habitats in Indiana:

- No financial incentive to develop/maintain/manage these habitats

## Appendix F-50: Early Successional Areas

Respondents listed top threats to early successional grassland habitats in Indiana (not ranked):

- Successional change results in habitat degradation as grasslands are invaded by woody vegetation
- Invasion by tall fescue
- Agricultural policy
- Competing products (food)

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

## Additional research and survey efforts

### Current body of research

#### Species research

Fifty percent of respondents stated that the current body of science is adequate; the other half listed it as inadequate for wildlife in early successional grassland habitats in Indiana.

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

Title = A 14-year study of BLARINA BREVICAUDA in east-central Illinois.;

Author = Getz, L. L.;

Date = 1989;

Publisher = J. Mammalogy 70:58-66.

Title = Blarina brevicauda;

Author = George, S. B., J. R. Choate, and H. H. Genoways;

Date = 1986;

Publisher = Mammalian Species 261:1-9

Title = Population Ecology and Harvest of the Cottontail Rabbit;

Author = Heraold A. Demaree, Jr.;

Date = 1978;

Title = Population ecology and harvest of the cottontail rabbit on the Pigeon River fish and wildlife area, 1962-1970;

Author = Harold Demaree Jr.;

Date = 1978;

Publisher = Indiana Division of Fish and Wildlife

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

#### Habitat research

Fifty percent of respondents stated that the current body of science is adequate; the other half listed it as inadequate for early successional grassland habitats in Indiana.



## Appendix F-50: Early Successional Areas

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

Title = A4-year study study of BLARINA BREVICAUDA un east-central Illinois;  
Author = Getz, L. L.;  
Date = 1989;  
Publisher = J. Mammalogy 70:58-66.

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

### Research needs

#### Species research

Respondents ranked research needs for wildlife in early successional grassland habitats in Indiana:

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

Respondents noted additional research needs for wildlife in early successional grassland habitats in Indiana:

- Determine what affect feral cats have on a local cottontail population

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 early successional grassland habitat. There were no responses.

#### Habitat research

Respondents ranked research needs for early successional grassland habitats in Indiana:

Rank	Research needs for early successional grassland habitats
1	Distribution and abundance (fragmentation)
2 (tie)	Successional changes
2 (tie)	Threats (land use change/competition, contamination/global warming)

## Appendix F-50: Early Successional Areas

- 3 (tie) Relationship/dependence on specific site conditions
- 3 (tie) Growth and development of individual components of the habitat

Respondents noted no additional research need for early successional grassland habitats in Indiana.

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

## Conservation actions necessary

### Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in early successional grassland habitats in Indiana:

Rank	Conservation efforts for wildlife in early successional grassland habitats
1 (tie)	Habitat protection (use below for details)
1 (tie)	Population management (hunting, trapping)
1 (tie)	Exotic/invasive species control
3	Food plots
4 (tie)	Native predator control
4 (tie)	Threats reduction
4 (tie)	Regulation of collecting

Respondents noted other current conservation practices for wildlife in early successional grassland habitats in Indiana (not ranked):

- Vegetative succession control
- Provide additional habitats through programs, agricultural and other. Rabbits are a by-product of the economy. The more human needs placed on the landscape, the less amount of by products will be produced. If we select for beef and corn there will be less rabbits. By selecting for something, you simultaneously select against something else.

Respondents recommended these practices for more effective conservation of wildlife in early successional grassland habitats in Indiana (not ranked):

- Promote early succession/protect early succession habitat
  - Associated with structure similar to *L. japonica*
  - Would require land use change every three to five years to setback natural succession

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the effective conservation of wildlife in early successional grassland habitat. There were no responses.

## Appendix F-50: Early Successional Areas

### Habitat actions

Respondents ranked conservation efforts by how well they address threats to early successional grassland habitats in Indiana:

<b>Rank</b>	<b>Conservation efforts for early successional grassland habitats</b>
1	Selective use of functionally equivalent exotic species in place of extirpated natives
2	Succession control (fire, mowing)
3	Habitat protection on public lands
4 (tie)	Habitat restoration incentives (financial)
4 (tie)	Corridor development/protection
4 (tie)	Technical assistance
5	Habitat restoration on public lands
6 (tie)	Cooperative land management agreements (conservation easements)
6 (tie)	Habitat protection incentives (financial)
6 (tie)	Land use planning
6 (tie)	Habitat protection through regulation
6 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
6 (tie)	Restrict public access and disturbance
6 (tie)	Habitat restoration through regulation

A respondent listed other current conservation practices for early successional grassland habitats in Indiana:

- Strip spraying/interseeding

Respondents recommended the following conservation practices for early successional grassland habitats in Indiana (not ranked):

- Successional control/prescribed burning
  - Best method to maintain usable rabbit habitat
  - Uncontrolled vegetative succession eventually excludes rabbits and makes future management difficult due to concerns for the Indiana Bat. (Stribling, H.L. and Speake, D. W. 1991. Responses of Bobwhite Quail and Eastern Cottontail Rabbit Populations to Prescribed Burning, Cover Enhancement and Food Plots. Alabama Game & Fish Division/Auburn University)
  - Maintenance would require restarting succession. Disturbance of a magnitude to create bare ground, such as a complete burn and plowing, would be required.

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

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in early successional grassland habitats in Indiana (not ranked):

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

Respondents were aware of no monitoring efforts by other organizations for wildlife in early successional grassland habitats in Indiana.

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in early successional grassland habitats in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in early successional grassland habitats
1 (tie)	Statewide once a year monitoring
1 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring

Respondents listed no monitoring efforts by other organizations that were crucial for conservation of wildlife in early successional grassland habitats in Indiana.

Respondents listed regional or local monitoring by state agencies for wildlife in early successional grassland habitats in Indiana (not ranked):

- Indiana DFW logged rabbit sightings during quail whistle counts
- DNR property harvest data
- Annual/biennial small game surveys of licensed hunters

Respondents listed no regional or local monitoring by other organizations for wildlife in early successional grassland habitats in Indiana.

Respondents listed organizations that monitor wildlife in early successional grassland habitats in Indiana:

- Indiana Division of Fish and Wildlife

Respondents considered monitoring techniques for wildlife in early successional grassland habitats in Indiana:

## Appendix F-50: Early Successional Areas

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

Respondents noted no other monitoring techniques for wildlife in early successional grassland habitats in Indiana.

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 early successional grassland habitat. There were no responses.

### Habitat inventory and assessment

Respondents were aware of no following inventory and assessment efforts by state agencies or other organizations for early successional grassland habitats in Indiana.

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

Rank	Inventory and assessment for conservation of early successional
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## Appendix F-50: Early Successional Areas

### grassland habitats

- 1 Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
- 2 Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

Respondents noted no inventory and assessment efforts by other organizations for early successional grassland habitats in Indiana.

Respondents listed regional or local inventory and assessment by state agencies for early successional grassland habitats in Indiana:

- DNR property evaluations

Respondents listed regional or local inventory and assessment by other organizations agencies for early successional grassland habitats in Indiana:

- Farm Bill/CRP type inventories, but none specifically for cottontail rabbits

Respondents listed no organizations that monitor early successional grassland habitats in Indiana.

Respondents considered inventory and assessment techniques for early successional grassland habitats in Indiana:

Inventory and assessment techniques for early successional grassland habitats	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	--	--
Aerial photography and analysis	X	--	--
Systematic sampling	X	X	--
Participation in land use programs	--	X	X
Modeling	--	X	--
Voluntary landowner reporting	--	--	X

Respondents listed no additional inventory and assessment techniques for early successional grassland habitats in Indiana.

## Appendix F-50: Early Successional Areas

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

### **Recommended monitoring** Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in early successional grassland habitats in Indiana (not ranked):

- Trapping and visual surveys (McWheter, Gary Randolph, 1991, Estimating abundance of cottontail rabbits using live trapping and visual surveys, Master's thesis, University of Tennessee)
- Monitoring specifically for the cottontail is not warranted. However, an analysis of vegetative structure by specie or species group in early successional habitats and then correlated with selected early successional species would be relevant!
- I would like to see a rural mail carrier survey initiated that would be useful for monitoring rabbits and several other wildlife species. Another method to monitor rabbit populations would be to include rabbit observations on the division's annual bobwhite whistle counts.

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 in early successional grassland habitat. There were no responses.

### Habitat inventory and assessment

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

- Cottontails are a mid to late early successional habitat resident. We do not know the amount of structure required to maintain optimum populations. We don't know what an optimum population is! We do know that it cycles, but we don't know why!
- The best habitat inventory technique would be creating a GIS with Landsat data from different time periods.

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 early successional grassland habitat. There were no responses.

## FARM BILL PROGRAM GRASSLAND HABITATS NARRATIVE

### Habitat description

Upland grasses and forbs dominate *grasslands/herbaceous habitats*. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

### Problems affecting species and habitats

#### Species threats

Respondents ranked threats to wildlife in Farm Bill Program grassland habitats in Indiana:

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



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Respondents listed other threats to wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- Impacts of herbicides and pesticides drifting over from nearby agricultural lands is unknown
- Mowing in June, July and August

Respondents listed top threats to wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- Loss of farm programs
- Loss or shortening of primary nesting season dates established by USDA. Mowing and haying during quail nesting season would be allowed on enrolled acreage if these dates were eliminated or shortened
- Loss of quality nesting and brood habitat (including mowing during breeding season)
- Habitat fragmentation

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

- Haying and Mowing during the nesting season could lead to waterfowl nest destruction.
- Yes. Continuation of positive farm programs, such as CRP, are critical to the farmland wildlife guild. At the same time, disturbance during the nesting season, and alterations of the nesting season dates must be minimized to insure the conservation benefits of these programs for wildlife. In addition, use of non-native invasive plant species should be avoided wherever possible, and replaced with appropriate native species.
- Yes, but I think non-native species such as fescue needs to be ranked higher.

### Habitat threats

Respondents ranked threats to Farm Bill Program grassland habitats in Indiana:

Rank	Threats to Farm Bill Program grassland habitats
1 (tie)	Habitat fragmentation
1 (tie)	Agricultural/forestry practices
2	Habitat degradation
3	Successional change
4	Commercial or residential development (sprawl)
5	Counterproductive financial incentives or decisions
6	Residual contamination (persistent toxins)
7	Invasive/non-native species
8 (tie)	Mining/acidification
8 (tie)	Nonpoint source pollution (sedimentation and

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nutrients)

### **8 (tie)** Point source pollution (continuing)

A respondent listed other threats Farm Bill Program grassland habitats in Indiana (not ranked):

- If Farm Bill programs (e.g. CRP) were to be eliminated, the negative effects on Indiana's northern bobwhite population would be substantial

Respondents described top threats to Farm Bill Program grassland habitats in Indiana (not ranked):

- Habitat fragmentation and urban sprawl
  - Clean farming
- Early mowing and haying
  - During primary nesting season – These activities are not allowed until after July 15 but mowing during late July and early August still destroys some nests and young
- Loss of large areas of warm season grasses
- Succession of grassland habitat is a major threat if mid-contract activities are not performed

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

- Impacts of herbicides and pesticides could be a big threat to grasslands.

