

ALL BIRDS IN ALL HABITATS NARRATIVE

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to all birds in all habitats in Indiana:

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

Respondents offered additional threats to all birds in all habitats in Indiana (not ranked):

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- Natural succession/lack of periodic vegetative disturbance
 - Occurring in remaining shrub/scrub habitats
 - Fire suppression is a major threat to many, many wildlife 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 which provide both food and shelter
 - Ruffed grouse
 - Lack of periodic vegetative disturbance (man-made or natural every five to 10 years) that adequately opens the forest canopy, especially in the large contiguous areas in public ownership which form the core or heart of the 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
 - Serious reduction in timber management and sales on public lands, consequently endangered species habitats are disappearing in forests. Private timber sales and management is too haphazard to replace the severe losses of young forests on public lands
- Genetic pollution
 - Urbanization and domestication of "wild" mallards leading to the hybridization with domestic stock of ducks. The threat is one of unusual circumstance. As opposed to typical habitat loss or fragmentation, this threat constitutes displacement of Mallards into undesirable/unnatural areas creating nuisance problems and genetic integrity concerns. The developed land itself creates wild scale loss of high quality habitat for mallards. However, mallard ducks are adaptable creatures and have adapted to this developed environment. Nonetheless, their adaptability could also be their downfall in developed lands
- Overpopulation
 - Urban Canada geese are a real problem in Indiana. I deal specifically with Fort Wayne (Allen County). Canada geese have benefited from the way humans have altered the landscape within urban areas. Human-geese conflicts within the urban environment will increase
 - Devaluing of birds due to overpopulation
- Habitat loss due to agricultural practices/development
 - Mowing in June, July and August
 - Early harvesting of hay crops
 - Impacts of herbicides and pesticides drifting over from nearby agricultural lands in unknown
 - Continued loss and degradation of emergent wetland habitat in portions of the state due to development and poor agricultural practices

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- Other human activity/interaction
 - Human interaction with some wildlife species (trapping, relocation, scaring)
 - Reproductive intervention by humans
 - Tolerance by building managers of nesting sites
 - Disturbance by recreational boating
- Restricted wildlife management options
- Lack of public knowledge/information
 - Ruffed grouse: 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. The lack of early successional habitats in forested areas is causing major declines in the ruffed grouse population
- Lack of research
 - We need to know the affect of silviculture and other land management, and how these effect demography (Cerulean Warbler)
- Parasitism
 - Brood parasitism by brown-headed cowbird likely has moderate to strong negative impact on population's success
 - Cowbird affects cerulean warblers

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

- Loss or change in farm programs
 - Loss or shortening of primary nesting season dates established by the USDA. Mowing or haying during the quail nesting season would be allowed on enrolled acreage if these dates were eliminated or shortened
- Habitat loss, degradation, fragmentation
 - Of brood-rearing, foraging and nesting areas
 - Of escape cover
 - Due to urbanization, clean farming and development
 - Redheaded woodpecker: 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
 - Degradation of movement/migration routes
 - Isolation of habitat or islands of habitat with no connecting travel lanes
 - Loss of shallow marshes due to drainage for development and farming
 - Loss of winter feed due to fall tillage
 - Loss of water quality
 - Degradation of habitat by invasive plant species
 - Loss of early successional forest age class
 - Loss of emergent wetlands and adjacent foraging areas of native vegetation
 - Lack of large areas in native grass

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- Mowing during the breeding season
- Degradation due to sedimentation, pollution
- Degradation due to invasion by exotic species
- 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
 - Habitat loss and fragmentation create small, isolated patches where nest predation and brood parasitism tend to increase
- Because this is an area-sensitive species, a loss of large tracts of mature forest on both the breeding and wintering grounds is a critical threat
- Timing and frequency of haying, as well as the cover type (alfalfa) can negatively affect nest success and limit productivity
- With prevailing land management that does not generate early succession habitat (such as maturation of forest on former farm lands), habitat is reduced.
- Loss of contiguous blocks of mature forest
- Natural succession/lack of periodic vegetative disturbance
 - Ruffed grouse
 - Lack of periodic vegetative disturbance (man-made or natural every five to 10 years) that adequately opens the forest canopy, especially in the large contiguous forested areas in public ownership which form the core of residual and current grouse range
 - Potential habitat on private lands is fragmented due to small ownership and different ownership objectives (lack of active timber management) that does not provide a consistent continuum of acceptable habitat for successful population dispersal
 - Fire suppression
- Genetic pollution
- Overpopulation and its effects
 - Population explosions and accompanying diseases, nuisance concerns, etc.
 - Canada geese: In developed lands habitats, the biggest threats are overpopulation and aggressive behavior during courtship/nesting
- Disease
 - Redheaded woodpecker: West Nile Virus is threat
 - Possible disease outbreaks due to large concentrations of birds in small areas
 - Loss of habitat (primarily American sycamores along riparian areas) in breeding areas
 - Loss and degradation of breeding and foraging habitats along river corridors and uplands
 - Loss of mature floodplain forest as nesting habitat
 - Loss of wintering habitat may be a primary threat
- Invasive species/predators
 - Domesticated animals

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- Loss of large blocks of mature forest and increases in forest fragmentation that causes an increase in cowbird nest parasitism and increases edge nest predators (e.g., blue jays). This causes a decrease in recruitment
- House sparrow preemption of nests
- Habitat loss and fragmentation create small, isolated patches where nest predation and brood parasitism tend to increase (cowbirds, blue jays)
- Loss of nests and nesting females to cats, chipmunks, snakes and other ground predators
- Genetic pollution
 - Hybridization with blue-winged warbler
- Lack of management to maintain/create these types of habitats
- Preservationist (anti-management folks) and their influence on the politics of timber management and legal challenges to sound timber/wildlife management activities
- Lack of public knowledge/information
 - Ruffed grouse: 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. The lack of early successional habitats in forested areas is causing major declines in the ruffed grouse population
- Lack of research
 - We still have very little information on Cerulean Warblers. 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
- Human disturbance
 - Vandalism potential at nesting colonies
 - Human intervention during nesting process
- Low reproductive output
 - Possibly 'sink' populations due to poor habitat quality
- Collisions with buildings, power lines, other structures
- 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 threats to all birds in all habitats. Their responses included:

- Yes, although a few of the additional threats listed separately are important and consequential enough to be included in the initial table. The negative effects of brown-headed cowbird parasitism and improper habitat management on publicly-owned and private property (controlled burns in prairie and savannas, removal of invasive plants and propagation of native vegetation in forests, etc.) should be evaluated more exclusively. In addition, a lack of public education/involvement in conservation issues and funding for such efforts should also be considered as a threat to birds in all habitats.
- Loss of wetlands affects
 - staging areas for waterfowl
 - nesting and brood rearing sites.

