Indiana Comprehensive Wildlife Strategy

Developed for:
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I. Foreword

Wildlife and natural resources play an important role in the quality of life for all people. The Indiana Department of Natural Resources (DNR) takes very seriously its responsibility to care for this natural legacy for future generations of Hoosiers.

Because the vast majority of Indiana's land and water resources are in private ownership, DNR recognizes that wildlife conservation in Indiana must be a joint effort between public agencies and private land managers.

Congress also has recognized the importance of partnerships and integrated conservation efforts, and has charged each state and territory in the country with developing a comprehensive wildlife conservation strategy by October 2005.

The DNR has taken advantage of this opportunity to identify and begin to integrate the broad range of existing efforts that conserve Indiana wildlife and the habitats upon which they depend. This strategy documents an ongoing process to increase collaboration within the DNR and among the many organizations across the state that work for conservation. The DNR is committed to seeking ways to knit our various programs more closely together to ensure they are efficiently focused on enhanced resource conservation.

Conservation doesn't just happen. It requires effort and resources, including technical training and financial incentives. With federal assistance through the Federal Aid in Fish and Wildlife Restoration Programs (hunter and angler money), DNR has had great success in managing game species and providing hunting and fishing opportunities for Hoosiers. To achieve similar conservation success for wildlife species that are not hunted or fished, a permanent, stable funding base will be required, both from federal sources and state matching funds. This strategy is a necessary step toward that goal. As a member of the International Association of Fish and Wildlife Agencies, DNR will work with other states and our partners to establish and maintain the level of support required to implement this groundbreaking strategy.

Hoosiers work together to build the future, whether in manufacturing or agriculture or wildlife conservation. Remembering that a wise tinkerer keeps all the parts, we intend to conserve all our natural resources to sustain economic development and contribute to quality of life for our citizens and visitors.

We have engaged hundreds of technical experts and partner organizations in establishing this compendium of baseline information on wildlife and habitat management at an unprecedented scale. We are grateful to all who have helped us create this foundation. Now, we invite all Hoosiers who care about conservation to help us continue the construction process. Join us as we use this strategy to guide development of action plans that will conserve all wildlife for generations to come.

We believe in Hoosier ingenuity and look forward to working with all our partners in this historic effort to ensure the future of our critical wildlife resources and the habitats on which they—and we—depend.

Kyle Hupfer, Director
Indiana Department of Natural Resources

II. Executive Summary

The Indiana Department of Natural Resources, Division of Fish and Wildlife (DFW) working with conservation partners across the state, developed a Comprehensive Wildlife Strategy (CWS) to protect and conserve habitats and associated wildlife at a landscape scale.

Taking advantage of Congressional guidance and nationwide synergy
Congress recognized the importance of partnerships and integrated conservation efforts, and charged each state and territory across the country to develop similar strategies. To facilitate future comparisons and cross-boundary cooperation, Congress required all 50 states and 6 U.S. territories to simultaneously address eight specific elements. Congress also directed that the strategies must identify and be focused on the "species in greatest need of conservation," yet address the "full array of wildlife" and wildlife-related issues. Throughout the process, federal agencies and national organizations facilitated a fruitful ongoing discussion about how states across the country were addressing wildlife conservation.

States were given latitude to develop strategies to best meet their particular needs. Congress gave each state the option of organizing its strategy by using a species-by-species approach or a habitat-based approach. Recognizing that very little is known about direct management of many rare species in Indiana, the DFW selected the habitat-based approach. This approach recognizes the interconnections between species in a community, provides for the needs of a variety of game and nongame species and provides a balanced approach that supports the conservation of Indiana's biological diversity.

Creating a baseline and mechanism for describing current conservation needs
The Indiana Comprehensive Wildlife Strategy (CWS) provides a comprehensive overview of conservation in Indiana and identifies needs and opportunities for helping prevent species from becoming threatened or endangered in the future. It identifies conservation needs, organizations working in those arenas and areas where interests overlap (potential partnerships).

Species of greatest conservation need (SGCN) were identified utilizing the most current published list of federally endangered, threatened or candidate species and Indiana's list of endangered species and species of special concern. The Indiana CWS was developed using an information system designed to link SGCN to all wildlife species and the habitats on which they depend. This was done by using a set of representative species as surrogates for guilds including the SGCN and which were reflective of habitat needs for all wildlife species.

More than 60 specific habitat types were identified for the state. Indiana State University (ISU) operated within a contract to research and compile data on these habitats using GIS databases. Major habitat categories included agricultural lands, aquatic systems, barren lands, developed lands, forest lands, grasslands, subterranean systems, and wetlands. Distribution maps show the changes in these habitats since presettlement times. Sophisticated mapping techniques will allow the agency to repeat the calculations of area and distribution, so that trends will be revealed during implementation of the strategy.

The DFW developed an information system designed for computer-based data entry to allow for an iterative process of generating and updating information, as well as improving the model for the future. Web-based surveys were used to collect information on species and habitats,

monitoring activities, current conservation efforts, and future conservation needs for representative species and habitats to specifically address the eight elements Congress requires in the CWS.

Technical experts, conservation organizations and the general public each provided input at relevant stages of strategy development. Working through a contractor that specializes in marketing and outreach, the DFW developed a communications plan to aid with partner identification, technical input, public involvement, and coordination with federal, state, and local agencies.

Over 80 technical experts provided input through an extensive online survey form, in accordance with the information requirements in the Congressional guidelines. Each wildlife species has specific habitat requirements for providing appropriate food, water, shelter and other resources to meet survival and reproduction needs. Therefore, conservation of wildlife must start with a focus on habitat. Habitat types such as wetlands, forests and grasslands benefit from specific incentive programs that encourage public and private acquisition and restoration. Habitat degradation and urban sprawl were the top two reported threats to habitat. Experts ranked the research and survey efforts needed for wildlife species in the major habitat types and for habitats. The highest-ranking research needs for habitats included dependence on specific site conditions in five of the eight major habitat types. In the technical expert survey, experts were asked what conservation actions were most needed in Indiana. The following results are organized by habitat type, beginning with actions needed for *wildlife* conservation, followed by actions needed for *habitat* conservation.

Monitoring progress into the future

Wildlife conservation and management is intended to provide stable, self-sustaining populations of native wildlife. Therefore, habitat and species monitoring projects contribute to two important aspects of the planning cycle: the inventory stage that tallies the state's raw materials for conservation and the evaluation stage that assesses the success of conservation efforts. The DFW has operated under a planned management system for over 20 years and has a long history of monitoring species. Based on inquiries received by DFW, the public expects the state to have some knowledge of the abundance and status of wildlife. Due to federal support for monitoring activities, inventory data has been more readily available for game and sport fish species.

Early detection and intervention are critical for implementing the array of conservation actions needed to prevent species from declining to the point of being endangered. All monitoring needs identified would benefit from standardized monitoring efforts that would make interstate or regional comparisons possible. To date, only bird and fish survey efforts seem to have achieved some measure of standardization. Monitoring efforts for amphibians, (especially salamanders), all reptiles and mussels need to be increased. Standardized protocols that allow comparison of population trends between state, regions and sample areas must be established to improve the efficiency of increased monitoring. Habitat inventory and monitoring has been even less deliberate and frequent than species monitoring. Sophisticated mapping techniques were not available 150 years ago when wholesale changes were made to habitats across the Hoosier landscape. Mapped data on the distribution and abundance of major habitat types provides essential baseline data at the beginning of this century against which changes may be documented.

Indiana wildlife and habitat biologists recognize that conservation practices will evolve and improve with future advances in research techniques and compilation of knowledge through time. Therefore, implementation of this strategy must be flexible and dynamic. To allow for adaptive management, successful survey and monitoring efforts have two necessary components: the technically proficient conduct of monitoring protocols and the effective dissemination of results. The DNR will conduct species and habitat assessment efforts as resources allow and will participate, as appropriate, in regional or national monitoring programs. Along with the results, all aspects of the inventory necessary to the responsible interpretation of the effort will be made available to the partners and other interested parties on an Internet site. Easily accessed, timely inventory information will allow conservation partners and other interested parties to track progress towards conservation goals and to apply adaptive management where appropriate. Information sharing by all partners will facilitate the application of accurate, timely information to the environmental review process.

Enhancing partnerships and collaboration

Over 570 partners received a solicitation to provide information regarding current efforts, specific interests and capacity for action among conservation organizations, professional societies, universities, federal, state and local agencies, individuals and major landholders in Indiana. The contractor team and agency staff directly solicited input through e-mail, phone calls and in-person meetings and presentations. A colorful project website facilitated further contact with a range of audiences across the state. The DFW staff and contractors hired to develop this strategy also actively participated in various mechanisms for interstate cooperation and communication that were facilitated by the International Association of Fish and Wildlife Agencies (IAFWA) and the U.S. Fish and Wildlife Service (FWS).

Many partnering agencies and organizations have established programs and funding for conservation projects in Indiana. More than 50 programs in Indiana provide funding for wildlife and habitat conservation. Over 120 partner organizations also provided their percentage of efforts spent on specific habitats in Indiana. Information provided by these organizations are compiled in a matrix within the CWS. A thorough examination of these missions, resources and tools reveals how they are complementary to each other and begins to identify gaps in conservation planning within the state. Full participation by Indiana in these programs and partnerships will require focused and stable, technical, financial and human resources for implementation of this strategy and associated actions.

Preparing to meet the natural resource needs of future generations

This is the first time in history that Indiana has strategically assessed habitats, wildlife species and conservation partners. The information gathered during the process is compiled into a database and will be used to develop operational action plans to enhance effective collaboration among agencies, organizations and individuals where the resources and conservation needs overlap. The next step in putting conservation on the ground will be guided by a communications plan that will continue to solicit active participation among relevant agencies, conservation organizations, and other public and private partners. The opportunity to fulfill the Congressional requirements provides a giant leap into the future of wildlife and habitat conservation for Indiana.

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List of Acronyms

ASTER: Advanced Space-borne Thermal Emissions Reflection Radiometer
Bird DB: Bird Database
CRP: Conservation Reserve Program
CWS: Comprehensive Wildlife Strategy
DFW: Division of Fish and Wildlife
DNP: Division of Nature Preserves
DNR: Department of Natural Resources
EPA: Environmental Protection Agency
ETM+: Enhanced Thermal Mapper plus
FHWA: Federal Highway Administration
FWS: Fish and Wildlife Service
GIS: Geographic Information Systems
HD: Heritage Database
IAFWA: International Association of Fish and Wildlife Agencies
IBA: Indiana Important Bird Areas Program
IBI: Index of Biotic Integrity
IDNR: Indiana Department of Natural Resources
IFIC: Indiana Forest Industry Council
IPL: Indianapolis Power and Light
ISB: Indiana Soybean Board
ISC: Indiana Smallmouth Club
ISGA: Indiana Soybean Growers Association
ISU: Indiana State University
LMEC: Lake Maxinkuckee Environmental Council
MAFWA: Midwest Association of Fish and Wildlife Agencies
MICRA: Mississippi Interstate Cooperative Resource Association
NABCI: North American Bird Conservation Initiative
NIPSCO: Northern Indiana Public Service Company
NIRPC: Northwestern Indiana Regional Planning Commission
ORSANCO: Ohio River Valley Water Sanitation Commission
Reptile DB: Reptile Database
RFP: Request For Proposal
SARE: Sustainable Agriculture Research and Education
SGCN: Species of Greatest Conservation Need
SWCD: St. Joseph County Soil & Water Conservation District
USDA: United States Department of Agriculture
USFWS: United States Fish and Wildlife Service
USGS: United States Geologic Service
WCRP: The Wildlife Conservation and Restoration Program
WRP: Wetland Reserve Program

IV. Introduction and Purpose

Because the vast majority of Indiana's land and water resources are in private ownership, wildlife conservation in Indiana must be a joint effort between public agencies and private land managers. Fish and wildlife depend on protection and conservation of a wide variety of habitats across the state. State fish and wildlife area managers, farmers, developers, land trusts, industries, and hunting, trapping, and fishing clubs are among the many stewards in Indiana who are taking steps to ensure that these resources will be around for the use and enjoyment of future generations.

Given that there are limited resources for all of these partner efforts, The Indiana Department of Natural Resources, Division of Fish and Wildlife (DFW) wants to encourage partnerships with other organizations where our interests overlap and our efforts can be mutually beneficial.

Congress also has recognized the importance of partnerships and integrated conservation efforts, and has charged each state and territory in the country with developing a comprehensive wildlife conservation strategy by October 2005.

Indiana is taking advantage of this opportunity to identify and begin to integrate the broad range of efforts that conserve wildlife and the habitats upon which they depend. This effort will prepare a framework for maximizing conservation efforts across the state.

Congressional Guidelines

Congress has given states great latitude in developing strategies that best meet state needs, but has required all states to address eight specific elements in their strategies. The locations of the sections of this document that address these requirements are noted below in parenthesis.

1. Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife (Chapter VII, pages 25-33 and Appendix E); and,
2. Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1) (Chapter VIII, pages 34-52); and,
3. Descriptions of problems which may adversely affect species identified in (1) or their habitats, (Chapter IX, pages 53-57 and Appendix E) and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats (Chapter X, pages 58-60 and Appendix E); and,
4. Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions (Chapter XI, pages 61-125 and Appendix E); and,
5. Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4) (Chapter XII, pages 126-135), and for adapting these conservation actions to respond appropriately to new information or changing conditions (Chapter XIV, pages 137-138); and,
6. Descriptions of procedures to review the strategy at intervals not to exceed ten years (Chapter XV, page 139-140); and,
7. Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes that manage significant land and

water areas within the State or administer programs that significantly affect the conservation of identified species and habitats (Chapter XII, pages 126-135).

8. Congress also affirmed through this legislation that broad public participation is an essential element of developing and implementing these plans (Chapter V, pages 18-22), the projects that are carried out while these plans are developed, and the Species in Greatest Need of Conservation that Congress has indicated such programs and projects are intended to emphasize.

Congress gave each state the option of organizing its strategy using a species-by-species approach or a habitat-based approach. The DFW selected the habitat-based approach for Indiana's strategy for the following reasons:

- Habitat loss or degradation has traditionally been considered the biggest threat to Indiana wildlife, so a habitat-based strategy was considered the most efficient way to address the needs of the widest variety of species.
- Previous DFW strategic plans have indicated the need to be working on habitats, but a "good way to get there" has never been developed.
- The species focus sometimes tends to polarize or insulate interests and resources. There was a concern that this divide could grow wider as the number of partnerships expands.
- Traditional Federal Aid funding and even Endangered Species funding tends to limit the areas and types of habitat-associated activities that qualify for grants. The Wildlife Conservation and Restoration Program (WCRP) and the State Wildlife Grants legislation (which initiated the comprehensive wildlife strategy process) make funds available for habitat work.
- When conservation efforts focus on one or a small group of species, important habitat for other species (potentially including species in greatest need of conservation) can be inadvertently impacted.

Indiana DNR staff identified more than 60 specific habitat types in Indiana (see Appendix A for complete list and definitions). All information on Indiana wildlife that is included in this strategy has been categorized by these habitat types. When results are presented by major habitat types this data is the aggregation of the results of sub-habitat information within that habitat type.

Indiana's CWS: What It Is—and What It Isn't

The Indiana Comprehensive Wildlife Strategy (CWS) provides a comprehensive overview of conservation in Indiana and identifies needs and opportunities for helping prevent species from becoming threatened or endangered in the future. The CWS includes biological aspects of wildlife and habitat conservation in the state, as well as information on the conservation organizations currently conducting on-the-ground efforts. It identifies conservation needs, organizations working in those arenas and areas where interests overlap (potential partnerships).

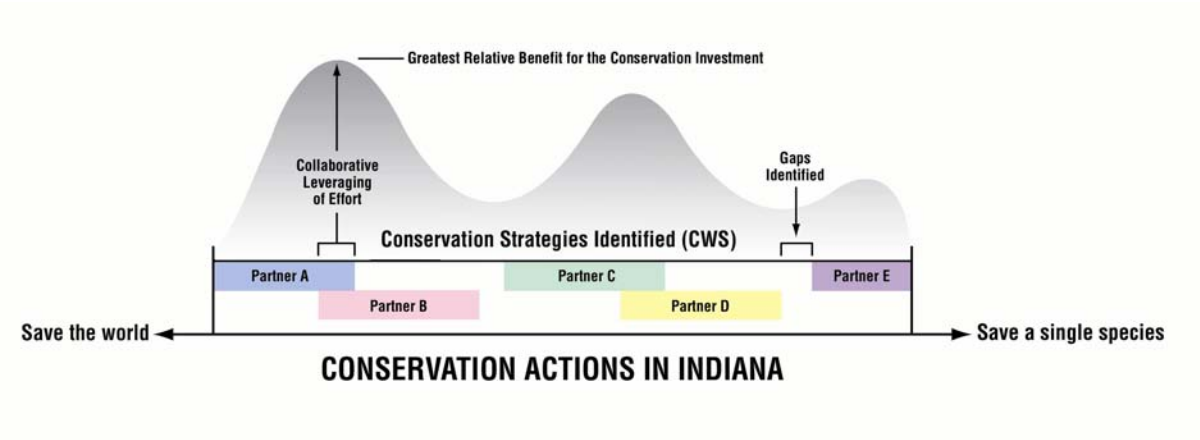


Figure 1. Purpose of Indiana's comprehensive wildlife conservation strategy (CWS). The Indiana CWS is an effort to identify conservation needs, existing partners and resources for addressing the needs. Where partners overlap, synergy allows greater relative benefit for a given effort. The process also identifies gaps in conservation efforts where additional time and resources should be applied.

The CWS is NOT an operational plan. It does not identify specific tasks, assignments, or schedules for achieving wildlife conservation. However, the intent of Congress and the DFW is that the CWS will guide and encourage development and/or compilation of operational plans from within the Department of Natural Resources (DNR) and from among DNR's many partners in the conservation community. Operational plans and partnerships are the next steps in the process.

CWS is a *model* for identifying habitat conservation needs

Generating information on conservation needs for all habitats and all wildlife species within the state is a daunting task, especially when little is known about many of these species. Models can be an efficient and effective way of maximizing limited knowledge by focusing on available research, enhanced by extrapolation from species that are better known, and all informed by best professional judgment. Information used to create recommendations for Indiana's CWS was generated through an information system, or tool, that was developed specifically to link species of greatest conservation need (SGCN) to all wildlife species and the habitats on which they depend. This was done by using a set of representative species as surrogates for the SGCN and for habitat needs of all wildlife species. In some cases, enough was known about certain SGCN that they were also used as representative species.

Linking the information system back to species of greatest conservation need

SGCN were identified utilizing the most current published list of federally endangered, threatened or candidate species and Indiana's list of endangered species and species of special concern (Table 1). These species were cross-referenced with the Indiana Academy of Science *Revised Checklist of the Vertebrates of Indiana* for species range, relative abundance, season and status. The state list of endangered species and species of special concern are reviewed and updated periodically, using expertise from scientists who study species within the state. Data were collected for representative species in all habitats that contained SGCN. This allows the habitat information to be used to infer conservation needs for SGCN. This will be especially significant for SGCN for which little

species-specific information is currently known. Habitat conservation efforts that benefit SGCN will also benefit all other wildlife in those habitats.

Electronic input allows for revisions to the information system
Knowledge about wildlife species and their habitats will improve over time and conditions will change. Therefore, DFW developed the information system around a computer-based data entry tool to allow for an iterative process of generating and updating information, as well as improving the model itself in the future. Web-based surveys were used to collect information on species and habitats, monitoring activities, current conservation efforts, and future conservation needs for representative species and habitats to specifically address the eight elements Congress requires in the CWS. Eighty-six professionals throughout Indiana completed more than 180 questionnaires. The resulting database and compiled narratives can be adjusted and/or repeated, as needed, to update progress in species and habitat conservation.

Finally, a landscape approach
For many years, natural resource managers and conservationists have identified the need for a comprehensive umbrella approach to conservation in Indiana and throughout the country. The DFW and some of its partners have been able to achieve some landscape-level conservation efforts, but there has not yet been a systematic attempt to compile all such efforts, along with the conservation needs of all Indiana wildlife and habitats, to identify gaps and potential partnerships and synergies. The CWS attempts to do just that.

A note on how to use the information in this strategy
Gathering the information for development of this strategy was for most states—including Indiana—a monumental and unprecedented effort. Many experts from throughout the state contributed uncounted hours to provide thoughtful input into creating this baseline for future collaborative conservation. As a result, well over a thousand pages of information has been collected and collated.

Most conservation partners will find that their detailed interest lies within a subset of this information. However, they may also wish to scan the overall status of wildlife conservation in Indiana. This document and associated information is organized to allow the reader to see a broad overview or to delve deeply into the data that were gathered during this process.

This document contains a series of tables that allow the reader to view condensed information about all habitats and species within those habitats. If the reader is interested in further information about particular habitats or major taxonomic groups, that information is found in appendices. If the reader wishes to go deeper still, the species- and habitat-specific input and responses from individual conservation organizations can be explored electronically on the Indiana CWS website.

NOTE: The outline used for this document was created from an outline recommended by the U.S. Fish and Wildlife Service (FWS). The process was modified as necessary to meet the particular needs of the State of Indiana while also satisfying guidance from the federal government.

Strategy Development Assistance

In September 2003, DFW distributed an RFP for a contractor to assist with development of the CWS. D.J. Case & Associates (DJ Case), a natural resources communications firm based in Mishawaka, Indiana was selected to provide this assistance.

V. Public Involvement and Partnership Solicitation

The DFW sought broad public and partner participation in the development of the CWS. The first step was to develop a communications plan to aid with partner identification and solicitation, public involvement and coordination with federal, state, and local agencies. The communications plan outlined specific objectives for the various target audiences, coupled with key messages and tactics for these audiences. (See Appendix B)

Based on the communications plan, and given the increased availability, access and acceptance of computer technology, DFW opted to utilize web-based techniques for species and habitat data collection and partner participation. This provided the opportunity for a larger audience to be involved than could have participated at traditional forums, because:

- Traditional techniques (workshops/meetings, focus groups, etc) often are poorly attended;
- Budget constraints would have limited the number and distribution of meetings;
- In-person meetings often create unintentional bias toward participants that have the means and/or availability to attend.

A. Technical expertise: a tool for identifying habitat conservation needs

Indiana DFW chose to use a habitat-based model for its CWS. The intent of the model is to maximize limited knowledge about wildlife species by focusing on available research, enhanced by extrapolation from species that are better known, and by including best professional judgment. SGCN were linked to all wildlife species and to the habitats on which they depend by using representative species as surrogates. The resulting information system, or tool, was developed through the following four steps.

Step 1: Assemble a guild of species for each habitat type

Using the Indiana Academy of Science *Revised Checklist of the Vertebrates of Indiana* as a guide, technical experts listed all vertebrate wildlife species with their associated habitats, forming *guilds* for more than 60 specific habitat types (See Appendix A for complete list of habitats and definitions and Appendix C for listing of guilds). Mussels also were included in the list as a placeholder for future invertebrate conservation needs. Insects and other invertebrates were not included because there is limited state statutory authority and little expertise available to directly manage these taxa. However, by protecting rare habitats, insects and other invertebrates can be indirectly protected. Three general rules were used to define guilds.

- Does the animal live in the habitat;
- How specific is the habitat association (is the animal *always* found in this habitat, versus usually or occasionally found); and
- Presence of a specific critical habitat for the survival or success of the animal.

The process was used to identify specific or critical habitat types that were not previously identified.

Species of greatest conservation need were included in appropriate guilds.

Step 2: Select a species to represent each guild

The DFW recognized that including all of the wildlife species in Indiana would create an unmanageably large strategy, which would limit its usability. Therefore, wildlife professionals

from DFW selected species to serve as representatives of each guild. The species were picked based on biological features and whether constituents would recognize them as representative of the guild. The selected species "painted a reasonable mental picture of the associated habitat type" when presented to a diverse user group including biologists, the public, legislators, grant reviewers and other partners. The focus is on habitat, not individual species. Species were selected that would automatically generate an association with the habitat-related guild and a desire to protect, enhance or somehow improve that habitat as the strategy is implemented. Representative species also were used as mental tools to focus technical expert input on particular relationships between species and their habitats, as they considered research and conservation needs for these associations.

Step 3: Collect, compile and analyze information on conservation and monitoring
Specific information on the biological components of the CWS was solicited from wildlife experts throughout the state. Members of DNR technical advisory committees and other professionals with expertise in wildlife or habitat science were asked to provide information to help describe the conservation needs and recommendations for wildlife and habitats in Indiana. A web-based survey was developed (See Appendix D) to collect information on current status and trends, threats, and opportunities facing the representative species and their associated habitats. The survey tool also collected information on monitoring activities, current conservation efforts, and future conservation needs for representative species and habitats.

The questionnaire was developed to specifically address the eight elements Congress requires to be included in the CWS. The survey was standardized across major taxonomic groups and habitats to facilitate comparison and identification of critical conservation efforts to be implemented in Indiana. Eighty-six professionals throughout Indiana completed more than 180 questionnaires (See Appendix E 1-78 for questionnaire results).

Data collected on the representative species were aggregated by habitat and sub-habitat type and descriptive statistics allowed the ranking (highest to lowest importance) of the information. This information has been compiled into narrative statements. These efforts were NOT an attempt to prioritize across habitats. Results indicate the most critical threats, species monitoring efforts and techniques, habitat inventory and assessment efforts and techniques, body of science, research needs, and current and recommended conservation practices for wildlife and for specific habitats.

The technical expert and partner communities were asked to review the results of the habitat aggregations and comment on whether the results are a reasonable representation of the conservation situation across the specific habitats and all the wildlife species in those habitats (See Appendix F 1-78 for comments on narratives). Comments were included in the draft CWS manuscript, which was made available for additional review by conservation organizations and the general public.

Step 4: Linking the results back to species of greatest conservation need
Species of greatest conservation need were included in their appropriate guilds and data were collected for species that represented those guilds and their associated habitats. The habitat information can then be used to infer conservation needs for SGCN, as well as for many taxa for which direct management strategies are not well known (e.g., insects and other invertebrates). This will be especially significant for SGCN for which little species-specific information is currently known.

B. Partnership Solicitation

The contractor hired to assist in CWS development created a communication plan to guide the partnership solicitation process. The DFW and the contractor searched for partners among conservation organizations, professional societies, universities, individuals and major landholders in Indiana. The search was conducted by referencing numerous agency databases, searching the Internet for non-traditional partners and through recommendations from other partners. The contractor followed the process below to invite 570 potential partners to participate in the development process.

Sent partners an electronic survey to collect information

An on-line survey (See Appendix G for survey instrument) was distributed to all potential partners in order to gather the following information for inclusion in the CWS:

- Partner name, mission, goals, authority, size (number of employees, members or volunteers), type (non-profit, for profit, local government, state government, federal government), and location (city, county, region or area) of the organization.
- Primary source of funding (foundation grants, state, federal, individual contributions, dues, etc.), and total annual budget.
- Types of habitats where efforts are focused.
- Estimated percent of total time spent on efforts in these habitats.
- Primary wildlife species of interest.
- Specific objectives with this/these species.
- Projects (current or proposed) that could contribute to a local, regional or statewide conservation strategy.
- Available resources or capabilities the organization could contribute to the development of the CWS.
- Developed conservation partnerships.
- Perceived need to improve existing partnerships, resources or programs focused on resource for conservation.
- Best way to communicate with the organization and the general public about the CWS and similar conservation efforts (e.g., member newsletters, email lists, meetings).
- Strategic or operational documents that could be incorporated into the CWS.

Sent customized e-mails and made calls to encourage partners to complete surveys

Partners received an e-mail with a link to an electronic survey and were encouraged to complete it. Following the initial e-mail, the contractor, on behalf of DFW, followed-up with another customized e-mail and in some cases made phone calls asking partners to complete the survey. The DFW, with help from the contractor, utilized survey responses to gauge the organizations' interest in participating in the CWS process. Survey responses also provided DFW with information about the organizations' impact on wildlife habitat and types of current conservation projects. Survey responses were automatically compiled in an electronic database and will be used in CWS implementation.

Categorized potential partners based on electronic survey responses

Based on responses to the partner survey, potential partners were placed into one of three partner levels: 1) Keystone Partners; 2) Partners; and 3) Stakeholders.

Most organizations that submitted a survey indicated interest in being involved in the development of the CWS and were categorized as "Keystone Partners." All Keystone Partners have significant impact on wildlife habitats in Indiana and/or reach a large number of people interested in habitat conservation. A total of 126 partners (three groups combined) completed the survey (See Appendix H for complete survey results). The DFW put more effort into communicating with Keystone Partners than the other two groups because these organizations will have a significant role and impact in the implementation of the CWS.

Sent customized e-mails and made personal calls to solicit partner input
Throughout CWS development, the contractor sent e-mail messages to all partners and called Keystone Partners to encourage comments and suggestions on versions of the draft CWS. Most e-mail contacts directed partners to an on-line form, where they could submit feedback on the various sections of the CWS. Once submitted, the on-line feedback was automatically compiled into a database for inclusion in the CWS. There were three opportunities for partners to provide information or feedback for inclusion in the CWS.

Asked selected partners about internal communication mechanisms that could be used to solicit additional input on CWS
During phone calls to Keystone Partners, the contractor asked organizations if they had access to communications mechanisms that could reach members and other publics interested in wildlife. The contractor also gathered media contacts that could be used to distribute solicitations to the public for CWS feedback. Informational materials (see Appendix I for informational materials) about the CWS were placed in partners' newsletters, on websites and distributed via e-mail. All materials directed the reader to the CWS website to learn more about CWS development and/or to provide comment on versions of the CWS.

The DFW and the contractor utilized partners' existing communication mechanisms to reach publics that already have an interest in wildlife because these were more likely to provide feedback on the CWS and become involved in implementation.

C. Public Involvement
During the CWS development phase, DFW focused most of its resources on communicating with publics (partners and others) that had a vested interest in the strategy (see above). However, input was also solicited from the "general public." In an effort to maximize effectiveness, the general public was further segmented into two subsets:

1. Publics predisposed to interest in wildlife.
2. "John Q. Public."

Many partners have direct communications with publics that share an interest in conserving wildlife and habitat. Information gathered via partner interviews described above was used to solicit input from publics with existing interest in wildlife. Organizations distributed solicitations for public comment via their newsletters, websites, listservs and meetings. The DFW had a better chance of receiving input from interested publics (partner members, nature center visitors and others with existing interest in wildlife) than from publics with no active interest in wildlife.

To reach "John Q. Public" (publics with no existing active interest or predisposition to wildlife conservation issues), DFW distributed a press release through the *Wild Bulletin* soliciting public

input on the final draft version of the CWS. *Wild Bulletin* reaches more than 10,000 recipients, including most media outlets in the state.

The contractor also made a CWS presentation to the Hoosier Outdoor Writers organization at their annual meeting. This led to publication of several informational newspaper articles about the CWS around the state.

The DFW developed a database of all partners with the capability to communicate about the CWS, and will continue to utilize these communication channels, partner websites, newsletters, list-serves, etc. to involve the public in implementation and revisions of the CWS.

VI. Coordination with Federal, State and Local Agencies and Indian Tribes

Federal, state and local agencies were involved in CWS development as partners and technical experts. The DFW solicited input through e-mail, phone calls and in-person meetings/presentations.

Throughout development, DFW scheduled in-person meetings and presentations with selected agencies statewide. During the in-person meetings and presentations, DFW informed agencies about the CWS and explained how they could be involved. DFW coordinated agency feedback via electronic communications.

A. Federal Agencies

Federal agencies in Indiana were considered Keystone Partners. The DNR solicited input from the following federal agencies:

- Federal Highway Administration
- Great Lakes Commission (binational agency)
- National Park Service (Indiana Dunes National Lakeshore)
- U.S. Army Chemical Materials Agency
- U.S. Department of Agriculture
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- National Resources Conservation Service

B. State Agencies

State agencies in Indiana were considered Keystone Partners. The DNR solicited input from the following state agencies:

- Internally from DNR staff
- Indiana Chamber of Commerce
- Indiana Department of Environmental Management
- Indiana Department of Transportation
- State universities in Indiana

C. Local Agencies

The DFW solicited input from local agencies including:

- Indiana Association of Cities and Towns
- Indiana Association of Soil and Water Conservation Districts
- Elkhart Public Works and Utilities
- Kankakee River Basin Commission
- Lake Lemon Conservancy District
- Merry Lea Environmental Learning Center
- Northwest Indiana Regional Planning Commission
- St. Joseph County Soil and Conservation District
- Valparaiso Chain of Lakes Watershed Group
- Wabash River Heritage Corridor Commission

D. Indian Tribes

There are no federally recognized Indian tribes in Indiana.

E. Neighboring States

The DFW staff and contractors hired to develop this strategy actively participated in various mechanisms for interstate cooperation and communication that were facilitated by the International Association of Fish and Wildlife Agencies (IAFWA) and the U.S. Fish and Wildlife Service (FWS). This included an electronic discussion forum, attendance at a meeting in Nebraska City, NE, in August 2004, and participation in CWS discussions at several other professional meetings (Midwest Fish and Wildlife Conference, International Association of Fish and Wildlife Agencies annual meeting, Association of Conservation Information annual meeting, North American Wildlife and Natural Resources Conference, etc.).

The DFW participates in regional conservation efforts that are coordinated at the national level such as Partners in Flight, North American Waterfowl Management Program (and associated All Birds Initiative), North American Amphibian Monitoring Plan, Great Lakes Fishery Commission, FWS Region 3 Endangered Species Coordinators meetings, and other similar programs. The DFW will continue to participate in these coordinating conservation efforts along with its partners.

The DFW anticipates further involvement in a project that will be sponsored by the Midwest Association of Fish and Wildlife Agencies (MAFWA) in which regional and cross-boundary issues will be identified for future development.

Effective participation in these regional efforts will be contingent upon out-of-state travel approval, staffing capacity, state matching funds, and other resources that may be required.

VII. Distribution and Abundance of Species of Greatest Conservation Need (1st Element)

The goal of the Indiana Comprehensive Wildlife Strategy is to preserve the native biological diversity of Indiana and thus contribute to the preservation of national and global biological diversity.

The Indiana Nongame and Endangered Species Conservation Act was enacted in 1973 in response to the federal Endangered Species Act. Endangered species is defined by IC 14-22-34-1 as "any species or subspecies of wildlife whose prospects of survival or recruitment within Indiana are in jeopardy or are likely within the foreseeable future to become so due to any of the following factors:

1. The destruction, drastic modification, or severe curtailment of the habitat of the wildlife.
2. The overutilization of the wildlife for scientific, commercial, or sporting purposes.
3. The effect on the wildlife of disease, pollution, or predation.
4. Other natural or manmade factors affecting the prospect of survival or recruitment within Indiana.
5. Any combination of the factors described in subdivisions (1) through (4)."

Additionally, by Indiana Statute "any species or subspecies of fish or wildlife appearing on the United States list of endangered native fish and wildlife (50 CFR 17, Appendix D)" is also considered endangered by Indiana law. The term "threatened" is not defined in Indiana statute; however, threatened is defined in Indiana Administrative Code. As there is no regulatory distinction between threatened and endangered, Indiana no longer uses the threatened category. Any species or subspecies deem vulnerable enough to require the protection of the state Endangered Species Act is considered endangered.