Invasive species may be more of a problem than development on Farm Bill grasslands. Farm Bill areas are usually protected by some type of easement which does not allow any development.

- Yes. The greatest threats are from mowing or haying during the nesting season, and from lack of appropriate disturbance (e.g. fire, discing) at regular intervals (4-5 years) to maintain early successional grassland habitat. Additional threats include the use of inappropriate plantings (e.g. fescue) and seeding rates that are too heavy for most early successional species.
- Yes

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

One respondent said that the current body of science for wildlife in Farm Bill Program grassland habitats in Indiana is adequate; another respondent said that science is non-existent.

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

Title = HESPS in mine land MS Thesis;

Author = Travis Devault;

Date = 2000;

Publisher = Indiana State Univ

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Title = Forest and Grassland Bird Productivity;

Author = Robb et. al.;

Date = 1998;

Publisher = USFWS internal report

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

- Not really.....neither of those studies even addresses Farm Bill programs. Additional publications include:

Hohman, W.L, and D.J. Halloum, ed. 2000. A comprehensive review of Farm Bill contributions to wildlife conservation, 1985-2000. USDA Natural Resources Conservation Service Technical Report USDA/NRCS/WHMI-2000.

Best, L.B. et. al. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: A regional approach. Wildl. Soc. Bull. 25:864-877.

Herkert. J.R. 1997. Population trends of the Henslow's sparrow in relation to the Conservation Reserve Program in Illinois, 1975-1995. Wildl. Soc. Bull. 26:227-231.

McCoy, T.D., et.al. 1999. Conservation Reserve Program: Source or sink habitat for grassland birds in Missouri. J. Wildl. Manage. 63:530-538.

Roseberry, J. L. and L.M. David. 1994. The Conservation Reserve Program and northern bobwhite population trends in Illinois. Trans. of the Ill. State Acad. of Science, 87:61-70.

Ryan, M.R., et.al. 1998. The impact of CRP on avian wildlife: A review. J. of Prod. Agric. 11:61-66.

- No, I am sure a bibliographic search would turn up more data.

### Habitat research

Respondents said that the current body of science for Farm Bill Program grassland habitats in Indiana is inadequate.

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

Title = Strip mine grassland birds;

Author = Travis Devault;

Date = 2000;

Publisher = Indiana State Univ.

Title = Vegetation management practices on conservation reserve program fields to improve northern bobwhite habitat quality;

Author = Greenfield, K. C.; W. B. Burger Jr.; M. J. Chamberlain, E. W. Kurzejeski;

Date = 2002;

Publisher = Wildlife Society Bulletin

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Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for Farm Bill Program habitats. Their responses included:

- Again, the above list is very limited. Some of the publications in the previous question address habitat issues as well.
- No, I am sure a bibliographic search would turn up more data.

### Research needs

#### Species research

Respondents ranked research needs for wildlife in Farm Bill Program grassland habitats in Indiana:

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

Respondents listed other research needs for wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- How to reduce clean farming and increase field size
- Research to determine the extent to which mowing and haying negatively impact production following the end of the primary nesting season (as defined by USDA)
- Following July 15 in Indiana, landowners can mow or hay enrolled lands. A substantial proportion of bobwhites still nest at that time

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

- Need to know other species nesting at this time.
- No. For Farm Bill programs to really have a landscape level impact on wildlife, there needs to be a strategic approach to program enrollment that takes into account the species needs on a landscape scale, and more effort needs to be undertaken to identify the level of

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intensity needed for program enrollment in a given landscape to affect a population change in the target species.

- Yes

### Habitat research

Respondents ranked research needs for Farm Bill Program grassland habitats in Indiana:

Rank	Research needs for Farm Bill Program grassland habitats
------	---

- 1 (tie) Successional changes
- 1 (tie) Distribution and abundance (fragmentation)
- 1 (tie) Relationship/dependence on specific site conditions
- 1 (tie) Growth and development of individual components of the habitat
- 2 Threats (land use change/competition, contamination/global warming)

Respondents listed other research needs for Farm Bill Program grassland habitats in Indiana (not ranked):

- Seeding mixtures and mid-contract management activities currently utilized on Farm Bill lands need to be evaluated to determine their value to bobwhite nesting and brood rearing
- How to create and maintain quality grassland habitat on a permanent basis

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

- Need to determine best mid-contract management for all species in grassland.
- More research needs to be done on the level of habitat disturbance through mid-contract management on CRP to best impact early successional species such as bobwhite.
- Yes

## **Conservation actions necessary**

### Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in Farm Bill Program grassland habitats in Indiana:

Rank	Conservation efforts for wildlife in Farm Bill Program grassland habitats
------	---

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- 1 Protection of migration routes
- 2 (tie) Public education to reduce human disturbance
- 2 (tie) Exotic/invasive species control
- 3 Habitat protection
- 4 (tie) Food plots
- 4 (tie) Threats reduction
- 4 (tie) Native predator control
- 4 (tie) Limiting contact with pollutants/contaminants

Respondents listed no other current conservation practices for wildlife in Farm Bill Program grassland habitats in Indiana.

Respondents recommended the following practices for more effective conservation of wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- Require mid-contract management (e.g., disking or burning) between three to five years after establishment on all Farm Bill acreage planted to grasses
- Protection of grassland habitat
- Restoration of habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife for Farm Bill Program habitats. Their responses included:

- Yes
- Additional funding is needed for Farm Bill Programs such as WHIP, WRP, and GRP to adequately address landowner requests for more assistance.

### Habitat actions

Respondents ranked conservation efforts by how well they address threats to Farm Bill Program grassland habitats in Indiana:

Rank	Conservation efforts for Farm Bill Program grassland habitats
1 (tie)	Habitat protection on public lands
1 (tie)	Habitat restoration on public lands
1 (tie)	Land use planning
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Cooperative land management agreements (conservation easements)
3 (tie)	Restrict public access and disturbance

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- 4 Succession control (fire, mowing)
- 5 (tie) Habitat protection through regulation
- 5 (tie) Habitat restoration through regulation
- 5 (tie) Habitat protection incentives (financial)
- 5 (tie) Protection of adjacent buffer zone
- 5 (tie) Technical assistance
- 5 (tie) Artificial habitat creation (artificial reefs, nesting platforms)
- 5 (tie) Selective use of functionally equivalent exotic species in place of extirpated natives
- 5 (tie) Corridor development/protection
- 5 (tie) Pollution reduction

A respondent listed another current conservation practice for Farm Bill Program grassland habitats in Indiana:

- Prevent early mowing and haying of CRP lands or other habitat

Respondents recommended the following practices for more effective conservation of Farm Bill Program grassland habitats in Indiana (not ranked):

- Making mid-contract management mandatory on enrolled acreage
- Protection and restoration of habitat
- Preventing early mowing and haying

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of Farm Bill Program habitats. Their responses included:

- Need to be concerned about private lands. Farm Bill programs almost exclusively deal with private lands.
- It's assumed that the #1 threat in the table above is habitat protection and restoration on "private" land, not "public" land. Since Farm Bill activities occur almost exclusively on private land, that is where the focus of the effort should be. The three main practices listed above are probably the most important.
- Yes

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents were aware of these monitoring efforts conducted by state agencies for wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- Statewide once-a-year monitoring

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- Periodic statewide (less than once a year and 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 statewide (less than once a year and still regularly scheduled) monitoring

Respondents were aware of these monitoring efforts conducted by other organizations for wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

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

Respondents ranked monitoring efforts conducted by state agencies by how well they contribute to wildlife conservation in Farm Bill Program grassland habitats in Indiana:

Rank	Monitoring by state agencies for wildlife in Farm Bill Program grassland habitats
1	Statewide once-a-year monitoring
2	Periodic statewide (less than once a year but still regularly scheduled) monitoring
3	Regional or local once-a-year monitoring
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
4 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
5	Statewide year-round monitoring
6	Periodic regional or local (less than once a year but still regularly scheduled) monitoring

Respondents ranked monitoring efforts conducted by other organizations by how well they contribute to wildlife conservation in Farm Bill Program grassland habitats in Indiana:

Rank	Monitoring by other organizations for wildlife in Farm Bill Program grassland habitats
1	Statewide once-a-year monitoring
2 (tie)	Regional or local once-a-year monitoring
2 (tie)	Periodic statewide (less than once a year but



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still regularly scheduled) monitoring

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

Respondents listed regional or local monitoring by state agencies for wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- The Indiana Division of Fish and Wildlife conducts a biennial mailing survey to small game hunters to estimate harvest. Additionally, the division conducts an annual spring whistle counts to provide an index to the spring breeding population. However, neither of these methods focuses directly on Farm Bill habitats
- Interlake Property, Division of Outdoor Recreation ownership
- Surveys on state properties and through efforts such as the Breeding Bird Atlas projects

Respondents listed regional or local monitoring by other organizations for wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- The National Audubon Society conducts the Breeding Bird Survey, and observers count the number of bobwhites seen along with other bird species. Again this survey is not directly focused on Farm Bill habitats
- BBS routes and work done on strip mine lands in southwest Indiana and Big Oaks National Wildlife Refuge

Respondents listed organizations that monitor wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- IN Department of Natural Resources
- U.S. Fish and Wildlife Service
- The Nature Conservancy
- USDA Forest Service
- Indiana State University

Respondents considered current monitoring techniques for wildlife in Farm Bill Program grassland habitats in Indiana:

Monitoring techniques for wildlife in Farm Bill Program grassland habitats	Used	Not used but possible with existing technology or data	Not economically feasible
Radio tracking and telemetry	--	X	X
Modeling	X	--	--

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Spot mapping	X	X	X
Driving a survey route	X	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	--	--
Mark and recapture	X	X	X
Professional survey/census	X	--	--
Volunteer survey/census	X	X	--
Trapping (by any technique)	X	X	X
Representative sites	X	--	--
Probabilistic sites	X	--	--

A respondent listed "nest monitoring" as another monitoring technique for wildlife in Farm Bill Program grassland habitats in Indiana.