Grassland and prairie loss reduces nesting sites for waterfowl.

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Habitat threats

Respondents ranked threats to all bird habitats in Indiana:

Rank	Threats to all bird habitats
1	Commercial or residential development (sprawl)
2	Habitat degradation
3	Agricultural/forestry practices
4	Habitat fragmentation
5	Successional change
6	Counterproductive financial incentives or regulations
7	Invasive/non-native species
8	Stream channelization
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)
13	Climate change
14	Mining/acidification
15	Diseases (of plants that create habitat)

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

- Habitat loss, degradation, fragmentation
 - Drainage of wetland areas
 - Loss of wetlands due to off site changes in the water table, i.e. multiple well sites in suburban/rural areas
- Pollution can reduce productivity of aquatic habitats over which cliff swallows feed
- Public opinion and policy
 - Public acceptance of periodic vegetative disturbance (timber management) is necessary because the forest cover across the landscape no longer exists in the same continuum and natural forces no longer operate (or are allowed to 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 be used to mimic natural disturbances on a smaller and controlled scale to create a diversity of habitats in the residual forested landscape where once such natural disturbances operated at a larger scale

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- Another threat is excessive environmental review and assessment that 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
- Legal jurisdiction issues presently unclear, draft of state isolated wetland law out for comment
- If Farm Bill programs (e.g. CRP) were to be eliminated the negative effects on Indiana's northern bobwhite population would be substantial
- Lack of research
 - Exact habitat associations of some birds are not known -- not clear what is optimal habitat in Indiana in my view
- Mallards: Developed land itself creates a threat to "quality habitat" for mallards. Mallards in an urban/suburban setting face and create a whole host of problems (genetic pollution, nuisance ducks, possible fecal contamination, etc.)
- Loss of disturbance regimes/fire suppression
 - Loss of disturbance regimes that maintained the open structure of savannahs (and swamp-forests) where the redheaded woodpecker resides
 - Suppression of natural disturbances such as fire has resulted in a shift in some birds 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.
 - 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
- Invasive species/predators/parasites
 - Lack of fire results in an increase of shade-tolerant invasive species like garlic mustard and Asian bush honeysuckle, further degrading the savannah habitat
 - Not clear what is causing decline of the Cerulean Warbler; regionally brood parasitism and forest fragmentation may be negative impacts
- Climate: It may be possible the birds geographic range is shifting (climate?)

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

- Loss of disturbance regimes/fire suppression
 - Succession of the grassland habitat is a major threat if mid-contract activities are not performed
 - Lack of active timber management that adequately opens or removes the overhead forest canopy and allows for natural regeneration back into a forest cover
 - Absence of early successional habitat in forests. Absence of clear-cutting, and other disturbance types in forested habitats is the major cause of ruffed grouse habitat declines. Forestry practices that do not lead to early successional habitat development are the problem
- Agricultural or other development practices
 - Another threat is 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

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- Clean farming
- Any changes in farming practices that causes the loss of escape cover (including along tree lines, fence lines and wood's edge)
- Agricultural/forestry practices: Lack of active management to create/maintain habitats
- Intensive agriculture and land use development have put a lot of pressure on remaining wetlands
- Soil runoff caused by poor agricultural practices and urban development
- Conversion of hayfields to row-crop or urban cover types
- Frequent haying, mowing, or over-grazing (though some disturbance is necessary every one to five years to maintain the proper vegetation structure)
- Changes in design of bridges and causeways to make them less suitable for nest placement
- Design of buildings that do not provide nesting ledges
- Urban sprawl; commercial or residential development
- Loss and fragmentation of wetlands
 - Of forested wetlands
 - Degradation of wetlands/plant communities by exotic plants invading wetland habitats
 - Of isolated wetlands
 - 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
 - Destruction of natural wetland habitats by development, agriculture and continued road construction
 - The loss of wetlands by draining to accommodate commercial and residential development still occurs at an alarming rate
- Shoreline habitat loss, fragmentation, degradation
 - Modification of stream shoreline habitats
 - Residential development around lake shorelines
 - Degradation of aquatic plants and wetlands around lake shorelines
- Channelization causing habitat loss, fragmentation, degradation
 - Loss due to stream channelization
 - Loss of nesting sites and brood habitat
 - Loss of vegetative and invertebrate communities. Channelization also alters the natural water flow which results in a much degraded habitat
- Riparian habitat loss, fragmentation, degradation
 - Stream and lake renovation have degraded habitat back to where it was when the original habitat destruction occurred
- Forest habitat loss, fragmentation, degradation
 - Loss of bottomland hardwoods continues to be a threat. These area provide a high quality food source and nesting sites for wood ducks
 - Destruction of nesting trees

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- Loss of high quality forest habitat (over mature uneven-aged forest)
- Forest fragmentation enables cowbirds and blue jays to compete/predate. This results in lower quality habitat available to ceruleans
- The cerulean's dependence on large tracts of mature deciduous forests, make the species especially sensitive to continuing forest fragmentation and isolation. The mechanism by which fragmentation affects populations in Indiana is unknown, but the response of this species to habitat fragmentation may be related to other factors associated with fragment size
- Loss of floodplain sycamores and upland pine forests
- Loss of cavity trees and harvest of older forests
- Loss and habitat degradation of forested habitat along riparian areas and in uplands
- Conversion of habitat to other than pine forests
- Grassland habitat loss
 - Conversion of savannah to agricultural and other development
 - Loss of large areas of warm season grasses and early mowing/haying
- General habitat loss, degradation, fragmentation
 - Habitat fragmentation that limits seasonal movements and population expansion; loss of connectivity
 - Drainage practices
- Urban sprawl creating attractive areas
 - For mallards to become "more domesticated" (i.e., retention/detention ponds)
 - Commercial and residential development with lakes and ponds offer all the resources Canada geese need to survive. With an overpopulation of Canada geese in urban areas; it's hard to say there is a habitat threat
- Public opinion/policy
 - Lack of public understanding and acceptance of timber management, especially even-age timber management
 - Lack of public understanding and acceptance that vegetative disturbance whether natural or man-made
 - Regulations
 - Grouse and many songbirds, need early forest successional stages and due to the current policies of the USDA Forest Service and some state properties, the grouse is being "not-managed" to extirpation
- Other human intervention
 - Feeding of birds by people
 - Human disturbance
 - Urban sprawl; commercial or residential development
- Overpopulation
 - Canada geese are their own worst enemy. Their concentrations by large numbers of geese on small wetlands have the capacity to pollute the water and cause increased erosion due to their feeding habits
- Predation/invasive species/competition