Species and subspecies are added or deleted from the state endangered species list through the administrative rule process. This process provides ample opportunity for public comment. Comments may be made in writing to an administrative law judge and/or by direct testimony to the Indiana Natural Resources Commission, the legal body with authority to adopt DNR administrative rules. In practice recommendations to add or delete species or subspecies originates in a Technical Advisory Committee (TAC). The DFW established five TAC for Mammals, Birds, Reptiles and Amphibians, Fish and Mussels and Crustaceans. Each committee is composed of five to nine experts, mainly from Indiana colleges and universities, with Indiana experience relative to the animal group covered by that committee. Each TAC has one DFW staff person assigned as an ex-officio member. The TAC's consider only resident wildlife and bird species breeding in Indiana. For a given species a listing recommendation is made by a TAC based on the consideration of several factors, including overall population size, a comparison of current distribution relative to historic distribution, threats to the species, status of closely related taxa or other species in a similar niche. The experts in each TAC use their best professional judgment, experience and applicable publications and unpublished reports to determine if the prospect for a given species' survival in Indiana is in jeopardy. The Technical Advisory Committees tend to be conservative. When there is insufficient data upon which to make a definitive determination, the committees have recommendation protection for a species facing significant risk. This precaution provides the maximum protection of Indiana law and elevates the survey, monitoring and/or research priority of that species. Each species or

subspecies is evaluated in light of prospects for survival in Indiana relative to the species historic occurrence in the state. The status of species newly discovered in Indiana, such as the green salamander and the mole salamander, are especially problematic. Historically systematic surveys were not conducted for all taxa and the historic distribution and population status In Indiana are unknown. However, disjunct populations or populations at the edge of their range may represent distinct gene pools that warrant conservation. For these species recovery is defined by the degree to which the known population is secure from threat rather than a specific population level or distribution.

Insects and other invertebrates, other than mollusks and crustaceans, are not protected by Indiana statute. A list of endangered insects has been developed based on the recommendation of insect experts working in Indiana. Many of these insects occur in rare habitats. To date most conservation efforts for these species consist of conservation of these rare habitats. As resources allow systematic surveys for all insect orders should be conducted to provide a more holistic assessment of the status of Indiana's insect fauna.

Species of special concern have no legal protection. Species are generally placed on the special concern list because the experts suspect the species' population is declining or their distribution is shrinking. Additionally, these species may be difficult to survey. Special concern status raises the survey and monitoring priority of these species and stimulates encounter reports from the scientific community. The status of all species most in need of conservation are reviewed annually by the TACs and additions and deletions are recommended.

In order to conserve the native biological diversity of Indiana the DFW uses all the tools of a modern scientific management program, including survey and monitoring, research, population and habitat management, education, land acquisition, and regulation to conserve all species most in need of conservation. Species are removed from this list when their prospects for survival in the state are known to be secure.

Element 1 of the Congressional guidelines requires that the CWS present information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife. Therefore, Indiana's Species of Greatest Conservation Need (SGCN) were identified using the published list of federally endangered, threatened or candidate species and Indiana's list of endangered species and species of special concern. These species were cross-referenced with the Indiana Academy of Science *Revised Checklist of the Vertebrates of Indiana* for species range, relative abundance, season and status (Table 1).

The numbers of SGCN are not distributed evenly across major habitat types. There were 7 species associated with agricultural habitat, 75 in aquatic systems, 5 in barren lands, 6 in developed lands, 50 in forestlands, 28 in grasslands, 10 in subterranean habitats, and 51 in wetlands. Some of these species may use different habitat types depending upon life stage and availability. Some habitats are better studied than others or receive more attention due to economic and aesthetic values. Some habitats are naturally smaller in size, widely scattered and may have historically supported low biodiversity.

By virtue of being rare or in remotely accessible habitats, scientific information is limited for many of these species. Other species may even continue to go undetected. Taxonomy is a field of

science that changed dramatically with development of new techniques to detect genetic relationships. Therefore, these lists are subject to change as more knowledge about the species identification, distribution and abundance becomes available. The complete list of species of greatest conservation need in Indiana and their associated habitat types can be found in Appendix J. For additional information on the distribution and status of mammals, birds, amphibians, reptiles, fishes and bi-valve mussels in Indiana see references in Appendix K. In at least the last 50 years no similar reference has been developed for the insects of Indiana.

Although the DNR does not have statutory responsibility or expertise in direct conservation and management practices for most groups of invertebrate wildlife, Table 1 documents the federal or state status of insects listed as threatened or endangered in Indiana. Federally listed insects are predominantly associated with rare habitat types. Management of these species in Indiana has largely consisted of protection of those habitats. These actions are within the purview of the Indiana DNR Division of Nature Preserves, which works closely with DFW on this and other related issues.

Table 1: Species of Greatest Conservation Need - species range, relative abundance and status (Source: Indiana's list of endangered species and species of special concern and the Indiana Academy of Science *Revised Checklist of the Vertebrates of Indiana* or from personal communication with insect experts working in Indiana.)

Range (within state):
Statewide (I), North (N), South (S), West (W), East (E), Central (C) and various combinations. U=Unknown

Relative abundance (within state):
Common (C): Don't have detectably lower populations than historical or expected levels. (Species that are included on this list of greatest conservation need due to identified habitat or ecological disturbances or threats).
Occasional (O): Disjunct populations who's occurrence is sporadic yet significantly less than historic or expected levels.
Rare (R): Significantly lower populations than historic or expected levels.
U: Unknown

Status
(Federal) Federally Endangered (FE), Federally Threatened (FT), candidates for federal listing (FC)
(State) State Endangered (SE), Special Concern in need of further study (SC)

Common Name	*Scientific name*	Range	Relative Abundance	Status
Allegheny Woodrat	*Neotoma magister*	SC	R	SE
Alligator Snapping Turtle	*Macrochelys temmincki*	SW	R	SE
American Bittern	*Botaurus lentiginosus*	I	R	SE
Badger	*Taxidea taxus*	I	R	SC
Bald Eagle	*Haliaeetus leucocephalus*	I	R	SE, FT
Banded Pygmy Sunfish	*Elassoma zonatum*	SW	R	SC
Bantam Sunfish	*Lepomis symmetricus*	W	R	SE
Barn Owl	*Tyto alba*	I	R	SE
Bigmouth Shiner	*Notropis dorsalis*	NW	R	SC
Black Rail	*Laterallus jamaicensis*	I	R	SE
Black Tern	*Chlidonias niger*	I	O	SE
Black-And-White Warbler	*Mniotilta varia*	I	O	SC

Common Name	*Scientific name*	Range	Relative Abundance	Status
Black-Crowned Night-Heron	*Nycticorax nycticorax*	I	R	SE
Blanding's Turtle	*Emydoidea blandingii*	N	O	SE
Blue-Spotted Salamander	*Ambystoma laterale*	N	O	SC
Bobcat	*Lynx rufus*	I	R	SC
Broad-Winged Hawk	*Buteo platypterus*	I	O	SC
Butler's Garter Snake	*Thamnophis butleri*	NE, C	R	SE
Cerulean Warbler	*Dendroica cerulea*	I	O	SC
Channel Darter	*Percina copelandi*	C	R	SE
Cisco	*Coregonus artedi*	NW	R	SC
Clubshell	*Pleurobema clava*	NC, NE	R	SE, FE
Common Moorhen	*Gallinula chloropus*	I	R	SE
Common Mudpuppy	*Necturus maculosus*	I	O	SC
Common Nighthawk	*Chordeiles minor*	I	O	SC
Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	SW, NE, SC	O	SE, FC
Cottonmouth	*Agkistrodon piscivorus*	S	R	SE
Crawfish Frog	*Rana areolata*	W	O	SE
Cypress Darter	*Etheostoma proeliare*	SW	R	SC
Eastern Fanshell	*Cyprogenia stegaria*	NC, SW, SC	R	SE, FE
Eastern Mud Turtle	*Kinosternon subrubrum*	NW, SW	R	SE
Eastern Pipistrelle	*Pipistrellus subflavus*	S	C	SC
Eastern Red Bat	*Lasiurus borealis*	I	A	SC
Eastern Spadefoot Toad	*Scaphiopus holbrookii*	S	O	SC
Ellipse	*Venustaconcha ellipsiformis*	N	C	SC
Evening Bat	*Nycticeius humeralis*	SC	O	SE
Fat Pocketbook	*Potamilus capax*	SW	O	SE, FE
Four-Toed Salamander	*Hemidactylium scutatum*	N, C	R	SE
Franklin's Ground Squirrel	*Spermophilus franklinii*	NW	R	SE
Gilt Darter	*Percina evides*	C	O	SE
Golden-Winged Warbler	*Vermivora chrysoptera*	I	R	SE
Gray Myotis	*Myotis grisescens*	SC	R	SE, FE
Great Egret	*Ardea alba*	I	O	SC
Greater Redhorse	*Moxostoma valenciennesi*	N	R	SE
Green Salamander	*Aneides aeneus*	SE	R	SE
Hellbender	*Cryptobranchus alleganiensis*	S	R	SE
Henslow's Sparrow	*Ammodramus henslowii*	I	R	SE
Hieroglyphic River Cooter	*Pseudemys concinna*	SW	R	SE
Hoary Bat	*Lasiurus cinereus*	I	O	SC
Hooded Warbler	*Wilsonia citrina*	I	R	SC
Indiana Myotis	*Myotis sodalist*	I	O	SE, FE
Kidneyshell	*Ptychobranchus fasciolaris*	NE, C, SE	O	SC
King Rail	*Rallus elegans*	I	R	SE
Kirtland's Warbler	*Dendroica kirtlandii*	I	R	SE, FE
Kirtland's Snake	*Clonophis kirtlandii*	N, C, SE	O	SE
Lake Sturgeon	*Acipenser fulvescens*	W, S	R	SE
Lake Whitefish	*Coregonus clupeaformis*	NW	C	SC
Least Bittern	*Ixobrychus exilis*	I	R	SE
Least Tern	*Sterna antillarum*	I	R	SE, FE

Common Name	*Scientific name*	Range	Relative Abundance	Status
Least Weasel	*Mustela nivalis*	N	R	SC
Little Brown Myotis	*Myotis lucifugus*	I	C	SC
Little Spectaclecase	*Villosa lienosa*	C, S	O	SC
Loggerhead Shrike	*Lanius ludovicianus*	I	R	SE
Longnose Dace	*Rhinichthys cataractae*	N	O	SC
Longnose Sucker	*Catostomus catostomus*	NW	R	SC
Longsolid	*Fusconaia subrotunda*	C	R	SE
Marsh Wren	*Cistothorus palustris*	I	R	SE
Massasauga	*Sistrurus catenatus*	N	R	SE
Mississippi Kite	*Ictinia mississippiensis*	I	R	SC
Northern Brook Lamprey	*Ichthyomyzon fossor*	NE	R	SE
Northern Cavefish	*Amblyopsis spelaea*	S	R	SE
Northern Harrier	*Circus cyaneus*	I	O	SE
Northern Leopard Frog	*Rana pipiens*	N, E	C	SC
Northern Madtom	*Noturus stigmosus*	W, C	R	SC
Northern Myotis	*Myotis septentrionalis*	I	C	SC
Northern Riffleshell	*Epioblasma torulosa rangiana*	NC	R	SE, FE
Ohio Pigtoe	*Pleurobema cordatum*	C, S	O	SC
Ohio River Muskellunge	*Esox masquinongy ohioensis*	S	R	SC
Orangefoot Pimpleback	*Plethobasus cooperianus*	S	R	SE, FE
Ornate Box Turtle	*Terrapene ornata*	NW, SW	O	SE
Osprey	*Pandion haliaetus*	I	R	SE
Pallid Shiner	*Hybopsis amnis*	W	R	SE
Peregrine Falcon	*Falco peregrinus*	I	R	SE
Pink Mucket	*Lampsilis abrupta*	S	R	SE, FE
Piping Plover	*Charadrius melodus*	I	R	SE, FE
Plains Leopard Frog	*Rana blairi*	W	R	SC
Plains Pocket Gopher	*Geomys bursarius*	NW	C	SC
Pointed Campeloma	*Campeloma decisum*	U	U	SC
Pugnose Shiner	*Notropis anogenus*	NE	R	SC
Purple Lilliput	*Toxolasma lividus*	NC, C	R	SC
Pygmy Shrew	*Sorex hoyi*	SC	O	SC
Pyramid Pigtoe	*Pleurobema rubrum*	C	R	SE
Rabbitsfoot	*Quadrula cylindrica cylindrica*	NC	R	SE
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	SC	R	SC
Rayed Bean	*Villosa fabalis*	NC	R	SC, FC
Red Salamander	*Pseudotriton rubber*	SC	R	SE
Red-Shouldered Hawk	*Buteo lineatus*	I	O	SC
Redside Dace	*Clinostomus elongatus*	E	R	SE
River Otter	*Lontra canadensis*	I	R	SC
Rough Green Snake	*Opheodrys aestivus*	S	O	SC
Rough Pigtoe	*Pleurobema plenum*	C	R	SE, FE
Round Hickorynut	*Obovaria subrotunda*	NC, WC	R	SC
Salamander Mussel	*Simpsonaias ambigua*	SE, SC, WC	R	SC
Sandhill Crane	*Grus canadensis*	I	O	SC
Scarlet Snake	*Cemophora coccinea*	S	R	SE
Sedge Wren	*Cistothorus platensis*	I	R	SE

Common Name	*Scientific name*	Range	Relative Abundance	Status
Sharp-Shinned Hawk	*Accipiter striatus*	I	O	SC
Sheepnose	*Plethobasus cyphyus*	NC, S	R	SE, FC
Short-Eared Owl	*Asio flammeus*	I	R	SE
Silver-Haired Bat	*Lasionycteris noctivagans*	I	O	SC
Slimy Sculpin	*Cottus cognatus*	NW	R	SC
Smoky Shrew	*Sorex fumeus*	SC	O	SC
Smooth Green Snake	*Liochlorophis vernalis*	NW	R	SE
Snuffbox	*Epioblasma triquetra*	C	R	SE
Southeastern Crowned Snake	*Tantilla coronata*	S	R	SE
Southeastern Myotis	*Myotis austroriparius*	SC	R	SE
Spotted Darter	*Etheostoma maculatum*	C	R	SC
Spotted Turtle	*Clemmys guttata*	N	O	SE
Star-Nosed Mole	*Condylura cristata*	NE	R	SC
Swamp Lymnaea	*Lymnaea stagnalis*	U	U	SC
Swamp Rabbit	*Sylvilagus aquaticus*	SW	R	SE
Timber Rattlesnake	*Crotalus horridua*	S	R	SE
Tippecanoe Darter	*Etheostoma tippecanoe*	C	R	SC
Trout-Perch	*Percopsis omiscomaycus*	NW, S	R	SC
Trumpeter Swan	*Cygnus buccinator*	I	R	SE
Tubercled Blossom	*Epioblasma torulosa torulosa*	U	Likely Extinct	SE, FE
Upland Sandpiper	*Bartramia longicauda*	I	R	SE
Variegate Darter	*Etheostoma variatum*	SE	R	SE
Virginia Rail	*Rallus limicola*	I	R	SE
Waveyrayed Lampmussel	*Lampsilis fasciola*	NC, C	C	SC
Western Meadowlark	*Sturnella neglecta*	N	R	SC
Western Mud Snake	*Farancia abacura*	SW	R	SE
Western Ribbon Snake	*Thamnophis proximus*	NW, SW	O	SC
Western Sand Darter	*Ammocrypta clara*	NW, S	O	SC
Whip-Poor-Will	*Caprimulgus vociferus*	I	C	SC
White Catspaw	*Epioblasma obliquata perobliqua*	NE	R	SE, FE
White Wartyback	*Plethobasus cicatricosus*	S	R	SE, FE
Whooping Crane	*Grus americana*	N	R	SE, FE
Worm-Eating Warbler	*Helmitheros vermivorum*	I	R	SC
Yellow-Crowned Night-Heron	*Nyctanassa violacea*	SW	R	SE
Yellow-Headed Blackbird	*Xanthocephalus xanthocephalus*	W, S	R	SE
Invertebrates in Indiana not protected by IC-14-22-34				
A Caddisfly	*Setodes oligius*	U	U	SE
A Flatheaded Mayfly	*Raptoheptagenia cruentata*	U	U	SE
A Homoplectran Caddisfly	*Homoplectra doringa*	U	U	SE
A Longhorned Casemaker Caddisfly	*Nectopsyche pavida*	U	U	SC
A Lytrosis Moth	*Lytrosis permagnaria*	U	U	SE
A Mayfly	*Epeorus namatus*	U	U	SE
A Mayfly	*Pseudiron centralis*	U	U	SE
A Mayfly	*Tortopus primus*	U	U	SE
A Millipede	*Conotyla bollmani*	U	U	SC

Common Name	*Scientific name*	Range	Relative Abundance	Status
A Millipede	*Pseudopolydesmus collinus*	U	U	SE
A Moth	*Dasychira cinnamomea*	U	U	SC
A Moth	*Lesmone detrahens*	U	U	SC
A Moth	*Leucania inermis*	U	U	SC
A Moth	*Macrochilo absorptalis*	U	U	SC
A Moth	*Pagara simplex*	U	U	SC
A Noctuid Moth	*Bellura densa*	U	U	SC
A Noctuid Moth	*Capis curvata*	U	U	SC
A Noctuid Moth	*Iodopepla u-album*	U	U	SC
A Noctuid Moth	*Macrochilo hypocritalis*	U	U	SC
A Noctuid Moth	*Oligia bridghami*	U	U	SE
A Northern Casemaker Caddisfly	*Goera stylata*	U	U	SE
A Northern Casemaker Caddisfly	*Pycnopsyche rossi*	U	U	SE
A Pentagenian Burrowing Mayfly	*Pentagenia vittigera*	U	U	SE
A Pseudoscorpion	*Chthonius virginicus*	U	U	SE
A Rove Beetle	*Lissobiops serpentines*	U	U	SE
A Sand Minnow Mayfly	*Siphloplecton basale*	U	U	SE
A Sand-filtering Mayfly	*Homoeoneuria ammophila*	U	U	SE
A Small Minnow Mayfly	*Paracloeodes minutus*	U	U	SC
A Sponge-feeding Caddisfly	*Ceraclea sp. 1*	U	U	SE
A Spongilla Fly	*Climacia sp. 1*	U	U	SE
Angular Spittlebug	*Lepyronia angulifera*	U	U	SE
Annointed Sallow Moth	*Pyreferra ceromatica*	U	U	SC
Appalachia Appalachian Eyed Brown	*Satyrodes appalachia*	U	U	SE
Appalachian Cave Spider	*Porhomma cavernicola*	U	U	SE
Argo Ephemerellan Mayfly	*Ephemerella argo*	U	U	SE
Barrens Metarranthis Moth	*Metarranthis apiciaria*	U	U	SC
Big Broad-winged Skipper Sedge	*Poanes viator viator*	U	U	SC
Bunchgrass Skipper	*Problema byssus*	U	U	SC
Catocaline Dart	*Cryptocala acadiensis*	U	U	SC
Cave Beetle	*Batrisodes krekeleri*	U	U	SE
Cave Beetle	*Pseudanophthalmus barri*	U	U	SE
Cave Beetle	*Pseudanophthalmus chthonius*	U	U	SE
Cave Beetle	*Pseudanophthalmus emersoni*	U	U	SE
Cave Beetle	*Pseudanophthalms eremite*	U	U	SE
Cave Beetle	*Pseudanophthalmus jeanneli*	U	U	SE
Cave Beetle	*Pseudanophthalmus leonae*	U	U	SE
Cave Beetle	*Pseudanophthalmus shilohensis*	U	U	SE
Cave Beetle	*Pseudanophthalmus shilohensis boonensis*	U	U	SE
Cave Beetle	*Pseudanophthalmus shilohensis mayfieldensis*	U	U	SE
Cave Beetle	*Pseudanophthalmus tenuis*	U	U	SE
Cave Beetle	*Pseudanophthalmus tenuis blatchleyi*	U	U	SE

Common Name	*Scientific name*	Range	Relative Abundance	Status
Cave Beetle	*Pseudanophthalmus tenuis morrisoni*	U	U	SE
Cave Beetle	*Pseudanophthalmus youngi*	U	U	SE
Cave Beetle	*Pseudanophthalmus youngi donaldsoni*	U	U	SE
Cave Millipede	*Pseudotremia nefanda*	U	U	SE
Cave Pseudoscorpion	*Apochthonius indianensis*	U	U	SE
Chandler's Cave Flatworm	*Sphalloplana chandleri*	U	U	SE
Cobblestone Tiger Beetle	*Cicindela marginipennis*	U	U	SE
Cobweb Skipper	*Hesperia metea*	U	U	SE
Columbine Borer	*Papaipema leucostigma*	U	U	SC
Common Roadside-skipper	*Amblyscirtes vialis*	U	U	SC
Donaldsons Cave Copepod	*Megacyclops donnaldsoni*	U	U	SE
Douglas Stenelmis Riffle Beetle	*Stenelmis douglasensis*	U	U	SC
Dusted Skipper	*Atrytonopsis hianna*	U	U	SE
Earwig Scorpionfly	*Merope tuber*	U	U	SE
Eastern Veined White	*Pieris oleracea*	U	U	SE
Frosted Elfin	*Callophrys irus*	U	U	SC
Gemmed Satyr	*Cyllopsis gemma*	U	U	SC
Gold-banded Skipper	*Autochton cellus*	U	U	SC
Great Copper	*Lycaena xanthoides*	U	U	SC
Great Spreadwing	*Archilestes grandis*	U	U	SC
Groundwater Isopod	*Caecidotea teresae*	U	U	SE
Harris's Checkerspot	*Chlosyne harrisii*	U	U	SC
Helianthus Leafhopper	*Mesamia stramineus*	U	U	SC
Hidden Springs Snail	*Fontigens cryptica*	U	U	SE
Hine's Emerald (Ohio Emerald?)	*Somatochlora hineana*	U	U	SE, FE
Ice Thorn	*Carychium exile*	U	U	SE
Indiana Crayfish	*Orconectes indianensis*	U	U	SC
Indiana Ochthebius Minute Moss Bee	*Ochthebius putnamensis*	U	U	SC
Indiana Spongilla Fly	*Sisyra sp. 1*	U	U	SE
Jeannel's Cave Copepod	*Diacyclops jeanneli*	U	U	SE
Jeannel's Cave Ostracod	*Pseudocandona jeanneli*	U	U	SE
Jordan Cave Isopod	*Caecidotea jordani*	U	U	SE
Karner Blue	*Lycaeides melissa samuelis*	U	U	SE, FE
Leadplant Flower Moth	*Schinia lucens*	U	U	SE
Leonard's Skipper	*Hesperia leonardus*	U	U	SC
Marengo Cave Ostracod	*Pseudocandona Marengoensis*	U	U	SE
Mitchell's Satyr	*Neonympha mitchellii mitchellii*	U	U	SE, FE
Morrison's Cave Copepod	*Bryocamptus morrisoni morrison*	U	U	SE
Mottled Duskywing	*Erynnis martialis*	U	U	SE
Nevada Buck Moth	*Hemileuca nevadensis*	U	U	SC
Northeastern Cave Isopod	*Caecidotea rotunda*	U	U	SE
Northern Cloudywing	*Thorybes pylades*	U	U	SC
Northern Hairstreak	*Fixsenia favonius*	U	U	SC
Northern Metalmark	*Calephelis borealis*	U	U	SC
Olympia Marble	*Euchloe olympia*	U	U	SE
Packard's Cave Amphipod	*Crangonyx packardi*	U	U	SC

Common Name	*Scientific name*	Range	Relative Abundance	Status
Persius Duskywing	*Erynnis persius persius*	U	U	SE
Phlox Moth	*Schinia indiana*	U	U	SE
Pinkpatched Looper Moth	*Eosphoropteryx thyatyroides*	U	U	SE
Pointed Campeloma	*Campeloma decisum*	U	U	SC
Salt-and-pepper Skipper	*Amblyscirtes hegon*	U	U	SC
Scarce Swamp Skipper	*Euphyes dukesi*	U	U	SC
Sedge Skipper	*Euphyes dion*	U	U	SC
Shaggy Cave Snail	*Antroselatus spiralis*	U	U	SE
Sharp Wedge	*Xolotrema obstrictum*	U	U	SE
Six-banded Longhorn Beetle	*Dryobius sexnotatus*	U	U	SE
Sooty Azure	*Celastrina nigra*	U	U	SC
Southwestern Virginia Cave Amphipo	*Stygobromus mackini*	U	U	SE
Spring Amphipod	*Gammarus bousfieldi*	U	U	SE
Springtail	*Arrhopalites bimus*	U	U	SE
Springtail	*Sinella alata*	U	U	SE
Swamp Lymnaea	*Lymnaea stagnalis*	U	U	SC
Swamp Metalmark	*Calephelis muticum*	U	U	SC
The Glorious Blazing Star Flower Mo	*Schinia gloriosa*	U	U	SC
The Hoary Edge Skipper	*Achalarus lyciades*	U	U	SC
The Included Cordgrass Borer	*Spartiniphaga includens*	U	U	SE
The Kansas Prairie Leafhopper	*Prairiana kansana*	U	U	SE
The Leadplant Underwing Moth	*Catocala amestris*	U	U	SE
The Pitcher Plant Borer Moth	*Papaipema appassionata*	U	U	SE
The Royal Fern Borer Moth	*Papaipema speciosissima*	U	U	SE
The Shadowy Arches	*Melanchra assimilis*	U	U	SE
The Southern Purple Mint Moth	*Pyrausta laticlavia*	U	U	SC
Troglobitic Crayfish	*Orconectes inermis testii*	U	U	SE
Two-spotted Skipper	*Euphyes bimacula*	U	U	SC
Undescribed Amphipod	*Stygobromus sp. 2*	U	U	SE
Undescribed Cave Amphipod	*Crangonyx sp. 1*	U	U	SC
Unicorn Beetle	*Dynastes tityus*	U	U	SC
Wallace's Deepwater Mayfly	*Spinadis wallacei*	U	U	SE
Weingartner's Cave Flatworm	*Sphalloplana weingartneri*	U	U	SE
West Virginia White	*Artogeia virginiensis*	U	U	SC
	Herpetogramma thestealis	U	U	SC
	Panthea furcilla	U	U	SC

VIII. Key Habitats and Communities for Species of Greatest Conservation Need (2nd Element)

Element 2 of the Congressional guidelines requires that the CWS describe locations and relative condition of key habitats and community types essential to conservation of SGCN. Recognizing that states varied in the amount of information they had about direct management of SGCN, the FWS reviewers provided states with an option to focus their efforts primarily on the species themselves or to address those species through conservation of their habitats.

The Indiana CWS is a habitat-based model. The intent of the model is to maximize limited knowledge about wildlife species by focusing on available research, enhanced by extrapolation from species that are better known, and all informed by best professional judgment. The model was developed to link species of greatest conservation need (SGCN) to all wildlife species and to the habitats on which they depend by using representative species as mental surrogates for the guilds and habitat needs (see Section V above for a description of model development).

Habitat can be classified in many ways and the classification scheme chosen often depends upon the intended purpose of the classification and the resources available for classification. Conservation organizations and conservation initiatives often result in habitat classifications relative to a particular species of interest for example bird habitat is often classified by flyways, Bird Conservation Regions, and Important Bird Areas. Other conservation organizations such as The Nature Conservancy take an ecoregion approach and identify natural community types representative of the ecoregion. Still other organizations classify lands based on land-use such as the USDA Forest Service Forest Inventory and Analysis (FIA). None of these classification schemes is holistic, measuring both traditional habitat types and human-impacted lands such as developed lands. In order to track habitat changers, that is conversion from one habitat type to another, and the degree of habitat fragmentation a baseline measure of all habitat types is needed. Current technology makes this type of habitat analysis possible and repeatable for future comparisons.

Statewide habitat assessments based on spectral analysis of space-born thematic or reflection radiometer photographs is now available. Land-use/Land-cover can be tracked by replication of the spectral analysis at reasonable time intervals. However, habitat measures derived from different methodologies may not be directly comparable. Forest cover from spectral analysis is greater than forest cover as measured by the FIA. Unlike the spectral analysis, the FIA does not include forest cover as part of developed lands (i.e. parks and stream corridors through cities, etc.). However, the database resulting from spectral analysis allows multiple parameters to be considered. Additional investigation can further refine habitat identification based on habitat associations. For example, the value of urban forest for wildlife species A may be a function of forest block size and connecting forest cover. Based on species A's refined habitat requirements the urban forest in every city can be analyzed for it value to that species. For the purposes of the Indiana CWS, the additional analysis possible with a comprehensive spectrally derived habitat database is desirable.

More than 60 specific habitat types were identified in Indiana, and Indiana State University (ISU) was contracted to research and compile data on these habitats using GIS databases. Specifically, by June 2006 ISU will have compiled quantitative or index information on the total acreage,

geographic distribution, patch size, native vs. non-native, vegetation diversity and relative abundance, ownership, and relative condition of the habitats (Table 2). Additionally, ISU will also compile historical trends in wildlife species occurrences for each of the habitat types in 1800, 1900 and 2000.

This CWS effort is the first comprehensive effort by the state to acquire statewide habitat data. A team of specialists, led by four scientists at Indiana State University, is to provide either a quantitative measure or an index of over 80 habitat features. Measures for major habitat features will be based on analysis of Landsat 7 Enhanced Thermal Mapper plus (ETM+) or Terra's Advanced Space-borne Thermal Emissions Reflection Radiometer (ASTER) digital data projects for Indiana. Additionally, ISU is to provide a historic overview of the changes in the eight major habitat categories in Indiana from pre-European settlement to present, in hundred-year intervals, with associated changes in fauna. The current habitat analysis and the historic overview are to be presented in a format suitable for publication as a reference book. This effort will be completed in the spring of 2006. The habitat analysis effort will be adequately documented so that the process maybe replicated in the future to allow for fully comparable sequential analyses. Thus, a habitat baseline will be established for Indiana at the beginning of this century against which changes may be documented.

Subterranean habitats cannot be measured by these methods but are vitally important for supporting rare and unique Indiana wildlife associated with caves and underground waters. To give a sense for the location of these habitats, a map of the karst regions of Indiana from the state GIS Atlas is provided in Figure 8, including layers for karst springs, density of case entrances, karst area dye points, karst area dye lines, and sinkhole area or sinking-streams.

Table 2: Habitat parameters from Indiana State University.

Habitat Features Q=Quantitative I=Indices								
					Vegetation			
Habitat Type	Total Acres	Geographic Distribution	Patch Size	Native vs. Non-Native	Diversity	Relative Abundance	Ownership Public/Private	Relative Condition
AGRICULTURE	Q	Q	Q					I
Row crop by type	I	Q	I					
Cereal grains	I							
Vineyards	I							
Feedlots	I							
Residue management	I							
Confined operations	I							
Orchards	I							
AQUATIC SYSTEMS	Q	Q	Q	I				I
Lake Michigan	Q	Q	Q				I	
Rivers and streames by order and	Q/I	Q	Q				I	

Habitat Features Q=Quantitative I=Indices								
					Vegetation			
Habitat Type	Total Acres	Geographic Distribution	Patch Size	Native vs. Non-Native	Diversity	Relative Abundance	Ownership Public/Private	Relative Condition
watershed								
Miles of unimpounded rivers and streams	Q/I	Q/I	Q/I				I	
Ditches	Q	Q	Q				I	
Oxbows	Q	Q	Q				I	
Creeks	Q	Q	Q				I	
Natural lakes	Q	Q	Q				I	
Impoundments	I	I	I				I	
Near shore tributaries	I	I	I				I	
Potholes	I	I	I				I	
BARREN LANDS	Q	Q	Q				I	I
Active mine-lands	Q	Q	Q				I	
Active quarries	Q	Q	Q				I	
Bare dunes	I	I	I				I	
Rock out-crops	I	I	I				I	
Cliffs	I	I	I				I	
DEVELOPED LANDS	Q	Q	Q		Q	Q	I	I
Industrial lands	Q/I	Q/I	Q/I				I	
Roads/Rails	Q	Q	Q					
Commercial	I	I	I				I	
Rights-of-way								
Golf courses	Q	Q	Q				I	
Soccer/recreation areas	I	I	I				I	
Towers (cell phone etc.)								
Storm-water retention ponds	I/Q	I/Q	I/Q			I/Q	I	
Borrow pits	Q	Q	Q					
FOREST LANDS **Successional Stage**	Q	Q	Q	I	I	Q	I	I
Pre-forest stage	I	I	I	I	I	I	I	
Early forest stage	I	I	I	I	I	I	I	
Pole stage	I	I	I	I	I	I	I	

Habitat Features Q=Quantitative I=Indices								
					Vegetation			
Habitat Type	Total Acres	Geographic Distribution	Patch Size	Native vs. Non-Native	Diversity	Relative Abundance	Ownership Public/Private	Relative Condition
Mature or high canopy stage	I	I	I	I	I	I	I	
Old forest stage	I	I	I	I	I	I	I	
Species Composition	I	I	I	I	I	I	I	
White pine	Q	Q	Q	Q	Q	Q	Q	
Shortleaf/Virginia pine	Q	Q	Q	Q	Q	Q	Q	
Eastern redcedar	Q	Q	Q	Q	Q	Q	Q	
Eastern redcedar/hardwoods	Q	Q	Q	Q	Q	Q	Q	
Oak/pine	Q	Q	Q	Q	Q	Q	Q	
Oak/hickory	Q	Q	Q	Q	Q	Q	Q	
Oak/gum/cypress	Q	Q	Q	Q	Q	Q	Q	
Elm/ash/cottonwood	Q	Q	Q	Q	Q	Q	Q	
Maple/beech	Q	Q	Q	Q	Q	Q	Q	
Cherry/ash/yellow poplar	Q	Q	Q	Q	Q	Q	Q	
Aspen/birch	Q	Q	Q	Q	Q	Q	Q	
Riparian wooded corridors/streams/ counties	I/Q	I/Q	I/Q	I	I	Q	Q	Q
Plantations	I	I	I	I	Q	Q	I	Q
Urban forest	Q	Q	Q	I	Q	Q	I	Q
Suburban forest	Q	Q	Q	I	Q	Q	I	Q
Forested wetlands	Q	Q	Q	I	Q	Q	I	Q
Deciduous forest	Q	Q	Q	I	Q	Q	I	Q
Evergreen forest	Q	Q	Q	I	Q	Q	I	Q
Upland forest	Q	Q	Q	I	Q	Q	I	Q
Flood-plain forest	I/Q	I/Q	I/Q	I	Q	Q	I	Q
Flat-wood forest								
Original forest	Q	Q	Q	Q	Q	Q	I	Q
GRASSLANDS	Q	Q	Q	I	I	Q	I	Q
Prairies	Q	Q	Q		Q	Q	Q	
Pasture	Q	I						
Haylands	Q	I						
Reclaimed mine land	Q	Q	Q	I	Q	Q	Q	
Fescue								

Habitat Features Q=Quantitative I=Indices								
					Vegetation			
Habitat Type	Total Acres	Geographic Distribution	Patch Size	Native vs. Non-Native	Diversity	Relative Abundance	Ownership Public/Private	Relative Condition
Early successional areas	I	I	I		I	I	I	
Vegetated dunes and swales								
Savannahs								
Historic grasslands	Q	Q	Q		Q	Q		
Farm Bill Program Lands								
CRP	Q	Q	Q		Q	Q	Q	
CP1	Q	Q	Q		Q	Q	Q	
CP2	Q	Q	Q		Q	Q	Q	
CP10	Q	Q	Q		Q	Q	Q	
SUBTERRANEAN SYSTEMS								
Caves	Q	Q					Q	
Cave aquatic and terrestrial features	Q	Q						
Karst	Q	Q					Q	
Subterranean features								
WETLANDS **Ephemeral**	Q	Q	Q	I	Q	Q	I	Q
Forested	Q	Q	Q	I	Q	Q	I	
Shrub/scrub	Q	Q	Q		Q	Q	I	
Emergent	Q	Q	Q	I	Q	Q	I	
Herbaceous								
Native								
Restored								
Created								
Permanent	Q	Q	Q	I	Q	Q	I	
Forested	Q	Q	Q	I	Q	Q	I	
Shrub/scrub								
Emergent	Q	Q	Q	I	Q	Q	I	
Native								
Restored								
Created								

Habitat Features Q=Quantitative I=Indices								
					Vegetation			
Habitat Type	Total Acres	Geographic Distribution	Patch Size	Native vs. Non-Native	Diversity	Relative Abundance	Ownership Public/Private	Relative Condition
Herbaceous/Marsh	Q	Q	Q	I	I	Q	I	
Native								
Restored								
Created								
Historic wetlands types and distribution	I	I	I	I	I	I	I	
Potholes								
Farmed	I	I	I	I	I	I	I	
Drained	Q	Q	Q		Q	Q	Q	
Ditched								
Mudflats	Q	Q	Q		Q	Q		
Wetlands created or restored for mitigation	Q	Q	Q		Q	Q	Q	

For the CWS, the following major habitats and sub-habitats were used. The major habitat based discussions in this manuscript are based on the aggregated data from all sub-habitats. The results of specific sub-habitats are available in Appendix E and F. For a complete list of sub-habitats and definitions see Appendix A.