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 Farm Bill Program habitats. Their responses included:

- Yes
- Yes

### Habitat inventory and assessment

Respondents were aware of the following inventory and assessments by state agencies for Farm Bill Program grassland habitats in Indiana (not ranked):

- Periodic statewide (less than once a year and 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 statewide (less than once a year and 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 assessments by other organizations for Farm Bill Program grassland habitats in Indiana (not ranked):

- Statewide year-round inventory and assessment
- Statewide once-a-year inventory and assessment
- Periodic statewide (less than once a year and still regularly scheduled) inventory and assessment
- Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment

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- Regional or local once-a-year inventory and assessment
- Periodic regional or local statewide (less than once a year and 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 by how well they conserve Farm Bill Program habitats in Indiana:

<b>Rank</b>	<b>Inventory and assessment by state agencies for wildlife in Farm Bill Program grassland habitats</b>
<b>1</b>	Statewide once-a-year inventory and assessment
<b>2 (tie)</b>	Periodic statewide (less than once a year and still regularly scheduled) inventory and assessment
<b>2 (tie)</b>	Regional or local once-a-year inventory and assessment
<b>2 (tie)</b>	Periodic regional or local statewide (less than once a year and still regularly scheduled) inventory and assessment
<b>2 (tie)</b>	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
<b>3 (tie)</b>	Statewide annual inventory and assessment
<b>3 (tie)</b>	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
<b>3 (tie)</b>	Regional or local year-round inventory and assessment

Respondents listed the following inventory and assessment efforts by other organizations as crucial to how they conserve Farm Bill Program habitats in Indiana (not ranked):

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

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Respondents listed regional or local inventory and assessment by state agencies for Farm Bill Program grassland habitats in Indiana (not ranked):

- Interlake property
- Habitats on state areas are surveyed occasionally for quality and quantity
- Indiana Division of Fish and Wildlife will be initiating some type of bobwhite monitoring program to determine success of the newest continuous CRP (CP33)

Respondents listed regional or local inventory and assessment by other organizations for Farm Bill Program grassland habitats in Indiana (not ranked):

- Farm Services Agency keeps track of location and acreage associated with each contract
- U.S. Fish and Wildlife Service, The Nature Conservancy and Indiana State University have surveyed quality and quantity of habitats for HESPs
- Farm Services Agency monitors acreage and location of tracts enrolled in each U.S. Department of Agriculture program
- Natural Resources Conservation Service provides technical support or administers most farm programs and conducts regular inspections

Respondents listed organizations that monitor Farm Bill Program grassland habitats in Indiana (not ranked):

- Indiana Division of Fish and Wildlife
- Farm Services Agency
- Natural Resources Conservation Service
- U.S. Department of Agriculture
- USDA Forest Service
- The Nature Conservancy
- Indiana State University

Respondents considered current inventory and assessment techniques for Farm Bill Program grasslands habitats in Indiana as follows:

<b>Inventory and assessment techniques for Farm Bill Program grassland habitats</b>	<b>Used</b>	<b>Not used but possible with existing technology or data</b>	<b>Not economically feasible</b>
GIS mapping	X	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	--	X	--
Participation in landuse programs	X	--	--
Modeling	X	--	--
Voluntary landowner reporting	X	X	--

A respondent listed another inventory and assessment technique for Farm Bill Program grassland habitats in Indiana: "I recently correlated the number of acres enrolled in USDA programs with our

## Appendix F-51: Farm Bill Programs

annual bobwhite whistle indices on a statewide scale. I am planning on modeling regional bobwhite indices and USDA idled acreage.”

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 Farm Bill Program habitats. Their responses included:

- Yes.
- YEs

### **Recommended monitoring**

#### Species monitoring

Respondents recommended the following monitoring technique for effective conservation of wildlife in Farm Bill Program grassland habitats in Indiana (not ranked):

- To monitor bobwhite populations specifically in farm bill habitats, I would suggest selecting a random sample of contracts and conducting flushing transects. Another intensive method would be to have hunters complete "report cards" when hunting on Farm Bill acreage. A less intensive method would be to request that landowners conduct whistle counts on their enrolled lands each spring
- Fall covey counts
- Professional and volunteer survey and census

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 Farm Bill Program habitats. Their responses included:

- One of the most important issues in monitoring wildlife populations relative to Farm Bill programs will be to conduct some surveys with a level of intensity that will be able to discern the impact of the program accomplishments on the population level. This can only be done on a smaller scale (e.g. township level) rather than statewide.
- Yes

#### Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of Farm Bill Program grassland habitats in Indiana (not ranked):

- Flush counts or more intensive whistle counts on farm program lands would be a useful method of evaluating their quality when compared to the same indices on non-Farm Bill lands
- Grassland mapping by major plant species type
- GIS mapping and participation in landuse programs (CRP)

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 Farm Bill Program habitats. Their responses included:

- Yes

## Appendix F-51: Farm Bill Programs

Technical experts and conservation organizations offered the following additional comments:

- Most responses were concerned about Bobwhite quail. Need other grassland species input.
- Two programs that really need to be looked at in detail to insure that wildlife benefits are being realized are the Grassland Reserve Program (GRP) and the Conservation Security Program (CSP). Both programs have the potential to benefit wildlife populations, but only if they are implemented properly, with wildlife considerations taken seriously.

## Appendix F-52: Fescue

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## HAYLAND GRASSLAND HABITAT NARRATIVE

### Habitat description

*Grasslands/herbaceous habitats* are areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

### Problems affecting species and habitats

#### Species threats

Respondents ranked threats to wildlife in hayland grassland habitats in Indiana:

Rank	Threats to wildlife in hayland grassland habitats
1 (tie)	Habitat loss (breeding range)
1 (tie)	Habitat loss (feeding/foraging areas)
2	Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
3 (tie)	Predators (native or domesticated)
3 (tie)	Small native range (high endemism)
4 (tie)	Bioaccumulation of contaminants
4 (tie)	Degradation of movement/migration routes
4 (tie)	Viable reproductive population size or availability
5 (tie)	Invasive/non-native species
5 (tie)	Near limits of natural geographic range
5 (tie)	Large home range requirements
5 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

A respondent listed another threat to wildlife in hayland grassland habitats in Indiana:

- Early harvesting of hay crops

Respondents described top threats to wildlife in hayland grassland habitats in Indiana (not ranked):

- Habitat loss and fragmentation create small, isolated patches where nest predation and brood parasitism tend to increase
- The timing and frequency of haying, as well as the cover type (alfalfa) can affect negatively nest success and limit productivity



## Appendix F-53: Haylands

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

### Habitat threats

Respondents ranked threats to hayland grassland habitats in Indiana:

Rank	Threats to hayland grassland habitats
1 (tie)	Habitat fragmentation
1 (tie)	Agricultural/forestry practices
1 (tie)	Commercial or residential development (sprawl)
1 (tie)	Counterproductive financial incentives or regulations
2	Habitat degradation
3 (tie)	Climate change
3 (tie)	Successional change
4 (tie)	Residual contamination (persistent toxins)
4 (tie)	Point source pollution (continuing)
5 (tie)	Invasive/non-native species
5 (tie)	Non-point source pollution (sedimentation and nutrients)
5 (tie)	Diseases (of plants that create habitat)
5 (tie)	Mining/acidification
5 (tie)	Drainage practices (stormwater runoff)

Respondents noted no other additional threats to hayland grassland habitats in Indiana.

Respondents listed top threats to hayland grassland habitats in Indiana (not ranked):

- Conversion of hayfields to row crop or urban cover
- Frequent haying, mowing or overgrazing

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

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

## Appendix F-53: Haylands

Respondents indicated that the current body of science for wildlife in hayland grassland habitats in Indiana is inadequate.

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

Title = Atlas of Breeding Birds of Indiana;  
Author = J.S. Castrale, E.M. Hopkins, & C.E. Keller;  
Date = 1998;  
Publisher = IDNR

Title = Effects of management practices on grassland birds: Bobolink;  
Author = Dechant, J.A., M.L. Sondreal, D.H. Johnson, L.D. Igl, C.M. Goldade, A.L. Zimmerman and B.R. Euliss;  
Date = 2001;  
Publisher = Northern Prairie Wildlife Research Center

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

### Habitat research

Respondents indicated that the current body of science for hayland grassland habitats in Indiana is inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of hayland grassland habitats in Indiana.

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

## **Research needs**

### Species research

The respondent indicated that "distribution and abundance" research for wildlife in hayland grassland habitats in Indiana is "greatly needed." The respondent stated that the following research is "needed" (not ranked):

- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)

The respondent listed the following as "slightly needed" for wildlife in hayland grassland habitats in Indiana: "relationship/dependence on specific habitats."

Respondents cited no additional research needs for wildlife in hayland grassland habitats in Indiana.

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

## Appendix F-53: Haylands

### Habitat research

Respondents agreed that the following research is “greatly needed” for hayland grassland habitats in Indiana (not ranked):

- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)

The respondent listed an additional research need for hayland grassland habitats in Indiana:

- Timing and frequency of haying and other agricultural practices

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

### **Conservation actions necessary**

#### Species actions

The respondent stated that the following conservation efforts address threats to wildlife in hayland grassland habitats in Indiana “very well” (not ranked):

- Habitat protection
- Threats reduction
- Public education to reduce human disturbance

The respondent stated that other current conservation practices for wildlife in hayland grassland habitats in Indiana include: “Restoration of native grasslands and increased enrollment in the Conservation Reserve Program provide refuges from agricultural disturbances (provided the proper vegetation structure is maintained.”

The respondent recommended the following practice for more effective conservation of wildlife in hayland grassland habitats in Indiana:

- Time haying and grazing around the breeding cycle before May and after June

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practice for more effective conservation of wildlife in hayland grassland habitat. There were no responses.

### Habitat actions

The respondent stated that the following conservation efforts address threats to hayland grassland habitats in Indiana “very well” (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration through regulation
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Succession control (fire, mowing)
- Cooperative land management agreements (conservation easements)

## Appendix F-53: Haylands

The respondent stated that the following conservation efforts address habitat threats “somewhat” (not ranked):

- Selective use of functionally equivalent exotic species in place of extirpated natives
- Land use planning

Respondents offered no other current conservation practices for hayland grassland habitats in Indiana.