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- Brood parasitism by the brown-headed cowbird (*Molothrus ater*), and high rates of nest predation by generalist predators such as blue jay (*Cyanocitta cristata*) and raccoon (*Procyon lotor*). 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
- Threats by gulls
- Lack of research
 - We still do not know the specific habitat preferences for this some birds. The types of habitats where some birds were especially abundant in the past (i.e. old-growth bottomland forest) no longer exist
- Specific dune habitat configuration
- Reduction in quantity and quality of prey populations
- Factors that affect food availability

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

- This is fairly reasonable, although it is a bit troubling that most of the additional comments, with the exception of cerulean warblers, are focused on waterfowl and upland game species. Certainly the protection of habitat utilized by ruffed grouse, for instance, will benefit other non-game brushland and successional forest species, but the strategy should also place greater emphasis on reversing the declination of neotropical migratory species like Black-billed Cuckoo, Blue-winged Warbler, Hooded Warbler, etc., which share similar habitats and are experiencing broader declines throughout their range. An additional threat which should also be assessed in this respect is monotypical habitat management strategies, especially when considering most publicly and privately-owned wetlands and their respective ecologies. Very few, if any, of these habitats are managed to support long-distance migratory shorebirds during both their north-bound and south-bound flights. It would appear that wetland management, when considering the waterlevels and surrounding vegetation, is narrowly focused on the support of waterfowl. At least a few of these properties should adequately and directly address the habitat needs of threatened species such as American Golden-Plover, Piping Plover, Marbled Godwit, Red Knot, etc., during migratory periods.

Additional research and survey efforts

Current body of research

Species research

Forty-six percent of respondents stated that the current body of science is complete, up to date and extensive or adequate for all birds in all habitats in Indiana; forty-four percent stated that information is inadequate or nonexistent.

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

Title = Bobwhite Quail Investigation;
Author = Maurice C. Reeves;
Date = 1954;

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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 = Ducks, Geese & Swans of North America;

Author = Frank C. Bellrose;

Date = 1976;

Publisher = Stackpole Books

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 = Managing Canada Geese in Urban Environments;

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

Date = 1999;

Publisher = Cornell Cooperative Extension

Title = Prevention and Control of Wildlife Damage;

Date = 1994;

Publisher = University of Nebraska

Title = Ducks, Geese & Swans of North America;

Author = Frank C. Bellrose;

Date = 1976;

Publisher = Stack Pole Books

Title = Waterfowl & Wetlands an Intergarted review;

Author = Theodore A. Bookout;

Date = 1979;

Publisher = LaCrosse Printing

Title = Ecology and Management of the Wood Duck;

Author = Bellrose and Holm;

Date = 1994;

Publisher = Stackpole Books

Title = Ducks, Geese and Swans of North america;

Author = Bellrose;

Date = 1976;

Publisher = Stackpole Books

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;

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Author = Castrale, John S., Edward M. Hopkins, and Charles E. Keller.;
Date = 1998;
Publisher = Indiana Department of Natural Resources

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 = Canada Goose Management;
Author = Clarence Schoenfield/Ruth L. Hine;
Date = 1977;
Publisher = University of Wisconsin, Stevens Point

Title = Managing Canada Geese in Urban Environments;
Author = Smith/Craven/Curtis;
Date = 1999;
Publisher = Jack Berryman Institute Publication #16/ Cornell University Cooperative Extension, Ithaca, NY

Title = Spring Breeding Duck Survey;
Author = Kristen Chodachek;
Date = 2003;
Publisher = IDNR

Title = Waterfowl Ecology & Management;
Author = Compiled by: Ratti, Flake, Wentz;
Date = 1982;
Publisher = The Wildlife Society

Title = The Birds of Indiana;
Author = Russel E. Mumford, Charles E. Keller;
Date = 1984;
Publisher = Indiana University Press

Title = Atlas of Breeding Birds of Indiana;
Author = John S. Castrale, Edward M. Hopkins, Charles E. Keller;
Date = 1998;
Publisher = Indiana Department of Natural Resources

Title = Unknown/Quail Investigations;
Author = Maurice Reeves;
Date = Unknown/Old;
Publisher = IDNR/Division of Fish & Wildlife

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;

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Publisher = Proceedings of Indiana Academy of Science: 94:227-230

Title = Atlas of Breeding Bird of Indiana;
Author = Castrale, Hopkins & Keller;
Date = 1998;
Publisher = Indiana Dept. of Natural Resources

Title = Birds of Indiana;
Author = Mumford;
Date = ?;
Publisher = Indiana University Press?

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

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

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 = 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;

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Author = Hagan, J.M.;
Date = 1993;
Publisher = Auk 110:863-874.