Agriculture: Lands devoted to commodity production, including intensively managed row crops (Figure 2).

Aquatic Systems include the following sub-habitats: Dunes and Shorelines, Impoundments, Kettle Lakes, Lake Michigan, Natural Lakes, Oxbows/Backwaters/Sloughs/Embayments, Rivers and Streams, Great Lakes Drainage Great River, Great Lakes Drainage Headwater, Great Lakes Drainage Wadeable/ Large River, Rivers and Streams Kankakee River (Illinois River) Drainage Headwater, Kankakee River (Illinois River) Drainage Wadeable/ Large River, Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Headwater, Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River, Rivers and Streams Ohio River Drainage Great River, Ohio River Drainage Interior River Lowland Headwater, Ohio River Drainage Interior River Lowland Wadeable/Large River (Figure 3).

Barren Lands include the following sub-habitats: Active Quarries, Bare Dunes, Cliffs, and Rock Outcrops (Figure 4).

Developed Lands includes the following sub-habitats: Golf Courses, Industrial Lands, and Roads/Rails/Bridges (Figure 5).

Forests include the following sub-habitats: Deciduous, Early Forest Stage, Evergreen, Floodplain Forests, Forested Wetlands, Mature or High Canopy Stage, Old Forest Stage, Pole Stage, Pre-Forest Stage, Riparian Wooded Corridors/Streams, Shrub/Scrub, Suburban, Upland, and Urban (Figure 6).

Grasslands include the following sub-habitats: Early Successional Areas, Farm Bill Programs, Fescue, Haylands, Pasture, Prairies, Reclaimed Minelands, Savannah, and Vegetated Dunes and Swales (Figure 7).

Subterranean Systems include both Caves and Cave Entrances. (Figure 8).

Wetlands include the following sub-habitats: Emergent, Ephemeral, Forested Wetlands, Herbaceous Marsh, Mudflats, Permanent Wetlands and Shrub/ Scrub Wetlands (Figure 9).

A. Location within the State

Scientists at ISU will calculate statewide areal coverage of each land use or vegetation type (Table 2). These results are very specific to the classification scheme used by ISU in spectral identification and mapping of the cover types. Therefore, results of this analysis may vary somewhat from other land cover calculations. For example, some old fields may be classified as either grasslands or young forest, depending on the appearance of vegetation, rather than being classified as agriculture. Some species of wildlife may be able to respond favorably to pasture lands that in other classification schemes would have been described as agricultural land use but were herein described as grasslands. In addition to reflecting the potential for use by wildlife, the methodology employed by ISU was selected so that it could be repeated using existing technology, resulting in a long-term trend analysis.

Less than 6 percent of Indiana is in public ownership. Additionally, a review of Table 3 and Figures 2-9 demonstrate that Indiana's habitat is fragmented and dominated by two land uses, Agriculture and Forest. Indiana's land ownership/use pattern determines the viability of potential conservation measures. Technical and financial assistance programs for private landowners are important conservation tools in Indiana. The distribution and size of Indiana's habitat fragments require efforts to retain, restore, and connect native wetlands, grasslands, aquatic-systems, barren lands and forests wherever land owners are willing to participate.

Five of the state's 92 counties have more than 90 percent of their land area in farm uses (Adams, Benton, Carroll, Clinton and Tipton counties in Northern Indiana).

Only six counties have less than one-third of their areas in farms. The presence of public parks and forest lands puts Brown, Monroe, Floyd and Crawford counties among those with the lowest percentage of land in farms. Marion County (Indianapolis) has just 11.4 percent of its land in farms, but most other urban counties still have extensive farm usage. Martin County (with the NSWC-Crane military facility) has less than one-third of its land in farms.

Figure 2: Agriculture Lands - Over half of Indiana's land area is classified as agriculture. Agriculture is dotted throughout the state.

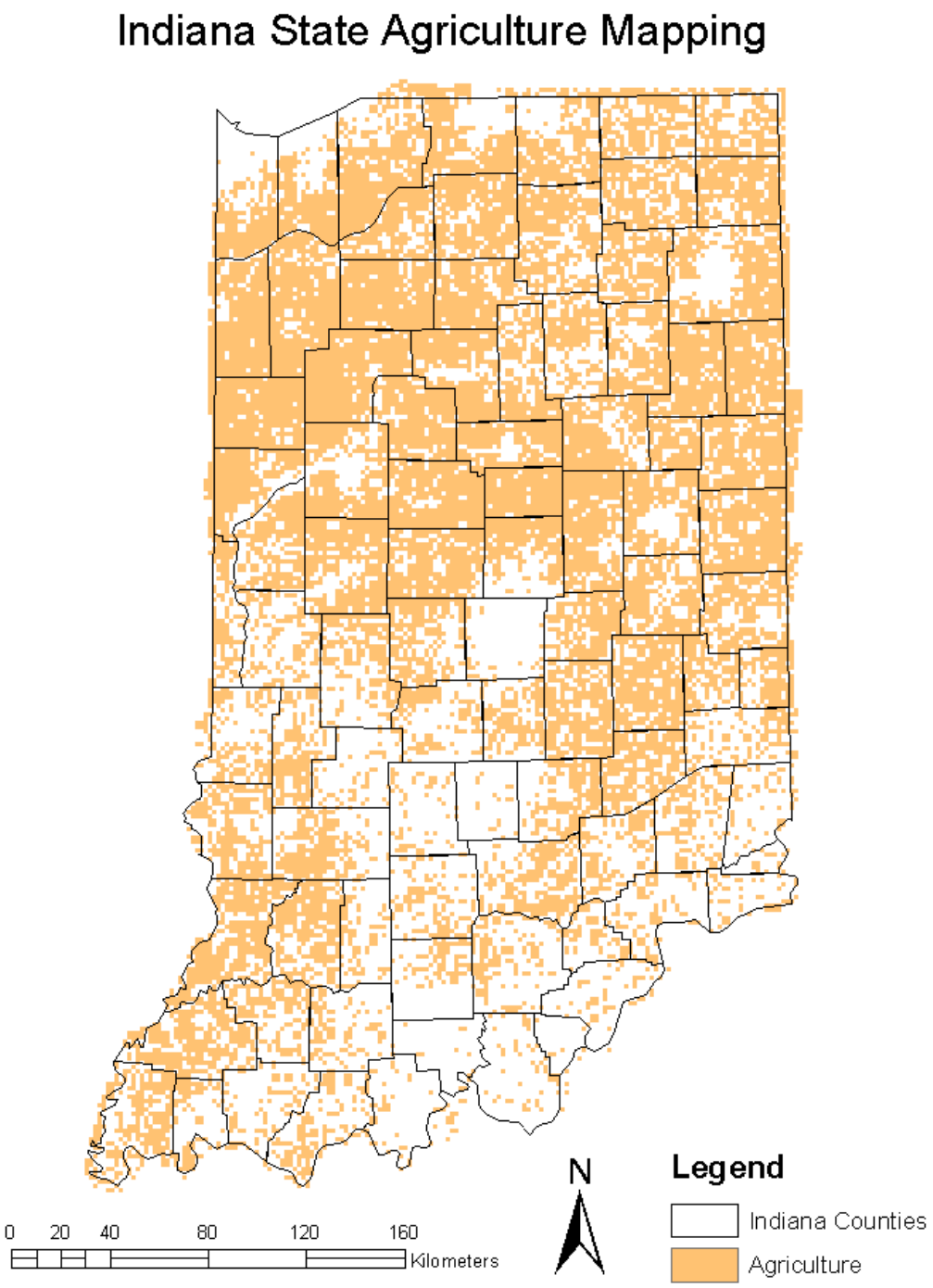


Figure 3: Aquatic Systems - Indiana's stationary and free flowing aquatics habitats are spread throughout the state, covering 2.36 percent of Indiana or 898.67 square miles (575,150.87 acres). Aquatic systems include lakes and reservoirs, streams and rivers, and parts of Lake Michigan.

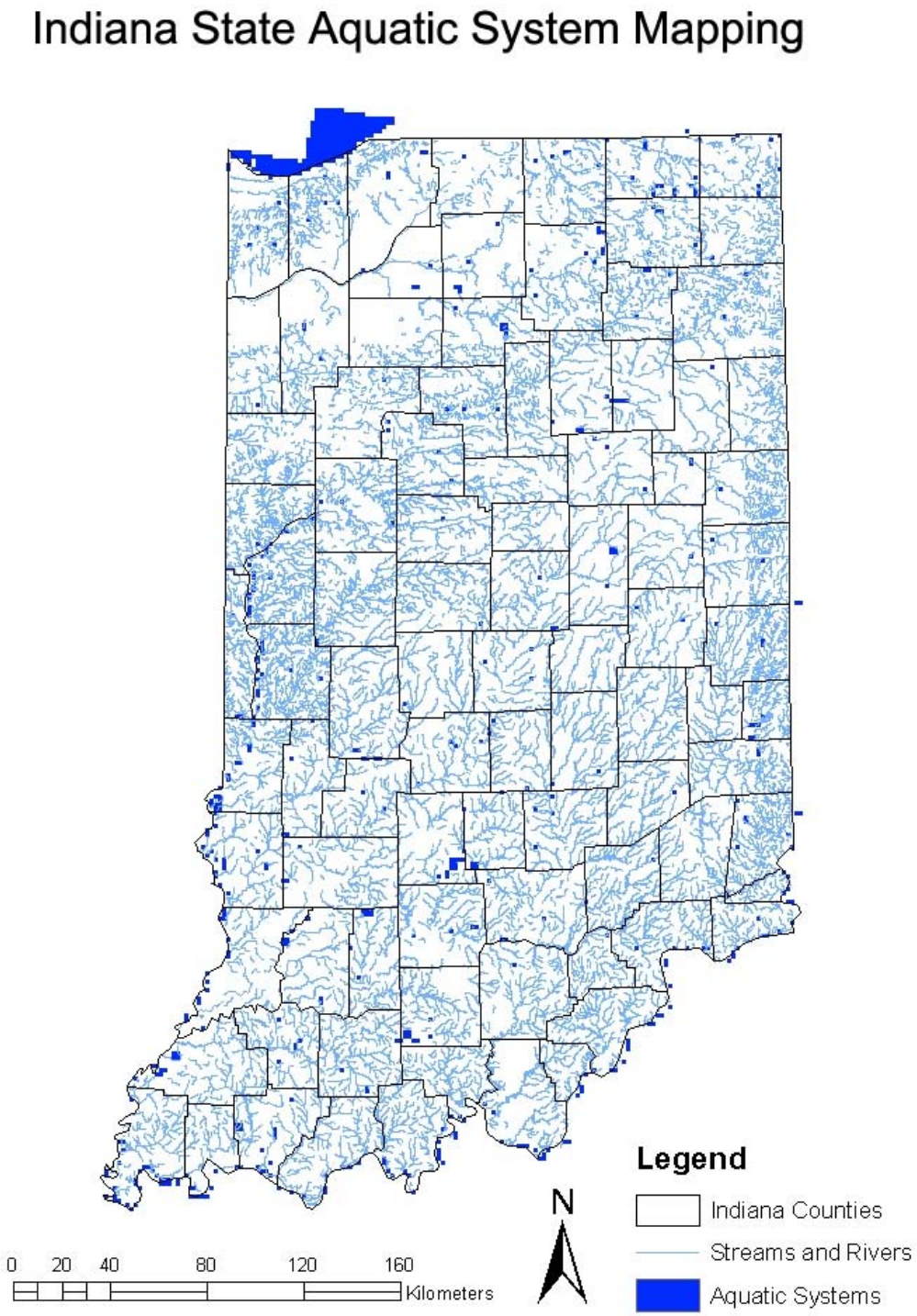


Figure 4: Barren Lands - Indiana's barren lands comprise 0.19 percent of Indiana. These lands dominated by exposed rock or minerals with sparse vegetation cover 72 square miles or 46,191 acres.

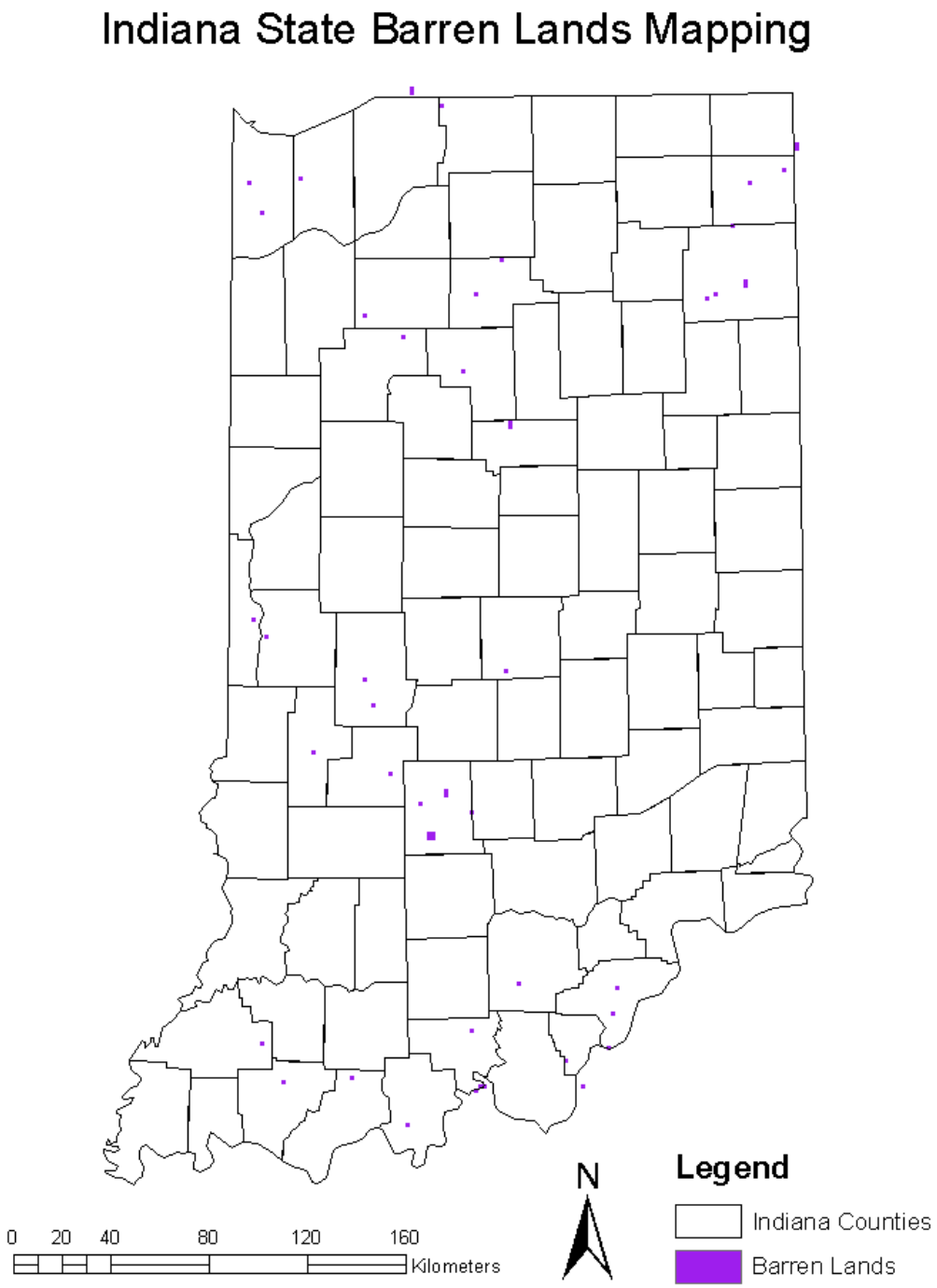


Figure 5: Developed Lands - Indiana's developed lands constitute 3.69 percent of Indiana, or 1,404.18 square miles (898,673.81 acres). While developed lands are sprinkled liberally throughout the state, particularly above I-70, they are concentrated in areas that include Gary, South Bend, Fort Wayne, Indianapolis, Evansville, and Louisville, Kentucky. There are fewer developed lands in South Central Indiana.

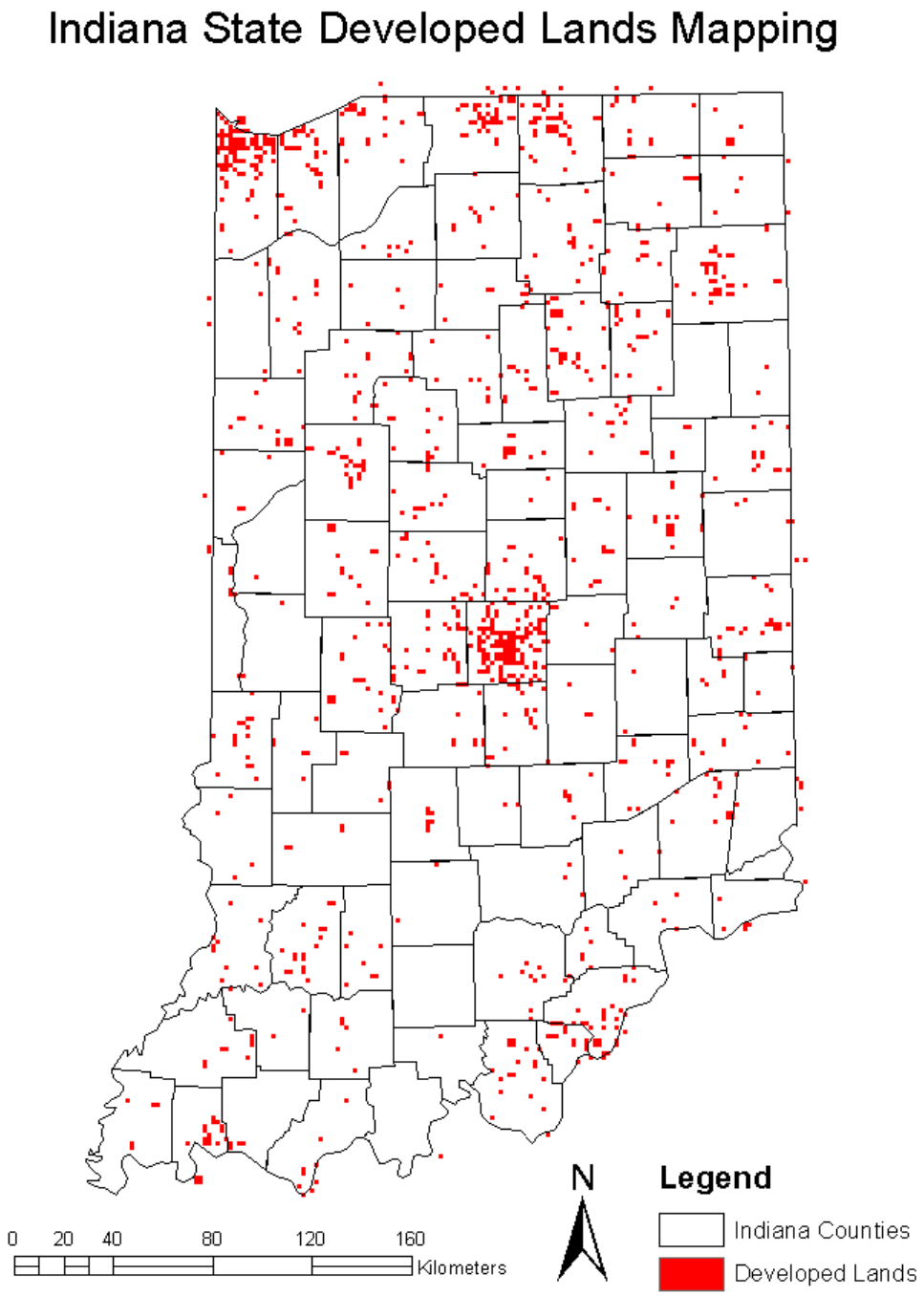


Figure 6: Forest Lands - Almost 23 percent of Indiana is forested, comprising 8,686.32 square miles (more than 5.5 million acres). While forest lands dot the landscape in Northern Indiana (24 percent), heavier concentrations of woodlands follow the hillier geography of West Central (21 percent woodlands), South Central (46 percent woodlands) and Southeastern Indiana (9 percent woodlands).

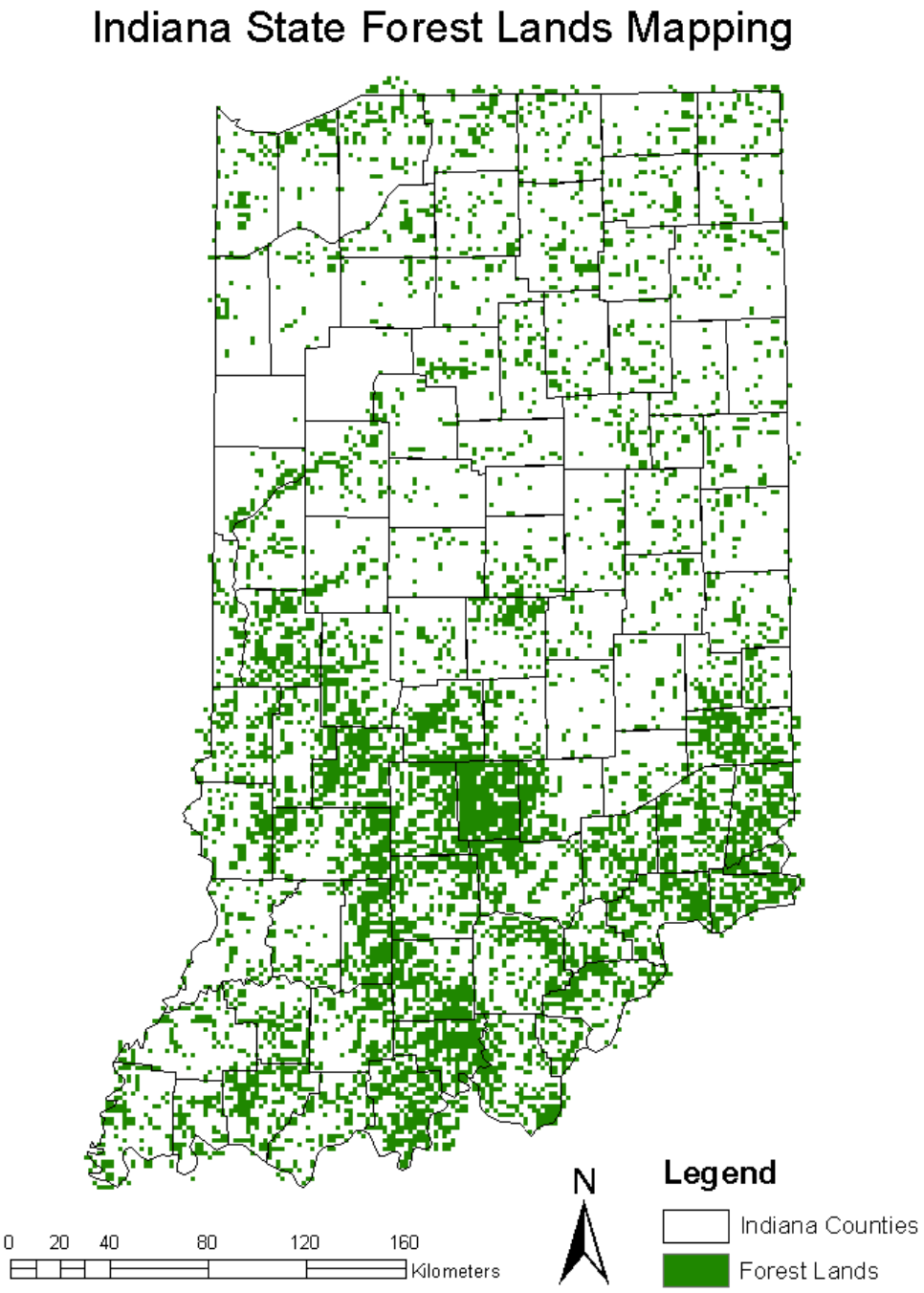


Figure 7: Grasslands - Over 15 percent of Indiana is in grasslands, constituting prairies and reclaimed mine lands. Those areas are primarily in southern, central and extreme northern parts of the state. Grasslands comprise more than 5,800 square miles or 3.7 million acres.

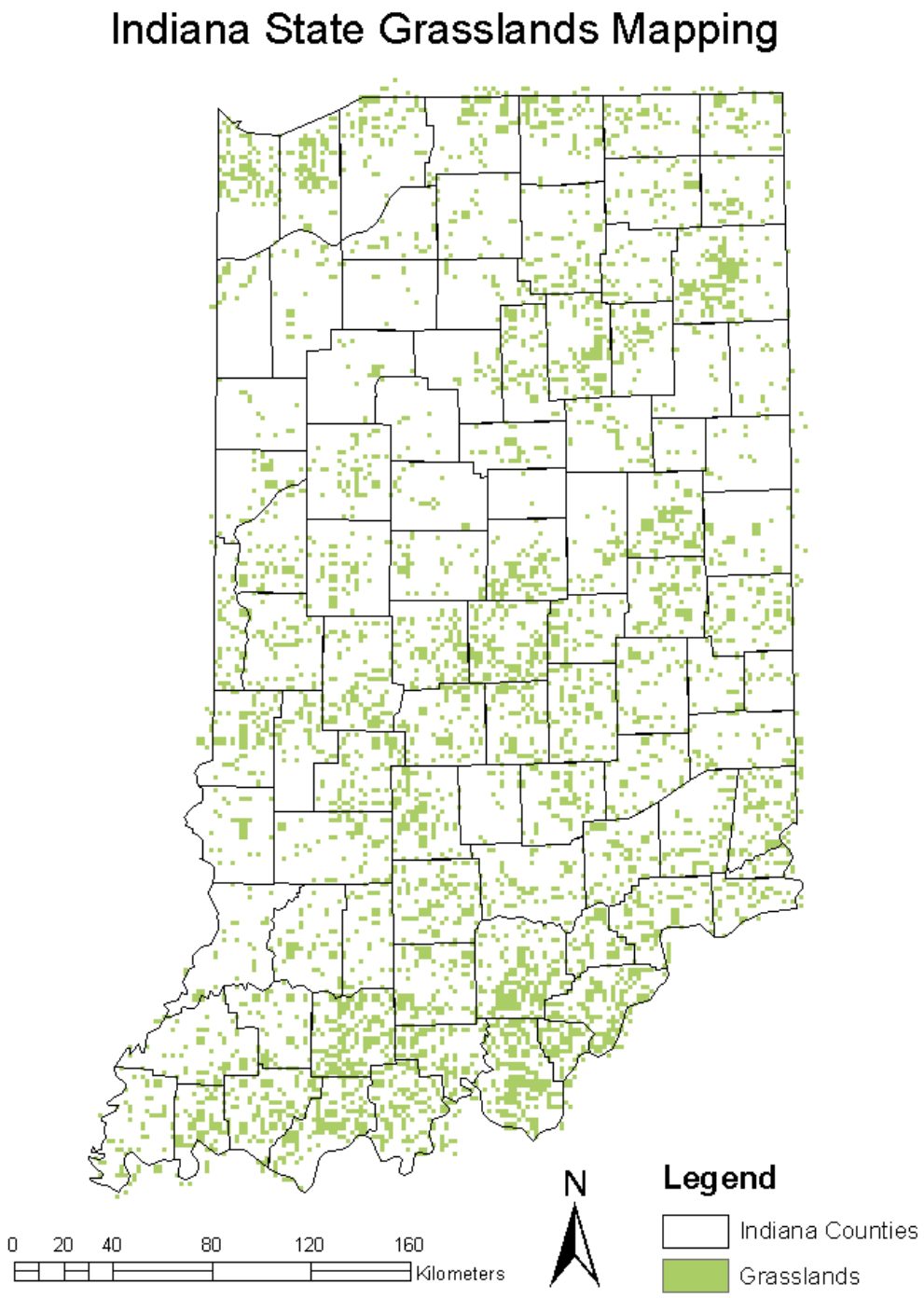


Figure 8: Subterranean Systems - the karst region of Indiana is predominantly located in the south central part of the state.

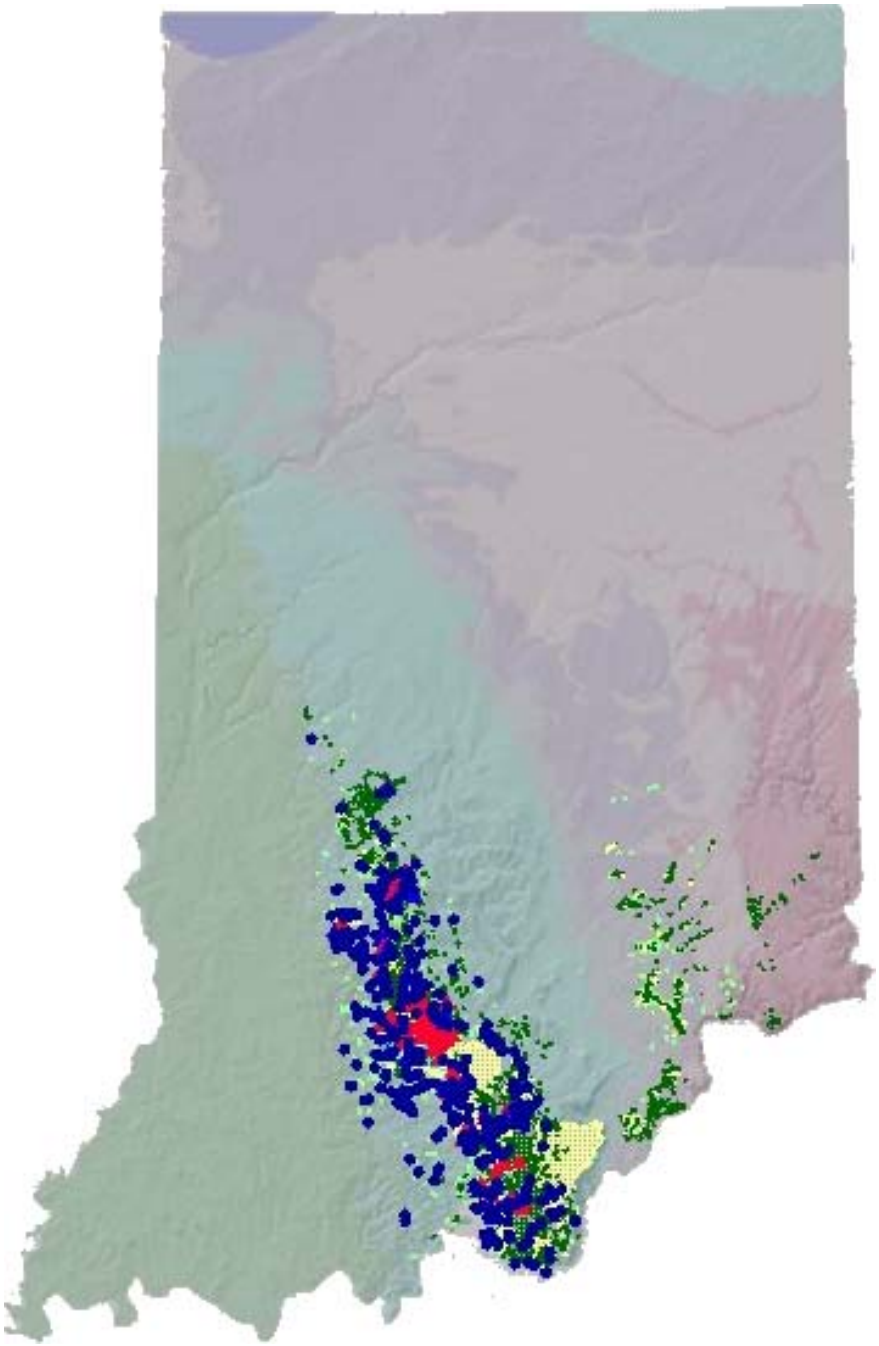


Figure 9: Wetlands - Less than 1 percent of Indiana remains in wetlands. Indiana's wetlands comprise 222,549.98 or 347.74 square miles. Today, wetlands are dotted throughout South Central, West Central, and Northeastern Indiana.

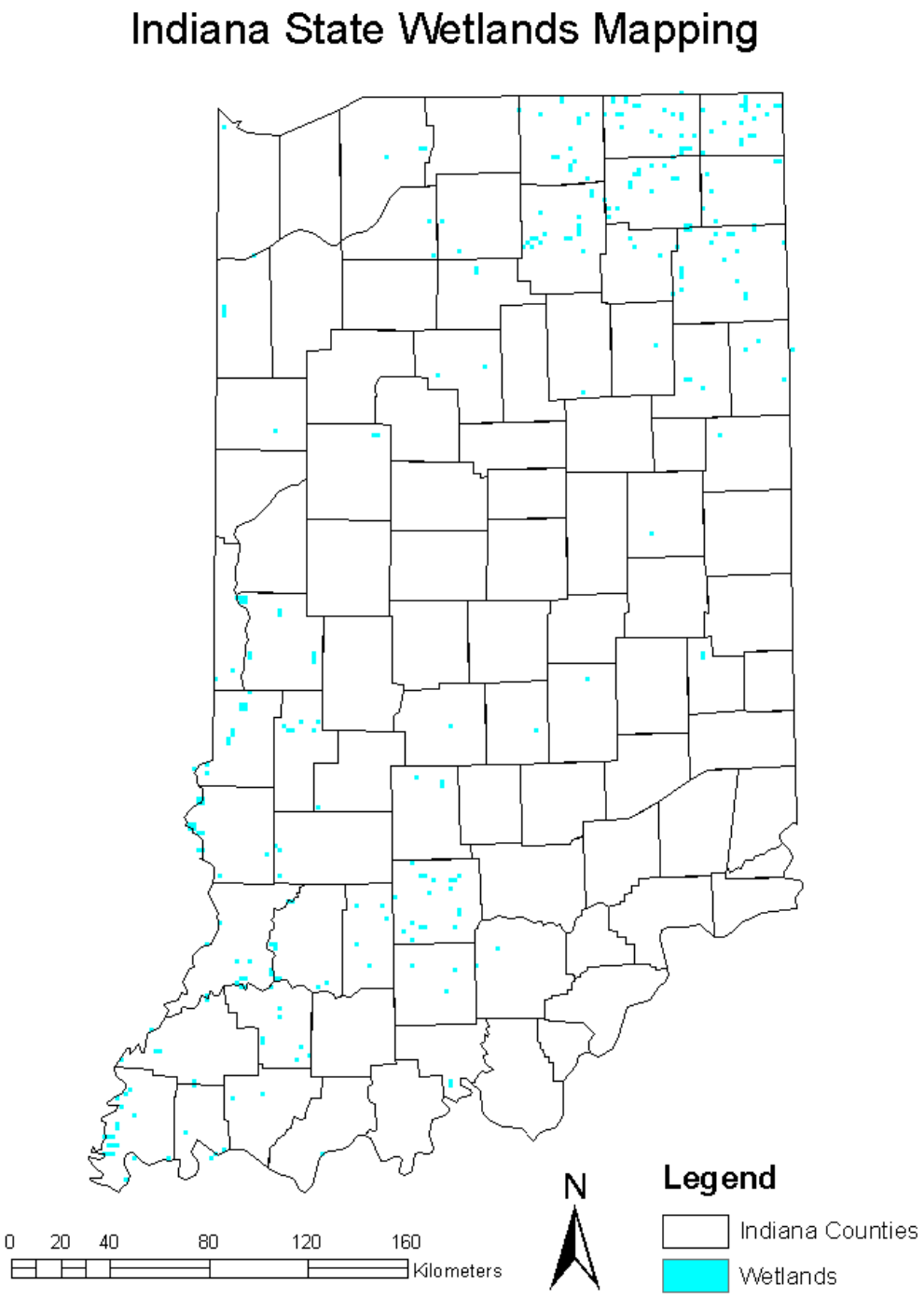


Table 3. Area and its percentage of each habitat type for Indiana in Year 2000

Habitat type	Area		Area percentage in 2000	Area of High Quality* habitat	Percent of High Quality* Habitat
	(Acres)	(Square miles)	(%)	(Acres)	(%)
Agriculture	13,296,995.43	20,776.56	54.58	NA	NA
Aquatic System	575,150.87	898.67	2.36	708	0.12
Barren Lands	46,191.57	72.17	0.19	988	2.1
Developed Lands	898,673.81	1,404.18	3.69	NA	NA
Forest Lands	5,559,244.40	8,686.32	22.82	33409	0.60
Grasslands	3,762,818.27	5,879.41	15.45	5256	0.14
Wetlands	222,549.98	347.74	0.91	10551	4.74

***** Derived from the Indiana Heritage Database and represents the highest quality remaining examples of Indiana's natural communities (a minority of these communities may be degraded, but no higher quality examples remain).