The respondent recommended the following practice for more effective conservation of hayland grassland habitats in Indiana (not ranked):

- Provide incentives to prevent landowners from haying or grazing during the breeding season
- Educate landowners about the importance of their land to the persistence of wildlife species

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

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents were aware of current monitoring efforts by state agencies for wildlife in hayland grassland habitats in Indiana (not ranked):

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

Respondents were aware of monitoring conducted by other organizations for wildlife in hayland grassland habitats in Indiana (not ranked):

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

Respondents ranked the importance of monitoring efforts by state agencies for wildlife conservation in hayland grassland habitats in Indiana:

## Appendix F-53: Haylands

Rank	Monitoring efforts by state agencies for wildlife in hayland grassland habitats
1	Occasional statewide (less than once a year and not regularly scheduled) monitoring
2 (tie)	Stateside once-a-year monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2 (tie)	Regional or local year-round monitoring
2 (tie)	Regional or local once-a-year monitoring
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
3 (tie)	Statewide year-round monitoring
3 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring

Respondents ranked the importance of monitoring efforts by other organizations for wildlife conservation in hayland grassland habitats in Indiana:

Rank	Monitoring efforts by other organizations for wildlife in hayland grassland habitats
1 (tie)	Regional or local once-a-year monitoring
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
2 (tie)	Stateside once-a-year monitoring
2 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring
2 (tie)	Regional or local once-a-year monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring

A respondent listed "IDNR's Nongame and Endangered Wildlife Program" as a state agency that does regional or local monitoring for wildlife in hayland grassland habitats in Indiana.

A respondent listed the following regional or local monitoring by other organizations for wildlife in hayland grassland habitats in Indiana (not ranked):

- Breeding Bird Survey routes are scattered throughout the state depending on volunteer participation
- Local intensive surveys, nest monitoring or mark-recapture studies

## Appendix F-53: Haylands

A respondent listed organizations that monitor wildlife in hayland grassland habitats in Indiana (not ranked):

- Indiana Academy of Science
- Indiana Audubon Society
- Local chapters of NAS worked with IDNR to complete Breeding Bird Atlas (1985-1990)
- USGS Bird Banding Lab coordinates BBS
- Universities such as Purdue complete local research projects

Respondents ranked current monitoring techniques for wildlife in hayland grassland habitats in Indiana:

Monitoring techniques for wildlife in hayland grassland habitats	Used	Not used but possible with existing technology or data	Not economically feasible
Radio tracking and telemetry	--	X	--
Modeling	X	--	--
Spot mapping	X	X	--
Driving a survey route	X	--	--
Mark and recapture	X	--	--
Professional survey/census	X	X	--
Volunteer survey/census	X	X	--
Trapping (by any technique)	X	X	--
Representative sites	--	X	--
Probabilistic sites	--	X	--

Respondents listed no other monitoring techniques for wildlife in hayland grassland habitats in Indiana.

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 hayland grassland habitat. There were no responses.

### Habitat inventory and assessment

A respondent was aware of current inventory and assessment efforts conducted by state agencies for hayland grassland habitats in Indiana (not ranked):

- Statewide annual inventory and assessment
- Periodic statewide (less than once a year but still regularly scheduled) monitoring
- Occasional statewide (less than once a year and not regularly scheduled) monitoring

## Appendix F-53: Haylands

- Regional or local year-round monitoring

A respondent was aware of the following inventory and assessment efforts conducted by other organizations for hayland grassland habitats in Indiana (not ranked):

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

The respondent listed no efforts by state agencies or other organizations as “very crucial” for conservation of hayland grassland habitats in Indiana. The respondent listed the following efforts conducted by state agencies as “somewhat crucial” (not ranked):

- Statewide annual inventory and assessment
- Periodic statewide (less than once a year and still regularly scheduled) inventory and assessment

A respondent listed regional or local inventory and assessment by state agencies for hayland grassland habitats in Indiana as follows (not ranked):

- Annual and 5-year census
- County level reports of acreage planted to various hay cover types and acreage harvested

Respondents offered no information on regional or local inventory and assessment by other organizations for hayland grassland habitats in Indiana.

A respondent listed USDA National Agricultural Statistics Services as an organization that monitors hayland grassland habitats in Indiana.

A respondent stated that these current inventory and assessment techniques are “frequently used” for hayland grassland habitats in Indiana (not ranked):

- GIS mapping
- Participation in land use programs

The respondent ranked “aerial photography and analysis” as “occasionally used,” but didn’t comment on the feasible or possible use of other listed techniques.

Respondents offered no other inventory and assessment techniques for hayland grassland habitats in Indiana.

## Appendix F-53: Haylands

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 hayland grassland habitat. There were no responses.

### **Recommended monitoring**

#### Species monitoring

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

- Point counts during breeding season
- Establish more Breeding Bird Survey routes
- Conduct point counts on private lands. If possible, estimate nest success

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 in hayland grassland habitat. There were no responses.

#### Habitat inventory and assessment

A respondent recommended the following inventory and assessment technique for effective conservation of hayland grassland habitats in Indiana:

- Survey of hay harvest dates and frequencies each year

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 hayland grassland habitat. There were no responses.



## Appendix F-54: Pasture

Technical experts did not provide input on a representative species for this habitat.

There are no species of greatest conservation need in this guild.

## PRAIRIE GRASSLAND HABITAT NARRATIVE

### Habitat description

A prairie is a complex natural community covered with a dense mixture of tall grasses and other herbaceous plants.

### Problems affecting species and habitats

#### Species threats

The respondent listed no "critical threats," but cited these "serious threats" to wildlife in prairie grassland habitats in Indiana (not ranked):

- Unintentional take/direct mortality (e.g., vehicle collisions, powerline collisions, by-catch, harvesting equipment, land preparation machinery)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

The respondent listed as "somewhat of a threat" to wildlife in prairie grassland habitats in Indiana (not ranked):

- Invasive/non-native species
- Predators (native or domesticated)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

The respondent listed as "slight threat" to wildlife in prairie grassland habitats in Indiana (not ranked):

- Near limits of natural geographic range
- Viable reproductive population size or availability

The respondent listed no additional threats to wildlife in prairie grassland habitats in Indiana.

The respondent listed top threats to wildlife in prairie grassland habitats in Indiana (not ranked):

- Availability of habitat
- Mowing grasslands

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

- No. We have less than 1/10th of 1% remaining of natural prairie grasslands in Indiana; thus, habitat loss must be considered a critical threat. In addition, the prairies that do remain are relatively small in size, so that area sensitive species are especially vulnerable. Finally, invasive species post a serious, if not critical threat, to our remaining prairies.
- No...this summary is wholly inadequate to address the significant threats to native prairie ecosystems in Indiana, which have declined by more than 99% since presettlement time. How can a habitat type that has declined by >99% not have critical threats? Grassland birds are the fastest declining guild of bird species in North America, and nearly 20 species of grassland dependent birds, mammals, reptiles, and amphibians are either state endangered or state special concern. In addition, 20% of the USFWS's Birds of Conservation Concern for the Midwest region are grassland dependent. Many of the threats

## Appendix F-55: Prairies

listed are correct, but I believe they are much more serious than depicted. Direct loss through successional change and lack of adequate management (e.g. fire) is a key component, as is habitat fragmentation and predation/parasitism, but there is so little native prairie remaining that any loss is considered a significant loss. While many grassland dependent wildlife species can use other types of grasslands for breeding and foraging, the majority of these grasslands are either highly disturbed (e.g. haylands) or ecologically poor in plant species composition and/or structure, making them inferior habitats for grassland wildlife.

### Habitat threats

The respondent named no "critical threats," but listed the following as "serious threats" to prairie grassland habitats in Indiana (not ranked):

- Counterproductive financial incentives or regulations
- Successional change
- Agricultural/forestry practices

The respondent considered the following as "somewhat of a threat" to prairie grassland habitats in Indiana (not ranked):

- Commercial or residential development (sprawl)
- Habitat fragmentation
- Habitat degradation

The respondent listed the following as "slight threats" to prairie grassland habitats in Indiana (not ranked):

- Invasive/non-native species
- Residual contamination (persistent toxins)

The respondent listed no additional threats to prairie grassland habitats in Indiana.

The respondent listed the following as top threats to prairie grassland habitats in Indiana:

- Mowing during breeding season
- Conversion of grasslands to row crops or housing developments

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

- Habitat fragmentation and degradation are serious threats
- Again, few remaining prairies compared to presettlement time, small size (fragmentation), and degraded (invasive species/succession) are all critical problems for Indiana prairies.
- As mentioned above, considering that >99% of the native prairie in Indiana is gone, how could there not be any critical threats to its continued persistence? Again, most of the threats are accurate, but the seriousness is much greater than depicted. Greatest threats include successional change (esp. woody invasion), invasive species, habitat fragmentation, ag encroachment (both mechanically and chemically), and mowing during the nesting season.

## Additional research and survey efforts

### Current body of research

#### Species research

The respondent said that the current body of science for wildlife in prairie grassland habitats is adequate.

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

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

Title = BNA Account - Savannah;  
Author = Wheelwright and Rising;  
Date = 1993;  
Publisher = American Ornithologists' Union

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

- No. A more thorough listing of literature for more prairie species would be useful.
- No...these publications either deal with a single species, or with the distribution of bird species in the state. What is needed is detailed information on life history and habitat needs for the full complement of representative species, which is more like the species list under aggregated grasslands. The two species listed in the prairie guild are wholly inadequate to describe the makeup of the diversity of prairie wildlife.

Few papers address Indiana specifically, but papers from the midwest region or other midwest states can substitute. Additional papers include:

Herkert, J.R., D.W. Sample, and R.E. Warner. 1996. Management of midwestern grassland landscapes for the conservation of migratory birds. Pages 89-116 in F.R. Thompson III, editor. Management of midwestern landscapes for the conservation of migratory birds. USDA, Forest Serv. Gen Tech. Rep. NC-187.

Samson, F.B and F.L. Knoop, editors. 1996. Prairie conservation. Island Press, Washington, D.C.

Sample, D.W. and M.J. Mossman. 1997. Managing habitat for grassland songbirds: A guide for Wisconsin. Wisconsin DNR.

#### Habitat research

The respondent said that the current body of science for prairie grassland habitats in Indiana is adequate.

## Appendix F-55: Prairies

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

Title = see previous citations

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

- No. Division of Nature Preserves has extensive data based on systematic inventory for prairies.
- No.....see previous citations. Also:

Thompson, J.R. 1992. Prairies, forests, and wetlands: The restoration of natural landscape communities in Iowa. Univ. of Iowa Press.

Packard, S. and C.F. Mutel. 1997. The tallgrass restoration handbook. Island Press.