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 = 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

Title = Atlas of Breeding Birds in Indiana;
Author = Castrale, J.S., E. Hopkins, C.E. Keller;
Date = 1998;
Publisher = IDNR

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

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 = 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 = Atlas of Breeding Birds of Indiana;

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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

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 = BNA Account - Golden-winged Warbler;
Author = JL Confer;
Date = 1992;
Publisher = American Ornithologists' Union

Title = Birds of Indiana;
Author = R Mumford and C. Keller;
Date = 1984;
Publisher = Indiana University Press

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

Title = Cerulean Warbler Status Assessment;
Author = Paul Hamel;
Date = 2000;
Publisher = US Fish & Wildlife Service

Title = BNA Species Account - Cerulean Warbler;
Author = Paul Hamel;
Date = 2000;
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 all birds in all habitats. Their responses included:

- No. With the exception of DeVault's MS thesis, much of the published research by the Peter Scott and Steven Lima (Indiana State University) regarding the productivity of reclaimed strip mines for grassland species has been omitted. Given the relative size of these areas in southwestern Indiana and the decline which grassland species are experiencing across their range, more emphasis should be placed on this type of research and documentation. Two published examples include "Breeding bird communities of reclaimed coal-mine grasslands in the American midwest" (*J. Field Ornithology*, 73(3):268-275, 2002) and "Reclaimed coal mine grasslands and their significance for Henslow's sparrows in the American midwest" (*The Auk* 118(2):422-431, 2001). Another noted omissions include "Partners in Flight

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Continental Priorities and Objectives Defined at the State and Bird Conservation Region Levels - Indiana" (Kenneth V. Rosenberg) and "Partners in Flight North American Landbird Conservation Plan". These reports, utilizing BBS data, present the best population estimates for most landbird species both in Indiana and in the United States.

Habitat research

Forty percent of respondents stated that the current body of science is complete, up to date and extensive or adequate for all bird habitats in Indiana; fifty-two percent stated that information is inadequate or nonexistent.

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

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 = Statewide Forest Inventory;

Author = ?;

Date = periodic;

Publisher = US Forest Service/IDNR

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 = Soil Survey's of Indiana Counties;

Author = U.S. Dept. of Agriculture, SCS;

Date = 1990;

Publisher = U.S. Dept. of Agriculture

Title = Management of Seasonally Flooded Impoundments;

Author = Leigh H. Fredrickson, T. Scott Taylor;

Date = 1982;

Publisher = U.S. Fish and Wildlife Service

Title = Wetlands; Author = Mitsch & Gosselink;

Date = 1993;

Publisher = Van Nostrand Rheinhold

Title = Southern Forested Wetlands;

Author = Messina & Conner;

Date = 1998;

Publisher = CRC Press LLC

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

Appendix F-74: Birds

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

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 = Canada Gose Management;
Author = uk;
Date = uk;
Publisher = uk

Title = Waterfowl & Wetlands- Integrated Review;
Author = Edited : Bookhout;
Date = 1979;
Publisher = The Wildlife Society

Title = Creating Freshwater Wetlands;
Author = Hammer;
Date = 1997;
Publisher = CRC Press

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 = Strip mine grassland birds;
Author = Travis Devault;
Date = 2000;
Publisher = Indiana State Univ.

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

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

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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 for all bird habitats. Their responses included:

- Yes, but please include the research noted in the above box addressing reclaimed coal mine grasslands.

Research needs

Species research

Respondents ranked research needs for all birds in all habitats in Indiana:

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

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

- Bobwhite quail: 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
- 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
- Mallards
 - To determine the genetic integrity of mallards in developed areas
 - To determine effective management tools and a management plan of mallards in developed lands
- 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

Appendix F-74: Birds

- Research is needed to justify extending or modifying the hunting seasons to eliminate the problem of the so-called nuisance goose in urban areas, around lakes and golf courses
- Ways to reduce urban populations
- Impact of high snow goose populations on Canada geese nesting sites
- Develop more effective dispersal, relocation or removal techniques for maxima geese
- 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
- Harvest; survival/nest success
- Food availability throughout annual cycle; ways to deter use
- Dispersal and repopulation methods of isolated habitats
- Cerulean warblers: Effects of Forestry practices on demography and presence and absence of cerulean warblers (TNC) proposed study
- Timing of agricultural practices in relation to the timing of breeding; reproductive loss due to agricultural practices
- Eastern towhee: It 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. The 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 all birds in all habitats. Their responses included:

- No. Although research for Canada Geese and Mallards may be needed, it should not exceed the prioritization of species experiencing significant decline in both population and preferred habitat. More research emphasis should be placed on the productivity and survivability of birds facing the greatest declines - for instance, Henslow's sparrow (96% decline in the last 30 years), Short-eared Owl (30%), Cerulean Warbler (80%), Loggerhead Shrike (77%), Grasshopper Sparrow (77%), etc.
- Snow goose populations are not affecting Canada goose nesting sites in Indiana.

Habitat research

Respondents ranked research needs for all bird habitats in Indiana:

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

Appendix F-74: Birds

Respondents noted additional research needs for all bird 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
- 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
- How to create and maintain quality grassland habitat on a permanent basis
- Affects of channelization on stream bank communities and the affects on adjacent oxbows, bottomland hardwoods and other riparian areas
- Relationship of fire to habitat structure needs to be better elucidated
- Canada geese
 - Habitat needs should be researched in an attempt to find and propagate habitats that are esthetically pleasing to humans for urban settings yet displeasing to geese.
 - Ways to exclude geese
 - How to keep emergent wetlands more attractive to Canada geese to reduce their use of manmade habitats in the urban community
- Availability throughout annual cycle
- Location and distribution of shrub/scrub habitat
- Cerulean warblers: Effects of forestry practices on cerulean warbler presence or absence and on demography
- Timing and frequency of haying and other agricultural disturbances
- Eastern towhees: Forest succession is well understood in Indiana. But 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 all bird habitats. Their responses included:

- See previous comments

Conservation actions necessary

Species actions

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

Rank	Conservation efforts for all birds in all habitats
1	Stocking
2	Population management (hunting, trapping)

Appendix F-74: Birds

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

Respondents noted additional conservation practices for all birds in all habitats in Indiana (not ranked):

- Habitat alteration
- Fire management in savannahs; water level management in swamp forests
- Restoration of native grasslands and increased enrollment in Conservation Reserve Program provide refuges from agricultural disturbances (provided the proper vegetation structure is maintained)
- Education of public to reduce losses due to exotic predators such as cats is probably important to some local populations

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

- Bobwhite quail: The most important practice that would benefit bobwhites in shrub/scrub habitat would be to spend more time educating the public about what constitutes suitable quail habitat
- Mallards
 - Habitat protection
 - Population management makes use of surplus numbers and regulates take ("The Mallard" by John Madson, Olin Mathieson Chemical Corporation)
- Eastern towhees
 - The major need is regional land management plans that 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