B. Relative Condition

This effort is the first attempt to describe the affects of habitat distribution and abundance on wildlife diversity at a statewide scale. Information provided above provides a reasonable baseline for location and distribution of habitat types across Indiana. Scientific information on habitat *condition* is even scarcer.

There are several specialized protocols used to measure relative habitat condition for particular conservation purposes. The Heritage Database, The Nature Conservancy, and other land trusts have developed systems for identifying the location of high quality habitats in order to consider them for acquisition and protection. The Indiana Natural Heritage Data Center, set up in 1978, represents a comprehensive attempt to determine the state's most significant natural areas through an intensive statewide inventory. The Indiana Natural Heritage Data Center is part of the Natural Heritage Network, a worldwide system of Heritage Programs. This program is designed to provide information about Indiana's diversity of natural ecosystems, species, landscape features, and outdoor amenities, and to assure adequate methods for evaluating this information and setting sound land protection priorities. The inventory is a continuous process, becoming an increasingly valuable tool for decision makers and scientists as it progresses. The Indiana Biodiversity Initiative designed a computerized system to map areas within Indiana's natural regions that may be valuable for biodiversity conservation.

Other systems have been explored to measure the quality of a limited number of particular habitat types—mostly aquatic systems. Since the mid-1990s, various scientists have been working together to establish standardized methods for measuring the function and quality of wetlands. These systems are based on classification of wetland plants according to their sensitivity to habitat degradation. Due to the complexity of these systems, no commonly accepted method is currently available, although research continues to that end. The Qualititative Habitat Evaluation Index (QHEI) is a standardized system designed by the Ohio EPA and modified for Indiana to evaluate the physical and chemical characteristics of river and stream habitats. Various programs within the

Indiana Department of Environmental Management (IDEM) and DNR use this protocol to evaluate the effects of habitat quality on stream fish and invertebrate communities. The U.S. Environmental Protection Agency (EPA) has developed a similar system for natural lakes, which is being tested in Indiana.

Section 303(d) of the Clean Water Act requires states to identify waters that do not or are not expected to meet applicable water quality standards with federal technology based standards alone. States are also required to develop a priority ranking for these waters taking into account the severity of the pollution and the designated uses of the waters.

A comprehensive assessment of 99.3 percent of Indiana stream miles was completed by the IDEM and included in USEPA's Total Waters File for support of aquatic life use (USEPA 1993; IDEM 2002). Sampling has been conducted on a five-year rotating basin cycle since 1998. Therefore, the first complete report was available in 2002. Supporting data for the 2004 update and information on all Indiana streams and lakes that have been assessed and reported since 1998 is available from IDEM and ISDH.

Based on the first complete statewide assessment cycle, a statewide picture indicates that around half of all water bodies are unsatisfactory for aquatic life and full body contact uses. Nearly 42 percent of the lake and reservoir surface acreage supports aquatic life uses. Approximately 64.5 percent of the stream miles fully support aquatic life use. Of the stream miles assessed, 58.6 percent support full body contact recreational use. Indiana's Lake Michigan shoreline outside the Indiana Harbor supports aquatic life use, but does not fully support full body contact recreational use. Causes of stream pollution affecting over 2,000 miles of stream each are: pathogens for recreational use, mercury and polychlorinated biphenyl for fish consumption. Over 2,000 stream miles also have biological communities with measurable adverse response to pollutants.

Fish tissue and surficial sediment were monitored for the presence of toxic pollutants. The Indiana Fish Consumption Advisory identifies fish species that contain toxicants at levels of concern for human consumption. The Great Lakes sport fish risk based approach was used to evaluate PCB contamination (Anderson 1993). As fish tissue and sediments from additional watersheds are analyzed for contaminants, it is expected that the miles of impaired streams and acres of impaired lakes and reservoirs due to fish consumption advisories will increase for the near term. Based on this information, the Indiana State Department of Health annually issues fish consumption advisories for many Indiana streams, the Indiana portion of Lake Michigan, and some inland lakes. A general carp fish consumption advisory has also been issued for all Indiana rivers and streams only (ISDH 2001).

Other habitat types have received no attention regarding development of similar methods to measure condition at a large scale. Therefore, data is not currently available at a scale that could inform the development of this iteration of the CWS.

What is known is that habitat types that once covered extensive areas of the state are now found as fragments scattered across the landscape. Lindsey and others presented a map in 1965 that showed the soil relations and distribution of the vegetation in presettlement Indiana (Figure 10), which later became a foundation for the seminal publication *Natural Areas in Indiana and their Preservation* (Lindsey, et al., 1970). Whereas most of the state was covered in forest and wetlands over 150 years ago, the state is now predominantly used to grow agricultural crops, as

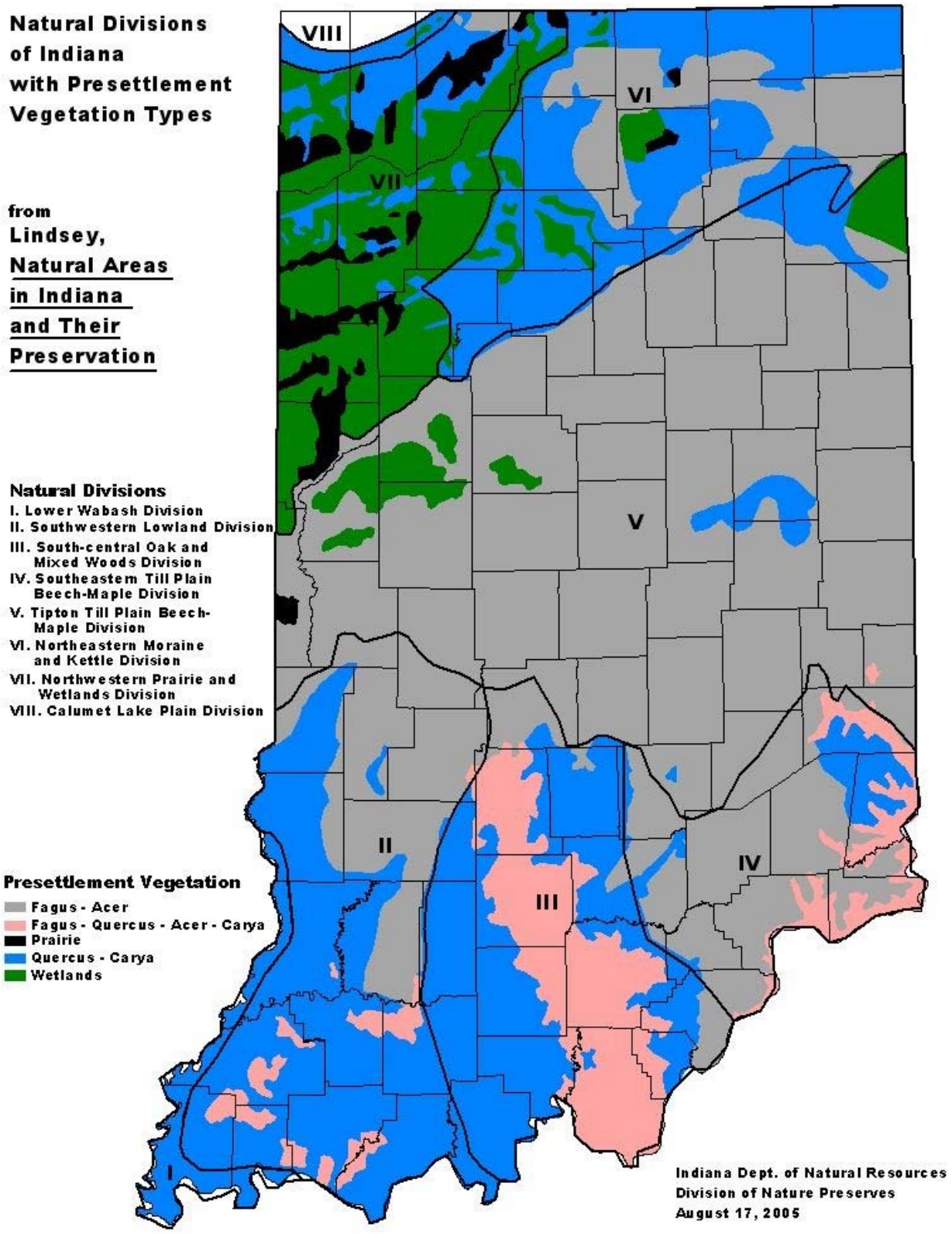
well as for mining, urban development, and other industries. As opposed to the dirt paths that once existed, roads and highways are now major barriers to plant and animal dispersal throughout the state. Conversely, highways and associated ditches may also facilitate dispersal of exotic and invasive plant species, such as purple loosestrife and common reed (*Phragmites*). Some sources state that 87 percent of Indiana was once forested. In addition, the state has lost more than 85 percent of its original wetlands. While 150 years seems like a long time, it represents the passing of less than five human generations.

In contrast, some types of habitat, such as barren lands and grasslands, were never very abundant. However, these areas may now be adjacent to or surrounded by land uses that are not amenable to thriving populations of SGCN. Quality of the plant community in these areas may also be affected by factors such as a lack of seed sources or air, water and land-based pollution.

Habitat types such as wetlands, forests and grasslands benefit from specific incentive programs that encourage public and private acquisition and restoration. While the science of restoring these habitats has progressed extensively over the past few decades, it is still difficult or impossible to completely recreate the successional stages and composition of plants that would mimic natural development of the systems. Site conditions are critically important to the adequate restoration of these systems. For example, soil types and topography are crucial for the development of plants and water regime necessary to support stable, functioning wetlands. In any case, these restoration projects are taking place in a very different landscape than that in which the original systems evolved. Never-the-less, in light of the considerable challenges in protecting the remaining fragments of high quality natural areas in Indiana, habitat restoration remains a major tool in the conservation of species most in need of conservation.

Some habitat types simply can’t be recreated. Lakes formed by glaciers, erosion of rock outcroppings and dunes, and karst regions slowly dissolving over geologic timescales cannot be destroyed and reconstructed in another location. Forces that drive evolution, such as fire, wind storms, flooding, earthquakes, glaciers, and climate change cannot be engineered. At the same time, some of these factors, such as fire, are being artificially controlled or suppressed. As a result, protection of these habitats may be the only way to effectively save the species and communities that depend on them.

Figure 10: Presettlement vegetative condition in Indiana (Source: Lindsey et al 1965)



IX. Problems Affecting the Species and Habitats Identified (3rd Element-partial)

In part, Element 3 of the Congressional guidelines requires that the CWS describe problems that may adversely affect species identified as SGCN or their habitats. To fulfill this information need, technical experts identified threats to wildlife species within habitats, and then threats to the habitats as a whole through an online survey. Respondents ranked the top threats in Indiana, as well as providing further detail on specific threats to either the species or the habitat. The results of sub-habitat data were aggregated by major habitat type and are presented below. Technical experts and conservation organizations reviewed the compiled results and were asked if these were a reasonable representation of the threats to wildlife and these habitats.

The survey provided an extensive list of potential threats to habitats. Individual results were compiled and mathematically ranked for responses to this prepared list. See Appendix E 1-78 for all sub-habitat expert questionnaire results. As a summary of these data, average rankings only are presented within the text below. Additional comments from the surveys are provided to illustrate specific concerns. All comments were captured and are presented in Appendix F 1-78.

A. Threats to Species

Each wildlife species has specific habitat requirements for providing appropriate food, water, shelter and other resources to meet survival and reproduction needs. Therefore, conservation of wildlife must necessarily start with a focus on habitat. Even in pre-European settlement Indiana, the amount and distribution of habitat in each of our eight habitat classifications was not evenly distributed. Currently, the amount, distribution and patch size of certain habitats is changing at an unprecedented rate.

Despite the different characteristics of these habitats, their varying histories, and susceptibility to change, wildlife in all of these habitat types face similar problems. Technical experts identified loss of habitat as the main problem facing wildlife in all habitats, with loss of breeding habitat considered to be slightly more of a problem than loss of feeding and foraging habitat (Table 4). The third-ranked problem facing wildlife in all habitats was degradation of movement/migration routes. This reflects the increased fragmentation of habitats in Indiana. Indeed, fragmentation that impedes movement was identified as the number one problem facing species inhabiting developed lands, and these species tend to be generalists and tolerant of disturbance (Table 4).

For specific habitats, habitat loss ranked high as a problem for wildlife in most habitats, but barren lands and developed lands deviated from this pattern. This likely reflects the distinctly different evolutionary pressures shaping the species that occur in these habitats. Experts identified the greatest threats to wildlife in barren lands to be variable population size and disease. Small, isolated populations are more vulnerable to negative stochastic events than more robust populations in contiguous or connected habitat patches. Wildlife dependent upon small, widely dispersed habitats would be more threatened by variable population size and disease than wildlife species in more common contiguous habitats. Wildlife species that continue to survive in developed lands tend to be more tolerant of disturbance and sufficiently capable of movement to locate their requirements. Therefore, habitat loss would not be considered a primary problem for these species. Rather, degradation of movement/migration routes would be a major threat to the survival of both terrestrial and aquatic wildlife in developed areas.

Degradation of movement/migration routes and variable reproduction population size also ranked high and the experts identified this as the number one problem facing forest habitat in Indiana.

Some threats to species are more prevalent than others. Overall, the first five threats identified for all wildlife species in all habitats relate to habitat loss, connectivity and quality (see Table 4). Addressing these shared threats, related to loss of quality habitat, provides fertile ground for efficient, effective conservation partnerships. Some habitats are naturally in short supply. Species in these habitats face unique stressors that need to be specifically addressed to conserve overall biodiversity.

B. Threats to Habitats

The top ranking threats of habitat degradation, commercial or residential development (sprawl), agricultural or forestry practices, habitat fragmentation, and counterproductive financial incentives or regulations are all inter-related and affected by land use policies (Table 5). As Indiana has developed over the past three centuries, the amount of habitat classified as developed land and agricultural land has increased as all other habitat types have decreased.

Today's forest differs from the forest of the 1800s in block size, stem size, and species composition due to changing land use and management practices. Economic forces driving timber production and agriculture have resulted in large-scale habitat cycles in southern Indiana. In the late 1800s, deforestation was rapid and Indiana's forested lands reached their point of lowest abundance in the early 1900s. Since the Great Depression, Indiana's forests have been increasing, especially in the southern part of the state; however current timber stand management practices may also be driving a conversion from oak-hickory dominance to more maples (Miller, 2005). Respondents to the technical survey stated that oak-hickory forest cover type is not regenerating itself due to the lack of disturbance (fire, even-aged silviculture) that provides 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; fire suppression favors growth of fire intolerant species such as sugar maple and American beech.

Water and streamside habitat are vital for the survival of both aquatic species and terrestrial species, particularly in developed lands where stream systems often provide the only habitat and travel corridors. Stream channelization was identified as the number one threat in aquatic systems and the number two threat in developed lands. Stream channelization certainly degrades the habitat quality and quantity. When streams are straightened, the linear distance of available habitat decreases significantly. Depending upon methods used to construct and maintain the channel, riparian habitat can be severely degraded (especially due to removal of trees along the bank and fallen logs in the stream), erosion and sedimentation may increase and flows will be altered. Therefore, stream channelization was expected to be a highly ranked threat to aquatic systems.

Although drainage practices (stormwater runoff) and flow regulation were ranked somewhat lower, it is closely related to channelization in both urban and rural areas. As examples of indirect impacts to species, scientists offered that changes in drainage patterns due to development could affect Kirtland's snakes, which also can be adversely affected by moving or clearing debris. Artificial manipulation of water levels in wetlands is also likely to increase

mortality of over wintering snakes. Snakes hibernate underground at the groundwater interface. Raising water levels in the winter could drown snakes and lowering water table could expose them to extreme cold temperatures.

Practices exclusively designed to reduce one kind of threat to habitats may inadvertently degrade other habitat characteristics. Point source (from pipes), nonpoint source (from runoff), and residual contamination were also identified as habitat threats, particularly in developed lands and subterranean systems. When grasses along streambanks replace tree cover, overland soil erosion may be controlled, but the grasses provide no instream habitat for fish and other aquatic animals. Removal of streamside trees and instream log jams results in overheated water (which affects animal physiology, water chemistry and oxygen levels), loss of food resources from falling leaves and insects, instability of streambanks and reduction of structures that provide cover from predators, nurseries, and egg-laying substrate. Around sinkholes, the use of grassed buffers may be possible without negative side effects on habitat.

Similarly, intentional use of invasive non-native plant species to control erosion has resulted in damages when those species took over native communities. Invasive species concerns were rated especially high for barren lands and wetlands, but can be a problem in any habitat type. The impact of invasive species on all ecosystems is so disruptive that the USFWS and the USGS state that invasive species rank second only habitat loss as a cause of endangerment to native species. Once introduced, it may be difficult or impossible to contain invasive species. Therefore, design of conservation practices must take into account effects on the entire range of habitat characteristics.

Some threats are specific to more local or limited habitats. Mining/acidification was considered to be a significant threat in agricultural lands and subterranean systems. Although this threat is not likely to be widespread in either habitat type, the acidification associated with mining can be locally very detrimental to the entire wildlife community and must be addressed to promote good conservation

In general, technical experts were satisfied that results from the questionnaire adequately addressed the threats to the eight habitat categories. One expert commented on a habitat type or sub-type—early/mid successional habitat—which was not specifically included in this survey. DNR staff involved in the development of the habitat classification system were also frustrated by this omission. However, they were unable to resolve how to define and detect this habitat type because in a mapping exercise, the habitat can either be an aging grassland or early successional-stage forest, an agricultural field or roadside border. The inability to detect and clearly classify these systems may be problematic for conservation, considering that the number two threat to grasslands was management of successional change. This refinement may be addressed in future versions of the CWS, as sensing and mapping techniques improve. Other comments identified additional threats relative to the following categories: public knowledge and conflicts, short-term climate events, insufficient data, lack of natural and anthropogenic disturbance in certain habitats (such as fire and silviculture), and rapid changes in habitat features such as drainage.

Table 4. Problems affecting Wildlife in each major habitat type
Ranked threats to wildlife by major habitat type in Indiana. (See Appendix E-1 to E-78 for responses to sub-habitat expert questionnaires).

Habitat	All habitats combined	Agricultural	Aquatic systems	Barren lands	Developed lands	Forested lands	Grasslands	Subterranean Systems	Wetlands
Habitat loss (breeding range)	1	1	1	4 (tie)	8 (tie)	1 (tie)	1	1	1
Habitat loss (feeding etc.)	2	3	2	3	9 (tie)	1 (tie)	2	2	2
Degradation of movement /migration routes	3		4	6	1	2	6	5	5
Dependence on irregular resources	4	2	5	5 (tie)	8 (tie)	10	5	8	3
High sensitivity to pollution	5	7 (tie)	3		3	12	11	4 (tie)	10
Predators (native and domesticated)	6	4 (tie)	9	5 (tie)	9 (tie)	4	4	9	7
Bioaccumulation of contaminants	7	5	7		5	11 (tie)	7	4 (tie)	6
Viable reproductive population size	8		8	1	11	3	9	10	8
Invasive/non-native species	9	4 (tie)	6	7	7	8	3	13	11
Diseases/Parasites	10		10	2	2	5	12	12	13
Specialized reproductive behavior	11		6 (tie)	8 (tie)	12 (tie)	7	13	3	9
Unintentional take	12	8 (tie)	11	8 (tie)	9 (tie)	6	8	6	12
Small native range (high endemism)	13	6 (tie)	14	5 (tie)	14	9	10	7	14
Near limits of natural geographic range	14	6 (tie)	15	4 (tie)	13 (tie)	13	15	11	4
Species overpopulation	15		17		4	14			17
Dependence on other species	16	7 (tie)	12		10 (tie)	18	16		19
Genetic pollution (hybridization)	17	8 (tie)	16		6	16			15
Large home range requirements	18		19	10	13 (tie)	11 (tie)	14	15	16
Unregulated take	19		18	9	10 (tie)	15	18	14	18
Regulated hunting/fishing pressure (too much)	20		13		12 (tie)	17	17		20

Table 5. Problems Affecting Habitats:
Ranked threats to each major habitat type in Indiana. (See Appendix E-1 to E-78 for responses to sub-habitat expert questionnaires).

Habitat	All habitats combined	Agriculture	Aquatic systems	Barren lands	Developed lands	Forested lands	Grasslands	Subterranean systems	Wetlands
Habitat degradation	1	2	2	1	2 (tie)	3	1	1	1
Commercial or residential development (sprawl)	2	3	5	4	1	1	4	2	4
Agricultural/Forestry practices	3	4	4	5	7	4	3	4	3
Habitat fragmentation	4	1	8	2 (tie)	8	2	5	6	2
Counterproductive financial incentives or regulations	5	7 (tie)	13	2 (tie)	4 (tie)	7	6	13	6 (tie)
Point source pollution (continuing)	6	7 (tie)	6	7 (tie)	5	12	10	5 (tie)	6 (tie)
Invasive/non-native species	7	6 (tie)	11	3	10 (tie)	6	7	11	8
Nonpoint source pollution	8	8 (tie)	3	7 (tie)	9	11 (tie)	12	7	5
Successional change	9	5	14	6	12	5	2	12	6 (tie)
Stream channelization	10		1		2 (tie)	10	15	10 (tie)	10
Residual contamination (persistent toxins)	11	8 (tie)	10	8	3	13	8	5 (tie)	12
Drainage practices (stormwater runoff)	12	6 (tie)	7	7 (tie)	6	14	13	9	7
Mining/acidification	13	6 (tie)	12		13	9	9	8	11
Impoundment of water/Flow regulation	14		9		4 (tie)	11 (tie)	16	10 (tie)	9
Climate change	15		15		11		11	3	13
Diseases (of plants that create habitat)	16		16		10 (tie)	8	14		14

X. Additional Research and Survey Efforts Needed (3rd Element-partial)

Part of Element 3 of the Congressional guidelines requires that the CWS identify priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats. A section of the online survey solicited input from technical experts to outline research and survey efforts needed for wildlife species within the major habitat types, and then specifically for the habitats themselves.

Respondents were asked to describe how complete the current body of research is. Technical experts and conservation organizations reviewed these results and were asked if the output was a reasonable representation of the current body of science.

Respondents ranked research needs for wildlife in the major habitats in Indiana, as well as providing more detail on specific research needs. 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 specific habitats. Additional comments from the surveys are provided to illustrate specific recommendations. All comments were captured and are presented in the appendix.

A. Additional Research and Survey Efforts Needed for *Wildlife Species*

The greatest need identified for wildlife species within their habitats was to conduct research and survey efforts on threats, including interactions and effects of predators, competitors, and contaminants (Table 6). The next greatest research need was to identify limiting factors, such as food, shelter, water and breeding sites. In developed lands, more research is needed on distribution and abundance of wildlife species. In barren lands, research on dependence of wildlife species in relationship to their habitats was a significant need. As an example of a research need, Indiana bat habitat has been protected through erection of metal grates at cave entrances, but still the species is not thriving. Additional efforts to address factors that may be limiting recovery of the species, such as contaminants and populations dynamics, would be critical in assisting species that have low reproductive potential. Burrowing crayfish research provides an example of the interrelationship between threats and various species within a habitat. A number of threatened and endangered species, including the copper belly water snake, massassauga rattlesnake, and crayfish frog, are dependent upon crayfish burrows for habitat. A $500,000 research project, funded by a State Wildlife Grant, is currently underway to conduct extensive research on burrowing crayfish to improve the understanding of how habitat and threats to crayfish can be limiting for a number of other species.

Table 6. Research needs for Indiana species
Ranked research and survey efforts needed for wildlife in each by major habitat types. (See Appendix E-1 to E-78 for responses to sub-habitat expert questionnaires).

Habitat	All Habitats Combined	Agriculture	Aquatic Systems	Barren lands	Developed Lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Threats (predators/competition, contaminants)	1	1		1 (tie)	5	1	2	1	2
Limiting factors (food, shelter, water, breeding sites)	2	3 (tie)	1	1 (tie)	2	5	1	2	1
Relationship and dependence on specific habitats	3	3 (tie)	3	1 (tie)	3	2	3	3	3
Population health (genetic and physical)	4	2	5 (tie)	2	4	4	4	4	4
Distribution and abundance	5	4	4	4 (tie)	1	3	5	5	5
Life Cycle	6	5	5 (tie)	4 (tie)	6	6	6	6	6

B. Additional Research and Survey Efforts needed for *Habitats*:
The highest-ranking research needs for habitats included dependence on specific site conditions in five of the eight major habitat types (Table 7). This information will be especially critical for restoration projects and for protection of migrating species. For example, when wetlands are restored, they may not provide all of the wildlife needs because of the location relative to soil types, nearby sources of seed for re-establishment of diverse plant species and damage due to invasion of adjacent nuisance species. Different age classes of the endangered Blandings' turtle are dependent upon a range of water depths throughout their life cycle. If the necessary combination of water depths is not available within the restored wetland, the habitat may not be suitable to this species. Respondents indicated a need for additional information on metapopulation dynamics and migration distances to and from ephemeral wetlands, habitat distribution within the landscape, and buffer size and vegetation composition around ephemeral wetlands.

Threats such as land use change, competition, contamination, and global warming were significant—most notably in aquatic habitats. Lakes, streams, wetlands and other waterways are highly susceptible to the impacts of changing environment due to watershed dynamics and flow through the systems. These aquatic systems cannot be isolated from the surrounding landscape. Distribution and abundance (fragmentation) was significant for barren lands and forested areas. As the landscape of Indiana changes through highway construction, farming and urban development in rural areas, forests become separated from each other, creating barriers to migration and genetic health of species that are dependent upon these areas. Successional changes were significant in agricultural areas and in forests, where the combination of species may be dependent on the mix of plants that grows and changes over time in an abandoned field or in a forested area affected by fire or wind storms. One technical expert noted that forest health

is compromised by the "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."

All of these factors also can be interrelated. Land use changes (categorized as a "threat" in the table) can affect the distribution, abundance and fragmentation of habitats. Research on each factor in isolation must be combined with an understanding of the synergy between these factors.

Table 7. Research needs for Indiana habitats.
Ranked research and survey efforts needed by each major habitat type. (See Appendix E-1 to E-78 for responses to sub-habitat expert questionnaires).

Habitat	All habitats combined	Agriculture	Aquatic Systems	Barren lands	Developed Lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Relationship/dependence on specific site conditions	1	1 (tie)	2	1 (tie)	1	4	1	1	3
Threats (land use change/competition, contamination/global warming)	2	1 (tie)	1	3	3	2	2	2	1
Distribution and abundance (fragmentation)	3	3	3	1 (tie)	2	1	3	3	2
Growth and development of individual components of habitat	4	4	4	2	4	5	4	4	4
Successional changes	5	2	5	4	5	3	5	5	5

XI. Conservation Actions Needed (4th Element)

Element 4 of the Congressional guidelines requires that the CWS describe the conservation actions determined to be necessary to conserve the identified species and habitats, as well as priorities for implementing such actions. In the technical expert survey, experts were asked what conservation actions were most needed in Indiana for both species within habitats, as well as for the habitats themselves.

A. Tables of Ranked Actions

The following results are organized by habitat type, beginning with actions needed for *wildlife* conservation (Table 8), followed by actions needed for *habitat* conservation (Table 9). Technical experts were asked to respond to each of the following information needs:

1. Rank a list of conservation efforts by how well they address threats.
2. Describe other current conservation practices for species and habitats in Indiana.
3. Provide more detailed recommendations for more effective conservation actions (not ranked).

Then, technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation actions needed. Following are tables that list the ranked actions needed for wildlife and for habitats in Indiana, along with reviewer comments. Additional comments from the surveys are provided to illustrate specific actions needed for conservation. All comments were captured and are presented in the appendix.

1. Species Conservation Actions

Overall, population management and protection of migration routes ranked the highest as recommended conservation actions for *species within habitats* (Table 8). Population management may be particularly effective in habitats where interactions with common species can detrimentally affect rare species.

Generalists that thrive on human disturbance may negatively affect a number of other species, depending on land use and resource management practices. For example, overpopulation of raccoons can result on unsustainable loss of turtle eggs, resulting in reproductive failure. Overabundant browsing deer have denuded plant communities—even in locations where the habitat is otherwise protected such as state parks or nature preserve. Woodrats may also have to cross non-forested areas to reach preferred feeding areas (e.g., hard mast crops, berries). While doing so, they may become exposed to ubiquitous predators (great-horned owls, raccoons). Game species can also transmit diseases and parasites to populations that may already be at unsustainably low levels. Raccoon densities may be higher in non-forested settings (such as farmed areas on top of cliffs) and could expose woodrats to higher levels of raccoon roundworm.

When game species become overabundant, population management through hunting and trapping can be a major tool for controlling negative impacts on rare plant and animal communities. This method was rated highly for all habitats except the rarer barren lands and inaccessible subterranean areas.

The highest ranking conservation action in agricultural landscapes, barren lands, forest lands, and subterranean habitats was direct habitat protection. These areas are either naturally rare

(subterranean and barren lands) or are directly affected by use of conservation practices in commercial harvest and production of natural resources (agriculture and forestry). Several community types occur in Indiana at or near the edge of their range, making these groups particularly susceptible to changes in climate or other factors. Populations on the outskirts of their natural distribution may be particularly useful for genetic study or to determine conditions that limit restoration and protection. The green salamander is one of these species. They are only found at two sites in Indiana, are at the edge of the geographic range and are vulnerable as habitat specialists in barren lands.

Reintroduction and stocking may be more commonly used in wetlands and Aquatic systems than for species in other habitat types. Wetland restoration has become a growing and developing area of science, propelled by incentive-based programs and regulatory mitigation. Otters and osprey are examples of species that benefit from successful reintroduction programs. While there is some potential for turtle reintroduction, requisite knowledge about behavior and life histories may not support its use. Furthermore, reintroduction can be financially costly and resource-intensive. Protection of habitats, including nesting and rearing sites, may be a far more cost-effective means of providing for these species. Direct reintroduction and stocking are less commonly employed in upland or more terrestrial habitats.

Protection of migration routes was recommended for species in developed lands, forest lands and barren lands. This need is related to fragmentation of these habitats, which was indicated as a major habitat threat. Wildlife must be able to survive dispersal between habitats, which may be affected by barriers such as roads, dams and other developed areas. So, establishment and protection of corridors becomes critical for survival within healthy habitats that are scattered across the landscape.

Direct population management by hunting or trapping was rated particularly high in grasslands, where many species are associated in guilds with game birds. In contrast, regulation of collecting was significant in subterranean systems where populations are so small and reproductive capacity is so low that these species cannot withstand the pressure of collection and removal by humans. Related to population management is the need in some cases to take direct action to control or remove invasive species, contaminants and predators that may be interfering with population recovery. One respondent noted that invasive species control (e.g., buckthorn, autumn olive, *Phragmites*) was necessary to maintain open herbaceous habitat suitable for massasauga rattlesnake protection. Translocation to a new geographic range is a specialized tool for direct manipulation of populations. An example would be establishing a population of prairie chickens in grasslands that have been developed in former strip-mined areas in southern Indiana. Neither the species nor the habitat would have existed naturally in this area in historic times.

Particularly in some habitats, direct population management may be virtually impossible. Another respondent illustrated why lack of knowledge about invertebrates and the difficulty of working in underground habitats deal a double blow that could seriously impede survival of rare species. He described how a non-native carnivorous millipede (*Oxidus gracilis*) is invading caves in the east and has now been found in several Indiana caves. This species preys on the food base for cave salamanders. Further east, reports of greatly decreased insect diversity in caves invaded by this millipede have been reported. Potential impacts are unknown, but could be significant. Once underground systems have been infested with exotic invaders, there are no known means of restoring the biotic integrity of these habitats.

While some of these conservation actions are dependent on decisions made through state or local public policy, individuals on private lands can implement other actions. In either case, public education to reduce human disturbance is intimately connected to the ability to implement all of these actions. Respondents especially noted the necessity of public information regarding rare or less noticeable habitats, such as barren lands, grasslands and subterranean (cave) systems.

2. Habitats Conservation Actions

Conservation action needs for habitats highlighted the importance of habitat protection and restoration on public lands (Table 9). Land trusts and public funds are the primary mechanisms to prioritize and protect significant habitats. Large blocks of habitat are required by some species with large home ranges and to protect species diversity and interactions that are dependent on large undisturbed areas. Additional tools are available for private lands management, including financial incentives for habitat protection and restoration (the Classified Wildlife Habitat Program) and cooperative land management agreements (conservation easements).

The first step to engage private landholders in conservation is to appeal to an ethic of long-term land stewardship. Once landowners understand the impacts of land use practices and are presented with viable alternatives, they will often take advantage of wildlife and habitat conservation programs. Like public education regarding wildlife species conservation, technical assistance is inextricably related to establishment of protected areas and habitat management through the use of public funds or private lands incentives. Delivery of technical assistance is seriously affected by changing patterns in land ownership. For example, private ownership patterns of forest land have changed significantly in the past three decades. While the number of forestland acres in Indiana remained relatively the same between 1978-1994, the average parcel size of private forest acres declined from 77 acres to 25 acres while the number of private forestland owners tripled; by 1994, sixty percent of the 151,300 forest landowners owned less than 9 acres (Broussard, 2005). Reaching the increased number of small landholders with adequate and timely information on land and water management practices can be difficult. Not reaching them can be even more costly, as these fragmented resources are even more vulnerable than they were as larger tracts of forest.

Partnerships between public land managers and private landholders can stretch coverage for critical habitats. Patoka River NWR manages agricultural habitat through cooperative farming agreements on refuge lands and restores prior converted wetlands to palustrine forested habitat on acquired refuge lands. The refuge also partners with the NRCS in reviewing lands nominated by farmers for inclusion in the WRP easement program. The refuge facilitates restoration of wetland and forested habitat on private agricultural lands through the Fish and Wildlife Services Private Lands Program.

Land use planning, corridor development, successional control, and regulation are all interrelated as tools for larger-scale management of habitats across space and time. Effective development and use of these tools also relates back to species and habitat research needs, such as factors that affect migration, dependence on site specific conditions, land use change, competition, contamination, and global warming.

Table 8. Conservation action needed for species in each of the habitats

Ranked conservation efforts needed for wildlife by each major habitat type. (See Appendix E-1 to E-78 for responses to sub-habitat expert questionnaires).