Herkert, J., et. al. 1993. Habitat establishment, enhancement, and management for forest and grassland birds in Illinois. Ill. Dept. of Conservation, Nat. Heritage Technical Pub. #1.

McClain, W.E. 1997. Prairie establishment and landscaping. Ill. Dept. of Nat. Resour., Nat. Heritage Tech. Pub. #2.

## Research needs

### Species research

The respondent listed no "urgently needed" or "greatly needed" research for wildlife in prairie grassland habitats in Indiana. The respondent listed as "needed" research (not ranked):

- Life cycle
- Distribution and abundance
- Limiting factors (food, shelter, water, breeding sites)
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats
- Population health (genetic and physical)

The respondent listed no other research needs for wildlife in prairie grassland habitats in Indiana.

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 prairie grassland habitats. Their responses included:

- Yes.
- Yes. I believe we need information on how prairie wildlife responds to habitat fragmentation, predation and parasitism, invasive species, and other threats, so as to design conservation efforts that address the most pressing issues.

### Habitat research

## Appendix F-55: Prairies

The respondent listed no “urgently needed” or “greatly needed” research for prairie grassland habitats in Indiana. The respondent listed as “needed” research (not ranked):

- Successional changes
- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of the habitat

The respondent listed no other research needs for prairie grassland habitats in Indiana.

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

- Mostly yes, but would also be useful to get better information regarding invasives control and management.
- Restoration of native prairie on private lands is the best way to increase habitat for grassland dependent wildlife. However, better information is needed on restoring prairie ecosystems, not just patches, and how networks of restored prairie can contribute to the conservation of grassland dependent species on a landscape scale.

## Conservation actions necessary

### Species actions

Reviewing a list of conservation actions, the respondent stated that none of them address threats to wildlife in prairie grassland habitats in Indiana “very well.” The following conservation efforts address threats “somewhat” (not ranked):

- Habitat protection
- Threats reduction
- Native predator control
- Exotic/invasive species control
- Regulation of collecting
- Protection of migration routes
- Limiting contact with pollutants/contaminants
- Public education to reduce human disturbance

The respondent offered no other current conservation practices for wildlife in prairie grassland habitats in Indiana.

The respondent listed the following practice for more effective conservation of wildlife in prairie grassland habitats in Indiana:

- Conservation and active management of grassland habitats

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

## Appendix F-55: Prairies

- Seems confusing. Actions listed above are "conservation and active management of grassland habitats." It would be extremely valuable if a few large restorations could be completed, so that a suite of large-sized, managed prairies, were available to prairie dependent wildlife.
- Partially. Active management (e.g. prescribed burning, control of exotics) is critical to maintaining existing prairie habitat, but to really conserve prairie wildlife, it will require large scale restoration of native prairie habitats, mostly on private lands. The best way to do that is to provide incentives to private landowners to convert cropland or non-native grasslands to native prairie habitat. This will need to be done strategically, and on a landscape scale that will influence populations over a large area. It will also require an understanding of the most pressing needs for restoration (e.g. shortgrass, tallgrass) based on the location and target species.

### Habitat actions

Reviewing a list of conservation actions, the respondent stated that none of them address threats to prairie grassland habitats in Indiana "very well." The following conservation efforts address threats "somewhat" (not ranked):

- Habitat protection through regulation
- Habitat protection on public lands
- Habitat protection incentives (financial)
- Habitat restoration through regulation
- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Selective use of functionally equivalent exotic species in place of extirpated natives
- Succession control (fire, mowing)
- Protection of adjacent buffer zone
- Restrict public access and disturbance
- Land use planning
- Technical assistance
- Cooperative land management agreements (conservation land easements)

The respondent offered no other current conservation practices for prairie grassland habitats in Indiana.

The respondent listed the following for more effective conservation of prairie grassland habitats in Indiana:

- Incentives for conserving and managing grasslands

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation actions for prairie grassland habitats. Their responses included:

- Private Land must be protected. CRP provides financial incentives for the landowner.
- Again, a few large-sized managed sites would be great benefit.
- Yes, but see above. Main efforts should be on private lands for restoration, not public lands.

### **Proposed plans for monitoring**

## Appendix F-55: Prairies

### Current monitoring

#### Species monitoring

The respondent was aware of no state agency monitoring efforts for wildlife in prairie grassland habitats in Indiana.

The respondent was aware of the following monitoring efforts by other organizations for wildlife in prairie grassland habitats in Indiana:

- Statewide once-a-year monitoring

The respondent stated that no state agency or organization monitoring efforts were “crucial” for conservation of wildlife in prairie grassland habitats in Indiana. The respondent stated that “statewide once-a-year-monitoring” by other organizations is “somewhat crucial.”

The respondent was aware of no regional or local monitoring by state agencies for wildlife in prairie grassland habitats in Indiana.

The respondent listed the following regional or local monitoring by other organizations for wildlife in prairie grassland habitats in Indiana (not ranked):

- Statewide breeding bird survey
- May Day bird counts
- Summer bird counts

The respondent listed the following organizations that monitor wildlife in prairie grassland habitats in Indiana (not ranked):

- USGS
- Birding organizations

The respondent listed the following as “frequently used” monitoring techniques for wildlife in prairie grassland habitats in Indiana (not ranked):

- Driving a survey route
- Volunteer survey/census

The respondent stated that the following monitoring techniques are “occasionally used” (not ranked):

- Spot mapping
- Mark and recapture
- Professional survey/census
- Trapping (by any technique)
- Representative sites
- Modeling
- Probabilistic sites

The respondent stated that “radio and telemetry and tracking” falls into the category of techniques “not used but possible with existing technology and data” for monitoring wildlife in prairie grassland habitats in Indiana. The respondent listed no techniques that were “not economically feasible.”



## Appendix F-55: Prairies

The respondent was aware of no other monitoring techniques for wildlife in prairie grassland habitats in Indiana.

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 prairie grassland habitats. Their responses included:

- Nongame Program conducts statewide monitoring.
- Yes

### Habitat inventory and assessment

The respondent was aware of no inventory and assessment efforts by state agencies for prairie grassland habitats in Indiana.

The respondent was aware of the following inventory and assessment efforts by other organizations for prairie grassland habitats in Indiana:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent listed no "crucial" efforts by state agencies for conservation of prairie grassland habitats in Indiana. The respondent listed the following as a "somewhat crucial" effort by other organizations:

- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

The respondent listed no regional or local inventory and assessment by state agencies for prairie grassland habitats in Indiana.

The respondent offered the following regional or local inventory and assessment by other organizations for prairie grassland habitats in Indiana:

- Statewide aerial imagery of habitats, land uses

The respondent listed USDA as an organization that might monitor prairie grassland habitats in Indiana.

The respondent listed the following as a "frequently used" inventory and assessment techniques for prairie grassland habitats in Indiana:

- Aerial photography and analysis

The respondent listed the following as "occasionally used" (not ranked):

- GIS mapping
- Systematic sampling
- Participation in land use programs
- Modeling

## Appendix F-55: Prairies

The respondent listed no items that fall into the categories of "not used but possible with existing technology and data" or "not economically feasible."

The respondent offered no other inventory and assessment techniques for prairie grasslands habitats in Indiana.

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 prairie grassland habitats. Their responses included:

- Division of Nature Preserves conducts statewide habitat inventory and assessment.
- Yes

### **Recommended monitoring**

#### Species monitoring

The respondent recommended the following monitoring techniques for effective conservation of wildlife in prairie grassland habitats in Indiana (not ranked):

- Roadside surveys
- Spot mapping on smaller area

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 in prairie grassland habitats. Their responses included:

- Natural Heritage Program within Division of Nature Preserves is beginning to use a methodology that creates "occurrence" polygons, based on GPS points, or polygons, that includes suitable habitat.

#### Habitat inventory and assessment

The respondent recommended this inventory and assessment technique for effective conservation of prairie grassland habitats in Indiana:

- Aerial imagery coupled with modeling

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 prairie grassland habitats. Their responses included:

- Division of Nature Preserves has completed statewide inventory, using aerial photographs, flight verification, and on the ground field surveys to find remnant prairies.

Technical experts and conservation organizations offered the following additional comments:

- If this information is based on only one respondent, then it seems that some method for obtaining more responses is needed.

## Appendix F-55: Prairies

## **RECLAIMED MINELANDS GRASSLAND HABITATS NARRATIVE**

### **Habitat description**

Open areas created by total soil disturbance related to surface mining activities and revegetated with warm or cool season grasses.

### **Problems affecting species and habitats**

#### Species threats

Technical experts did not provide input on a representative species for this habitat.

Upon review, technical experts and conservation organizations offered the following responses:

- The greatest threat to grassland birds nesting in Indiana would be losing these reclaimed mineland grasslands to housing developments, golf courses and industrial development.

There are no species of greatest conservation need in this guild.

If you would like to provide information on this habitat please contact Tim Longwell at (574)-258-0100 or at [cws@djcase.com](mailto:cws@djcase.com).

### **Additional research and survey efforts**

#### **Current body of research**

##### Species research

Technical experts did not provide input on a representative species for this habitat.

Upon review, technical experts and conservation organizations offered the following responses:

- Also, see list of literature references pertaining to reclaimed minelands, habitat fragmentation and brown-headed cowbird parasitism.

There are no species of greatest conservation need in this guild.

If you would like to provide information on this habitat please contact Tim Longwell at (574)-258-0100 or at [cws@djcase.com](mailto:cws@djcase.com).

### **Conservation actions necessary**

#### Species actions

Technical experts did not provide input on a representative species for this habitat.

Upon review, technical experts and conservation organizations offered the following responses:

## Appendix F-56: Reclaimed Minelands

- Non-native vegetation including tall fescue, smooth brome, orchard grass and Japanese brome was used successfully for nesting. The size of the reclaimed minelands and isolation from forested habitat apparently accounted for a reduced level of brown-headed cowbird parasitism and high nesting use and success.

There are no species of greatest conservation need in this guild.

If you would like to provide information on this habitat please contact Tim Longwell at (574)-258-0100 or at [cws@djcase.com](mailto:cws@djcase.com).

### Habitat actions

Technical experts did not provide input on this habitat.

Upon review, technical experts and conservation organizations offered the following responses:

- Purchase of fee title or easement rights by the State is the last hope to preserve significant grassland habitat for grassland and savanna nesting birds.

There are no species of greatest conservation need in this guild.

If you would like to provide information on this habitat please contact Tim Longwell at (574)-258-0100 or at [cws@djcase.com](mailto:cws@djcase.com).