Appendix F-74: Birds

- Canada geese
 - Modification of hunting seasons and opening of urban areas to hunting to reduce numbers of so-called nuisance geese populations in lieu of nest destruction and egg shaking
 - Population reduction
- Pine warblers: Prescription burning to maintain sparse understory in mature pine forests may potentially help this species, for example on DNR lands. (Suggested reference: Rodewald, P.G., J.H. Withgott, and K.G. Smith. 1999. Pine Warbler (*Dendroica pinus*). In *The Birds of North America*, No. 438 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA)
- Ruffed grouse
 - Habitat decline must be addressed. Methods to initiate active timber/wildlife management on the landscape is necessary to stem the serious decline of 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
- 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
 - Increasing the size and reducing the fragmentation of forest blocks within the state will likely improve habitat for this species
 - Habitat protection (maintenance of old-growth/mature forest components in Indiana)
 - 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 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
- Forestlands
 - Active timber management, especially on the larger blocks of public forestlands, especially those timber management practices that remove at least 75 percent of the overhead canopy
 - Increasing the area of mature forest in the landscape and decreasing fragmentation. The conservation of existing forestland is also critical
 - Incentives to conserve wooded riparian corridors and responsible forestry practices

Appendix F-74: Birds

- Wetlands
 - Restore wetlands and providing quality upland nesting cover adjoining these wetlands
 - Reduce fall tillage near wetlands
- Shrub/scrub habitat
 - Establishment of more shrub/scrub habitat
- Grasslands
 - Permanent protection of grassland habitat; long-term fire management
 - Conservation and active management of grassland habitats
- Limit disturbance
 - By humans and predators if birds ever recolonize Indiana's Lake Michigan shoreline
 - In nesting/migration habitat
- Habitat protection (intensive); reproduction and protection (Ducks, Geese and Swans of North America, Bellrose); protection of migration routes (intensive)
- Hunting
- Hen houses; habitat conservation; buffer zones
- Enhance migratory/staging habitat; enhance breeding habitat where populations do not conflict with land use
- Continue 5-year surveys
- Remove habitat in urban zones
- Vegetative succession control to provide early successional plant species
- Develop practices and procedures to increase harvest of local birds
- Exotic/invasive species control
- Nesting habitat needs to be improved in areas where possible, thereby reducing nest depredation; traditional migration corridors of Indiana should be improved and enhanced through water level management where possible
- Time and haying and grazing around the breeding cycle, before May or after June
- Continued use of bridge architecture that favors nest placement
- Education/awareness of falcon needs for feeding and nesting
- Prevention of stream channelization and other (pollution) habitat factors
- Require mid-contract management (e.g., disking or burning) between three to five years after establishment on all Farm Bill acreage planted to grasses

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

- Absolutely not - habitat protection should be the first priority for conservation efforts. Stocking typically can only advance the populations of waterfowl and upland gamebirds in the short-term; this leaves the conservation needs of non-game passerines and non-passerines as well as the long-term stabilization of game species' populations unaddressed.

Appendix F-74: Birds

- The effects of urban hunting on Canada goose populations need to be addressed. If the urban geese do not enter areas that are suitable for hunting changing seasons will have no affect on the problem.

Habitat protection is the most important issue to address.

Habitat actions

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

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

Respondents listed other current conservation practices for all bird habitats in Indiana (not ranked):

- Some states have policies or regulations that specifically mandate that a certain percentage of their public lands will be maintained in early successional and transitional forest types

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

- Habitat protection through regulation/legislation

Appendix F-74: Birds

- This is the only sure way to protect habitat without public ownership
- Making mid-contract management mandatory on enrolled acreage
- Habitat conservation regulations
- Habitat protection and restoration through incentives are the best means to conserve the Canada goose in emergent wetlands. However, it is difficult for the government to compete financially with developers
- Lobby for legislation that would protect any remaining wetlands

- Create incentives for landowners
 - Provide incentives to prevent landowners from haying or grazing during the breeding season
 - INDFW already provides financial incentives to maintain or establish bobwhite habitat on private land. These incentives do help some to provide quality bobwhite habitat
 - Restoration bottomland hardwoods through the Farm Bill and other incentive programs
 - Create easements to protect existing wetlands or to restore wetlands
 - Incentives to conserve floodplain forests
 - Incentives to preserve forests and use good timber management practices
 - Incentives to conserve wooded riparian corridors
 - Incentives for conserving and managing grasslands
 - Incentives to conserve shrubby habitats
 - Encourage tree plantings in floodplain areas where forest has been removed

- Control succession
 - Setting back succession with burning or discing
 - Active timber management that removes at least 75 percent of the existing forest canopy on a proportion every five to 10 years on an 80 to 120 year rotation (depending on site constraints and management objectives) using primarily even-age timber management techniques
 - Implement forestry practices that will benefit early successional species including gray fox, bobcat and woodcock, as well as ruffed grouse
 - 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
 - Encourage forest management plans that retain/create mix of young and older forest should retain towhees in regional avifaunas. Forest habitat restoration provides habitat in early stages
 - Retard succession to desired habitat stage

Appendix F-74: Birds

- Purchase, protect and restore public land; prevent habitat loss, fragmentation, degradation
 - Purchase of remnant savannahs, restoration of savannahs that have undergone succession to forest or have been farmed
 - Maintain mature floodplain forest
 - Reduce or eliminate stream and ditch channelization
 - Create buffers
 - Protect and enhance wetland and riparian habitats
 - Woodland edge feathering
 - Develop shrub corridor/hedgerows
 - Critical habitat for cliff swallows is nesting sites, most are on public (DOT) structures (bridges)
 - Improve water quality, etc. for feeding areas
 - Habitat protection (maintenance of old growth/mature forest components in Indiana)
 - Protection of nesting habitat along streams
- Control invasives
 - Control plant species that spread by vegetative means that form thick colonies such as cattail
 - Get rid of the invasive species degrading savannah habitats, including those invasive species deliberately planted by wildlife agencies
- Land use planning
 - Landscaping to exclude Canada geese
 - Removal of habitat in urban zones
- Create food plots
- Technical assistance
 - To maintain habitat in shrub/scrub type
 - Educate landowners about the importance of their land to the persistence of some birds
- Public 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
 - Education/awareness programs for building managers
- Promote wildlife-friendly agricultural practices
 - Preventing early mowing/haying
- Manage water regimes
 - Actively manage the water levels if at all possible to insure ducklings will fledge and to encourage use by spring and fall migrants
 - Water regime management for migration habitat

Appendix F-74: Birds

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

- Yes.
- Removing habitat in urban zones will be difficult. The ponds in the urban areas attracts ducks and geese and then the green grass the people have in there yards feeds the geese. People want there grass to be green and until they let it go brown and die the geese and ducks are going to eat it.