Conservation Action	All habitats combined	Agricultural	Aquatic systems	Barren lands	Developed lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Population management (hunting, trapping)	1		2		3 (tie)	2	1		2 (tie)
Protection of migration routes	2		4	2 (tie)	1	1 (tie)	4		3
Habitat protection	3	1	5	1	3 (tie)	1 (tie)	6	1 (tie)	5
Reintroduction (restoration)	4		1	2 (tie)	6 (tie)				1 (tie)
Stocking	5		6		6 (tie)				1 (tie)
Food plots	6		9 (tie)		3 (tie)	3	5		2 (tie)
Regulation of collecting	7		11 (tie)	2 (tie)	2	4	7 (tie)	1 (tie)	6
Translocation to new geographic range	8		3	2 (tie)	6 (tie)				9 (tie)
Public education to reduce human disturbance	9		11 (tie)	2 (tie)	4	6 (tie)	2	3	9 (tie)
Threats reduction	10		8	3	6 (tie)	5		2	8
Exotic/invasive species control	11	2	12 (tie)	2 (tie)	6 (tie)	6 (tie)	3		7
Population enhancement (captive breeding and release)	12		10	2 (tie)	6 (tie)				
Limiting contact with pollutants/contaminants	13		11 (tie)	2 (tie)	5	6 (tie)	7 (tie)	4	9 (tie)
Native predator control	14		9 (tie)	2 (tie)	6 (tie)	6 (tie)	7 (tie)		9 (tie)
Culling/selective removal	15		7		6 (tie)	6 (tie)			9 (tie)
Disease and parasite management	16		12 (tie)		6 (tie)	6 (tie)			4

Table 9. Conservation actions needs for habitats.
Ranked conservation efforts needed for each major habitat type. (See Appendix E-1 to E-78 for responses to sub-habitat expert questionnaires).

Conservation Action	All habitats combined	Agriculture	Aquatic systems	Barren lands	Developed lands	Forested lands	Grasslands	Subterranean systems	Wetlands
Habitat protection on public lands	1	1 (tie)	5	2	3 (tie)	3	2	5	1
Cooperative land management agreements (conservation easements)	2		4	3 (tie)	3 (tie)	8	3	2	3
Habitat restoration on public lands	3	1 (tie)	3	3 (tie)	2	4	4	7 (tie)	4
Habitat restoration incentives (financial)	4	2 (tie)	1	3 (tie)	1 (tie)	7 (tie)	1	7 (tie)	9 (tie)
Land use planning	5		9 (tie)	3 (tie)	1 (tie)	2	7	4	6 (tie)
Habitat protection incentives (financial)	6	1 (tie)	6	3 (tie)	1 (tie)	5 (tie)	10	7 (tie)	7 (tie)
Corridor development/protection	7		8	3 (tie)	3 (tie)	5 (tie)	6	7 (tie)	5
Succession control(fire mowing)	8		10	3 (tie)	1 (tie)	5 (tie)	12		2
Habitat restoration through regulation	9	2 (tie)	9 (tie)	3 (tie)	3 (tie)	6	9 (tie)	7 (tie)	8
Restrict public access and distribution	10		7 (tie)	1	5 (tie)	7 (tie)	8	3	11
Protection of adjacent buffer zone	11		2	3 (tie)	4 (tie)	9 (tie)	13 (tie)	7 (tie)	6 (tie)
Artificial habitat creation (artificial reefs, nesting platforms)	12	2 (tie)	11		1 (tie)		13 (tie)	7 (tie)	7 (tie)
Habitat protection through regulation	13	1 (tie)	12		5 (tie)	7 (tie)	11	6	10
Technical assistance	14		13	3 (tie)	5 (tie)	9 (tie)	9 (tie)	1	12
Selective use of functionally equivalent exotic species in place of extirpated natives	15		14		7	1	5		13
Managing water regimes	16		7 (tie)		4 (tie)	9 (tie)	13 (tie)	7 (tie)	9 (tie)
Pollution reduction	17		7 (tie)	3 (tie)	6	9 (tie)	13 (tie)	7 (tie)	14

B. Indiana's Priority Conservation Actions

Early guidance regarding the development of state strategies stressed that these were not intended to "belong to" or "to provide guidance only to" the state fish and wildlife agency. Rather, the state's CWS was to be a blueprint for **all** engaged in conservation in the state. Whereas, inclusiveness provides the opportunity for collaboration, coordination, synergy and other obviously desirable traits that improve efficiency of effort; inclusiveness also presented challenges. In Indiana, government agencies, conservation organizations, and individuals have been working independently, for well over a century. A great deal of conservation work was accomplished in the absence of a CWS or other statewide multi-group plan. However, a great deal more remains to be done and endangered species concerns have increase the sense of urgency. Therefore, in keeping with modern effective management tenets, Congress required states to provide for broad public participation in the development and implementation of their CWS. To successfully complete this mandate Indiana had to employ an approach suitable to the state's culture and environmental conditions. Therefore, the Indiana DFW endeavored to develop an inclusive-CWS that valued and made room for the efforts of all conservation groups, and facilitated the positive aspects of inclusion.

During the development of this CWS the Indiana DFW sought information on the distribution, abundance, threats, and appropriate conservation actions for all wildlife and habitats from qualified experts working for conservation organizations, universities and federal and state agencies, including DFW staff. The expertise, perspectives and preferences of all participants were treated equally to promote ownership by all. Overall the Indiana DFW seeks to participate through the same avenues available to partners in both the development and implementation of Indiana's CWS, fundamentally employing a leadership by example approach.

Threats and conservation actions presented in the following habitat sections are based on the expert input described above; but, have been expanded by the DFW to make them more useful for all potential conservation partners. Priority Conservation Actions by habitat and SGCN are the result of an analysis and synthesis of expert questionnaire presented Tables 8 and 9. The actions have been expanded by providing specific examples (implementation guidance) to facilitate implementation and evaluation of Indiana's CWS.

<u>Characteristics of the Indiana CWS:</u>

- **The Habitat Approach:** The IN CWS focuses on habitat conservation to conserve all species and to address Indiana's highly modified, fragmented landscape and minimal amount of public lands.

- **Comprehensive:** The IN CWS was developed in consideration of all species (guilds and representative species approach) and to include all potential partners. It provides a way to identify and minimize management conflicts, especially those detrimental to the conservation of SGCN. The CWS also supports and disseminates a management system that includes inventory and evaluation.

- **Adaptive:** Activities supported by the IN CWS (see below) allow the conservation actions to be reviewed and evaluated to provide a basis for adaptive modification of conservation actions to achieve conservation of SGCN.

Conservation Actions supported by the CWS:

- **Survey and Monitoring:** Species monitoring is required to support the inventory stage of the planning cycle, to determine species status and to provide for adaptive management, especially the monitoring of SGCN. Therefore, SGCN will be monitored by standard/traditional means, development of new protocols for species currently not adequately surveyed or by the implementation of acceptable regional, national, or multi-state protocols. Habitat monitoring also supports the inventory stage of the planning cycle. Monitoring of habitats will be required to determine if appropriate habitats are available in the quantity, quality and distribution needed for sustaining populations of SGCN.

- **Research**: Scientifically valid information regarding a species' natural history, ecological relationships, physiology, behavior and/or responses to population or habitat management is required to adequately conserve species or the habitat upon which they depend. As critical information gaps are identified for SGCN or their habitats appropriate and adequate studies will be conducted.

- **Land Acquisition:** SGCN can be limited by available appropriate habitats (breeding, feeding/foraging, resting, migratory/stopover). Protection of appropriate habitat for SGCN will occur via fee simple acquisition, conservation easements, cooperative agreements and habitat management assistance programs.

- **Technical Assistance:** Public support is critical to the conservation of SGCN. Agency staff and other appropriate professionals will respond to a variety of queries from the public, NGO's and other entities to encourage support for conservation. Best Management Practices for the conservation of specific SGCN and/or their habitat will also be developed and distributed.

- **Coordination:** Coordination and communication between conservation stakeholders ensures: partners minimize working at cross-purposes, partnership opportunities (such as leveraging funds) are maximized, and appropriate new techniques and relevant information is applied. Development and implementation of the Action Plan will facilitate communication and provide a forum for partners to share resource planning and evaluation of conservation actions to benefit SGCN.

- **Population Management:** Populations of SGCN require protection from threats and efforts to increase their numbers and distribution to achieve improved security. Population management activities to remove threats to SGCN (control exotic competitors, control excessive predators, monitor/control disease) and restore or augment populations as appropriate, will be employed to promote the development of secure self-sustaining populations of SGCN.

- **Habitat Management:** The quality, quantity and security of habitat required by SGCN is decreasing. Management for these species often requires creating and/or maintaining specific habitat conditions, (e.g. vegetation succession control, water level control, corridor development) and the control of exotic plant and animal species

Implementation Guidance

The following sections are organized by habitat focus areas and include the habitat definitions. The possible threats as determined by the technical experts to the SGCN and their habitats are listed. Indiana's priority conservation actions and implementation guidance are presented for both the SCGN and their habitats.

Agriculture

Lands devoted to commodity production, including intensively managed nonnative grasses, row crops, fruit and nut-bearing trees. Nearly 55% of Indiana is agriculture.

Species of Greatest Conservation Need (SGCN) in Agriculture

Crawfish Frog
Eastern Spadefoot
Northern Leopard Frog
Plain's Leopard Frog
Barn Owl
Sandhill Crane
Ornate Box Turtle

Threats to Agriculture

- Habitat fragmentation
- Habitat degradation
- Commercial or residential development (sprawl)
- Agricultural/forestry practices
- Successional change
- Mining/acidification
- Drainage practices (stormwater runoff)
- Invasive/non-native species
- Counterproductive financial incentives or regulations
- Point source pollution (continuing)

Threats to SGCN in Agriculture

- Habitat loss (breeding range)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Habitat loss (feeding/foraging areas)
- Predators (native or domesticated)
- Invasive/non-native species
- Bioaccumulation of contaminants
- Small native range (high endemism)
- Near limits of natural geographic range
- High sensitivity to pollution
- Dependence on other species (mutualism, pollinators)

High Priority Conservation Actions for Agriculture

- Habitat protection through regulation
    - Work with the State Chemist Office and others to develop herbicide and pesticide label directions that are protective of SGCN.
    - Support compliance with all state and federal environmental regulations relative to agricultural lands.

- Habitat protection on public lands
  - Support the use of agricultural/environmental BMPs on public lands to support the conservation of SGCN as a demonstration for private agricultural interest.
  - Ensure herbicides and pesticides are applied according to label directions and that aquatic environments are not contaminated for the benefit of all amphibians and the species that depend upon them.
- Habitat restoration on public lands
  - Encourage the use of restoration programs such as Farm Bill programs on public agricultural lands.
- Habitat protection incentives (financial)
  - Support programs and practices, such as the Farm Bill Programs, that promote the use of soil and wildlife conservation BMPs for the benefit of SGCN.
- Habitat restoration incentives (financial)
  - Promote programs to encourage diversified agriculture especially pasture, hayfields, and idle areas to benefit barn owls and other grassland birds.
  - Discourage fall tilling of row-crop fields in order to provide fall and winter foods (waste grain, weed seeds) for sandhill cranes and other wildlife species.
- Artificial habitat creation (artificial reefs, nesting platforms)
  - Support the creation and protection of riparian habitat and vernal pools for the crawfish frog, eastern spadefoot toad northern leopard frog and the plains leopard frog. The crawfish frog, eastern spadefoot toad, northern leopard frog, and plains leopard frog could be conserved in this environment by protecting vernal pools and riparian corridors. Additionally amphibian species can be better conserved if herbicides and pesticides are applied in the correct doses and not allowed to enter nearby aquatic environments.
  - Re-vegetate sandy hills near farm land with native grasses to provide hibernation sites and refugeia from farm equipment for ornate box turtles
  - Provide nest boxes in areas with adequate grasslands to encourage nesting by barn owls and American kestrels.
- Cooperative land management agreements (conservation easements).
  - Promote the use of conservation easements to provide for the protection of significant habitat types patches or corridors (riparian, wetland, travel corridors, etc) in farm lands for all SGCN.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Agriculture</u>

- Habitat Protection
  - Provide technical support to rural planning efforts to retain wildlife values of rural landscapes.
- Exotic/invasive species control
  - Work with the agricultural industry to avoid and minimize the use and spread of exotic invasive species to conserve more natural habitats for SGCN.
- Adaptive Management

- Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Aquatic Systems

This habitat is comprised of all water, both flowing and stationary, habitats in Indiana. The habitat encompasses the following sub-types: Dunes and Shorelines; Impoundments, Kettle Lakes, Lake Michigan, Natural Lakes, Oxbows/Backwaters/Sloughs/Embayments; Rivers and Streams; Rivers and Streams Great Lakes Drainage Great River; Rivers and Streams Great Lakes Drainage Headwater; Rivers and Streams Great Lakes Drainage Wadeable/Larger River; Rivers and Streams Kankakee River (Illinois River) Drainage Headwater; Rivers and Streams Kankakee River (Illinois River) Drainage Wadeable/Larger River; Rivers and Stream Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Headwater; Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River; Rivers and Stream Ohio River Drainage Great River; Rivers and Streams Ohio River Drainage Interior River Lowland Headwater and Rivers and Streams Ohio River Drainage Interior River Lowland Wadeable/Large River (see definitions in Appendix A). Only 2.36 % of Indiana is covered by aquatic systems.

Species of Greatest Conservation Need (SGCN) in Aquatic Systems

Blue-spotted Salamander
Four-toed Salamander
Hellbender
Common Mudpuppy
Plains Leopard Frog
Bald Eagle
Black Tern
Least Tern
Osprey
Peregrine Falcon
Piping Plover
Trumpeter Swan
Banded Pygmy Sunfish
Bantam Sunfish
Bigmouth Shiner
Channel Darter
Cisco (Lake Herring)
Cypress Darter
Gilt Darter
Greater Redhorse
Lake Sturgeon
Lake Whitefish
Longnose Dace
Longnose Sucker
Northern Brook Lamprey
Northern Madtom
Ohio River Muskellunge
Pallid Shiner
Pugnose Shiner
Redside Dace
Slimy Sculpin
Spotted Darter
Tippecanoe Darter
Trout-perch
Variegate Darter
Western Sand Darter
River Otter
Clubshell
Ellipse
Fanshell
Fat Pocketbook
Kidneyshell
Little Spectaclecase
Longsolid
Northern Riffleshell
Ohio Pigtoe
Orangefoot Pimpleback
Pink Mucket
Pointed Campeloma
Purple Lilliput
Pyramid Pigtoe
Rabbitsfoot
Rayed Bean
Rough Pigtoe
Round Hickorynut
Salamander Mussel
Sheepnose
Snuffbox

Swamp Lymnaea
Tubercled Blossom
Wavyrayed Lampmussel
White Catspaw
White Wartyback
Alligator Snapping Turtle
Blanding's Turtle
Copperbelly Water Snake
Cottonmouth
Eastern Mud Turtle
Hieroglyphic River Cooter
Spotted Turtle

Threats to Aquatic Systems

- Stream channelization
- Habitat degradation
- Nonpoint source pollution (sedimentation and nutrients)
- Agricultural/forestry practices
- Commercial or residential development (sprawl)
- Point source pollution (continuing)
- Drainage practices (stormwater runoff)
- Habitat fragmentation
- Impoundment of water/flow regulation
- Residual contamination (persistent toxins)

Threats to SGCN in Aquatic Systems

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- High sensitivity to pollution
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Specialized reproductive behavior or low reproductive rates
- Invasive/non-native species
- Bioaccumulation of contaminants
- Viable reproductive population size or availability
- Predators (native or domesticated)

High Priority Conservation Actions for Aquatic Systems

- Habitat restoration incentives (financial)
    - Promote the retention and development of sloughs, oxbows, and backwater habitats to benefit the banded pygmy sunfish, bantam sunfish and cypress darter in the lower Wabash River drainage.
- Protection of adjacent buffer zone
    - Promote the establishment and maintenance of buffers on all aquatic systems to control sedimentation and to benefit aquatic SGCN, especially the blue spotted salamander, four-toed salamander, and plains leopard frog, ellipse, swamp lymnaea, bigmouth shiner and pallid shiner.
    - Provide grassy, shrubby, and/or woody riparian cover along rivers and streams for resting, denning, and loafing sites for otters.
- Habitat restoration on public lands

  - Create nesting islands for least terns in appropriate areas.
  - Restore wetland habitats in floodplain areas to provide alternative habitats for aquatic species. Target wetlands in close proximity to rivers & streams.
- Cooperative land management agreements (conservation easements)
  - Promote the protection of aquatic systems for SGCN by encouraging public and private entities to enter into cooperative land management agreements and conservation easements. Provide technical assistance on the species that benefit from such protection and potential enhancement measures.
- Habitat protection on public lands
  - Protect nesting and foraging areas from human disturbance in order to ensure successful nesting and foraging by bald eagles, osprey, peregrine falcons, least terns, black terns, and piping plovers (potential).
  - Conserve existing riparian cover along rivers & streams to provide habitat for otters.
- Habitat protection incentives (financial)
  - Provide technical assistance and support the use of state, federal and private incentive programs to protect aquatic habitat for the benefit of SGCN.
- Managing water regimes
  - Ensure appropriate water regime targets are selected in manipulated headwater streams, especially headwater streams occupied by redside dace.
- Pollution reduction
  - Work with state, federal and private partners to reduce point and non-point source pollution in aquatic systems to maintain and increase the distribution of the fat pocketbook, western sand darter, northern madtom and channel darter populations in the lower Wabash, White and Ohio Rivers where they are now confined.
  - Maintain healthy fish and aquatic invertebrate populations with low contaminant loads in order to provide food for bald eagles, osprey, least terns, black terns, piping plovers, trumpeter swans, and other aquatic birds and species that prey on aquatic systems dependent birds such as peregrine falcons and bald eagles.
  - Develop/support programs that reduce input of heavy metals, PCBs, and related contaminants into aquatic systems to benefit river otters and other SGCN.
- Restrict public access and disturbance
  - Develop and distribute BMPs relative to avoiding and minimizing disturbance to reptile hibernating areas (backwaters, small pools and shallow inlets to lakes and rivers) to promote the conservation of SGCN found in aquatic systems.
  - Protect nesting and foraging areas from human disturbance in order to ensure successful nesting and foraging by bald eagles, osprey, peregrine falcons, least terns, black terns, and piping plovers (potential).
- Corridor development/protection
  - Promote the development and adoption of BMPs to protect aquatic systems shorelines and riparian corridors to minimize eutrophication to benefit pointed campeloma populations and other SGCN.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

High Priority Conservation Actions for SGCN in Aquatic Systems

- Reintroduction (restoration)
  - Support the development and implementation of practical mussel restoration and evaluation techniques for use in appropriate situations for the restoration of extirpated or nearly extirpated mussel species i.e. longsolid, orangefoot pimpleback, pink mucket, pyramid pigtoe, rough pigtoe, tubercled blossom, white catspaw and white wartyback
  - Monitor the abundance and distribution of newly restored aquatic system dependent species such as the river otter and osprey.
- Population management
  - Determine factors affecting the distribution and relative abundance of rare aquatic-based wildlife such as the river otter.
  - Refine and improve survey and monitoring programs for aquatic wildlife species such as river otters, mussels species and osprey..
  - Implement harvest strategies (season dates, trap set techniques, etc) to maximize take of targeted species and minimize unintentional take of otters.
  - Determine age-specific reproductive parameters for river otters and mussel species.
- Translocation to new geographic range
  - Support the development of technical assistance materials to heighten public awareness of the dangers of releasing aquatic species in new geographical areas (even SGCN).
  - Track shifts in species geographic range for correlation to global warming trends and new ecological relationships.
- Protection of migration routes
  - Protect shoreline areas from high human use along Lake Michigan for migrating piping plovers.
  - Secure and appropriately manage sufficient aquatic areas to provide for the needs of self-sustaining populations of migrating birds.
- Habitat protection
  - Support programs that promote clean water and maintenance of a diverse aquatic ecosystem for the benefit of reptile and amphibian SGCN.
  - Identify and secure critical spawning grounds for greater redhorse, lake sturgeon, northern brook lamprey and Tippecanoe darter to ensure maintenance of self-sustaining populations.
  - Develop and/or support programs that restore/maintain riparian cover along rivers and streams for the benefit of mussels and other aquatic SGCN.
- Culling/selective removal
  - Monitor the health of hellbenders and other aquatic SGCN and evaluate the use of selective removal of infected individuals to control the spread of contagious disease.
- Threats reduction
  - Cooperate with other programs to evaluate threats (contamination, gravel mining, dams, etc) to aquatic systems and provide information on impacts to SGCN.
- Native predator control

    - Evaluate the use of muskrat and raccoon control in sensitive areas (where populations of SGCN are known to occur) to promote the survival and reproduction of SGCN, especially nesting turtles and mussels.
    - Employ effective and appropriate predator deterrents in near least tern nesting colonies and similar vulnerable concentrations of SGCN.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Wadeable/Large Rivers in the Eastern Cornbelt/Interior Plateau Ecoregions of the Ohio River Drainage (Ohio River/E.C.-I.P)

Streams of the Ohio River drainage, Eastern Corn Belt ecoregion are found in central and east-central Indiana; Interior Plateau ecoregion streams are found in south-central and southeastern Indiana. Wadeable/large rivers are those having a drainage area of > 19 < 2,000 mi^2. The streams of the Eastern Corn Belt ecoregion are highly influenced by the extensive agriculture that dominates the ecoregion. The Interior Plateau ecoregion includes Indiana's karst region and the most rugged terrain of Indiana.

Species of Greatest Conservation Need (SGCN) in Ohio River/E.C.-I.P

Hellbender
Gilt Darter
Ohio River Muskellunge
Spotted Darter
Variegate Darter
Clubshell
Kidneyshell
Little Spectaclecase
Northern Riffleshell
Purple Lilliput
Rabbitsfoot
Rayed Bean
Round Hickorynut
Salamander Mussel
Sheepnose
Snuffbox
Wavyrayed Lampmussel

Threats to Ohio River/E.C.-I.P

- Stream channelization
- Habitat degradation
- Point source pollution (continuing)
- Nonpoint source pollution (sedimentation and nutrients)
- Agricultural/forestry practices
- Drainage practices (stormwater runoff)
- Habitat fragmentation
- Commercial or residential development (sprawl)
- Counterproductive financial incentives or regulations
- Impoundment of water/flow regulation

Threats to SGCN in Ohio River/E.C.-I.P

- High sensitivity to pollution
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Invasive/non-native species
- Specialized reproductive behavior or low reproductive rates
- Viable reproductive population size or availability
- Predators (native or domesticated)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

- Bioaccumulation of contaminants

High Priority Conservation Actions for Ohio River/E.C.-I.P

- Protection of adjacent buffer zone
  - Promote all public and private initiatives that support the development and maintenance of vegetative (native vegetation) drainage paths and riparian corridors to maintain the ecological heath and ecological function of Ohio River/E.C.-I.P. streams.
- Pollution reduction
  - Develop and/or distribute BMPs that target pollution reduction to protect Ohio River/E.C.-I.P. aquatic systems that support or could support kidneyshell, little spectaclecase, purple lilliput, rayed bean mussels and wavyrayed lampmussel
- Corridor development/protection
  - Promote the establishment and protection of vegetated (native vegetation) riparian corridors for all Ohio River/E.C.-I.P. streams to provide suitable habitat for SGCN.
- Habitat restoration incentives (financial)
  - Support the implementation of existing and the development of new financial incentive programs that promote the use of BMPs for restoration of drainage paths in the Ohio River E.C.-I.P. aquatic systems to provide quality habitat for SGCN dependant on this system.
- Habitat protection incentives (financial)
  - Support the implementation of existing and the development of new financial incentive programs that promote the use of BMPs to protection drainage paths in the Ohio River E.C.-I.P.
- Habitat protection through regulation
  - Provide technical assistance (relative to the distribution, life history and ecology of SGCN and their habitat) to regulatory agencies that administer laws and rules to protect habitat.
- Habitat restoration through regulation
  - Provide technical assistance (relative to the habitat requirements of SGCN) to regulatory agencies that administer laws and rules that seek to avoid, minimize and mitigate habitat loss.
- Habitat restoration on public lands
  - Employ BMPs and develop new techniques for the restoration of Ohio River /E.C.-I.P. aquatic systems on public lands. Provide demonstration technical assistance opportunities to the public to promote restoration in other areas.
- Habitat protection on public lands
  - Employ BMPs and develop new techniques for the protection of Ohio River /E.C.-I.P. aquatic systems on public lands. Provide demonstration technical assistance opportunities to the public to promote protection in other areas
- Artificial habitat creation (artificial reefs, nesting platforms)
  - Create or protect nesting islands for least terns in appropriate areas.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

High Priority Conservation Actions for SGCN in Ohio River/E.C.-I.P

- Reintroduction (restoration)
  - Coordinate with multi-state efforts to develop and implement restoration protocols for the northern riffleshell mussel. (This may be the only viable method of reestablishing this species now thought to be extirpated.)
  - Provide for the evaluation of reintroduction efforts for any SGCN.
- Habitat protection
  - Cooperate with all ongoing efforts to protect the Blue River from all threats (impoundment, siltation, point source and non-point source pollution, etc) for the benefit of the hellbender and other SGCN.
  - Promote the protection of clean, rocky riffles that are currently inhabited by gilt, spotted and variegate darters to help maintain their populations.
- Limiting contact with pollutants/contaminants
  - Maintain up-to-date, accurate records of the location of SGCN to use to avoid and minimize the placement of high risk facilities near sensitive populations.
- Translocation to new geographic range
  - Investigate the impact of impoundments on the distribution of species and determine the feasibility/necessity of recreating ecological assemblages in appropriate areas.
- Population management
  - Investigate regulatory processes for protecting the Ohio River muskellunge from take in its native range to support self-sustaining populations of this SGCN
- Population enhancement (captive breeding and release)
  - Support the development and implementation of practical mussel restoration and evaluation techniques for use in appropriate situations for the restoration of clubshell, rabbitsfoot, round hickorynut, sheepnose and snuffbox, mussel and other mussel species that have very limited distribution in Indiana.
  - Support the long-term evaluation of population enhancement activities.
- Threats reduction
  - Cooperate and support efforts to identify and minimize chemical and physical alteration threats to Ohio River /E.C.-I.P. aquatic systems. Provide technical assistance to help avoid or minimize detrimental impacts to SGCN.
- Exotic/invasive species control
  - Cooperate with and provide technical assistance to the Aquatic Nuisance Species Program in the detection of invasive, exotic species, species control and control measure evaluation aspects of the program
- Regulation of collecting
  - Investigate the relationship between mudpuppy harvest and salamander mussel population viability to determine if harvest regulation might be warranted to protect the SGCN mussel.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Lake Michigan

Lake Michigan is Indiana's largest natural lake, although Indiana can only lay claim to about 1% (224 mi2) of its area and only 45 miles of its shoreline. The southern tip of Lake Michigan forms Indiana's extreme northwest border. Ecology of the lake is ruled by the massive amount of offshore, deep, cold water, wind seiches, and newly introduced exotic species including near shore developments and input from tributaries.

Species of Greatest Conservation Need (SGCN) in Lake Michigan

Peregrine Falcon
Lake Whitefish
Longnose Dace
Longnose Sucker
Slimy Sculpin
Trout-perch

Threats to Lake Michigan

- Invasive/non-native species
- Residual contamination (persistent toxins)
- Nonpoint source pollution (sedimentation and nutrients)
- Habitat degradation
- Habitat fragmentation
- Point source pollution (continuing)
- Drainage practices (stormwater runoff)
- Climate change

Threats to SGCN in Lake Michigan

- Invasive/non-native species
- Viable reproductive population size or availability
- Specialized reproductive behavior or low reproductive rates
- Predators (native or domesticated)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Bioaccumulation of contaminants
- Diseases/parasites (of the species itself)
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, bycatch, harvesting equipment, land preparation machinery)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

High Priority Conservation Actions for Lake Michigan

- Artificial habitat creation (artificial reefs, nesting platforms)
    - Erect and maintain nesting boxes for peregrine falcons at industrial areas along Lake Michigan.
- Habitat protection through regulation

    - Investigate threats to Lake Michigan aquatic habitat and provide technical assistance to regulatory agencies to encourage regulatory relief from those threats or to develop protective regulatory measures.
- Technical assistance
    - Provide technical assistance to industrial landowners, planning commissions, regulatory agencies and others responsible for land management, protection or remediation on the shore and near shore area of Lake Michigan for the protection of SGCN.
- Habitat restoration through regulation
    - Promote the use of drainage maintenance BMPs and the use of native species in the restoration of the habitat of the near shore and Indiana portions of Lake Michigan for the benefit of longnose dace, slimy sculpin and trout-perch populations.
- Land use planning
    - Provide technical assistance to city, county and regional planners and others regarding the ecological needs and requirements of SGCN in the Lake Michigan to promote the conservation of SGCN.
- Pollution reduction
    - Reduce contaminant loads in birds fed upon by resident and migratory peregrine falcons along Lake Michigan. Encourage avian control operators to utilize methods that will minimize secondary poisoning threats to peregrine falcons and other raptors.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Lake Michigan</u>

- Habitat protection
    - Cooperate with all local land owners, land trust and government agencies to secure (acquisition, easements, and cooperate agreements) to protect habitat in and on the near shore of the Indiana portion of Lake Michigan
- Population management
    - Investigate and employ as appropriate all animal and plant population management (i.e. deer hunting, exotic control, etc.) techniques that promote the maintenance of native biological diversity in and on the near shore of the Indiana portion of Lake Michigan.
- Threats reduction
    - Investigate threats and limiting factors affecting SGCN in and on the near shore of the Indiana portion of Lake Michigan
- Regulation of collecting
    - Examine reports submitted by holders of the state's Scientific Purposes License to detect changes in the distribution of lake whitefish, longnose dace, longnose sucker, slimy sculpin and trout perch. Adjust limits and capture techniques as warranted to protect SGCN.
- Public education to reduce human disturbance
    - Make site managers aware of peregrine falcon nesting needs and breeding timelines and encourage adaptive measures to support falcon nest success.

- Population enhancement (captive breeding and release)
    - Cooperate with Lake Michigan and Great Lake's fishery initiatives that promote a healthy Lake Michigan ecosystem including self sustaining populations of all native species.
- Disease/parasite management
    - Support efforts to prevent the release of exotic pathogens and parasites from international shipping.
    - Provide technical assistance to the public and community leaders regarding all aspects of disease/parasite introduction, spread and control to foster the support of an informed citizenry.
- Limiting contact with pollutants/contaminants
    - Promote and support programs that limit pollution/contaminants release and remediate contaminated areas impacting Lake Michigan to enhance lake whitefish and longnose sucker populations.
    - Support programs to reduce contaminant loads in birds fed upon by resident and migratory peregrine falcons along Lake Michigan. Encourage avian control operators to utilize methods that will minimize secondary poisoning threats to peregrine falcons and other raptors.
- Stocking
    - Support evaluation of all intentional and unintentional plant and animal stockings in Lake Michigan to determine the impact on native biological diversity and the maintenance of self-sustaining populations of native species.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Natural Lakes

Eighteen counties in northern Indiana contain natural lakes, although Kosciusko, Lagrange, Noble and Steuben counties contain nearly 70% of the total surface acreage. Natural lakes vary widely in habitat and eutrophication. Less fertile lakes tend to be deep and well oxygenated with marl or sandy substrates. More fertile lakes tend to be shallow with muck bottoms and dense stands of aquatic vegetation.

Species of Greatest Conservation Need (SGCN) in Natural Lakes

Pugnose Shiner
Cisco (Lake Herring)

Threats to Natural Lakes

- Habitat degradation
- Commercial or residential development (sprawl)
- Nonpoint source pollution (sedimentation and nutrients)
- Agricultural/forestry practices
- Drainage practices (stormwater runoff)
- Successional change
- Stream channelization
- Habitat fragmentation
- Invasive/non-native species
- Point source pollution (continuing)

Threats to SGCN in Natural Lakes

- High sensitivity to pollution
- Habitat loss (feeding/foraging areas)
- Viable reproductive population size or availability
- Specialized reproductive behavior or low reproductive rates
- Habitat loss (breeding range)
- Near limits of natural geographic range
- Predators (native or domesticated)
- Small native range (high endemism)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
- Dependence on irregular resources (cyclical annual variations) (e.g. food, water, habitat limited due to annual variations in availability

High Priority Conservation Actions for Natural Lakes

- Habitat protection through regulation
    - Support the implementation of environmental BMPs and regulations to prevent eutrophication of Indiana's natural lakes for the conservation of pugnose shiner and cisco.
- Pollution reduction

    - Promote the implementation of BMPs to decrease the rate of eutrophication in Indiana's natural lakes to help maintain pugnose shiner and cisco populations
- Protection of adjacent buffer zone
    - Cooperate with partners to protect (acquisition, easements, BMPs, etc.) the watersheds, wetlands and upland areas associated with Indiana natural lakes to protect provide quality habitat for the pugnose shiner and cisco.
- Land use planning
    - Provide technical assistance to lake associations and work with other government programs (e.g. Lake and River Enhancement Program) and encourage land uses that protect the Indiana's natural lakes
- Habitat protection on public lands
    - Employ BMPs and watershed protection measures on public lands within the watershed of a natural lake for the benefit of SGCN, especially the pugnose shiner and cisco.
- Habitat restoration through regulation
    - Promote the use of native vegetation, wetland development and watershed protection practices to benefit SCGN in Natural lakes on projects conducted under state permit or receiving public funds.
- Cooperative land management agreements (conservation easements)
    - Develop cooperative agreements with landowners in natural lake watersheds for the protection of natural lake habitat for SGCN.
- Habitat protection incentives (financial)
    - Support cost-share programs that provide financial incentives for the protection of natural lake shorelines and watersheds for the benefit of SGCN.
- Habitat restoration incentives (financial)
    - Provide technical assistance to partners provide financial incentives for the restoration of natural lake habitat features for the benefit of pugnose shiner and cisco.
- Habitat restoration on public lands
    - Restore degraded wetlands, control exotic vegetation and re-vegetate eroded areas (with appropriate native plants) on public lands within natural lake watersheds and provide demonstration sites for these BMPs.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Natural Lakes</u>

- Habitat protection
    - Employ technical assistance, land protection measures and support regulations to protect natural lake habitat for the benefit of SGCN.
- Threats reduction
    - Investigate threats to the pugnose shiner and cisco to determine priority actions in the conservation of these species.
- Exotic/invasive species control
    - Support the development and implementation of measures to control exotic/invasive species at natural lakes (e.g. the release of beetles to control purple loosestrife) to provide a higher quality habitat for SGCN.

- Population management
    - Investigate the impacts to cisco from predatory fish management.
    - Investigate the impacts of fishing on cisco.
- Public education to reduce human disturbance
    - Support the work of the Lake Management Work Group in the development of sustainable use of natural lakes.
- Population enhancement (captive breeding and release)
    - Investigate the feasibility of population augmentation for pugnose shiner and cisco.
- Reintroduction (restoration)
    - Investigate the feasibility of restoring cisco and pugnose to natural lakes from which they have been extirpated.
- Regulation of collecting
    - Support fishing regulations that limit the accidental take of cisco and pugnose shiner.
- Disease/parasite management
    - Monitor populations of pugnose shiner and cisco to detect disease/parasite incidence.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Barren Lands

All barren lands habitats are characterized by bare rock, gravel, sand, silt, clay or other earthen material, with little or no "green" vegetation present, regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive. The habitat encompasses the following sub-types: bare dunes, cliffs, rock outcrops and active quarries (see definitions in Appendix A). Only 0.19% of Indiana is barren land.