## SAVANNA GRASSLAND HABITATS NARRATIVE

### Habitat description

Savanna is the name given to the transitional area that bridges the boundary between Prairie and Forest and is characterized by grassland interspersed with widely spaced trees with a canopy cover of less than 50% - 80%. Once thought to be merely a meeting of the Prairie and Forest communities it has recently been shown to be a distinct biological community in its own right - as different from Forest or Prairie communities as Forest and Prairie communities are from each other - with its own unique set of plants and animals.

### Problems affecting species and habitats

#### Species threats

Respondents ranked threats to wildlife in savanna grassland habitats in Indiana:

Rank	Threats to wildlife in savanna grassland habitats
1 (tie)	Habitat loss (breeding range)
1 (tie)	Habitat loss (feeding/foraging areas)
2 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
2 (tie)	Diseases/parasites (of the species itself)
3 (tie)	Invasive/non-native species
3 (tie)	Viable reproductive population size or availability
3 (tie)	Small native range (high endemism)

Respondents listed "fire suppression" as an additional threat to wildlife in savanna grassland habitats in Indiana.

Respondents described top threats to wildlife in savanna grassland habitats in Indiana (not ranked):

- This species is more of an obligate to open areas with scattered dead trees than most Indiana species. Outright loss of this habitat is probably the leading threat to the red-headed woodpecker. West Nile virus is probably the second leading threat
- Fire suppression

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

#### Habitat threats

Respondents ranked threats to savanna grassland habitats in Indiana:

## Appendix F-57: Savanna

Rank	Threats to savanna grassland habitats
1 (tie)	Successional change
1 (tie)	Agricultural/forestry practices
1 (tie)	Habitat degradation
2 (tie)	Commercial or residential development (sprawl)
2 (tie)	Invasive/non-native species
3 (tie)	Habitat fragmentation
3 (tie)	Diseases (of plants that create habitat)
3 (tie)	Climate change
4 (tie)	Counterproductive financial incentives or regulations
4 (tie)	Drainage practices (stormwater runoff)
5	Nonpoint source pollution (sedimentation and nutrients)

Respondents listed other threats to savanna grassland habitats in Indiana (not ranked):

- Loss of disturbance regimes that maintained open structure of savannas (and swamp forests) where the red-headed woodpecker resides
- Fire suppression is a major threat. Lack of fire also results in an increase of shade-tolerant invasive species like garlic mustard and Asian bush honeysuckle, further degrading savanna habitat

Respondents described top threats to savanna grassland habitats in Indiana (not ranked):

- Conversion of savanna to agricultural and development uses
- Fire suppression results in loss of open structure in existing savannas. It also results in successional change to more shade-tolerant forests

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

## Additional research and survey efforts

### Current body of research

#### Species research

One respondent indicated that current body of science for wildlife in savanna grassland habitats in Indiana is adequate. An other respondent mentioned that we know quite a bit about habitat use patterns of the Red-headed Woodpecker but much less about the effects of landscape fragmentation.

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

## Appendix F-57: Savanna

Title = Red-headed Woodpecker (*Melanerpes erythrocephalus*). In *The Birds of North America*, No. 518;

Author = Smith, K. G., J. H. Withgott, and P. G. Rodewald.;

Date = 2000;

Publisher = The Birds of North America, Inc., Philadelphia, PA.

Title = 1998. *Atlas of Breeding Birds of Indiana*

Author = Castrale, John S., Edward M. Hopkins, and Charles E. Keller.;

Date = 1998;

Publisher = Indiana Department of Natural Resources

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

### Habitat research

Both respondents said that the current body of research for savanna grassland habitats in Indiana is adequate.

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

Title = *Surviving where ecosystems meet: ecotonal animal communities of midwestern oak savannas and woodlands*;

Author = Temple, Stanley A.;

Date = 1998;

Publisher = *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 86: 206-222

Title = *Savannas, barrens, and rock outcrop plant communities of North America*;

Author = Anderson, Roger C., Fralish, James S. , and Baskin, Jerry M.;

Date = 1999;

Publisher = Cambridge University Press

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

### **Research needs**

#### Species research

Respondents ranked research needs for wildlife in savanna grassland habitats in Indiana:

Rank	Research needs for wildlife in savanna grassland habitats
1 (tie)	Limiting factors (food, shelter, water, breeding sites)
1 (tie)	Distribution and abundance



## Appendix F-57: Savanna

- 2 Threats (predators/competition, contamination)
- 3 (tie) Relationship/dependence on specific habitats
- 3 (tie) Population health (genetic and physical)
- 3 (tie) Life cycle

A respondent listed the following research needs for wildlife in savanna grassland habitats in Indiana: "Detailed demographic data needs to be gathered and the effects of habitat structure and fragmentation on those demographic patterns understood."

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 savanna grasslands habitat. There were no responses.

### Habitat research

Respondents ranked research needs for savanna grassland habitats in Indiana:

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

A respondent listed other research needs for savanna grassland habitats in Indiana: "Relationship of fire to habitat structure needs to be better elucidated."

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

## **Conservation actions necessary**

### Species actions

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

## Appendix F-57: Savanna

Rank	Conservation efforts for wildlife in savanna grassland habitats
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- 1 Habitat protection
- 2 (tie) Exotic/invasive species control
- 2 (tie) Protection of migration routes
- 2 (tie) Public education to reduce human disturbance

Respondents listed current conservation practices for wildlife in savanna grassland habitats in Indiana (not ranked):

- Fire management
- Water level management in swamp forests

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

- Restoration of former savanna sites
- Long-term fire management of existing savanna sites/prescribed fire

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

### Habitat actions

Respondents ranked conservation efforts by how well they address threats to savanna grassland habitats in Indiana:

Rank	Conservation efforts for savanna grassland habitats
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- 1 Succession control (fire, mowing)
- 2 (tie) Habitat protection through regulation
- 2 (tie) Habitat protection on public lands
- 2 (tie) Habitat restoration on public lands
- 2 (tie) Habitat restoration through regulation
- 2 (tie) Corridor development/protection
- 2 (tie) Managing water regimes
- 2 (tie) Protection of adjacent buffer zone
- 2 (tie) Technical assistance

Respondents listed no other conservation practices for savanna grassland habitats in Indiana.

## Appendix F-57: Savanna

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

- Purchase of remnant savannas
- Restoration of savannas that have undergone succession to forest or have been farmed
- Fire management
- Get rid of invasive species degrading savanna habitats, including those deliberately planted by wildlife agencies

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

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents were not aware of current monitoring efforts by state agencies for wildlife in savanna grassland habitats in Indiana.

One of two respondents were aware of the following monitoring efforts by other organizations for wildlife in savanna grassland habitats in Indiana (not ranked):

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

Respondents listed no monitoring efforts by state agencies as “crucial” for conservation of wildlife in savanna grassland habitats in Indiana.

Respondents listed the following monitoring efforts by other organizations as “somewhat crucial” for conservation of wildlife in savanna grassland habitats in Indiana:

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

Respondents listed no techniques as “very crucial.”

Respondents did not list or were not aware of regional or local monitoring efforts by state agencies for wildlife in savanna grassland habitats in Indiana.

A respondent listed the following regional or local monitoring by other organizations for wildlife in savanna grassland habitats in Indiana:

- National Breeding Bird Survey includes routes in Indiana that incorporate sites occupied by red-headed woodpeckers. This annual survey will therefore potentially count red-headed woodpeckers at a few sites annually

## Appendix F-57: Savanna

A respondent listed the following organizations that monitor wildlife in savanna grassland habitats in Indiana:

- USGS in Porter, Indiana, has conducted studies of oak-savanna birds, including the red-headed woodpecker

Half of respondents rated the current monitoring efforts for wildlife in savanna grassland habitats in Indiana as “not used but possible with existing technology or data” (not ranked):

- Radio tracking and telemetry
- Spot mapping
- Mark and recapture
- Trapping (by any technique)

No respondents listed current monitoring efforts that are “frequently used.” None listed techniques as “not economically feasible.”

A respondent listed “distance sampling” as another monitoring technique for wildlife in savanna grassland habitats in Indiana.

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

### Habitat inventory and assessment

A respondent was aware of the following inventory and assessment activities by state agencies for savanna grassland habitats in Indiana (not ranked):

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

One of two respondents was aware of the following inventory and assessment activities by other organizations for savanna grassland habitats in Indiana:

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

Half of respondents listed the following inventory and assessment efforts by state agencies as “somewhat crucial” for conservation of savanna grassland habitats in Indiana (not ranked):

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

No respondents listed efforts as “very crucial.”

Half of respondents listed the following inventory and assessment efforts by other organizations as “somewhat crucial” for conservation of savanna grassland habitats in Indiana:

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

No respondents listed efforts as “very crucial.”

## Appendix F-57: Savanna

A respondent listed the following regional or local inventory and assessment efforts by state agencies for savanna grassland habitats in Indiana:

- Indiana DNR Division of Nature Preserves has inventoried habitats across the state over the past three decades. Savannas mainly occur in the northern third of the state

A respondent listed the following regional or local inventory and assessment efforts by other organizations for savanna grassland habitats in Indiana:

- In the northern third of the state

A respondent listed the following organizations that conduct inventory and assessment activities for savanna grassland habitats in Indiana (not ranked):

- Indiana DNR Division of Nature Preserves
- The Nature Conservancy
- Chicago Wilderness
- U.S. Geological Survey
- National Park Service
- U.S. Fish and Wildlife Service

Respondents noted that the following inventory and assessment techniques are used for savanna grassland habitats in Indiana (not ranked):

- GIS mapping
- Aerial photography and analysis
- Systematic sampling
- Regulatory information
- Modeling

Respondents listed no techniques that are “not used but possible with existing technology or data”. They listed no techniques as “not economically feasible.”

Respondents did not list other inventory and assessment techniques for savanna grassland habitats in Indiana.

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 savanna grasslands habitat. There were no responses.

### **Recommended monitoring**

#### Species monitoring

A respondent recommended the following monitoring techniques for effective conservation of wildlife in savanna grassland habitats in Indiana:

- Point counts in potential habitats using distance sampling. This technique is relatively simple to implement and provides density information rather than an index. Observers count birds from points randomly located in the studied habitat and measure or estimate distance to observed birds. Calculation of density from data, however, does require some technical expertise. (Buckland, S.T., D.R. Anderson, et al. (2001). Introduction to distance sampling. Oxford, UK, Oxford University Press)

## Appendix F-57: Savanna

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 in savanna grasslands habitat. There were no responses.