Need to protect private lands.

Proposed plans for monitoring

Current monitoring

Species monitoring

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

Rank	Monitoring efforts by state agencies for conservation of all birds in all habitats
1	Statewide once-a-year monitoring
2	Regional or local once-a-year monitoring

Appendix F-74: Birds

- 3 Statewide year-round monitoring
- 4 Occasional statewide (less than once a year and not regularly scheduled) monitoring
- 5 Periodic statewide (less than once a year but still regularly scheduled) monitoring
- 6 Regional or local year-round monitoring
- 7 Periodic regional or local (less than once a year but still regularly scheduled) 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 all birds in all habitats in Indiana:

Rank	Monitoring efforts by other organizations for conservation of all birds in all habitats
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	Statewide year-round monitoring
6	Regional or local year-round monitoring
7	Periodic statewide (less than once a year but still regularly scheduled) monitoring
8	Occasional statewide (less than once a year and not regularly scheduled) monitoring

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

- The Indiana Division of Fish and Wildlife conducts annual spring whistle counts on 77 established routes across the state. The division also conducts biennial surveys of small game license holders to assess bobwhite harvest. However, neither of these surveys are focused directly on shrub/scrub habitat or Farm Bill habitat
- Division of Fish and Wildlife properties in northern Indiana
- Ruffed grouse
 - Eight 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
- Regionally (throughout the state): Waterfowl breeding status surveys, population surveys
- Regionally (throughout the state): Statewide trapping, banding, and recapture efforts

Appendix F-74: Birds

- Geese
 - Division of Fish and Wildlife conducts Canada goose banding yearly. This consists of neck collars and leg bands
 - Waterfowl surveys
 - Hunter harvest reports
- Interlake Property, Division of Outdoor Recreation ownership
- State monitoring: banding and nest box surveys
- Wood duck
 - Several fish and wildlife areas perform annual wood duck banding. These properties include Hovey Lake, Glendale, Minnehaha, Willow Slough, Jasper-Pulaski, LaSalle, Pigeon River and Tri-County fish and wildlife areas. There may be others
 - Many of these properties also conduct nest box monitoring activities on an annual basis
 - Indiana participates in the Harvest Information Program which can provide information about migration, population index and/or trends, as well as information about the amount of hunting pressure
- Routes throughout the state by Division of Fish and Wildlife biologists
- Fish and wildlife areas and reservoirs as part of the weekly waterfowl survey from August to January
- Hovey Lake, Tri-County, Jasper Pulaski, Pigeon River, Winamac, Willow Slough, LaSalle fish and wildlife areas
- At present only when a permit for work in a wetland is applied for; smaller more numerous wetlands have little oversight
- Statewide for existing and new colonies every five years
- Quail
 - Quail whistling counts in selected counties
 - Hunter/Harvest surveys by geographic regions
 - Bird Breeding survey in survey blocks
 - Winamac FWA conducts annual bobwhite whistle call survey on that property
- In southern Indiana in the unglaciated forested region
- All state fish and wildlife properties
- 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)
- IDNR Nongame and Endangered Wildlife Program
- 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
- Statewide breeding bird atlas efforts are coordinated by the state DNR. This atlas effort was done in the 1980s, and is being redone now. Also the state DNR nongame bird program coordinates publication of a summer bird count that generates some data on towhee numbers (along with all other summer birds. No analysis is done, however

Appendix F-74: Birds

- DNR monitors most nest sites in the state and obtains information from others
- Breeding Bird Atlas statewide every 20 years
- Awareness of reports by bird watchers
- Periodic statewide Breeding Bird Atlas

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

- Breeding Bird Survey
 - Is conducted by the National Audubon Society and observers counts the number of bobwhites seen along with other bird species. Again this survey is not directly focused on Farm Bill habitats
 - Includes routes in Indiana that incorporate sites occupied by the redheaded woodpecker. This annual survey will therefore potentially count redheaded woodpeckers at a few sites yearly
 - BBS routes and work done on strip-mined lands in southwest Indiana and Big Oaks National Wildlife Refuge
 - 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
 - U.S. Geological Survey 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
 - At Big Oaks National Wildlife Refuge
 - At Hoosier National Forest
- Christmas, May Day and summer bird counts
 - Audubon supports May Day count throughout state that detects cerulean warblers.
 - Different Audubon members and clubs may be involved in Christmas Bird Counts and with an intensive Bird-a-Thon in the spring
- Species occurrence noted during the Statewide Breeding Bird Atlas Project (only one ever done)
- Population surveys
- Fish and wildlife properties in northern Indiana, natural lakes and nature preserves
- Ducks Unlimited conducts waterfowl surveys
- Muscatatuck National Wildlife Refuge (performs wood duck banding)
- Quail Unlimited chapters
- Lake associations, businesses and anyone living around a emergent wetland with a yard and has Canada Goose complaints will monitor populations to prove they have a problem so they can destroy nests or eggs
- Habitat changes requiring permits are checked by, IDNR, IDEM, U.S. Army Corps of Engineers (in some cases)

Appendix F-74: Birds

- On state properties or USDA Forest Service land where populations have been known to exist
- The major state watersheds, particularly Kankakee and St Joseph river watersheds in the north, Tippecanoe and Wabash river in central and Wabash Ohio river watersheds in the south
- Various university personnel may also be involved in surveying wetlands periodically throughout the year
- Cornell Lab of Ornithology collects data on the cerulean warbler for the Birds in Forested Landscapes program. I am unsure whether data has been collected and submitted in Indiana.
- The Nature Conservancy is working on developing a research project in the state for cerulean warblers
- Local intensive surveys, nest monitoring, or mark-recapture studies
- Eastern towhees: Other bird monitoring efforts that collect data nationwide generate information on eastern towhees. These include the Breeding Bird Surveys, Christmas Bird Counts (towhees are rare in winter though) and Cornell University nest record program. Hoosier National Forest conducts breeding bird monitoring on the forest since 1991
- Building managers and volunteers report nesting activity at many nests
- Indiana Dunes National Lakeshore biologists stay abreast of sightings along Lake Michigan