Species of Greatest Conservation Need (SGCN) in Barren Lands

Crawfish Frog
Green Salamander
Plains Leopard Frog
Piping Plover
Allegheny Woodrat

Threats to Barren Lands

- Habitat degradation
- Counterproductive financial incentives or regulations
- Habitat fragmentation
- Invasive/non-native species
- Commercial or residential development (sprawl)
- Agricultural/forestry practices
- Successional change
- Nonpoint source pollution (sedimentation and nutrients)
- Point source pollution (continuing)
- Drainage practices (storm water runoff)

Threats to SGCN in Barren Lands

- Viable reproductive population size or availability
- Diseases/parasites (of the species itself)
- Habitat loss (feeding/foraging areas)
- Habitat loss (breeding range)
- Near limits of natural geographic range
- Small native range (high endemism)
- 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)
- Invasive/non-native species

High Priority Conservation Actions for Barren Lands

- Restrict public access and disturbance
  - Minimize human and domestic pet use in areas used by foraging piping plovers and at sites with potential breeding habitat.
- Habitat protection on public lands
  - Protect Lake Michigan sand dunes and allow natural dune processes to provide foraging areas and potential nesting habitat for piping plovers
  - Maintain large diameter, mast-producing tree species in proximity to woodrat colonies.
  - Enter into cooperative agreements for management of woodrat habitats on State Forest and State Park properties.
  - Investigate crayfish abundance and distribution and other factors impacting crayfish frog colonies to develop land management practices for crayfish frogs.
- Protection of adjacent buffer zone
  - Provide for the development and/or maintenance of a forested buffer area around the bluffs occupied or suitable for occupancy by Green salamanders.
  - Provide buffer of mature forested habitats adjacent to cliff lines containing woodrat colonies.
- Habitat protection through regulation
  - Develop and encourage the implementation of BMPs to avoid and minimize adverse impacts to barren lands, especially dunes, bluffs, cliffs, and rock outcrops for the benefit of green salamanders, piping plover, and Allegheny woodrat.
- Habitat restoration on public lands
  - Promote the development of moist prairies areas, and vernal pools on suitable public lands; maintain these areas with limited disturbance in the spring and early summer for the benefit of crawfish frogs and plains leopard frogs.
  - Implement silvicultural practices that promote oak-hickory component to provide hard mast for forest-dependent wildlife such as the Allegheny woodrat.
- Habitat restoration incentives (financial)
  - Enroll private properties that harbor woodrat colonies into the Classified Forest Program; develop management plans for woodrat habitats at privately-owned colony sites.
- Succession control (fire, mowing)
  - Prevent and eliminate woody encroachment into sparsely vegetated clay soil areas to benefit the crawfish frog.
- Corridor development/protection
  - Investigate the dispersal characteristics of the crawfish frog, green salamander, plains leopard frog, and Allegheny woodrat to assess available dispersal habitat and barriers to dispersal.
- Land use planning
  - Work with local and county municipalities for identification, protection, and management of crawfish frog, green salamander, plains leopard frog, piping plover and Allegheny woodrat habitats.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

High Priority Conservation Actions for SGCN in Barren Lands

- Habitat protection
  - Protect Lake Michigan sand dunes and allow natural dune processes to provide foraging areas and potential nesting habitat for piping plovers.
  - Ensure silvicultural techniques allow for an adequate annual supply of hard mast for Allegheny woodrats.
  - Protect bluff lines and sparsely vegetated clay and sandy moist soil for the green salamander, crawfish frog and plains leopard frog respectively.
- Regulation of collecting
  - Investigate the role of intentional and/or un-intentional take on the viability of SGCN in barren lands.
- Reintroduction (restoration)
  - Identify limiting factors for Allegheny woodrats.
  - Determine distribution and relative abundance of rare species using barren lands such as the Allegheny woodrat, crawfish frog, plains leopard frog, and green salamander.
  - Identify sites suitable for woodrat reintroductions within historic range.
- Threats reduction
  - Reduce raccoon populations in proximity to woodrat colonies to decrease the threat to woodrats from the raccoon roundworm.
  - Provide technical assistance to land use planners stressing the importance of undeveloped barren lands for crawfish frogs, green salamanders, plains leopard frog, piping plover and Allegheny woodrats.
- Native predator control
  - Discourage gull use of dunes at sites with potential breeding habitat for piping plovers.
  - Reduce raccoon populations in proximity to woodrat colonies.
- Exotic/invasive species control
  - Eliminate and/or control exotic invasive plant species (e.g., Tree of Heaven, garlic mustard) on cliff lines occupied by Allegheny woodrats and green salamander. Encourage retention and planting of native species that provide both soft and hard mast as food for woodrats.
- Translocation to new geographic range
  - Support the development of technical assistance materials to heighten public awareness of the dangers of releasing species into new geographical areas (even SGCN).
  - Track shifts in the geographic range of barren land SGCN for correlation to global warming trends and new ecological relationships.
- Protection of migration routes
  - Protect Lake Michigan sand dunes and allow natural dune processes to provide foraging areas and potential nesting habitat for piping plovers
- Limiting contact with pollutants/contaminants
  - Investigate the impact of pollutants/contaminants on crayfish frogs.
- Public education to reduce human disturbance
  - Minimize human and domestic pet use in areas used by foraging piping plovers and at sites with potential breeding habitat.

    - Minimize human and domestic pet use in cliff and bluff areas supporting green salamanders and Allegheny woodrats.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Developed Lands

Highly impacted lands, intensively modified to support human habitation, transportation, commerce and recreation. This habitat encompasses the following sub-types: golf courses, industrial lands and roads/rails/bridges (see definitions in Appendix A). Nearly 3.7 % of Indiana is developed.

Species of Greatest Conservation Need (SGCN) in Developed Lands

Eastern Spadefoot
Common Nighthawk
Peregrine Falcon
Kirtland's Snake
Smooth Greensnake

Threats to Developed Lands

- Commercial or residential development (sprawl)
- Habitat degradation
- Stream channelization
- Residual contamination (persistent toxins)
- Counterproductive financial incentives or regulations
- Impoundment of water/flow regulation
- Point source pollution (continuing)
- Drainage practices (stormwater runoff)
- Agricultural/forestry practices
- Habitat fragmentation

Threats to SGCN in Developed Lands

- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
- Diseases/parasites (of the species itself)
- High sensitivity to pollution
- Species overpopulation
- Bioaccumulation of contaminants
- Genetic pollution (hybridization)
- Invasive/non-native species
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Habitat loss (breeding range)
- Predators (native or domesticated)

High Priority Conservation Actions for Developed Lands

- Habitat protection incentives (financial)
    - Encourage the use of gravel on flat-roofed buildings to provide nesting habitat for common nighthawks.

- Habitat restoration incentives (financial)
  - Encourage the use of private funding sources for the development of open spaces in urban environments.
- Artificial habitat creation (artificial reefs, nesting platforms)
  - Erect and maintain nesting boxes for peregrine falcons at industrial areas along Lake Michigan.
- Succession control (fire, mowing)
  - Provide cover for smooth green snakes and eastern spadefoot toads by leaving um-mowed areas during the growing season.
- Land use planning
  - Provide technical assistance to and encourage urban/industrial/transportation/recreation land use planners to provide open spaces, use rock cover and provide connecting corridors for the benefit of SGCN, especially spadefoot toads, Kirtland's snake and smooth greensnake.
- Habitat restoration on public lands
  - Where possible develop and implement BMPs for the benefit of SGCN on the more developed portions of public lands and use the implementation sites as demonstration projects.
- Corridor development/protection
  - Investigate the parameters defining good dispersal corridors for SGCN in developed lands.
- Habitat protection on public lands
  - Develop and implement SGCN habitat friendly development BMPs on public lands, including public golf courses.
- Cooperative land management agreements (conservation easements)
  - Promote the use of cooperative management agreements to provide open spaces, corridors, beneficial landscape features (e.g. natural drainages, rock or stone landscape materials) and native vegetation in developed areas.
- Habitat restoration through regulation
  - Promote the use of native vegetation, natural drainage protection, corridor protection and other landscape features to benefit SCGN in developed lands on projects conducted under state permit or receiving public funds.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Developed Lands</u>

- Protection of migration routes
  - Investigate methods to minimize the adverse impacts of man-made structures on SGCN, especially migrating birds.
- Regulation of collecting
  - Develop technical assistance materials that promote leaving SGCN in the natural environment.
- Population management
  - Investigate the impacts of un-exploited or lightly exploited game species, often found in developed areas (e.g. deer, raccoon, beaver), on SGCN.
- Food plots

    - Develop and provide technical assistance to property managers, grounds keepers, park managers and landscape technicians regarding the use of native plants and landscape feature that attract food for SGCN.
- Habitat protection
    - The reptiles and amphibians that can be found in this habitat type can be conserved through habitat protection. Kirtland's snakes and smooth green snakes can be found in urban environments. However, these species require some undisturbed habitat in order to thrive. By creating protected islands of habitat in those areas where these species occur, you could conserve them in an urban situation. Examples would include creating parks that overlap moist areas and providing protective cover.
    - Minimizing disturbance on areas of sandy soil can protect the eastern spadefoot. By minimizing soil disturbance, this burrowing species can remain in semi-developed areas.
- Public education to reduce human disturbance
    - Make site managers aware of peregrine falcon nesting needs and breeding timelines. Discourage human use of building roofs used by nesting common nighthawks.
- Limiting contact with pollutants/contaminants
    - Reduce contaminant loads in birds fed upon by resident and migratory peregrine falcons along Lake Michigan. Encourage avian control operators to utilize methods that will minimize secondary poisoning threats to peregrine falcons and other raptors.
- Population enhancement (captive breeding and release)
    - Investigate the possibility of using captive breeding and releases to augment populations of SGCN in developed lands.
- Reintroduction (restoration)
    - Continue to support the peregrine falcon restoration by providing technical assistance to facility managers that allow the placement of nest boxes on their properties.
- Threats reduction
    - Investigate threats to SGCN in develop lands.
    - Support the retention of vernal pools and some un-mowed tall grass areas in developed areas to the benefit of eastern spadefoot toads and smooth green snakes.
    - Encourage minimal use of pest-control and lawn chemicals in developed lands, especially those near water to benefit eastern spadefoot toads, Kirtland's snake and the smooth green snake.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Forests

A plant community extending over a large area and dominated by trees, the crowns of which form an unbroken covering layer or canopy. Almost 23% of Indiana is covered by forests. This habitat includes: deciduous, early forest stage, evergreen, floodplain forests, forested wetlands, mature or high canopy stage, old forest stage, pole stage, pre-forest stage, riparian wooded corridors/streams, suburban, upland and urban forests (see definitions in Appendix A).

Species of Greatest Conservation Need (SGCN) in Forests

Blue-spotted Salamander
Four-toed Salamander
Green Salamander
Red Salamander
Bald Eagle
Barn Owl
Black-and-white Warbler
Black-crowned Night-Heron
Broad-winged Hawk
Cerulean Warbler
Common Nighthawk
Golden-winged Warbler
Great Egret
Hooded Warbler
Kirtland's Warbler
Mississippi Kite
Osprey
Red-shouldered Hawk
Sharp-shinned Hawk
Whip-poor-will
Worm-eating Warbler
Yellow-crowned Night-Heron
Allegheny Woodrat
Bobcat
Eastern Pipistrelle
Eastern Red Bat
Evening Bat
Gray Myotis
Hoary Bat
Indiana Myotis
Least Weasel
Little Brown Myotis
Northern Myotis
Pygmy Shrew
Rafinesque's Big-eared Bat
Silver-haired Bat
Smoky Shrew
Southeastern Myotis
Copperbelly Water Snake
Kirtland's Snake
Rough Green Snake
Scarlet Snake
Smooth Green Snake
Southeastern Crowned Snake
Timber Rattlesnake

Threats to Forests

- Commercial or residential development (sprawl)
- Habitat fragmentation
- Habitat degradation
- Agricultural/forestry practices
- Successional change
- Invasive/non-native species
- Counterproductive financial incentives or regulations
- Diseases (of plants that create habitat)
- Mining/acidification
- Stream channelization

Threats to SGCN in Forests

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
- Viable reproductive population size or availability
- Predators (native or domesticated)
- Diseases/parasites (of the species itself)
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, bycatch, harvesting equipment, land preparation machinery)
- Specialized reproductive behavior or low reproductive rates
- Invasive/non-native species
- Small native range (high endemism)

High Priority Conservation Actions for Forests

- Land use planning
    - Maintain or create landscapes dominated by forest in order to provide for needs of area sensitive species such as bald eagle, black-and-white warbler, black-crowned night-heron, broad-winged hawk, cerulean warbler, common nighthawk, hooded warbler, Mississippi kite, red-shouldered hawk, sharp-shinned hawk, whip-poor-will, worm-eating warbler, and yellow-crowned night-heron
    - Work with local units of government for protection and management of forested habitats.
    - Encourage the retention of forested corridors to connect forest blocks for SGCN, especially Indiana bat and timber rattlesnake.
- Habitat protection on public lands
    - Provide technical assistance to management plan development and implementation for state and federal forest properties
- Habitat restoration on public lands
    - Encourage sustainable timber management practices to provide a variety of forest stages for the wide variety of forest-dependent birds, including bald eagle, barn owl, black-and-white warbler, black-crowned night-heron, broad-winged hawk, cerulean warbler, common nighthawk, golden-winged warbler, great egret, hooded warbler, Kirtland's warbler, Mississippi kite, osprey, red-shouldered hawk, sharp-shinned hawk, whip-poor-will, worm-eating warbler, yellow-crowned night-heron
- Succession control (fire, mowing)
    - Encourage sustainable timber management practices to provide a variety of forest stages for the wide variety of forest-dependent birds, including bald eagle, barn owl, black-and-white warbler, black-crowned night-heron, broad-winged hawk, cerulean warbler, common nighthawk, golden-winged warbler, great egret, hooded warbler, Kirtland's warbler, Mississippi kite, osprey, red-shouldered hawk, sharp-shinned hawk, whip-poor-will, worm-eating warbler, yellow-crowned night-heron
- Corridor development/protection
    - Investigate features of functional dispersal corridors in forests that benefit SGCN.

    - Promote development and retention of functional dispersal corridors in forest to benefit SGCN.
- Habitat protection incentives (financial)
    - Encourage sustainable timber management practices to provide a variety of forest stages for the wide variety of forest-dependent birds, including bald eagle, barn owl, black-and-white warbler, black-crowned night-heron, broad-winged hawk, cerulean warbler, common nighthawk, golden-winged warbler, great egret, hooded warbler, Kirtland's warbler, Mississippi kite, osprey, red-shouldered hawk, sharp-shinned hawk, whip-poor-will, worm-eating warbler, yellow-crowned night-heron
    - Support enrollment into state-sponsored forest management programs such as Classified Forest and Classified Wildlife Habitat programs.
    - Provide technical assistance to forest habitat protection incentive programs, such as Farm Bill programs and Forest Legacy.
- Habitat restoration through regulation
    - Promote forest restoration practices that use native trees, protection natural drainage and protection of other landscape features to benefit SCGN in forest restoration projects conducted under state permit or receiving public funds.
- Habitat protection through regulation
    - Provide technical assistance to regulatory agencies protecting forest habitat to benefit SGCN.
- Habitat restoration incentives (financial)
    - Support enrollment into state-sponsored forest management programs such as Classified Forest and Classified Wildlife Habitat programs
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Forests</u>

- Habitat protection
    - Protect forest habitat especially forest in close proximity to wetlands, rocky glades or connecting corridors between forest blocks for copperbelly watersnakes, rough green snakes, scarlet snakes, southeastern crowned snakes and timber rattlesnakes
    - Determine what constitutes high quality foraging and roosting habitat for forest-dwelling bats.
    - Implement silvicultural strategies that provide for a continuous supply of large, dead and/or dying deciduous trees to provide roost sites for crevice-dwelling bats such as the Indiana bat.
- Protection of migration routes
    - Investigate forest distribution in Indiana and provide adequate forestlands for migrating birds and bats.
- Population management
    - Determine distribution and relative abundance of rare forest-dependent wildlife such as the Indiana bat, Northern myotis, and Allegheny woodrat.
    - Develop survey and monitoring programs for forest-dwelling bats.

    - Develop survey and monitoring programs for Allegheny woodrats and other forest-dwelling rodents.
- Food plots
    - Provide for adequate regeneration of native tree species to provide adequate food for forest dwelling SGCN.
- Regulation of collecting
    - Develop technical assistance materials that promote leaving SGCN in the natural environment.
- Threats reduction
    - Determine threats to forest-dwelling bats
    - Determine impacts of different forest management regimes on habitat quality (foraging and roosting) for forest-dwelling bats.
    - Investigate the impact of forest management practices on the blue-spotted salamander, four-toed salamander, green salamander, red salamander, Allegheny woodrat and other SGCN.
- Native predator control
    - Investigate the impact of human persecution on timber rattlesnakes and other rare snakes and determine preventative measures.
- Disease/parasite management
    - Reduce raccoon populations in proximity to woodrat colonies
- Limiting contact with pollutants/contaminants
    - Monitor the impacts of forest-pest management measures on forest SGCN.
- Public education to reduce human disturbance
    - Post signs at important cave sites used by forest bats to reduce/eliminate unauthorized human visitation.
    - Provide technical assistance to land managers and landowners to reduce adverse impacts to timber rattlesnakes that encounter humans.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Riparian Wooded Corridors/Streams

Forests associated with river and stream banks. Often utilized as travel corridors by wildlife and affects in-stream habitat.

Species of Greatest Conservation Need (SGCN) in Riparian Wooded Corridors/Streams

Gray Myotis
Cerulean Warbler
Great Egret
Red-shouldered Hawk
Black-crowned Night-Heron
Osprey
Yellow-crowned Night-Heron
Bald Eagle

Threats to Riparian Wooded Corridors/Streams

- Commercial or residential development (sprawl)
- Habitat fragmentation
- Habitat degradation
- Stream channelization

Threats to SGCN in Riparian Wooded Corridors/Streams

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

High Priority Conservation Actions for Riparian Wooded Corridors/Streams

- Habitat protection through regulation
    - Provide technical assistance to regulatory programs regarding impacts to SCGN in forest relative to projects conducted under state permit or receiving public funds.
- Habitat protection on public lands
    - Protect existing riparian forest and forest corridors to provide habitat for SGCN including cerulean warbler, great egret, and red-shouldered hawk.
- Habitat protection incentives (financial)
    - Provide tax incentives to protect existing riparian forest and riparian forest corridors to provide habitat for SGCN species including cerulean warbler, great egret, red-shouldered hawk, and gray myotis.
- Habitat restoration through regulation
    - Provide technical assistance to regulatory programs regarding forest restoration measures beneficial to SCGN in forest relative to projects conducted under state permit or receiving public funds.
- Habitat restoration on public lands
    - Reforest bottomland areas to provide habitat for SGCN including gray bat, cerulean warbler, great egret, and red-shouldered hawk,
- Habitat restoration incentives (financial)

    - Promote funding programs that support the reforesting of bottomland areas to provide habitat for SGCN including gray bad, cerulean warbler, great egret, and red-shouldered hawk.
- Succession control (fire, mowing)
    - Develop and implement methods of vegetation control that provide a ecologically functional riparian wooded corridors/streams with native plants.
- Corridor development/protection
    - Develop and implement BMPs for the development and maintenance of ecologically functional riparian wooded corridors/streams.
- Pollution reduction
    - Reduce contaminant loads in fish and other aquatic vertebrates and invertebrate fed upon by SGCN including gray bat, great egret, and red-shouldered hawk.
- Protection of adjacent buffer zone:
    - Promote the use of BMPs relative to pesticide application and soil erosion control and silviculture in areas immediately adjacent to riparian wooded corridors/streams to benefit SGCN dependent on aquatic invertebrates.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Riparian Wooded Corridors/Streams</u>

- Habitat protection
    - Protect existing riparian forest corridors and create additional bottomland forests to provide habitat for SGCN including gray bat, cerulean warbler, great egret, and red-shouldered hawk.
    - Provide wooded riparian cover along rivers & streams for foraging cover for summer resident bat species.
- Threats reduction
    - Investigate loss of riparian wooded corridors/streams and the alternative uses for this habitat type and develop programs to protect and promote development and retention of riparian wooded corridors/streams.
- Protection of migration routes
    - Maintain wooded riparian corridors for migratory SGCN, including cerulean warbler.
- Limiting contact with pollutants/contaminants
    - Promote the development and retention of riparian wooded corridors/streams for runoff control to reduce the migration of pollutants and contaminants from non-forested areas into streams.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Grasslands

Open area dominated by grass species. Grasslands cover almost 16% of Indiana. This habitat includes early successional areas, farm bill program lands, fescue, haylands, pasture, prairies, reclaimed minelands, savanna, vegetated dunes and swales, and shrub/scrub (see definitions in Appendix A).

Species of Greatest Conservation Need (SGCN) in Grasslands

Blue-spotted Salamander
Crawfish Frog
Eastern Spadefoot
Northern Leopard Frog
Plains Leopard Frog
Blanding's Turtle
Butler's Garter Snake
Kirtland's Snake
Ornate Box Turtle
Smooth Green Snake
Spotted Turtle
Western Ribbon Snake
American Bittern
Barn Owl
Henslow's Sparrow
Loggerhead Shrike
Northern Harrier
Sedge wren
Short-eared Owl
Upland Sandpiper
Western Meadowlark
Badger
Bobcat
Franklin's Ground Squirrel
Least Weasel
Plains Pocket Gopher

Threats to Grasslands

- Habitat degradation
- Successional change
- Agricultural/forestry practices
- Commercial or residential development (sprawl)
- Habitat fragmentation
- Counterproductive financial incentives or regulations
- Invasive/non-native species
- Residual contamination (persistent toxins)
- Mining/acidification
- Point source pollution (continuing)

Threats to SGCN in Grasslands

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- 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)
- Degredation of movement/migration routes (overwintering habitats, nesting and staging sites)
- Bioaccumulation of contaminants
- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, bycatch, harvesting equipment, land preparation machinery)

- Viable reproductive population size or availability
- Small native range (high endemism)

High Priority Conservation Actions for Grasslands

- Habitat restoration incentives (financial)
    - Support farm programs that convert row-crop areas to grasslands to benefit a variety of birds including American bittern, barn owl, Henslow's sparrow, loggerhead shrike, northern harrier, sedge wren, short-eared owl, upland sandpiper, western meadowlark.
    - Develop large-scale grassland restoration projects on reclaimed strip mined lands and assess their effectiveness for providing habitat for area-sensitive bird (SGCN) species.
- Habitat protection on public lands
    - Restore native grasslands on public land to benefit blue-spotted salamander, crawfish frog, eastern spadefoot, northern leopard frog, plains leopard frog, Blanding's turtle, Butler's garter snake, Kirtland's snake, ornate box turtle, smooth green snake, spotted turtle, western ribbon snake, American bittern, barn Owl, Henslow's sparrow, loggerhead shrike, northern harrier, sedge wren, short-eared owl, upland sandpiper, western meadowlark, badger, bobcat, Franklin's ground squirrel, least weasel plains pocket gopher.
    - Restore moist soil units or grassy wetlands for the benefit of blue-spotted salamander, crawfish frog, eastern spadefoot, northern leopard frog, plains leopard frog, Blanding's turtle, Butler's garter snake, Kirtland's snake, smooth green snake, spotted turtle, western ribbon snake, and American bittern, northern harrier, sedge wren, short-eared owl, upland sandpiper, least weasel.
    - Convert row-crop areas to grasslands to benefit a variety of SGCN including: blue-spotted salamander, crawfish frog, eastern spadefoot, northern leopard frog, plains leopard frog, Blanding's turtle, Butler's garter snake, Kirtland's snake, ornate box turtle, smooth green snake, spotted turtle, western ribbon snake, barn owl, Henslow's sparrow, loggerhead shrike, northern harrier, sedge wren, short-eared owl, upland sandpiper, western meadowlark, badger, bobcat, Franklin's ground squirrel, least weasel, plains pocket gopher
    - Incorporate management for rare grassland-dependent SGCN such as blue-spotted salamander, crawfish frog, eastern spadefoot, northern leopard frog, plains leopard frog, Blanding's turtle, Butler's garter snake, Kirtland's snake, ornate box turtle, smooth green snake, spotted turtle, western ribbon snake, American bittern, barn Owl, Henslow's sparrow, loggerhead shrike, northern harrier, sedge wren, short-eared owl, upland sandpiper, western meadowlark, badger, bobcat, Franklin's ground squirrel, least weasel, plains pocket gopher on public lands (e.g., Fish and Wildlife Areas, Indiana Dunes National Lakeshore).
- Cooperative land management agreements (conservation easements)
    - Develop cooperative agreements with transportation agencies for management and restoration of habitats on railroad ROWs to benefit Franklin's ground squirrels, badgers, and other grassland dependent species.
- Habitat restoration on public lands
    - Incorporate management for rare grassland-dependent SGCN, such as the Franklin's ground squirrel and badger, on public lands (e.g., FWA).
- Corridor development/protection

    - Identify and promote the retention of natural habitat corridors to connect patches of grassland habitat for the benefit of SGCN>
- Land use planning
    - Provide technical assistance to land use planning entities to promote development and retention of landscape features and management practices that benefit SGCN.
- Restrict public access and disturbance
    - Develop and promote implementation of BMPs that limit disturbance to nesting grassland birds (SGCN), especially on public conservation lands.
- Habitat restoration through regulation
    - Promote the use of native grass and forb vegetation to benefit SGCN on projects conducted under state permits or receiving public funds.
    - Provide technical assistance relative to grassland restoration to benefit SGCN to state agencies involved in habitat mitigation.
- Technical assistance
    - Provide information to landowners and public land managers on methods to manage grassland areas for the benefit of SGCN including: blue-spotted salamander, crawfish frog, eastern spadefoot, northern leopard frog, plains leopard frog, Blanding's turtle, Butler's garter snake, Kirtland's snake, ornate box turtle, smooth green snake, spotted turtle, western ribbon snake, American bittern, barn Owl, Henslow's sparrow, loggerhead shrike, northern harrier, sedge wren, short-eared owl, upland sandpiper, western meadowlark, badger, bobcat, Franklin's ground squirrel, least weasel, plains pocket gopher
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Grasslands</u>

- Population management
    - Determine distribution and relative abundance of grassland-dependent SGCN such as badger and Franklin's ground squirrel.
    - Develop survey and monitoring programs for grassland-dependent SGCN such as badgers and Franklin's ground squirrels.
- Public education to reduce human disturbance
    - Develop and promote implementation of BMPs that limit disturbance to nesting grassland birds (SGCN), especially on public conservation lands.
- Exotic/invasive species control
    - Control shrub encroachment and invasive species in grassland areas in order to benefit a variety of SGCN including American bittern, barn owl, Henslow's sparrow, loggerhead shrike, northern harrier, sedge wren, short-eared owl, upland sandpiper, western meadowlark.
- Protection of migration routes
    - Identify and protect potential dispersal corridors for grassland species occupying isolated blocks of habitats
- Food plots
    - Promote the use of native grass and forb species in the restoration of suitable disturbed areas, such as surfaced mined areas, for the benefit of grassland SGCN.
- Threats reduction

    - Determine threats to grassland-dependent SGCN, such as the Franklin's ground squirrel.
- Habitat protection
    - Promote the protection and proper management of grassland habitat, including wet prairies, for the benefit of grassland SGCN.
- Regulation of collecting
    - Encourage public support for collection prohibitions to protect vulnerable populations of grassland SGCN, especially reptiles and amphibians.
- Native predator control
    - Investigate the impact of predation, especially raccoon predation, on vulnerable populations of grassland SGCN, especially turtles (eggs).
- Limiting contact with pollutants
    - Work with the State Chemist Office and other to develop herbicide and pesticide label directions that are protective of SGCN
    - Support compliance with all state and federal environmental regulations relative to grasslands lands.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Early Successional Grasslands

These habitats are composed primarily of grasses and other early successional non-woody vegetation. Relatively frequent disturbances are required for their maintenance.

Species of Greatest Conservation Need (SGCN) in Early Successional Grasslands

Franklin's Ground Squirrel

Threats to Early Successional Grasslands

- Commercial or residential development (sprawl)
- Habitat degradation
- Successional change
- Invasive/non-native species
- Habitat fragmentation
- Agricultural/forestry practices
- Counterproductive financial incentives or regulations
- Nonpoint source pollution (sedimentation and nutrients)
- Drainage practices (stormwater runoff)
- Stream channelization

Threats to SGCN in Early Successional Grasslands

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- 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)
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, bycatch,
- harvesting equipment, land preparation machinery)
- Viable reproductive population size or availability
- Diseases/parasites (of the species itself)
- Regulated hunting/fishing pressure (too much)

High Priority Conservation Actions for Early Successional Grasslands

- Selective use of functionally equivalent exotic species in place of extirpated natives
    - Investigate the impact of intentionally deployed exotic plants and animals on grassland SGCN.
- Succession control (fire, mowing)
    - Implement controlled burning regimes to maintain functional and desirable components and processes of grassland habitats.
- Habitat protection on public lands
    - Incorporate management for grassland-dependent SGCN such as the Franklin's ground squirrel on Fish & Wildlife Areas and other public lands.
- Habitat restoration incentives (financial)

    - Promote the enrollment of private lands into Farm Bill Wildlife Conservation Programs and similar programs to benefit SGCN dependent on early successional stage grassland habitats.
- Corridor development/protection
    - Work with railroad, highway transportation, and energy agencies to provide wildlife habitat on linear corridors where feasible.
- Technical assistance
    - Develop and distribute BMPs and other technical information on the development and management of early successional grasslands for the benefit of SGCN.
- Habitat restoration on public lands
    - Incorporate management for grassland-dependent SGCN such as the Franklin's ground squirrel on Fish & Wildlife Areas and other public lands.
- Cooperative land management agreements (conservation easements)
    - Develop cooperative agreements with transportation agencies for management and restoration of grassland habitats on railroad ROWs to benefit Franklin's ground squirrels.
- Habitat protection incentives (financial)
    - Support farm programs that convert row-crop areas to early successional grasslands to benefit Franklin's ground squirrel.
    - Acquire suitable land and develop large-scale grassland restoration projects and assess their effectiveness for providing habitat for Franklin's ground squirrel.
- Land use planning
    - Work with public land managers and other land managers to ensure adequate distribution and abundance of early successional grassland habitat to benefit Franklin's ground squirrel.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Early Successional Grasslands</u>

- Habitat protection
    - Determine habitat needs for early successional stage grassland species such as the Franklin's ground squirrel.
    - Support early successional grassland management (e.g. burning) and the control of invasive exotic plant species.
- Population management
    - Determine distribution and relative abundance of SGCN dependent on early successional stage grasslands such as Franklin's ground squirrel.
    - Develop surveys and monitoring programs for SGCN dependent on early successional stage grasslands such as the Franklin's ground squirrel.
- Exotic/invasive species control
    - Support programs to identify and control the adverse impacts of exotic, invasive plant and animal species on early successional grassland SGCN.
- Food plots
    - Promote the inclusion of an appropriate diversity of grasses and forbs in the establishment of early successional grassland habitat for the benefit of SGCN.
- Native predator control

    - Investigate the impact of predation, especially raccoon predation, on vulnerable populations of grassland SGCN, especially turtles (eggs).
- Threats reduction
    - Determine threats to existing colonies of Franklin's ground squirrels.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Farm Bill Program Grasslands

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.

Species of Greatest Conservation Need (SGCN) in Farm Bill Program Grasslands

Henslow's Sparrow

Threats to Farm Bill Program Grasslands

- Habitat fragmentation
- Agricultural/forestry practices
- Habitat degradation
- Successional change
- Commercial or residential development (sprawl)
- Counterproductive financial incentives or decisions
- Residual contamination (persistent toxins)
- Invasive/non-native species
- Mining/acidification
- Nonpoint source pollution (sedimentation and nutrients)

Threats to SGCN in Farm Bill Program Grasslands

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Predators (native or domesticated)
- Viable reproductive population size or availability
- Invasive/non-native species
- Bioaccumulation of contaminants
- High sensitivity to pollution
- Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, bycatch, harvesting equipment, land preparation machinery)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Degradation of movement/migration routes

High Priority Conservation Actions for Farm Bill Program Grasslands

- Habitat restoration on public lands
    - Encourage the use of Farm Bill programs to restore former agricultural lands.
- Land use planning
    - Promote the use of Farm Bill programs for grassland to the benefit of grassland dependent SGCN.
- Habitat restoration incentives (financial)
    - Target sign-ups to encourage larger fields or areas with existing grasslands in order to benefit area sensitive species such as Henslow's sparrows.

- Cooperative land management agreements (conservation easements)
    - Investigate the benefits of Farm Bill program grasslands for grassland dependent SGCN and provide technical assistance to other public/private programs supporting cooperative land management agreements for the conservation of grasslands.
- Restrict public access and disturbance
    - Develop and promote implementation of BMPs that limit disturbance to nesting grassland birds (SGCN), especially on public conservation lands.
- Succession control (fire, mowing)
    - Periodically (3-5 years) burn or mow portions of Farm Bill program grassland used by Henslow's sparrows in order to maintain late successional grasslands habitat.
    - Or Develop succession management BMPs for Farm Bill program grasslands to ameliorate benefits to grassland SGCN, especially Henslow's sparrows.
- Habitat protection through regulation
    - Provide technical assistance to establish protective mowing seasons for Henslow's sparrows.
- Habitat restoration through regulation
    - Require the use of Farm Bill grassland programs to benefit SGCN on agricultural endeavors conducted by state agencies or receiving public funds.
    - Provide technical assistance to state agencies involved in habitat mitigation relative to Farm Bill type grassland programs to restore grasslands to benefit SGCN.
- Habitat protection incentives (financial)
    - Support Farm Bill programs that convert row-crop areas to early successional grasslands to benefit SGCN, especially Henslow's sparrow.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

<u>High Priority Conservation Actions for SGCN in Farm Bill Program Grasslands</u>

- Protection of migration routes
    - Promote the use of Farm Bill grassland programs to provide migratory habitat for SGCN.
- Public education to reduce human disturbance
    - Develop a technical assistance program to maximize public awareness of the value of undisturbed Farm Bill program lands to nesting birds and other SGCN.
- Exotic/invasive species control
    - Support programs to identify and control the adverse impacts of exotic, invasive plant and animal species on grassland SGCN in Farm Bill program grasslands.
- Habitat protection
    - Determine habitat needs and limiting factors for SGCN using Farm Bill program grassland.
    - Support retention and maintenance (management activities) of Farm Bill program grasslands to ameliorate benefits to grassland dependent SGCN.
- Threats reduction

    - Investigate threats to grassland dependent SGCN in Farm Bill program grasslands and support science based adjustments to conservation practices to the benefit of SGCN.
- Native predator control
    - Investigate the impact of predation on grassland dependent SGCN in Farm Bill program grassland habitat, especially in linear/corridor conservation practice sites that may serve as population sinks.
- Limiting contact with pollutants/contaminants
    - Investigate the impacts of pollutants/contaminants on grassland SGCN and other wildlife using Farm Bill program conservation practice sites and investigate the movement of pollutants/contaminants through such sites.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Subterranean Systems

Surface openings of subterranean features reaching as far as natural light can penetrate (i.e., twilight zone) and connected underground rooms and passages beyond natural light penetration. This habitat encompasses the following sub-types: caves and cave entrances (see definitions Appendix A).