### Habitat inventory and assessment

Respondents did not recommend any inventory and assessment techniques for effective conservation of savanna grassland habitats in Indiana.

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 savanna grasslands habitat. There were no responses.

## VEGETATED DUNES AND SWALES GRASSLANDS HABITATS NARRATIVE

### Habitat description

Ridge and valley topography developed by wind blown sand deposits. These deposits are near Lake Michigan. Vegetative cover progresses the further the dunes are from the lakeshore.

### Problems affecting species and habitats

#### Species threats

The respondent listed the following as “critical threat” to wildlife in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Viable reproductive population size or availability

The respondent listed the following as “serious threat” to wildlife in vegetated dunes and swales grasslands habitat in Indiana:

- Specialized reproductive behavior or low reproductive rates

The respondent listed the following as “somewhat of a threat” to wildlife in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Unregulated collection pressure

The respondent listed the following as “slight threat” to wildlife in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Invasive/non-native species
- Predators (native or domesticated)

The respondent listed no other threats to wildlife in vegetated dunes and swales grasslands habitat in Indiana.

The respondent listed the top threat to wildlife in vegetated dunes and swales grasslands habitat in Indiana as: “Populations seem to be in steep decline due to habitat fragmentation (from land use change and inappropriate management, e.g., fire suppression.) Most known populations seem to occur at such low densities that mating seems a remote possibility. All the problems associated with small population size and low reproductive rate seem likely to be plague the Ornate box turtle. Most populations seem likely to be in a slow-motion death spiral at the moment.”

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in vegetated dunes and swales grasslands habitats. There were no responses.

#### Habitat threats

## Appendix F-58: Vegetated Dunes and Swales

The respondent listed the following as “critical threat” to vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Habitat fragmentation
- Successional change
- Habitat degradation

The respondent listed no “serious threats,” but listed the following as “somewhat of a threat” to vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Invasive/non-native species
- Agricultural/forestry practices

The respondent listed the following as “slight threat” to vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Commercial or residential development (sprawl)
- Counterproductive financial incentives or regulations
- Impoundment of water flow/regulation

The respondent offered no other threats to vegetated dunes and swales grasslands habitat in Indiana.

The respondent described top threats to vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Fragmentation and small habitat size: Most habitats are small remnants of native grassland, surrounded by either agriculture or fire-suppressed oak-savannah. Habitat size needs to be expanded at sites that support seemingly salvageable populations of the Ornate box turtle
- Much potentially suitable habitat has been lost through succession to exotic species and oak woodland. This turtle requires expansive open grassland. Lack of habitat management (or in the case of invasive species because of purposeful introduction of native shrubs) has resulted in open, native grassland being lost to shrubland and oak woodland

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to vegetated dunes and swales grasslands habitats. There were no responses.

## **Additional research and survey efforts**

### **Current body of research**

#### Species research

The respondent stated that the current body of science for wildlife in vegetated dunes and swales grasslands habitat in Indiana is inadequate.

The respondent did not identify citations (title, author, date, publisher) that would give the best overview of wildlife in vegetated dunes and swales grasslands habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in vegetated dunes and swales grasslands habitats. There were no responses.



## Appendix F-58: Vegetated Dunes and Swales

### Habitat research

The respondent stated that the current body of science vegetated dunes and swales grasslands habitat in Indiana is inadequate.

The respondent did not identify citations (title, author, date, publisher) that would give the best overview of vegetated dunes and swales grasslands habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for vegetated dunes and swales grasslands habitats. There were no responses.

### **Research needs**

#### Species research

The respondent stated that the following research is “urgently needed” for wildlife in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Distribution and abundance
- Population health (genetic and physical)

The respondent stated that the following research is “greatly needed” for wildlife in vegetated dunes and swales grasslands habitat in Indiana:

- Limiting factors (food, shelter, water, breeding sites)

The respondent stated that the following research is “needed” for wildlife in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Life cycle
- Threats (predators/competition, contamination)
- Relationship/dependence on specific habitats

The respondent listed no other research needs for wildlife in vegetated dunes and swales grasslands habitat in Indiana.

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 vegetated dunes and swales grasslands habitats. There were no responses.

### Habitat research

The respondent stated that the following research is “greatly needed” for vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Successional changes
- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)
- Relationship/dependence on specific site conditions
- Growth and development of individual components of the habitat

The respondent listed no other research needs for vegetated dunes and swales grasslands habitat in Indiana.

## Appendix F-58: Vegetated Dunes and Swales

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for vegetated dunes and swales grasslands habitats. There were no responses.

### **Conservation actions necessary**

#### Species actions

The respondent stated that “exotic/invasive species control” addresses threats to wildlife in vegetated dunes and swales grasslands habitat in Indiana “very well.” The respondent listed the following as addressing threats “somewhat” (not ranked):

- Habitat protection
- Regulation of collecting

The respondent listed no other current conservation practices for wildlife in vegetated dunes and swales grasslands habitat in Indiana.

The respondent recommended the following for more effective conservation of wildlife in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Restoration of grassland habitats adjacent to known population sites would be a great start. Restoration could involve creation of native grassland systems from adjacent agricultural fields, with the restoration designed to create habitat specifically for this and other species
- Restoration of oak-savannah at known sites would involve opening the canopy in oak woodlands to ~50 percent cover and controlling invasive exotic shrubs. This would restore connectivity between potentially occupied habitat patches at larger public lands and expand potential habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices of wildlife in vegetated dunes and swales grasslands habitats. There were no responses.

#### Habitat actions

The respondent stated that the following conservation efforts address threats to vegetated dunes and swales grasslands habitat in Indiana “very well” (not ranked):

- Habitat restoration on public lands
- Succession control (fire, mowing)
- Corridor development/protection

The respondent stated that the following efforts address threats “somewhat” (not ranked):

- Habitat protection through regulation
- Protection of adjacent buffer zones

The respondent listed no other current conservation practices for vegetated dunes and swales grasslands habitat in Indiana.

The respondent recommended no specific practices for more effective conservation of vegetated dunes and swales grasslands habitat in Indiana.

## Appendix F-58: Vegetated Dunes and Swales

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of vegetated dunes and swales grasslands habitats. There were no responses.

### Proposed plans for monitoring

#### Current monitoring

##### Species monitoring

The respondent listed current monitoring efforts by state agencies for wildlife in vegetated dunes and swales grasslands habitat in Indiana:

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

The respondent was not aware of monitoring efforts by other organizations for wildlife in vegetated dunes and swales grasslands habitat in Indiana.

The respondent listed the following monitoring efforts by state agencies as “very crucial” for wildlife conservation in vegetated dunes and swales grasslands habitat in Indiana:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring

The respondent listed the following as “somewhat crucial”:

- Statewide-year round monitoring

The respondent listed the following monitoring efforts by state agencies as “slightly crucial” for wildlife conservation in vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Statewide once-a-year monitoring
- Periodic statewide (less than once a year but still regularly scheduled) monitoring

The respondent listed no monitoring efforts by other organizations as crucial for wildlife conservation in vegetated dunes and swales grasslands habitat in Indiana.

The respondent cited no local or regional monitoring by state agencies or other organizations for wildlife in vegetated dunes and swales grasslands habitat in Indiana. The respondent listed no organizations that do monitoring work for wildlife in vegetated dunes and swales grasslands habitat in Indiana.

The respondent ranked the following monitoring technique as “not used but possible with existing technology and data” for wildlife in vegetated dunes and swales grasslands habitat in Indiana:

- Radio telemetry and tracking

The respondent did not indicate that any of the listed monitoring techniques are “frequently used,” but listed the following as “occasionally used” (not ranked):

- Spot mapping
- Professional survey/census

## Appendix F-58: Vegetated Dunes and Swales

The respondent listed no other monitoring techniques for wildlife in vegetated dunes and swales grasslands habitat in Indiana.

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 vegetated dunes and swales grasslands habitats. There were no responses.

### Habitat inventory and assessment

The respondent listed no current inventory and assessment methods by state agencies or other organizations for vegetated dunes and swales grasslands habitat in Indiana.

The respondent listed the following efforts by state agencies as “very crucial” for conservation of vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- 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
- Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment

The respondent listed no efforts by other organizations as “very crucial” for conservation of vegetated dunes and swales grasslands habitat in Indiana. The respondent listed the following as “somewhat crucial”:

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

The respondent listed the following as “slightly crucial” for conservation of vegetated dunes and swales grasslands habitat in Indiana (not ranked):

- Statewide year-round inventory and assessment
- Statewide once-a-year inventory and assessment

The respondent listed no regional or local inventory and assessment by state agencies or other organizations for vegetated dunes and swales grasslands habitat in Indiana. The respondent listed no organizations involved in such efforts.

The respondent rated the current inventory and assessment techniques for vegetated dunes and swales grasslands habitat in Indiana as “not used but possible with existing technology and data” (not ranked):

- GIS mapping
- Aerial photography and analysis
- Systematic sampling

The respondent did not indicate that any of the listed inventory and assessment techniques are “frequently used” or “occasionally used.” The respondent listed no techniques as “not economically feasible.”

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 vegetated dunes and swales grasslands habitats. There were no responses.

## **Recommended monitoring**

### Species monitoring

The respondent recommended the following monitoring technique for wildlife in vegetated dunes and swales grasslands habitat in Indiana: "I'm not sure if a salvageable population exists in Indiana. It would be critical to survey known populations to determine population structure, density and potential for recruitment. This information could be used to plan and implement a conservation effort geared toward the Ornate box turtle."

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 vegetated dunes and swales grasslands habitats. There were no responses.

### Habitat inventory and assessment

The respondent recommended no inventory and assessment techniques for effective conservation of vegetated dunes and swales grasslands habitat in Indiana.

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 vegetated dunes and swales grasslands habitats. There were no responses.

## SHRUB/SCRUB HABITATS NARRATIVE

### Habitat description

Shrubland includes areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall, with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

Shrubs dominate this habitat; shrub canopy accounts for 25 to 100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25 percent and shrubs cover exceeds the cover of the other life forms.