Respondents listed organizations that monitor all birds in all habitats in Indiana:

- National Audubon Society, Indiana Audubon Society, local Audubon chapters (Breeding Bird Survey, Christmas bird counts)
- Ducks Unlimited
- Indiana Division of Fish and Wildlife
- Indiana Division of Parks and Reservoirs
- U.S. Fish and Wildlife Service, Big Oaks and Muscatatuck national wildlife refuges
- Waterfowl USA
- U.S. Geological Survey in Porter, Indiana has conducted studies of oak savannah birds, including the redheaded woodpecker
- Quail Unlimited
- The Nature Conservancy
- American Bird Conservancy, MAPS program (Point Reyes Bird Observatory)
- Local bird clubs, NRCS (thru WRP program monitoring)
- Indiana State University
- USDA Forest Service, Hoosier National Forest
- Various universities
- Indiana Academy of Science, Indiana Audubon Society, an 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-level research projects

Appendix F-74: Birds

- U.S. Geological Survey (roadside bird surveys)
- Cornell's Laboratory of Ornithology collects nest records
- 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
- Private companies (NIPSCO, Ispat Inland, building managers)
- Birdwatchers/volunteers

Respondents considered monitoring techniques for all birds in all habitats in Indiana:

Monitoring techniques for all birds in all 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	X
Driving a survey route	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
Volunteer survey/census	X	X	--
Trapping (by any technique)	X	X	X
Representative sites	X	X	--
Probabilistic sites	X	X	--

Respondents noted other monitoring techniques for all birds in all habitats in Indiana:

- Nest box survey
- Distance sampling
- Aerial surveys

Appendix F-74: Birds

- Nest monitoring, territory mapping, call playback and color banding
- Surveys for colonies and periodic censuses of nests/populations
- 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 all birds in all habitats. Their responses included:

- Yes.

Habitat inventory and assessment

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

Rank	Inventory and assessment by state agencies for conservation of all bird habitats
1	Statewide annual inventory and assessment
2	Periodic statewide (less than once a year but

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- still regularly scheduled) inventory and assessment
- 3 Statewide once-a-year inventory and assessment
- 4 Regional or local year-round inventory and assessment
- 5 Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
- 6 Regional or local once-a-year inventory and assessment
- 7 Occasional regional or local (less than once a year and not regularly scheduled) 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 bird habitats in Indiana:

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

- Natural lakes in northern Indiana
- Continuous Statewide Forest Inventory jointly conducted by the USDA Forest Service and the Indiana Division of Forestry, IDNR
- Interlake Property
- Nearly all of river and stream habitats in Indiana falls under state and/or federal jurisdiction, so obtaining and maintaining accurate and current information on these habitats is always occurring on a statewide basis
- IDNR Division of Nature Preserves has inventoried habitats across the state over the past three decades. Savannahs mainly occur in the northern third of the state
- Isolated wetlands law
- The state examines habitat on state properties periodically and uses GAP and other habitat modeling programs to assess forest habitats
- Habitats on state areas are occasionally surveyed for quality and quantity
- Managers of public properties are responsible for maintenance and assessment of wetland habitat on their areas
- Annual and 5-year census, county-level reports of acreage planted to various hay cover types and acreage harvested
- Forest inventory plots in established forest management lands give some information on trends in early succession habitat. 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
- Opportunistic statewide determination of potential nest sites in Indiana with the idea of erecting a nest box
- Lake Michigan shoreline/Gibson Lake

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

- Farm Service Agency keeps track of the location and acreage associated with each contract
- Many local zoning boards, planning commissions and drainage boards also keep and maintain their own records in regard to land use patterns within these habitats
- In the northern third of the state
- Statewide by regions
- Indiana wetland inventory maps
 - County aerial photos for NRCS
 - Soils mapping county maps
- The Nature Conservancy, U.S. Fish and Wildlife Service and USDA Forest Service use habitat models to examine forest habitat in Indiana (Hoosier National Forest and Big Oaks National Wildlife Refuge)
- U.S. Fish and Wildlife Service, The Nature Conservancy and Indiana State University have surveyed quality and quantity of habitats for HESP's

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- Natural Resources Conservation Service and other federal offices dealing with compliance review may be involved in inventory of habitat types as they pertain to the Farm Bill. However, these folks are not making habitat assessments as it relates specifically to mallards
- 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 cerulean warbler habitat use. I am not sure if data has been submitted from Indiana
- Lake Michigan shoreline
- Statewide aerial imagery of habitats in Indiana
- U.S. Department of Agriculture
- U.S. Geological Survey

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

- Bobwhite quail:
 - Indiana Division of Fish and Wildlife will initiate some type of bobwhite quail monitoring program to determine the success of the newest continuous CRP practice (CP33).
 - Farm Services Agency monitors acreage and location of tracts enrolled in each USDA program
 - Natural Resources Conservation Service provides technical support or administers most farm programs and I believe they conduct regular inspections
- Indiana Department of Natural Resources
 - Division of Fish and Wildlife
 - Division of Nature Preserves
- U.S. Fish and Wildlife Service
- U.S. Department of Agriculture
- Indiana Department of Environmental Management
- U.S. Army Corps of Engineers
- Environmental Protection Agency
- Local government entities (area plan commissions, zoning boards etc.)
- The Nature Conservancy
- Chicago Wilderness
- U.S. Geological Survey
- National Park Service
- Quail Unlimited
- USDA Forest Service (Hoosier National Forest; North Central Research Station)
- Natural Resources Conservation Service
- Ducks Unlimited
- Waterfowl USA
- Indiana State University

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- Cornell Lab of Ornithology
- USDA National Agricultural Statistics Service for Indiana <http://www.nass.usda.gov/in/>
- Ball State University, Department of Biology

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

Inventory and assessment techniques for all bird habitats	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	--
Aerial photography and analysis	X	X	X
Systematic sampling	X	X	--
Property tax estimates	X	--	--
Regulatory information	X	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 bird 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
- Remote sensing
- Visual driving surveys and soil surveys
- 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 vertical stratification of foliage
- Habitat for some birds is suitable nesting sites near water. Volunteer participation in building a database of known breeding colonies and volunteer periodic censusing of colony sizes

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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 bird habitats. Their responses included:

- Yes.