Species of Greatest Conservation Need (SGCN) in Subterranean Systems

Green Salamander
Four-toed Salamander
Northern Cavefish
Gray Myotis
Indiana Myotis
Rafinesque's Big-eared Bat
Eastern Pipistrelle
Little Brown Myotis
Northern Myotis
Southeastern Myotis

Threats to Subterranean Systems

- Habitat degradation
- Commercial or residential development (sprawl)
- Climate change
- Agricultural/forestry practices
- Residual contamination (persistent toxins)
- Point source pollution (continuing)
- Habitat fragmentation
- Nonpoint source pollution (sedimentation and nutrients)
- Mining/acidification
- Drainage practices (stormwater runoff)

Threats to SGCN in Subterranean Systems

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Specialized reproductive behavior or low reproductive rates
- High sensitivity to pollution
- Bioaccumulation of contaminants
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, bycatch, harvesting equipment, land preparation machinery)
- Small native range (high endemism)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Predators (native or domesticated)

High Priority Conservation Actions for Subterranean Systems

- Technical assistance
  - Develop educational materials for landowners in karst topography about relationships between surface activities and subterranean systems.
- Cooperative land management agreements (conservation easements)
  - Promote the use of cooperative land agreements to protect sensitive karst features for green salamanders, four-toed salamander and subterranean systems that support northern cavefish and bat species of greatest conservation need.
- Restrict public access and disturbance
  - Post signs at important cave sites to reduce/eliminate unauthorized human visitation.
  - Erect physical barriers (i.e., fences, gates) where needed to protect important cave sites.
- Land use planning
  - Identify surface recharge areas for cave systems to identify sources of potential threats.
- Habitat protection on public lands
  - Develop land management plans protective of subterranean systems and permit recreation use consistent with the conservation of SGCN.
- Habitat protection through regulation
  - Support regulations relative to cave closures to protect bat SGCN, especially the Indiana myotis.
  - Provide technical assistance to regulatory programs regarding subterranean systems beneficial to SCGN for evaluation of projects conducted under state permit or receiving public funds.
- Habitat restoration on public lands
  - Determine and support development of beneficial habitat conditions to be maintained near surface openings (e.g. cave entrances, sinkholes, rises) to subterranean systems.
- Protection of adjacent buffer zone
  - Protect woodland buffers surrounding cave entrances to provide habitat for the green salamander.
  - Determine effective size of forested buffer around caves used as hibernacula by Indiana bats and other caverniculous SGCN.
  - Provide vegetative buffer strips/zones around sinkholes.
- Pollution reduction
  - Identify surface recharge areas.
  - Provide adequate filter and buffer strips around input sources to cave systems.
- Corridor development/protection
  - Identify all cave system openings and karst stream (Lost River) tributaries and promote the protection of the entire system.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

High Priority Conservation Actions for SGCN in Subterranean Systems

- Habitat protection

    - Protect wet areas around seeps and springs for the benefit of four-toed salamanders.
    - Protect the water quantity and quality in subterranean streams to benefit northern cavefish populations.
    - Inventory subterranean systems cave-dependent SGCN such as the Indiana bat and southeastern bat.
    - Restrict human access to caves during seasonal use by Indiana bats and other cave-dwelling species. Erect physical barriers (gates, fences) as needed.
- Regulation of collecting
    - Provide public notification materials throughout the Karst region of Indian regarding the adverse consequences of collecting or disturbing subterranean system SGCN.
- Threats reduction
    - Investigate the threats (e.g. pesticides, water level changes, soil erosion, human disturbance) to subterranean system SGCN.
- Public education to reduce human disturbance
    - Erect interpretive warning signs at entrances to important cave sites to discourage human entry.
- Limiting contact with pollutants/contaminants
    - Investigate sinkhole buffer systems to minimize the adverse impacts of runoff into subterranean systems from surrounding lands on SGCN.
    - Investigate the impact of smoke and other air quality problems on subterranean system SGCN.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

Wetlands

Wetlands include areas shallowly flooded temporarily or permanently to cover the base of plants but not prolonged inundation of the entire plant. Only 0.91% of Indiana is covered by wetlands. This habitat includes: emergent, ephemeral, forested, herbaceous marsh, mudflats, permanent and shrub/scrub wetlands (see definitions in Appendix A).

Species of Greatest Conservation Need (SGCN) in Wetlands

Blue-spotted Salamander
Crawfish Frog
Eastern Spadefoot
Four-toed Salamander
Northern Leopard Frog
Plains Leopard Frog
Blanding's Turtle
Butler's Garter Snake
Copperbelly water Snake
Cottonmouth
Massasauga
Spotted Turtle
Western Mud Snake
Western Ribbon Snake
American Bittern
Black Rail
Black Tern
Black-crowned Night-heron
Common Moorhen
Golden-winged Warbler
Great Egret
King Rail
Least Bittern
Marsh Wren
Sandhill Crane
Sedge Wren
Virginia Rail
Whooping Crane
Yellow-crowned Night-heron
Yellow-headed Blackbird
Bobcat
River Otter
Star-nosed Mole
Swamp Rabbit

Threats to Wetlands

- Habitat degradation
- Habitat fragmentation
- Agricultural/forestry practices
- Commercial or residential development (sprawl)
- Nonpoint source pollution (sedimentation and nutrients)
- Point source pollution (continuing)
- Successional change
- Counterproductive financial incentives or regulations
- Drainage practices (stormwater runoff)
- Invasive/non-native species

Threats to SGCN in Wetlands

- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Near limits of natural geographic range
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

- Bioaccumulation of contaminants
- Predators (native or domesticated)
- Viable reproductive population size or availability
- Specialized reproductive behavior or low reproductive rates
- High sensitivity to pollution

High Priority Conservation Actions for Wetlands

- Habitat protection on public lands
    - Conserve and manage diverse wetlands on public lands for the benefit of SGCN including mammals, birds, amphibians and reptiles.
- Succession control (fire, mowing)
    - Manage plant succession using water level manipulation, fire, and other methods to conserve diverse wetlands for the benefit of SGCN including mammals, birds, amphibians and reptiles.
- Cooperative land management agreements (conservation easements)
    - Support the use of cooperative land management agreements to conserve and protect privately owned wetlands for the conservation of wetland SGCN.
- Habitat restoration on public lands
    - Restore wetlands on public lands for the benefit of SGCN including mammals, birds, amphibians and reptiles.
    - Create wetland areas for black terns.
    - Support the planting of appropriate native plant stocks to accelerate and enhance wetland restorations and to use for demonstration purposes.
- Corridor development/protection
    - Promote the development and protection of wetland complexes including connecting wetland habitats for the benefit of copperbelly water snakes and other SGCN.
- Land use planning
    - Provide technical assistance to land use planners that promotes the values and benefits of wetlands.
- Protection of adjacent buffer zone
    - Promote the protection of adjacent buffer zones around wetlands to protect the wetlands and ameliorate benefits to SGCN.
- Habitat protection incentives (financial)
    - Cooperate with programs (Wetland Reserve Program) and organizations (Ducks Unlimited) that provide financial incentives to private landowners to develop and/or protect wetlands.
- Artificial habitat creation (artificial reefs, nesting platforms)
    - Provide nesting platforms in appropriate wetlands for black terns.
- Habitat restoration through regulation
    - Provide technical assistance to regulatory programs regarding wetlands beneficial to SCGN for evaluation of projects conducted under state permit or receiving public funds, especially in regarding minimizing adverse impacts or mitigation.
- Adaptive Management
    - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for SGCN.

High Priority Conservation Actions for SGCN in Wetlands

- Reintroduction (restoration)
  - Determine feasibility of restoring wetland-dependent SGCN such as the swamp rabbit and star-nosed mole.
- Population management
  - Determine distribution and relative abundance of rare wetland-dependent wildlife such as the swamp rabbit and star-nosed mole.
  - Develop survey and monitoring programs for rare species associated with wetland habitats such as swamp rabbits and star-nosed moles.
  - Investigate the impact of regulated species (e.g. raccoons and coyotes) on populations of Blanding's turtle, spotted turtle, and other wetland dependent SGCN
- Protection of migration routes
  - Target the restoration, protection and acquisition of wetlands to provide for the needs of migrating SGCN.
- Disease/parasite management
  - Investigate suspicious mortality or disease in wetland species to determine risk to wetland dependent SGCN and appropriate protective measures.
- Habitat protection
  - Conserve and manage a variety of wetland types for the benefit of SGCN including mammals, birds, amphibians, and reptiles.
- Regulation of collecting
  - Investigate the role or intentional and/or un-intentional take on the viability of reptile and amphibian SGCN populations.
- Exotic/invasive species control
  - Reduce invasive plants in wetlands using water level manipulation, fire, herbicides, and other methods for the benefit of SGCN including mammals, birds, amphibians, and reptiles.
- Threats reduction
  - Investigate threats (e.g. exotic species competition, loss of wetland diversity, dependence on other species such as burrowing crayfish) to wetland dependent SGCN.
- Adaptive Management
  - Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve conservation efficiency for SGCN.

C. Partnering Agencies and Organizations

In association with Element 4, guidelines called for the CWS to describe specific projects and programs, in addition to partnering agencies and organizations, who will likely be involved in implementing these conservation actions. A major characteristic of Indiana's CWS approach is that it provides a statewide umbrella strategy for conservation of all known habitats and all fish and wildlife species that depend on those habitats. This approach can be compared to several other decision-making tools and matched with existing conservation programs that have been developed by organizations at the state, regional or national level. By examining each of these tools, programs and organizational resources, it is possible to describe how the collection of programs and their associated decision-making tools are complementary to the CWS and identify where there may be gaps in conservation planning within the state.

1. Programs for conservation

An inventory of programs that provide resources and tools that may be useful to implement wildlife and habitat conservation actions is provided in Table 10. Additional detail on conservation programs is given in Appendix L. To facilitate implementation, these organizations are categorized by the major habitats they address, recognizing that there may be overlaps in some cases.

For each program, the following information is provided, if applicable:

Program Title:	name of the organization or program
Administered:	agency that administers the organization or program
Primary Taxa:	wildlife species or groups that are the primary focus for the program
Relationship to CWS:	how actions or interests could be aligned with CWS conservation needs
Implementation constraints:	barriers to implementation, including financial or technical resource constraints
Eligibility:	who may apply for funding
How Much:	how much funding is typically available
Application Deadline:	deadline for submitting an application
Web Pages/Links:	sources of specific online information

Based on this summary, conservationists in Indiana have access to more than 50 programs that could provide technical or financial assistance for wildlife and habitat conservation in the state.

For state agencies and private organizations, thousands of dollars are available each year from federal and non-profit funds for states to purchase, manage or improve habitats. Other programs allow the state or private organizations to provide dollars to partners to carry out conservation work on public and private lands. In addition, several coalitions encourage agencies to band with stakeholders to share resources and achieve larger goals than an agency could achieve alone.

Despite these opportunities, internal constraints often prevent state agencies from using these resources to their fullest potential. Restrictions on out-of-state-travel can constrain participation, as does a lack of state staff to participate in or develop these efforts. Funding that requires state

matches often can't be realized because matching funds are inadequate or non-existent. Many of the federal programs require state matching funds in excess of 25-50% of the total project amount. When federal funds operate by reimbursing state expenditures, the state must have to total project amount available as a cash outlay at the outset of the project. Federal tax dollars dedicated to habitat conservation programs such as the Conservation Reserve Enhancement Program (CREP) within the Farm Bill programs have gone unused for years due to the lack of state matching funds. Reversion of federal funds to the federal Sport Fish Restoration and Wallop-Breaux programs have also loomed as possibilities in years when state funding came up short.

For state agencies to realize and reap the benefits of programs and partnerships, agency leaders need to look for ways to better tap funding, resources and partnerships heralded through the CWS. A major component of implementation for CWS will be to continue identifying appropriate programs, determining how barriers can be overcome, and linking these programs with conservation needs. As program scope, capacity and resources change, this information will have to be continually updated. For these reasons, Table 10 and Appendix L are not necessarily comprehensive or complete and remain a work in progress.

Table 10: Conservation Programs and Resources
Programs currently available for wildlife conservation in Indiana and barriers to effective implementation of conservation actions. (See Appendix L for additional information)

Program	Funds available	Implementation Constraints				
		Out of state travel	State match	Lack staff	Funding issues or limits	Other
Programs for All Habitats						
2002 IPL Golden Eagle Environment Grant	Yes	--	--	--	--	--
Classified Wildlife Habitat Program	Yes	--	--	--	X	--
Ecoregional planning (TNC)	Yes	--	--	--	--	X
Game Bird Habitat Program	Yes	--	--	--	X	--
General Challenge Grant	Yes	--	X	?	?	?
Indiana Biodiversity Initiative	Yes	--	--	--	X	--
Indiana Heritage Trust	Yes	--	--	--	--	--
Land trusts in Indiana	Yes	--	?	?	?	?
Nongame Tax Check-off	Yes	--	X		X	--
North American Bird Conservation Initiative (NABCI)	No	X	--	X	--	--
Partners In Flight	No	--	--	--	--	--
State wildlife agency management strategic plans	Yes	--	--	--	X	--
Tipmont REMC Envirowatts Trust	Yes	--	?	?	X	X
Wildlife Habitat Cost Share Program	Yes	--	--	--	X	--
Programs for Agricultural Habitats						
Conservation Reserve Enhancement Program	Yes	--	X	--	--	X
Conservation Reserve Program	Yes	--	--	--	--	X
Core 4 Alliance Grants	Yes	--	--	--	--	X
Game Bird Habitat Program	Yes	--	--	--	X	--
Indiana Environmental Quality Incentives Program	Yes	--	--	--	--	X
Sustainable Agriculture Research and Education (SARE) Producer Grant Program	Yes	--	--	--	--	X
Wetland Reserve Program	Yes	--	--	--	X	--
Wildlife Habitat Cost Share Program	Yes	--	--	--	X	--
Wildlife Habitat Incentives Program	Yes	--	?	?	?	X
Programs for Aquatic Habitats						
Aquatic Ecosystems Restoration	Yes	--	X	--	--	--
Bring Back the Natives	Yes	?	?	?	?	?
Clean Water Act Nonpoint Source Grants (Section 319)	Yes	--	X	--	X	X
Clean Water Act Planning Grants (Section 205(j))	Yes	--	--	--	--	--
Clean Water Act Stormwater Grants (Section 104(b) (3))	Yes	--	X	--	X	X

Program	Funds available	Implementation Constraints				
		Out of state travel	State match	Lack staff	Funding issues or limits	Other
Great Lakes Aquatic Habitat Network & Fund	Yes	?	?	?	X	?
Great Lakes Basin Program for Soil Erosion and Sediment Control	Yes	?	?	?	X	?
Great Lakes Regional Collaboration	Unknown	X	--	--	--	--
Hoosier Riverwatch Water Quality Monitoring	Yes	--	--	--	--	X
Lake and River Enhancement Program	Yes	--	--	--	X	X
Lake Michigan Coastal Program	Yes	--	?	?	?	X
Mississippi Interstate Cooperative Resource Association (MICRA)	No	X	--	--	--	--
National Fish Habitat Initiative	TBD	TBD	TBD	TBD	TBD	TBD
Ohio River Valley Water Sanitation Commission (ORSANCO)	No	X	--	--	--	--
Partners for Fish and Wildlife	Yes	?	?	?	X	?
Project Modifications for Improvement of the Environment (Section 1135 (b))	Yes	--	X	--	--	--
Re-Grants	Yes	?	?	?	X	?
Research grants	Yes	--	?	?	?	?
Science Program	Yes	X	--	--	--	--
State Revolving Fund Program	Yes	--	--	--	X	--
Watershed assistance grants	Yes	?	?	?	X	?
Programs for Developed Lands Habitats						
Brownfields Cleanup Revolving Loan Fund	Yes	--	--	--	--	X
Clean Water Act Stormwater Grants (Section 104(b) (3))	Yes	--	X	--	X	X
Hometown Indiana Grant Program	Yes	--	--	--	X	X
State Revolving Fund Program	Yes	--	--	--	X	--
Urban Forest Conservation Grants	Yes	?	?	?	X	?
Programs for Forest Lands Habitat						
Classified Forest Program	Yes	?	?	?	X	?
Forest Legacy Program	Yes	?	?	?	X	?
Hometown Indiana Grant Program	Yes	--	--	--	X	X
National forest planning rules	No	--	--	--	--	X
Urban Forest Conservation Grants	Yes	?	?	?	X	?
Wildlife Habitat Cost Share Program	Yes	--	--	--	X	--
Programs for Subterranean Systems Habitats						
Conservation Fund	Yes	?	?	?	?	?
Conservation grants	Yes	?	?	?	X	?
Fellowship	Yes	?	?	?	X	?
Indiana Environmental Quality Incentives Program	Yes	--	--	--	--	X
Programs for Wetlands Habitats						
Conservation Reserve Enhancement Program	Yes	--	X	--	--	X

Program	Funds available	Implementation Constraints				
		Out of state travel	State match	Lack staff	Funding issues or limits	Other
Conservation Reserve Program	Yes	--	--	--	--	X
Lake and River Enhancement Program	Yes	--	--	--	X	X
North American Wetlands Conservation Act Grants	Yes	?	X	?	?	?
Wetland Reserve Program	No	--	--	--	X	--
Wetlands Protection Development Grants Program	Yes	?	?	?	?	?
Wildlife Habitat Incentives Program	Yes	--	?	?	?	X
More Funding Sources						
Catalog of Federal Funding Sources for Watershed Protection	Yes	TBD	TBD	TBD	TBD	TBD
GrantsWeb	Yes	TBD	TBD	TBD	TBD	TBD
The Foundation Center	Yes	TBD	TBD	TBD	TBD	TBD

2. Partners for conservation

Appendix H contains listings of conservation organizations, what types of habitat they focus, what types of work they do, and what percent of their time they spend on that work and detailed descriptions of each organization's activities if the respondent provided this requested information. A matrix of conservation partners contains the responses from the CWS Partner Survey (Table 11). Organizations were asked "On which of the following types of habitats does your organization focus its efforts?" and "Percent of your total time spent on efforts in this habitat." Fields with an "X" indicate that the organization responded that they have activities in this habitat but did not include a percentage. All other responses are as completed by the individual completing the form.

Information submitted by potential conservation partners suggests some trends in the amount and kind of attention various habitats and species are currently receiving. The largest number of partners spends at least some time addressing wetlands (84), aquatic systems (83), forest lands (74), and grasslands (60) with the lowest number of partners available to do work in barren lands (21) and subterranean habitats (21). Likewise the largest average percentage of time that partners reported was for aquatic systems (18%), forest lands (17%) and wetlands (15%). The smallest percentage of time spent was reported for barren lands (0.8%), subterranean systems (2%), grasslands (7%) and developed lands (7%).

For the most part, efforts seem to be correlated with the prevalence of some habitat types in presettlement Indiana, such as grasslands, forest lands and wetlands. Grasslands (pasture, hay and abandoned fields) and forest lands are associated with agriculture and timber production. These systems benefit from stable, well-funded nationwide incentive programs such as the Farm Bill and funding for management of game species. Techniques for restoring these habitats may be better developed due to the long-term stable funding and research associated with production systems.

Program and partner attention also reveals a predisposition for working in water-related systems. State and national surveys have repeatedly shown the importance of clean water in the minds of the public. In relation to this interest, wetland conservation and regulation have received a tremendous amount of attention relative to other habitat types. While wetlands may comprise a small land area, their contribution to water quality and quantity is disproportionately significant. Wildlife-related recreation such as waterfowl hunting, fishing and bird-watching also propel an interest and investment in aquatic systems and wetlands that is out of proportion to the land area that they cover. These systems directly benefit from funding provided for the support of game species and fisheries management.

Habitats that are difficult to access, such as cliffs or dunes (barren lands) and below ground (subterranean) habitats, also received relatively little attention. Working in these systems is highly specialized and may include hazardous conditions (e.g., caves and sinking streams). These habitats are also extremely fragile and may not be able to withstand the attention of a very large number of researchers and practitioners. Collecting was identified as one of the serious threats to species in some of these highly sensitive habitats.

Table 11. Matrix of conservation partners
Responses from the Indiana Comprehensive Wildlife Strategy (CWS) Partner Survey to indicate what approximate percentage of their efforts are spent in which habitats.

	Agricultural	Aquatic systems	Barren lands	Developed lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Conservation Partner	***Efforts by habitat type***							
ACRES, Inc.	15	30	5	0	30	5	0	30
American Consulting, Inc.	5	15		45	5			35
American Society of Landscape Architects, Indiana Chapter	X	X		X	X	X		X
Amos W Butler Audubon Society		X						X
Aquatic Weed Control		100						
Arrow Head Country Resource Conservation & Development Area, Inc.	10	30		10	30			10
Bartholomew County Conservation Council, Inc.								2
Big Oaks National Wildlife Refuge, USFWS	5	5		0	30	30	10	20
Blue Heron Ministries, Inc.		5		5	10	40		40
Center For Urban Policy and The Environment								
Central Hardwoods Joint Venture/American Bird Conservancy		X			X	X		X
Central Indiana Land Trust					90	5		5
Central Indiana Trout Unlimited		100						
Cinergy Corp.	5	20	5	30	10	15	0	15
Clark's Valley Land Trust	50	10			30			10
Cordry Sweetwater Conservancy District		50		45				
Crooked Creek Conservation & Gun Club, Inc.						X		
Division of Fish and Wildlife	28	28	1	2.5	6	6	0.5	28
DNR Division of Nature Preserves		10	10		30	30	10	X
Ducks Unlimited, Inc.		10			10	15		65
Dunes-Calumet Audubon Chapter					20	30		50
Earth Source, Inc.		10		20	10	10		50
Enviroscience Incorporated		40		20	5			20
Federal Highway Administration (FHWA)	?	?		?	?	?	?	?
Fish Lake Conservancy District	5	90						5
Four Rivers Resource Conservation & Development Area		50	10					5
Fur Takers of America	X	X	X	X	X	X	X	X
Fur Takers of America Chapter 7-E North West In.	?	?		?	?	n/a		?
Great Lakes Commission	NA	NA		NA				NA

	Agricultural	Aquatic systems	Barren lands	Developed lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Conservation Partner	***Efforts by habitat type***							
Hamilton Lake Conservancy District		100						
Hoosier Conservation Alliance					15			
Hoosier Environmental Council	10	40			25	5	10	10
Hoosier Heartland Resource Conservation and Education Council	10	20		35	35			
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)	15	5	2		70	5	2	15
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	~5	~5		~4-5	~75-80		~2-3	X
Indiana Academy of Science								
Indiana Association of Cities and Towns		10		10				5
Indiana Association of Soil and Water Conservation Districts	30	10	10	20	10	10	0	10
Indiana Bass Chapter Federation		80						20
Indiana Beaglers Alliance	10							
Indiana Beef Cattle Association	X					X		
Indiana Biodiversity Initiative Indian University - School of Public and Environmental Affairs								
Indiana Chamber of Commerce	15	45	10	20				10
Indiana Deer Hunters Association		10		0	25	10		10
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	1	3	1	60	31	1	2	1
Indiana Department of Natural Resources, Division of Outdoor Recreation								
Indiana Department of Transportation								
Indiana Division of The Izaak Walton League of America	1	20	1	2	5	3	1	30
Indiana Dunes National Lakeshore		5			45	20		30
Indiana Environmental Institute	10	30		5				10
Indiana Forest Industry Council (IFIC)					100			
Indiana Forestry and Woodland Owners Association					100			
Indiana Forestry Educational Foundation					100			
Indiana Grand Kankakee Marsh Restoration Project						30		70
Indiana Hunter Education Association								
Indiana Karst Conservancy							100	
Indiana Land Resources Council	X			X	X			
Indiana Michigan Power and Affiliate of American Electric Power; Land Management Department		X	X					
Indiana Native Plant and Wildflower Society				10	30	30	0	30

	Agricultural	Aquatic systems	Barren lands	Developed lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Conservation Partner	***Efforts by habitat type***							
Indiana Pork Producers Association	100							
Indiana Quail Unlimited	45			10	10	30		5
Indiana Rural Water Association								
Indiana Smallmouth Club (ISC)	15	80						5
Indiana Soybean Board (ISB) & Indiana Soybean Growers Association (ISGA)	100							
Indiana Sportsmen's Roundtable								
Indiana State Trappers Assoc	40	10		5	5	5	0	35
Indiana Watershed Leadership (New Initiative)with Purdue University		X						
Indiana Wildlife Federation				45	10			45
Indianapolis Flycasters		X						X
Indianapolis Power & Light Co.		5		5	5			
JFNew and Associates		10		40	10	10		30
Kankakee River Basin Commission	X	X						X
Lake Bruce Conservancy District		90						10
Lake Lemon Conservancy District		75		25				
Lake Maxinkuckee Environmental Council (LMEC)	5	50		25				20
Lake McCoy Conservancy District		X						
LaPorte County Conservation Trust, Inc.								
Law Enforcement Division, Indiana Department of Natural Resources	X	X	X	X	X	X	X	X
Lincoln Hills RC&D	30				30	20	10	10
Little River Wetlands Project, Inc.								90
Lost River Conservation Association	7	10	3	5	10	5	40	20
Mason & Hanger Corp. Newport Chemical Depot	50				15	15		5
Merry Lea Environmental Learning Center of Goshen College	1	4			30	35		30
Midwest Peregrine Falcon Recovery Project		10	20	70				
Muscatatuck National Wildlife Refuge USFWS	4	5		6	30		2	40
MWH Americas, Inc.		30		30	10	10		20
National Audubon Society - Indiana Important Bird Areas Program (IBA)		X	X		X	X		X
National Wild Turkey Federation	30				70			
Naval Support Activity Crane		5		10	80			5
Niches Land Trust		5			50	25		20
Northeast Chapter 7 Furtakers								

	Agricultural	Aquatic systems	Barren lands	Developed lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Conservation Partner	***Efforts by habitat type***							
Northeastern Indiana Trout Association		80		5				
Northern Indiana Public Service Company (NIPSCO) a Subsidiary of NiSource					10	25		10
Northwestern Indiana Regional Planning Commission (NIRPC)		25		25		10		10
Patoka River National Wildlife Refuge & Management Area		20			20	20		40
Pheasants Forever Inc.	40	15				25		20
Potawatomi Audubon Society								
Quail Forever								
Red-Tail Conservancy, Inc.					33	33		33
Robert Cooper Audubon Society	5	28	1	5	28	5	3	25
Sassafras Audubon Society		25			25	25		25
Save The Dunes Conservation Fund		35			10	10		25
Sierra Club Hoosier Chapter	15	40		15	5	5		20
South Bend-Elkhart Audubon Society		10-20?				10-15?		10-20?
St. Joseph County Soil & Water Conservation District (SWCD)	70	3		15	3	4		5
St. Joseph River Watershed Initiative	35	36	1	7	7	7		7
Steelheaders of Northwest Indiana (Northwest Indiana Steelheaders)		70		20				10
Summit Lake State Park		10		20	10	20		
Sycamore Land Trust	10				30	10		10
The Indiana Audubon Society					90	10		
The Nature Conservancy	10	10	5		20	20	10	25
Tippecanoe Audubon Society					40			
Trillium Land Conservancy, Inc.		25			25	25		25
U.S. Army Corps of Engineers Regulatory Branch, Louisville District (Please Note This Is Only a Part of The Larger Organization and While The Greater Organization May Be Involved In Areas Not Noted Below, Our Answers Are Specific To The Regulatory Program		X						X
U.S. Department of Agriculture, Forest Service Hoosier National Forest		5	5	5	65	10	5	5
U.S. Fish and Wildlife Service - Indiana Private Lands Office					10	30		60
US Fish and Wildlife Service Ecological Services (Does Not Include National Wildlife Refuges)	10	25	5	15	10	5	5	25
USDA Natural Resources Conservation Service	X	X			X	X	X	X

	Agricultural	Aquatic systems	Barren lands	Developed lands	Forest lands	Grasslands	Subterranean systems	Wetlands
Conservation Partner	***Efforts by habitat type***							
Valparaiso Lakes Area Conservancy District		25		10				5
Valparasio Chain of Lakes Watershed Group, Inc.		30		10	10			50
Veolia Water Indianapolis, LLC	10	45		25	5	5	5	5
Wabash River Heritage Corridor Commission	10	40		25	5			20
Wawasee Area Conservancy Foundation, Inc.		10			10	10		70
Whitewater Valley Land Trust, Inc.	15	10		0	60	5	0	10
Total number of partners	50	83	21	48	74	60	21	84
Average time spent (%)	8	18	0.8	7	17	7	2	15
Land coverage (%)	55	2	0	4	23	15	N/A	1

XII. Proposed Plans for monitoring with Time Lines or Schedules Indicated

Wildlife conservation and management is intended to provide stable, self-sustaining populations of native wildlife. Therefore, habitat and species monitoring projects contribute to two important aspects of the planning cycle: the inventory stage that tallies the state's raw materials for conservation and the evaluation stage that assesses the success of conservation efforts.

A. Species Monitoring

The DFW has operated under a planned management system for over 20 years and has a long history of monitoring species (Table 12). Based on inquiries received by DFW, the public expects the state to have some knowledge of the abundance and status of wildlife. Due to federal support for survey/monitoring activities, inventory data have been more readily available for game and sport fish species. Readily observable bird species have benefited from longstanding bird survey protocols that provide population trend data. Survey protocols for other nongame species have increased in Indiana in the last two decades but are often limited in geographic coverage and of short duration. Individual records of SGCN are entered into the Heritage Database, maintained by the Division of Nature Preserves. These records are seldom the result of statewide or regional survey efforts; rather more limited studies or accidental encounters. However, the Heritage Database represents the most enduring and complete repository of general SGCN occurrence data available. Additional survey and monitoring and data sharing efforts are needed.

Element 5 of the CWS Congressional guidelines requires that species monitoring needs be identified. Review of current monitoring efforts was an important component in identification of additional monitoring needs. Through the expert survey we attempted to determine awareness of species monitoring efforts conducted by the state and other entities. Table 13, derived from the Technical Expert Survey, is an account of the awareness of species survey and monitoring efforts conducted in Indiana by the state or other organizations. In all species groups, except amphibians, species monitoring by the state exceeded species monitoring by all other organizations. All amphibian monitoring conducted by others (other than the state) were local or regional efforts. Additionally, the expert respondents recognized that state monitoring efforts were conducted more often, on a more regular schedule, and tended to be extensive state or range-wide efforts. Monitoring by other organizations tended to be less frequent and more regional or local in scope (Appendix E 1-78).

State monitoring efforts are used to determine species status, set harvest regulations, and prioritize conservation efforts. Historically, the majority of these surveys have been aimed at game or commercially valuable species. In addition to species status information, collectively, these surveys have provided insight into habitat and environmental health changes in Indiana. More recently, other monitoring efforts, mainly conducted or supported by the Nongame and Endangered Wildlife Program (currently the Wildlife Diversity Section), have provided population status information for a limited number of species with greatest conservation need. Implementing conservation actions needed to prevent species from declining to the point of being endangered requires early detection and intervention. Therefore, four distinct levels of species monitoring are essential for comprehensive conservation:

1. Monitoring of game, commercial, or common species.
2. Monitoring of indicator species in declining or at-risk habitats.
3. Monitoring of suspected at-risk species.

4. Monitoring of known species of greatest conservation need.
As long as appropriate, the Division of Fish and Wildlife will continue the monitoring efforts in Table 12. Monitoring efforts in categories two through four above are the purview of this CWS and are directly related to the detection (determine the conservation status of a species) or monitoring of SGCN.

The DFW does not have statutory authority for insects. As a result, insects were not included in habitat guilds. Indiana has developed a list of rare insects based largely on the serendipitous results of various insect taxa experts conducting fieldwork in Indiana (Table 1). As a general trend, rare insects occur in rare habitats. Correspondingly, staff to address the needs of federally endangered insects in Indiana has come from the Division of Nature Preserves (DNP). In Indiana, the DNP has responsibility for rare plants and plant communities. The DFW works with the DNP to protect and manage rare habitats and the species, including insects that depend upon them. As resources (funds, expertise, etc.) permit, a more comprehensive insect inventory should be pursued.

Pursuant to Element 5 of the CWS Congressional guidelines, DFW sought to identify gaps in species monitoring coverage. This included consideration of monitoring technique development. At this time, reptiles (and to lesser extent mussels) are under-monitored species groups by both the state and non-state agency groups (Table 13). Most of these identified needs would benefit from standardized monitoring efforts that would make inter-state or regional comparisons possible. To date, only bird and fish survey efforts seem to have achieved some measure of standardization. Bird monitoring efforts likely benefit from the unifying influence of federal control under the Migratory Bird Treaty Act. Fish monitoring efforts are often related to game fish management needs or environmental monitoring. Considerable effort has been expended to establish standardized fish sampling and analysis protocols relative to water and environmental quality monitoring. Undoubtedly, the use of fish in environmental monitoring has contributed to a better understanding of fish abundance and distribution. Monitoring efforts for amphibians, (especially salamanders), all reptiles and mussels need to be increased. However, to improve the efficiency of increased monitoring, standardized protocols that allow comparison of population trends between state, regions and sample areas is desirable. It is likely that similar monitoring needs and the need to standardize protocols were identified nationally in most state strategies. Indiana intends to participate in national or regional efforts to develop effective, efficient and standardized protocols for species or species groups identified in Table 13, especially amphibians, mussels and reptiles. If these multi-jurisdictional efforts at protocol standardization are not forthcoming, then IDNR will facilitate an intra-state effort to develop suitable protocols.

New monitoring techniques may be needed for specific SGCN, especially cryptic or fragile species. In general, the expert comments on the questionnaire called for increased efforts using established survey procedures (Appendix F 1-78). There were species-specific exceptions. New techniques will have to be developed for some sensitive species or species using specialized habitats, such as burrows in bogs. The Indiana CWS supports the development of new survey/monitoring techniques and the standardization of survey protocols that facilitate comparison.

Table 14 provides a list of anticipated survey/monitoring needs, derived from expert comments provided on the questionnaire and from DNR biologists. Additional information is located in Appendix M. Element 5 of the Congressional guidelines required this list. The degree to which

these survey and monitoring efforts are implemented and the schedule (plan) for implementation depend upon a variety of factors, including funding and available expertise. In response to new information, regional or national priorities, or efficient inventory opportunities, this list may be amended to provide for efficient, effective conservation. Given the magnitude of the inventory needs, use of properly trained citizen volunteers is an attractive option for certain species. Efforts should be applied to determination techniques and protocols that can be successfully conducted by volunteers provided only limited training. Method of data verification and volunteer recruitment and retention also need to be explored. A successful volunteer program is expected to require the full-time attention of one or more volunteer coordinators, provided either by the state or a conservation partner.

Table 12. Current species monitoring efforts conducted by the State (DFW).

Species Group	Survey Name	Schedule	Area
Game	Archers Index – beaver, bobwhite, coyote, deer, fox squirrel, gray fox, gray squirrel, ruffed grouse, feral; cat, muskrat, opossum, rabbit, raccoon, red fox, skunk, and turkey	Annual	Statewide
	Dove	Annual	Statewide
	Duck - breeding	Annual	Statewide
	Goose-breeding survey	Annual	Statewide
	Goose - neck collar	Annual	Statewide
	Grouse - driving drumming counts	Annual	Southern Indiana Forest
	Grouse – drumming counts	Annual	Maumee study area
	Landowner survey – similar to the small game license survey below but for the 'unlicensed' sportsperson	Annual	Statewide
	Quail	Annual	Statewide
	Pheasant	Annual	Statewide
	Pheasant broods	Annual	Northern Indiana
	Raccoon –road-killed	Annual	Statewide

	Small game license holder survey - bobwhite quail, cottontail rabbits, fox squirrels, gray squirrel, mourning dove, pheasant, woodcock	Annual	Statewide
	Turkey	Annual	Northern Indiana
	Turkey – occurrence	As reported	Recent transplant areas
	Woodcock	Annual[1]	Statewide
	Wood duck - banding	Annual[1]	Statewide
	Wood duck - brood	Annually	Statewide
	Wood duck – nest box survey	Annual	On selected state properties
Sport Fish	Game and commercially valuable fish	Annually	Statewide in selected streams, lakes and reservoirs on a rotating schedule.
Amphibians	Anurans - calling frogs and toads *	Annual [1]	Statewide
	Crawfish frog *	Periodic (< 5 yr interval)	Southern Indiana
	Green tree frog *	Periodic (< 5 yr interval)	Southern Indiana (as range expands)
	General salamander *	Periodic (< 5 yr interval)	Fish and Wildlife Areas
	Hellbender *	Annually	Southern Indiana
	Mole Salamader *	Periodic (< 5 yr interval)	Southeastern Indiana
	Spadefoot toad *	Periodic (< 5 yr interval)	Southern Indiana
Birds	Bald eagle – nesting *	Annually	Statewide
	Bald eagle – wintering *	Annually	Statewide

	Barn owl *	Periodic	Statewide, some nest sites each year
	Breeding birds – atlas *	20 year cycle	Statewide
	Breeding birds – summer counts *	Annually with volunteers	Statewide
	Breeding birds – survey *	Annually[1]	Statewide (random routes)
	Colonial waterbird survey *	Periodic (< 5 years)	Statewide
	Least tern *	Annually	Southwest Indiana
	Osprey *	Annually	Statewide
	Peregrine Falcon	Annually	Statewide
Mammals	Allegheny woodrats	Periodic (< 4years)	Extreme southern Indiana
	Archer Index – bobcat, badger, river otter *	Annually	Statewide
	Bobcats – occurrences *	Annually – as reported	Statewide
	Badgers – occurrences *	Annually – as reported	Statewide
	Franklin Ground Squirrels *	Periodic (< 10 year intervals	Northwestern Indiana
	Indiana bats- winter hibernacula census *	Biennially	Caves in southern Indiana
	River otter – bridge /stream survey *	Annual	Statewide
	River otters – occurrences *	Annual – as reported	Statewide
	Swamp rabbits *	Periodic (< 10 year intervals	Southwestern Indiana
Mussels	Mussel (focus on former commercial species) *	10-12 year interval	Big rivers in central and southern Indiana
Fish	Lake sturgeon *	Annual	Big rivers in southern Indiana
	Nongame Fish *	Continuous	Statewide

Reptiles	Box turtle *	Annually	Statewide with emphasis on South-central Indiana
	Kirtland Snake *	Annually	Statewide
	Timber rattlesnake *	Periodic (< 5 yr interval)	South central Indiana
	Mud turtle *	Periodic (< 5 yr interval)	Southeastern Indiana
	Snapping turtle *	Periodic (< 5 yr interval)	South central Indiana
	Wall lizard *	Periodic as reported	Potentially statewide

* Efforts include Species of Greatest Conservation Need
[1.] Conducted under a national or regional protocol.