### Problems affecting species and habitats

#### Species threats

Respondents ranked threats to wildlife in shrub/scrub habitats in Indiana:

Rank	Threats to wildlife in shrub/scrub habitats
1 (tie)	Habitat loss (breeding range)
1 (tie)	Habitat loss (feeding/foraging areas)
2 (tie)	Predators (native or domesticated)
2 (tie)	Viable reproductive population size or availability
2 (tie)	Invasive/non-native species
3 (tie)	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
3 (tie)	Near limits of natural geographic range
3 (tie)	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
3 (tie)	Regulated hunting/fishing pressure (too much)
4 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
5 (tie)	Diseases/parasites (of the species itself)

Respondents listed an additional threat to wildlife in shrub/scrub habitats in Indiana:

- Natural succession in remaining shrub/scrub habitats

## Appendix F-59: Shrub/Scrub

Respondents described top threats to wildlife in shrub/scrub habitats in Indiana (not ranked):

- Habitat loss
  - Development and farming destroys brooding and foraging areas and escape cover
  - Clean farming practices
- Lack of management to maintain/create these types of habitats
- Isolation of habitat or islands of habitat with no connecting travel lands
- Predators (especially domesticated animals)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in shrub/scrub habitat. Their responses included:

- Habitat is important for nesting wood ducks. Also used by migrating waterfowl.

### Habitat threats

Respondents ranked threats to shrub/scrub habitats in Indiana:

Rank	Threats to shrub/scrub habitats
1	Commercial or residential development (sprawl)
2	Successional change
3 (tie)	Habitat fragmentation
3 (tie)	Habitat degradation
3 (tie)	Agricultural/forestry practices
4	Climate change
5 (tie)	Invasive/non-native species
5 (tie)	Residual contamination (persistent toxins)
6 (tie)	Point source pollution (continuing)
6 (tie)	Counterproductive financial incentives or regulations
6 (tie)	Nonpoint source pollution (sedimentation and nutrients)
7 (tie)	Impoundment of water/flow regulation
7 (tie)	Diseases (of plants that create habit)
7 (tie)	Mining/acidification
7 (tie)	Drainage practices (stormwater runoff)
8	Stream channelization

Respondents listed no other threats to shrub/scrub habitats in Indiana.

## Appendix F-59: Shrub/Scrub

Respondents listed top threats to shrub/scrub habitats in Indiana (not ranked):

- Successional change
  - Due to lack of management/disturbance of vegetation
- Habitat fragmentation and destruction
  - Agricultural/forestry practices
    - Cause loss of escape cover (including treeline, fence line and wood's edge)
  - Commercial and residential development
  - Limits seasonal movements and population expansion

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

## Additional research and survey efforts

### Current body of research

#### Species research

Twenty-five percent of respondents said that current body of science for wildlife in shrub/scrub habitats in Indiana is adequate. Fifty percent said that it was inadequate. One respondent noted that "most research is not specific to Indiana".

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

Title = Bobwhite Quail Investigation;  
Author = Maurice C. Reeves;  
Date = 1954;  
Publisher = Indiana Department of Conservation

Title = On the edge: a guide to managing for bobwhite quail;  
Author = T. Dailey and T. Hutton;  
Date = 2003;  
Publisher = Missouri Department of Conservation

Title = 2003 Breeding Population Index of Northern Bobwhite Quail;  
Author = James C. Pitman;  
Date = July 16, 2004;  
Publisher = IDNR F&W

Title = Population Ecology of the Bobwhite;  
Author = John L Roseberry;  
Date = 1984;  
Publisher = SIU Press

Title = Unknown/Quail Investigations;  
Author = Maurice Reeves;  
Date = Unknown/Old;  
Publisher = IDNR/Division of Fish & Wildlife

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body science for wildlife in shrub/scrub habitat. Their responses included:



## Appendix F-59: Shrub/Scrub

- Breeding Bird Atlas of Indiana

### Habitat research

Twenty-five percent of respondents said that current body of science for shrub/scrub habitats in Indiana is adequate. Seventy-five percent said that it was inadequate or non-existent.

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

Title = Some Aspects of the Relationship between Land and Utilization and Bobwhite Quail;  
Author = John L. Roseberry;  
Date = 1960;  
Publisher = SIU Press

Title = The Bobwhite Quail - Its Life and Management;  
Author = Walter Rosene;  
Date = 1969;  
Publisher = Rutgers University Press

Title = see previous section entry

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

### **Research needs**

#### Species research

Respondents ranked research needs for wildlife in shrub/scrub habitats in Indiana:

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

A respondent listed additional research needs for wildlife in shrub/scrub habitats in Indiana:

- Dispersal and repopulation methods of isolated habitats

## Appendix F-59: Shrub/Scrub

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 shrub/scrub habitat. Their responses included:

- Other species use of this habitat type.

Wood duck, Mallard, Hooded Merganser, Canada Goose

### Habitat research

Respondents ranked research needs for shrub/scrub habitats in Indiana:

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

A respondent listed other research needs for shrub/scrub habitats in Indiana:

- Location and distribution of shrub/scrub habitat

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

## **Conservation actions necessary**

### Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in shrub/scrub habitats in Indiana:

Rank	Conservation efforts for wildlife in shrub/scrub habitats
1 (tie)	Population management (hunting, trapping)
1 (tie)	Food plots
1 (tie)	Public education to reduce human disturbance
2	Habitat protection

## Appendix F-59: Shrub/Scrub

- 3 (tie) Native predator control
- 3 (tie) Exotic/invasive species control
- 3 (tie) Regulation of collecting
- 3 (tie) Limiting contact with pollutants/contaminants

Respondents listed no other conservation practices for wildlife in shrub/scrub habitats in Indiana.

Respondents recommended these practices for more effective conservation of wildlife in shrub/scrub habitats in Indiana (not ranked):

- Habitat protection, development and maintenance
  - Establish more shrub/scrub habitat
  - Control vegetative succession
- Habitat restoration
- Public education: The most important practice that would benefit bobwhites in shrub/scrub habitat is to educate public about what constitutes suitable quail habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in shrub/scrub habitat. There were no responses.

### Habitat actions

Respondents ranked conservation efforts by how well they address threats to shrub/scrub habitats in Indiana:

Rank	Conservation efforts for shrub/scrub habitats
1	Selective use of functionally equivalent exotic species in place of extirpated natives
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Habitat restoration on public lands
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Succession control (fire, mowing)
2 (tie)	Technical assistance
3 (tie)	Land use planning
3 (tie)	Protection of adjacent buffer zone
4 (tie)	Habitat protection on public lands
4 (tie)	Corridor development/protection
4 (tie)	Cooperative land management agreements (conservation easements)
5 (tie)	Habitat protection through regulation

## Appendix F-59: Shrub/Scrub

**5 (tie)** Restrict public access and disturbance

**5 (tie)** Habitat restoration through regulation

Respondents listed no other conservation practices for shrub/scrub habitats in Indiana.

Respondents recommended the following for more effective conservation of shrub/scrub habitats in Indiana (not ranked):

- Financial incentives to restore and establish habitat
- Succession control (burning, disking)
- Corridor establishment (Woodland edge feathering, shrub corridor, hedgerow development)
- Technical assistance to maintain habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for shrub/scrub habitat. Their responses included:

- Habitat protection on Private lands

## Proposed plans for monitoring

### Current monitoring

#### Species monitoring

Respondents indicated that the following monitoring efforts are conducted by state agencies for wildlife in shrub/scrub habitats in Indiana:

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

Respondents indicated that the following monitoring efforts are conducted by other organizations for wildlife in shrub/scrub habitats in Indiana:

- Statewide year-round monitoring
- Statewide once-a-year monitoring
- Regional or local year-round monitoring

Respondents ranked monitoring efforts by state agencies by their importance for wildlife conservation in shrub/scrub habitats in Indiana:

Rank	Monitoring efforts by other organizations for wildlife in shrub/scrub habitats
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## Appendix F-59: Shrub/Scrub

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

Respondents ranked monitoring efforts by other organizations by their importance for wildlife conservation in shrub/scrub habitats in Indiana:

Rank	Monitoring efforts by other organizations for wildlife in shrub/scrub habitats
1	Regional or local year-round monitoring
2 (tie)	Statewide year-round monitoring
2 (tie)	Statewide once-a-year monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in shrub/scrub habitats in Indiana (not ranked):

- Division of Fish and Wildlife conducts annual spring thistle counts on 77 established routes. The division also conducts biennial surveys of small game license holders to assess bobwhite harvest. Neither of these surveys is focused directly on shrub/scrub habitats
- Division of Fish and Wildlife biologists run routes
- Quail whistling counts in selected counties
- Hunter/harvest surveys by geographic region
- Breeding Bird Survey by survey blocks
- Winamac Fish and Wildlife Area conducts annual bobwhite whistle call surveys on that property

A respondent stated that Quail Unlimited chapters conduct local and regional monitoring for wildlife in shrub/scrub habitats in Indiana.

Respondents listed the following organizations that conduct monitoring for wildlife in shrub/scrub habitats in Indiana (not ranked):

- Quail Unlimited
- National Audubon Society – annual breeding bird survey
- IDNR Division of Fish and Wildlife

Respondents considered current monitoring techniques for wildlife in shrub/scrub habitats in Indiana as follows:

## Appendix F-59: Shrub/Scrub

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

Respondents listed no other monitoring techniques for wildlife in shrub/scrub habitats in Indiana.

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 shrub/scrub habitat. There were no responses.

### Habitat inventory and assessment

Respondents indicated that the following inventory and assessment efforts are conducted by state agencies for shrub/scrub habitats in Indiana (not ranked):

- Statewide annual inventory and assessment
- Regional or local year-round inventory and assessment

Respondents indicated that the following inventory and assessment efforts are conducted by other organizations for shrub/scrub habitats in Indiana (not ranked):

- Statewide annual inventory and assessment
- Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
- Regional or local year-round inventory and assessment

## Appendix F-59: Shrub/Scrub

Respondents ranked inventory and assessment efforts by state agencies for their importance in conserving shrub/scrub habitats in Indiana:

Rank	Inventory and assessment efforts by state agencies for in shrub/scrub habitats
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Statewide annual inventory and assessment
2 (tie)	Regional or local year-round inventory and assessment
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Statewide once-a-year inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations for their importance in conserving shrub/scrub habitats in Indiana:

Rank	Inventory and assessment efforts by other organizations for in shrub/scrub habitats
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Statewide year-round inventory and assessment
4	Regional or local year-round inventory and assessment

Respondents provided no regional or local inventory and assessment by state agencies for shrub/scrub habitats in Indiana.

Respondents listed the following regional or local inventory and assessment conducted by other organizations for shrub/scrub habitats in Indiana (not ranked):

- Statewide by regions
- I am not aware of any other agency monitoring this habitat type, but it is likely that one of the state universities has remotely sensed data that could be used to monitor changes in acreage over a number of years. I would like to see remotely sensed data used to track statewide and regional changes in acreage over the last 30+ years