Recommended monitoring

Species monitoring

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

- Bobwhite quail
 - To monitor bobwhite populations in Farm Bill habitats, I 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
 - Annual harvest surveys
 - A less intensive method would be to request that landowners conduct whistle counts on their enrolled lands each spring
 - I would like to see a radio telemetry study of bobwhites in Indiana because we are lacking most of the baseline data for bobwhites in Indiana. Much of the information we use to manage quail populations comes from studies in other states
 - Whistle counts that are already conducted provide a less intensive (but important) method of tracking the statewide population
- Professional surveys or counts on fish and wildlife areas during migration periods (tracks annual migration trends and is index to population levels). Harvest surveys on fish and wildlife areas (tracks annual numbers taken) "Wildlife Investigational Techniques" by The Wildlife Society
- Ruffed grouse: Roadside drumming indices
- 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)
- Neck collars and leg bands
- Driving surveys
- Aerial surveys
- Fall covey counts
- Brood surveys
- Populations surveys
- Mark/recapture-banding (intensive) (Reference: Ducks, Geese and Swans of North America, Frank C. Bellrose); Harvest data collection (less intensive) (Reference: Wildlife Management Vol. 2, Reuben Edwin Trippensee)

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- Continued participation in HIP is perhaps the most cost effective method for monitoring the flyway population; Banding operations help in determining the status of populations on a local or statewide level
- 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 (Reference: Buckland, S. T., D. R. Anderson, et al. (2001). Introduction to distance sampling. Oxford, UK, Oxford University Press)
- Mark and recapture. Means to track species movement and association with non-target species and times of interaction with non target species; Mark and harvest eliminates and reduces concentrations in non desirable areas
- Continue current state surveys every five years
- Monitoring throughout annual cycle
- Weekly waterfowl counts at selected sites. Samples most of the major concentration areas. Very good historical data for trend analysis
- Ruffed grouse: On particular or "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
- Hunter harvest surveys
- A study that experimentally tests how forest management influences demography and presence and absence. Some birds need basic life history studied, too
- The use of GIS technology may be an economical and efficient method to monitor and classify wetlands throughout Indiana. Selective sampling within each geographical region may provide baseline data of mallard use and abundance. A more intensive approach may involve DNR staff, volunteers, and University staff that would conduct a statewide inventory of wetlands during one week in April
- 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
 - Professional survey/census to locate warblers
 - Nest search and monitoring to assess productivity to determine if Indiana has a 'source' or 'sink' population of cerulean warblers (Reference: 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)

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- Establish more Breeding Bird Survey routes <http://www.pwrc.usgs.gov/bbs/>; conduct point counts on private lands. If possible estimate nest success too
- Surveys for colonies and periodic censuses of nests/ populations
- Roadside bird surveys on selected routes maximizing forest habitats; repeated point count surveys in representative forest sites
- 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 are probably 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
- Nest monitoring of all known nests (or representative sample) with two to three visits according to U.S. Fish and Wildlife Service protocol
- Directed surveys (canoe surveys, migration counts) most intensive; general breeding bird surveys less intensive
- Because the Piping Plover rarely occur in Indiana, keep track of all reports by birders and have Indiana Dunes personnel systematically survey appropriate habitat along Lake Michigan
- Spot-mapping in appropriate habitats
- Sampling potential nesting areas for some birds to obtain additional information on the species abundance and distribution.
- Sampling of mature pine forest habitat to better determine distribution

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 birds in all habitats. Their responses included:

- Yes.

Habitat inventory and assessment

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

- GIS mapping
 - See "Wildlife Investigational Techniques" by The Wildlife Society
 - Along with aerial surveys (See reference: Wildlife Management Techniques Manual, Fourth Edition, Sanford D. Schemnitz)
 - As the most cost affective means to create an inventory of emergent plant species that would support Canada geese in emergent wetlands
 - GIS modeling, and intensive study to determine habitat quality (source vs. sink)
 - GIS mapping and participation in land use programs (CRP)
 - GIS technology appears to be the system of choice. NRCS offices have statewide distribution and a close relationship with landowners so I would recommend utilizing their resources if possible
 - As stated before, I am unaware of efforts to monitor young age classes of forest. GIS mapping can certainly generate amounts and trends of habitat if forest type and age

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are mapped. Aerial photography can be used when young age classes appear distinct from other habitat classes

- Aerial photography in concert with other methods
 - Wetlands should be monitored by overhead photo methods with ground truth checks. This should occur on a regular basis with aggressive enforcement against illegal wetlands destruction
 - Aerial photography and analysis and soil surveys are already being done and could provide a cheap way to monitor and assess emergent wetlands. Any of the USDA's soil surveys for the individual counties can be used as a resource
 - Aerial imagery of riparian and pine habitats coupled with habitat modeling
- Bobwhite quail
 - 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
 - Remotely sensed data to monitor changes in statewide and regional acreage and distribution. It would be interesting and useful to see how trends in shrub/scrub habitat relate to the Indiana Division of Fish and Wildlife bobwhite whistle indices
- Canada geese
 - Systematic water sampling of high use areas would determine nutrient loading and water quality. (See U.S. Fish and Wildlife Service Draft Environmental Impact Statement, Resident Canada Goose Management, Feb. 2002)
- Cerulean warbler
 - I think that 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 Cerulean Warblers
Hutto et al. 1986. Auk 103:593-602
- Pine warbler: 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)
- Survey of hay harvest dates and frequencies each year
- Habitat for some birds is suitable nesting sites near water. Volunteer participation in building a database of known breeding colonies and volunteer periodic censusing of colony sizes
- Spring, summer, fall and winter surveys
- Reports from state fish and wildlife areas
- Habitat association studies to determine which habitat types used/preferred
- Only casual assessment needed
- Statewide Forest Inventory

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- Grassland mapping by major plant species type
- Permanent plot monitoring to assess changes in canopy cover and woody species size and composition
- Participation in land use programs
- Aerial spring counts

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 bird habitats. Their responses included:

- Yes.