Table 13: Percentage of respondents aware of various monitoring efforts by state agencies and other organizations for species groups in all habitats.

Species group	State efforts	Other Organization Efforts
Amphibians	12.5	15.6
Birds	28.3	22.2
Fish	30.2	10.1
Mammals	18.5	7.4
Mussels	15.0	12.5
Reptiles	12.5	4.9

Table 14. Suggested survey, monitoring, survey technique, survey protocol, and database needs for wildlife species in Indiana.

Species Group	Species	Schedule	Area	Associated database needs
Amphibians	Salamanders	Annual	Statewide	Yes
Birds	Migratory stopover sites	Annual	Selected migratory stopover sites	Yes
	Nesting habitat searches	Annually	Selected habitats	Yes – part of Statewide Bird DB
	Owls and Nightjars	Annually	Statewide in suitable habitat	Yes – part of Statewide Bird DB
	Rails, bitterns, and shorebirds	Annually	Statewide in appropriate wetlands habitat on a regular cycle	Yes – part of Statewide Bird DB
Cave Invertebrates	Cave invertebrates	Continuous	Selected cave systems on a regular cycle	Yes

Species Group	Species	Schedule	Area	Associated database needs
Fish and Mussels	Freshwater mussels	Annually	A subset of Indiana's small steams on a 5-10 year rotation	Yes
Insects	General insect survey	Continuous	Selected rare habitats on a regular cycle	Yes
Mammals	Bats (summer)	Annual	Portions of the state on a regular cycle	Yes
	Bats (winter)	Annual	Known or suspected bat caves on a schedule. (except *Myotis sodalist* caves)	Yes
	Small mammals (shrews, mice and voles)	Annual -	Statewide - representative habitats, by county on a regular cycle	Yes
	Trapper survey (otter , bobcat, and badger)	Annual	Statewide	Yes
Reptiles	Lizards	Annual	Statewide or by county on a regular cycle	Yes – part of statewide reptile DB
	Snakes	Annual	Statewide or by county on a regular cycle	Yes – part of statewide reptile DB
	Turtles	Annual	Statewide or by county on a regular cycle	Yes – part of statewide reptile DB
General surveys	Surveys of species most in need of conservation, especially in certain habitats.	Annually	Statewide in appropriate habitats on a regular cycle	Yes – part of the Heritage Database (HD)
	General prey inventories,- insect, small mammals, amphibians, etc.	As needed	Specific study sites	No – include in study report
State Land Surveys	General Nongame survey - All nongame wildlife and insects	Annually	DNR properties	Yes – could be part of each area's database and the HD
Additional Database needs	Bird sighting database	Continuous	Statewide	Yes – could be part of a statewide bird database
	(Pit tag database			Yes
	Bat Band Database			Yes
	Road kill database (all vertebrate species)	Annually	Statewide (selected roadways on an established cycle	Yes
	Wildlife disease	Continuous	Statewide	Yes
	Wildlife rehabilitation	Annual	Statewide	Yes
	Window, cell tower and windmill bird and bat kill database	Annual	Statewide	Yes – could be part of a statewide bird database

B. Habitat Monitoring

Habitat inventory and monitoring has been less deliberate and frequent than species monitoring. In the past, the DNR and the public have depended upon a disjunct collection of separate inventories (e.g., the 10-year USDA Forest Service Forest Inventory and Analysis, National Wetland Inventory, rare community entries in the Heritage Database and others), and specific habitat measures collected in association with specific species inventory surveys. More recently, in aquatic systems, collection of corresponding habitat data has been an important component of sampling protocols aimed at aquatic community assessment such as the Index of Biotic Integrity (IBI), which classifies species in part by their habitat requirements, and the Qualitative Habitat Evaluation Index (QHEI) which directly describes habitat characteristics. However, most of these efforts collect data on a limited number of indicator parameters, in selected portions of streams, lakes, or reservoirs. Even the systematic efforts of the EPA and USGS in Indiana fail to provide a complete picture of aquatic system habitat in Indiana.

Monitoring plans for habitats required by species with greatest conservation need as required by Element 3 of the Congressional guidelines has been hampered by an inability to precisely define the habitat type or component upon which the species depends. Monitoring distribution and abundance of major habitat types to provide baseline data for future comparisons provides a critical foundation.

This CWS effort is the first comprehensive effort by the state to acquire statewide habitat data. A team of specialists, led by four scientists at Indiana State University, will provide either a quantitative measure or an index of over 80 habitat features. Measures for major habitat features will be based on analysis of Landsat 7 Enhanced Thermal Mapper plus (ETM+) or Terra's Advanced Space-borne Thermal Emissions Reflection Radiometer (ASTER) digital data projects for Indiana. Additionally, ISU is to provide a historic overview of the changes in the eight major habitat categories in Indiana from pre-European settlement to present, in hundred-year intervals, with associated changes in fauna. The current habitat analysis and the historic overview are to be presented in a format suitable for publication as a reference book. This effort will be completed in the spring of 2006. The habitat analysis effort will be adequately documented so that the process maybe replicated in the future to allow for fully comparable sequential analyses.

Thus, a habitat baseline will be established for Indiana at the beginning of this century against which changes may be documented. Every major revision of the CWS (likely 10-year intervals) will include a replication of the habitat analysis. However, factors affecting habitats and our understanding of species/habitat interactions change. As an understanding of these factors develops, so does the need to measure specific habitat characteristics. DNR biologists, species experts and conservation partners identified additional habitat survey and monitoring needs. Table 15 and Appendix N provides a list of additional habitat monitoring needs as required by Element 5 of the CWS Congressional guidelines. The degree to which these monitoring efforts are implemented and the implementation schedule (plan) depends upon a variety factors including funding and available technology and expertise. In response to new information, regional or national priorities, or availability of inventory opportunities, this list may be amended to provide for efficient, effective conservation. To accommodate adaptive management, additional habitat characteristics may need to be inventoried.

Table 15. Habitat monitoring needs and associated database.

Habitat Type	Habitat Feature	Schedule	Area	Associated database needed
All Habitats	Quantitative or index information on the total acreage, geographic distribution, patch size, native vs. non-native, vegetation diversity and relative abundance, ownership, and relative condition of the habitats.	Once per decade	Statewide	Yes
All Habitats	Invasive animals and plants	Continuous	Statewide	Yes – including treatment information and results
All Habitats	Soil maps	Continuous	Statewide	Yes
All Habitats	Land cover/land use	As available	Statewide	Yes
Agricultural	Agricultural statistics	Annual	Statewide	Yes
Aquatic Systems	Aquatic systems - bottom substrate and contour	Continuous	Statewide	
Aquatic Systems	Environmental contaminants in waterways	Some streams should be monitored annually others on a rotating schedule	Statewide	Yes
Barren lands	Rock outcrops	Continuous	Statewide	Yes
Forest lands	Forest statistics	As available, large public landholding should be monitored annually	Statewide	Yes
Subterranean systems	Cave locations, cave recharge areas, and general karst feature inventory	Continuous	Southern Indiana	Yes
Wetlands	Restored Wetlands	Continuous	Statewide	Yes

C. The Effectiveness of the Conservation Actions Taken

Conservation actions should be based on the best available science. Element 5 of the CWS Congressional guidelines addresses the need for adapting conservation actions in response to new information or changing conditions. To allow for adaptive management, successful survey and monitoring efforts have two necessary components: the technically proficient conduct of survey/monitoring protocols and the effective dissemination of results. Both steps are necessary to direct and evaluate the effectiveness of the conservations actions undertaken. The survey/monitoring efforts proposed by the CWS relate to the identification of SGCN (especially early identification), identification of threats to these species and their habitats, monitoring known SGCN, and evaluation of conservation actions. The purpose of survey/monitoring activities is to detect population or habitat change. All partners, including the DFW, are expected to respond appropriately to detected change and adapt their conservation activities. Therefore, all partners involved in the implementation of the CWS have the same responsibility—to conduct well-designed inventory protocols in a technically proficient manner and to make the results of the survey/monitoring efforts available to other partners and interested

parties. The DNR will conduct species and habitat survey/monitoring efforts as resources allow (including, but not necessarily limited to those identified in Tables 12, 14, & 15) and to participate, as appropriate, in regional or national monitoring programs. Along with the results, all aspects of the inventory necessary to the responsible interpretation of the effort will be made available to the partners and other interested parties on an Internet site. Partners are urged to provide their survey/monitoring efforts in a similar manner. Additionally, the DFW will continue to provide relevant data to the Indiana Heritage Database. Easily accessed, timely inventory information will allow conservation partners and other interested parties to track progress towards conservation goals and to apply adaptive management where appropriate. Information sharing by all partners will facilitate the application of accurate, timely information to the environmental review process.

Individual conservation goals set by partners may have specific timelines. The success of these efforts may be evaluated by the available monitoring efforts as appropriate to their specific timeline. The effectiveness of the entire 2005 CWS will be evaluated and addressed in subsequent reviews of this document (not to exceed 10 years as delineated in required item 6)

XIII. Coordination of Conservation Actions Among Relevant Federal, State, Local Agencies, and Other Public and Private Partners

Following the guidance provided in Element 7 of the Congressional Guidelines, the development of the 2005 Indiana CWS was coordinated from its inception with input from federal, state and local conservation agencies that manage significant land and water areas within Indiana or administer programs that significantly affect the conservation of identified species and habitats. Input was solicited from scientists associated with the major land holding and land managing federal and state agencies in Indiana and local and national land trusts operating in the state (See Chapter VI). There are no recognized Indian tribes in Indiana. Presentations were made to DFW staff and DNR executives to ensure that internal audiences were cognizant of this effort. Federal agency staff, NGO staff and university-based experts were contacted by phone and briefed on the CWS mandate and Indiana's approach. Additionally, over 570 potential partners, including federal, state and local agencies, were contacted and e-mailed an electronic survey to determine the nature of their capacity to partner on conservation actions and their area of wildlife or habitat interest (see page 19 for survey methods and survey instrument description). As the CWS developed, additional opportunities were provided for input and review through online reviews, telephone interviews, as well as through face-to-face meetings with significant land and water management agencies and organizations. Where appropriate the CWS was revised based on comments received during draft CWS review and comments received are included in Appendix F 1-78.

XIV. Use of New Information to Adapt Conservation Action During Implementation

Following the guidance provided in part of Element 5 of the Congressional Guidelines (page 13) conservation actions will be adapted by responding appropriately to new information or changing conditions. The Indiana CWS process and associated electronic tools have been designed from the outset to provide a mechanism for gathering baseline information in a format that can be updated as needed. The system has established an extensive database of contact information that reflects the current knowledge base in the state of Indiana, both in regard to technical expertise and conservation partnership opportunities. It truly lays the groundwork for more expansive collaboration and information sharing as new knowledge, tools, and concepts are developed in the future.

The congressional requirement for the development of Conservation Wildlife Strategies in coordination with all levels of potential conservation partners has firmly established an unprecedented level of responsibility for all conservation partners to share information at to work efficiently towards common goals. This is the first time in history that Indiana has strategically assessed habitats, wildlife species and conservation partners. The sheer magnitude of the conservation needs identified herein underscores the need to coordinate conservation actions based on the best available science.

Implementation of the 2005 CWS will be guided by an action plan to be developed with partner input in early 2006 with the potential for each partner to design coordinated work plans in accordance with the direction set in the state action plan. Conservation minded entities will no longer have the luxury—or limitations—of working in isolation. While they may be exposed to increased scrutiny from conservation colleagues, they will also receive more credit for efforts that may currently go unnoticed.

The DFW is committed to the promotion of communication and information sharing, using the best available communications technology, and urges all our conservation partners to engage in this dialogue. Nyberg and Taylor 1995 define adaptive management in its simplest form as "a strategy for generating reliable information—that is, for learning—from resource management actions". Through web based sharing of habitat and species monitoring efforts, participation in professional organizations, and enactment of the implementation action plan, the DFW will facilitate the sharing of reliable information to form the scientific foundation of adaptive management. Communication between partners, as the implementation of the action plan proceeds, will ensure that conservation actions respond appropriately to new information or changes in condition.

However, "adaptive management" also describes a more complex process that acknowledges uncertainty in management policies and practices and uses experimental design to develop and test alternative hypothesis relative to these policies or practices. There are many barriers to the application of complex, active adaptive management (Nyberg and Taylor 1995, Prato 2005). For example, basing the selection of the best management alternative for rare or endangered wildlife or habitats on experimentation is not always appropriate or consistent with environmental regulations such as the National Environmental Policy Act (Prato 2005). However, where possible and applicable the DFW can model desirable aspects of complex adaptive management

to address management decisions in the light of uncertainty. By careful and appropriate application of adaptive management elements such as: rigorous hypothesis and/or assumption identification, project design including experimental and control replicates, monitoring key response indicators, and documentation and dissemination of results for learning, the DFW can demonstrate the path to improved management practices.

Effective conservation is the product of biological, social and political forces and is fraught with uncertainty in all areas. The implementation of Indiana's Action Plan under the influence of adaptive management concepts and principles provides an approach for dealing with uncertainty, which will speed learning and thus provide a framework in which to explore management alternatives and foster trust among partners. More effective management policies and practices will be adopted as new information is learned thus Indiana's CWS will be in a constant state of revision and improvement.

XV. Future Strategy Revision and Update

A. Coordination with relevant individual federal, state, and local agencies and Indiana Tribes

Element 6 of the Congressional Guidance (page 13) directs that Strategies be reviewed at intervals not to exceed 10 years. Element 7 provides direction to ensure that Strategies provide effective dynamic guidance by requiring ongoing coordination with partners in the review, revision and implementation of the strategy. Indiana has identified a large number of potential conservation partners to implement this strategy. Indiana's CWS was specifically designed to facilitate the formation of conservation partnerships during the implementation of the strategy.

The matrix of conservation partners, Table 11, provides information to allow partners to locate other conservation groups with similar habitat or wildlife species focus. Partner survey responses provide detailed information the resources and capacity of these organizations to implement conservation actions, including preferred methods of communication and contact information. The state has never before had such a complete database of conservation organizations, providing an enhanced conduit for continued interaction as implementation proceeds.

The magnitude of the conservation needs identified in the CWS is such that the logical next step is to provide more focus for implementation. This focus can be accomplished by the development of an action plan in coordination with conservation partners and in consideration of available implementation resources. In early 2006, all partners (including relevant individual federal, state and local agencies and other conservation partners) will be invited to develop an operational plan (action plan) for implementation of the 2005 CWS. These partners will be encouraged to participate to the greatest extent possible and to assist in the dissemination of information relative to the implementation of the CWS. Information gathered via the electronic partnership survey (page 19) and presented in Appendix H will allow partners to recognize where organizations and resources can come together to address conservation needs.

All active partners are expected to claim conservation actions appropriate to their goals and objectives and to provide performance measures for their efforts. Review and revision of Indiana's 2005 CWS based on the partner's self-determined performance measures is expected to be an ongoing activity. A great deal of insight is expected to result from the ongoing iterative process of the action plan that includes implementation of conservation actions, evaluation, strategy revision, and adaptation. These insights will be applied to the next major revision of the Indiana CWS.

The next major revision of the CWS is scheduled for completion before 2015 and is expected to build on the 2005 effort and to benefit from over 8 years of experience gained from the implementation of this CWS. The 2005 Indiana CWS was developed to establish baseline information on the distribution and abundance of wildlife in Indiana, including species of greatest conservation need, the habitats upon which the species depend and the threats to the species and their habitats, and research and monitoring needs. The online surveys used to gather information on these elements can be updated and used to replicate this study at regular intervals to track the progress of Indiana's conservation efforts. Comparison of the 2005 and 2015 results will provide the best long-term evaluation of the conservation efforts guided and supported by this congressionally mandated and funded strategic process.

B. Obtaining Public Input and Partner Involvement

A web site was created and maintained throughout the development of the CWS to facilitate public participation and information sharing about all aspects of this process as required by Element 8 of the Congressional Guidance. News releases, public presentations at professional meetings and web links were used to direct the public to the CWS web site. The public was invited to provide comment on the draft plan in September 2005 and those comments are included in Appendix O. The draft Indiana Comprehensive Wildlife Strategy was made available for public comment between July 24th and September 21st 2005. The following partners utilized press kit materials to generate awareness and solicit public comment on the DRAFT Indiana Comprehensive Wildlife Strategy. The partner either posted an article on its website with a link to the draft strategy, put an article in its newsletter directing readers to the CWS website to review the strategy, wrote an article for a daily newspaper referencing the press kit or provided information about the strategy at its facility for the public to take home.

- Muncie Star
- Dunes-Calumet Audubon Chapter
- Merry Lea Environmental Learning Center of Goshen College
- Indiana Wildlife Federation
- Indiana Academy of Science
- Robert Cooper Audubon Society
- Indiana Forestry and Woodland Owners Association
- Central Indiana Land Trust

Numerous other partners presented the materials to members during monthly meetings and encouraged members to visit the website to provide comment on the DRAFT strategy. According to Webtrends, the website tracking service, the Draft Indiana Comprehensive Wildlife Strategy was downloaded over 2,800 times during this time period.

Partner organizations communicate with their members and the public in various ways, such as newsletters, member letters, e-mail or website updates. All partners will be encouraged to report to their respective audiences on their activities and the progress of the 2005 CWS implementation. The contractors DFW hired to assist with the development of the CWS will also facilitate the development of the 2005 CWS action plan and provide guidance to the partners on how to communicate their activities to the public. Conservation partners that responded to the electronic partner survey were re-contacted regarding their methods of member and supporter communications. Partner groups will be provided with factual information regarding their potential involvement in implementing the CWS for expanded dissemination to their members and supporters. For broad public consumption, the DFW is committed to providing an Internet site with progress reports on the implementation of the 2005 strategy. Members of the public wishing to participate in the implementation of the CWS will be directed to contact the DFW or relevant partners.

XVI. Glossary

Abundance - The number of individuals of a particular species.

Acidification - To make or become acidic. For example, mine waste can cause acidification of streams by lowering the pH of the water below 7.0.

Aggregated - A totaling of all data received relative to a designated factor.

Agriculture - Lands devoted to commodity production, including intensively managed nonnative grasses, row crops, fruit and nut-bearing trees.

Aquatic Systems - All water habitats (both flowing and stationary) in Indiana, including lakes, reservoirs, rivers, streams and other waterways, but excluding wetlands.

Barren Lands - Lands dominated by exposed rock or minerals with sparse vegetation.

Bioaccumulation - The accumulation of a substance, such as a toxic chemical, in various tissues of a living organism.

Biodiversity - The number and variety of organisms found within a specified geographic region. The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems.

Bogs - An area having a wet, spongy, acidic substrate composed chiefly of sphagnum moss and peat in which characteristic shrubs and herbs and sometimes trees usually grow. Bogs are usually acid areas, frequently surrounding a body of open water. Bogs receive water exclusively from rainfall.

Breeding range - The geographic region or area in which a species reproduces.

Buffer zone - An area maintained in a land use that provides a transition zone between two types of habitat. In conservation, buffer zones are neutral areas between wildlife habitat and areas that have been highly disturbed by humans. An area planted with a variety of grasses may be a buffer zone between a wetland and an urban development.

Candidate species - A species of plants or animals classified as a candidate for possible listing as endangered or threatened by a government agency.

Channelization - Straightening of a stream or dredging of a new channel to which the stream is diverted, resulting in the removal of its sinuosity (bends).

Community types - A group of populations or species that interrelate directly with each other and their specific environment. Characteristics used for identifying community types include factors such as water regimes, soils, substrate type, topographic position (elevation), plant species composition, and animal associations. Sixty-one community types have been identified within Indiana. Information on community types is maintained by the Indiana DNR Division of Nature Preserves.

Conservation - The protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water.

Conservation easements - A voluntary binding agreement that permanently limits a particular property to conservation-compatible uses.

Conservation practices - Specific actions taken to protect, preserve, manage or restore wildlife and natural resources. Examples include establishing wind breaks, streambank stabilization, and tree planting. Incentive programs may list the particular kinds of conservation practices for which cost-share funding is available.

Contaminant - A toxin, hazardous substance, or pollutant introduced into the environment through human activity, either directly or as a byproduct.

Culling - Selective removal of particular individuals from a population to achieve an overall improvement in the health of the population. Can be done to reduce overall population size or to remove only individuals with certain undesirable characteristics, such as those that are diseased or of a certain age or size class.

Degradation - A decline in conditions or characteristics of wildlife species or habitat to a lower condition, quality or level.

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

Distribution - The geographic area over which a species occurs.

Ecoregional planning initiative - A collaborative initiative launched by The Nature Conservancy (TNC) in the mid-1990s to identify high priority biodiversity conservation sites across North America.

Endangered Species - (federal classification) Any species that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species - (state classification) Any animal species whose prospects for survival or recruitment within the state are in immediate jeopardy and are in danger of disappearing from the state. This includes all species classified as endangered by the federal government that occur in Indiana.

Endemism - A native plant or animal by virtue or originating or occurring naturally in a particular place.

Extirpated - (state classification) Any animal species that has been absent from Indiana as a naturally occurring breeding population for more than 15 years.

Extrapolation - To infer or estimate by extending or projecting from known information by assuming that the estimated value or condition follows logically from known values.

Fens - A type of wetland ecosystem characterized by peaty soil, dominated by grasslike plants, grasses, sedges, and reeds. Fens are alkaline rather than acid areas, receiving water mostly from surface and groundwater sources.

Foraging areas - An area where animals look for food.

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

Fragmentation - Scattered or patchy distribution of a particular habitat type in an area that once was continuous habitat.

Genetic pollution - The dispersal of genes to natural organisms, especially by cross-pollination or introduction of closely related exotic species or genetically engineered organisms. Resulting progeny may be less well adapted to the local environment.

GIS - (Geographical Information System) A computer system for capturing, storing, checking, integrating, manipulating, analyzing, and displaying map-based data related to positions on the Earth's surface.

Grant reviewer - An individual or group that evaluates a grant proposal.

Grasslands - Open areas dominated by grass species (e.g., prairies or reclaimed mine lands).

Guild - The group of wildlife species associated with a particular habitat type.

Habitat - The type of environment in which an organism or group normally lives or occurs.

Hybridization - Interbreeding of different species or varieties of animals or plants, producing a genetic cross. In some cases, hybrids are sterile or produce offspring that are less well adapted to the environment.

Impoundment - A body of water, such as a reservoir, made by damming flowing waters.

Indiana Heritage Trust (IHT) - Established in 1992 to ensure that Indiana's rich natural heritage would be preserved and enhanced for present and succeeding generations. The purpose of the IHT is to acquire state interests in real property that are examples of outstanding natural resources and habitats or have historical or archaeological significance or provide areas for conservation, recreation, protection or restoration of native biological diversity within the state of Indiana. The use of the power of eminent domain to carry out its purposes is expressly prohibited. Property will be acquired only from willing sellers.

Invasive or non-native species - A species that is 1) non-native (alien or exotic) to the ecosystem under consideration *and* 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Iterative - Characterized by or involving repetition, recurrence, reiteration, or repetitiousness.

John Q. Public - Used as a name to designate a typical member of the general public.

Keystone partners - Organizations or agencies that identified themselves when they completed the conservation partner survey by indicating they wanted to be involved in the development of the CWS and that their organization had a large reach or significant impact on wildlife in Indiana.

Land trusts - A trust created to effectuate a real estate ownership arrangement in which the trustee holds legal title to the property that is significant for wildlife or habitat conservation.

Landholders - One that owns land.

Landscape-level conservation - Conservation of areas large enough to contain functioning ecosystems in which crucial natural processes take place. Processes like fire, flooding, and wildlife migration are essential to the health, biological diversity, and long-term sustainability of an ecosystem.

Mental surrogates - A species that provides a mental picture for the needs of a guild within a particular habitat.

Migration routes - The geographic route along which birds, fish or other species customarily migrate.

Monitoring - To keep track of systematically through collection of information.

Nonpoint source pollution - Pollution that comes from many diffuse sources, caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water.

Objectives - Something worked toward or striven for; a goal

Operational documents - Plans that specify particular actions, generally including the timing, cost, and responsible party for the action.

Partners - One that is united or associated with another or others in an activity or a sphere of common interest; organizations or individuals capable of supporting conservation actions.

Point source pollution - Pollution that generally comes from wastewater discharged from the pipes into rivers, streams, lakes, and the ocean. Examples include industrial facilities and municipal sewage treatment plants.

Press kit - A packaged set of promotional materials, such as photographs and background information, for distribution to the press, as at a news conference or before the release of a new product.

Professional societies - A nonprofit, cooperative, voluntary organization of persons joined by their interest and background in a professional, technical, or managerial field of work.

PSA - An announcement for which no charge is made and which promotes programs, activities, or services Federal, State, and Local Governments or the programs, activities or services of non-profit organizations and other announcements regarded as serving community interests.

Range - The geographic region in which a plant or animal normally lives or grows.

Regimes - Trends in the characteristics of a system, such as the typical changes in seasonal water flow or level.

Reintroduction - Restoring a wildlife species to a habitat type or area where the species was known to have existing in the past, but from which it had disappeared.

Relative abundance - The number of individuals of a particular species as a percentage of the total number of individuals in a given area or community.

Representative species - A wildlife species selected from a guild to "paint a reasonable mental picture of the associated habitat type" when presented to a diverse user group including biologists, the public, legislators, grant reviewers and other partners. The selected species would automatically generate an association with the habitat-related guild and a desire to protect, enhance or somehow improve that habitat as the strategy is implemented. Representative species also were used as mental tools to focus technical expert input on particular relationships between species and their habitats, as they considered research and conservation needs for these associations.

Restoration - Conservation actions taken to return a degraded habitat to a normal or healthy condition.

Savannas - Upland communities of scattered trees, typically oaks, above a ground layer of prairie grasses and forbs. Fire and periodic grazing naturally maintained most of the savannas of the Midwest. Black-oak savannah is the most endangered habitat type in Indiana.

Special concern - (state classification) Any animal species about which some problems of limited abundance or distribution in Indiana are known or suspected and should be closely monitored.

Species - A classification of related organisms that can freely interbreed.

Species of greatest conservation need - Animal species whose populations are rare, declining, or vulnerable.

Sprawl - Haphazard growth or extension outward, especially that resulting from real estate development on the outskirts of a city:

Staging sites - Particular geographic areas used by migrating species to stop as a group for resting along a migration route. Specific staging sites may be consistently used year after year by

the same species. For example, Jasper-Pulaski State Park is a staging site for the migration of sandhill cranes.

Subterranean systems - Surface openings of underground features and connected rooms and passages beyond natural light penetration, such as caves and “disappearing” rivers.

Stakeholders - One who has a share or an interest in the outcome of a planning or strategic process.

State Wildlife Grants (SWG) - A grant that provides funding to every state and territory to support cost effective conservation aimed at keeping wildlife from becoming endangered.

Stewards - An individual that practices the careful management of land usage to ensure natural systems are maintained or enhanced for future generations.

Stocking - To hatch, grow or transfer a group of individuals for release into a habitat for the purposes of establishing or augmenting a wildlife population.

Strategy - A documented process to systematically identify and begin to integrate the broad range of efforts that conserve wildlife and the habitats upon which they depend. A framework for maximizing conservation efforts across the state that fulfills eight elements required for funding through the federal State Wildlife Grant program. Not an operational plan, in that it does not identify specific tasks, assignments, or schedules for achieving wildlife conservation. .

Successional change - The gradual and orderly process of ecosystem development brought about by changes in community composition and the production of a climax characteristic of a particular geographic region.

Synergy - Interaction among qualities in the environment that produce an enhanced combined effect, such as a combination of reproductive and habitat factors affecting species survival and distribution.

Systematic - Carried on using step-by-step procedures.

Talus slopes - A sloping mass of rock debris at the base of a cliff.

Taxa - A taxonomic category or group, such as a phylum, order, family, genus, or species

Taxonomic groups - Animal or plant groupings that show evolutionary relationships between organisms.

Technical expert - A person with specific knowledge or expertise regarding species or habitats found within the state of Indiana.

Terrestrial - Of or relating to or inhabiting the land as opposed to the sea or air.

Territory - A defined area (including land and waters) in possession of and defended by an animal.

Threatened species (federal classification) - Any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Threatened species (state classification) - There is no legal classification for state-listed threatened species.

Toxin - A poisonous substance introduced through pollution.

Wetlands - Areas shallowly flooded temporarily or permanently to cover the base of plants but not prolonged inundation of the entire plant; areas temporarily flooded often supporting aquatic plants and animals; areas temporarily or permanently flooded with woody vegetation taller than 6 meters; areas of usually shallow wetlands dominated by non-woody plants such as cattail, reeds or rushes; areas with moist non-vegetated soil, often produced in shallow wetlands by advance and retreat of water levels; areas permanently flooded and often supporting aquatic plants and animals; and areas flooded temporarily or permanently with woody vegetation shorter than 6 meters.

XVII. References and Acknowledgments

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Conservation Partners:
ACRES, Inc.
American Consulting, Inc.
American Society of Landscape Architects, Indiana Chapter
Amos W. Butler Audubon society
Aquatic Weed Control
Arrow Head Country Resource Conservation & Development Area, Inc.
Bartholomew County Conservation Council, Inc.
Big Oaks National Wildlife Refuge, USFWS
Blue Heron Ministries, Inc.
Center for Urban Policy and the Environment
Central Hardwoods Joint Venture/American Bird Conservancy
Central Indiana Land Trust
Central Indiana Trout Unlimited
Cinergy Corp.
Clark's Valley Land Trust
Cordry Sweetwater Conservancy District

Crooked Creek Conservation & Gun Club, Inc.
Division of Fish and Wildlife
DNR Division of Nature Preserves
Ducks Unlimited, Inc.
Dunes-Calumet Audubon Chapter
Earth Source, Inc.
EnviroScience Incorporated
Federal Highway Administration (FHWA)
Fish Lake Conservancy District
Four Rivers Resource Conservation & Development Area
Fur takers of America chapter 7-E North West IN.
Fur Takers of America, Inc
Great Lakes Commission
Hamilton Lake Conservancy District
Hoosier Conservation Alliance
Hoosier Environmental Council
Hoosier Heartland Resource Conservation and Education council
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)
Indian Deer Hunters Association
IN DNR, Division of State Parks & Reservoirs, Interpretive Services
Indiana Academy of Science
Indiana Association of Cities and Towns
Indiana Association of Soil and Water Conservation Districts
Indiana Bass Chapter Federation
Indiana Beaglers Alliance
Indiana Beef Cattle Association
Indiana Biodiversity Initiative
Indian University - School of Public and Environmental Affairs
Indiana Chamber of Commerce
Indiana Department of Natural Resources, Division of Forestry, Properties Section (State Forests)
Indiana Department of Natural Resources, Division of Outdoor Recreation
Indiana Department of Transportation
Indiana Division of the Izaak Walton League of America
Indiana Dunes National Lakeshore
Indiana Environmental Institute
Indiana Forest Industry Council (IFIC)
Indiana Forestry and Woodland Owners Association
Indiana Forestry Educational Foundation
Indiana Grand Kankakee Marsh Restoration Project
Indiana Hunter Education Association
Indiana Karst Conservancy
Indiana Land Resources Council
Indiana Michigan Power and affiliate of American Electric Power; Land Management Department
Indiana Native Plant and Wildflower Society
Indiana Pork Producers Association
Indiana Quail Unlimited

Indiana Rural Water Association
Indiana Smallmouth Club (ISC)
Indiana Soybean Board (ISB) & Indiana Soybean Growers Association (ISGA)
Indiana Sportsmen's Roundtable
Indiana State Trappers Assoc.
Indiana Watershed Leadership (new initiative) with Purdue University
Indiana Wildlife Federation
Indianapolis Flycasters
Indianapolis Power & Light Co.
JFNew and Associates
Kankakee River Basin Commission
Lake Bruce Conservancy district
Lake Lemon Conservancy District
Lake Maxinkuckee Environmental Council (LMEC)
Lake McCoy Conservancy District
Law Enforcement Division, Indiana Department of Natural Resources
Lincoln Hills RC&D
Little River Wetlands Project, Inc.
Lost River Conservation Association
Mason & Hanger Corp. Newport Chemical Depot
Merry Lea Environmental Learning Center of Goshen College
Midwest Peregrine Falcon Recovery Project
Muscatatuck National Wildlife Refuge US FWS
MWH Americas, Inc.
National Audubon Society - Indiana Important Bird Areas Program (IBA)
National Wild Turkey Federation
Naval Support Activity Crane
NICHES Land Trust
Northeast Chapter 7 Furtakers
Northeastern Indiana Trout Association
Northern Indiana Public Service Company (NIPSCO) a Subsidiary of NiSource
Northwestern Indiana Regional Planning Commission (NIRPC)
Patoka River National Wildlife Refuge & Management Area
Pheasants Forever Inc.
Potawatomi Audubon Society
Red-tail Conservancy, Inc.
Robert Cooper Audubon Society
Sassafras Audubon Society
Save the Dunes Conservation Fund
Sierra Club Hoosier Chapter
South Bend-Elkhart Audubon Society
St. Joseph County Soil & Water Conservation District (SWCD)
St. Joseph River Watershed Initiative
Steelheaders of Northwest Indiana (Northwest Indiana Steelheaders)
Summit Lake State Park
Sycamore Land Trust
The Indiana Audubon Society
The Nature Conservancy

Tippecanoe Audubon Society
Trillium Land Conservancy, Inc.
U.S. Army Corps of Engineers Regulatory Branch, Louisville District
U.S. Department of Agriculture, Forest Service, Hoosier National Forest
U.S. Fish and Wildlife Service - Indiana Private Lands Office
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)
USDA Natural Resources Conservation Service
Valparaiso Lakes Area Conservancy District
Valparasio Chain of Lakes Watershed Group, Inc.
Veolia Water Indianapolis, LLC
Wabash River Heritage Corridor Commission
Wawasee Area Conservancy Foundation, Inc.
Whitewater Valley Land Trust, Inc.

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