NATURAL LAKES HABITAT NARRATIVE

Habitat description

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.

Problems affecting species and habitats

Species threats

Respondents ranked threats wildlife in natural lakes habitat in Indiana:

Rank	Threats to wildlife in natural lakes habitat
1	High sensitivity to pollution
2 (tie)	Habitat loss (feeding/foraging areas)
2 (tie)	Viable reproductive population size or availability
3	Specialized reproductive behavior or low reproductive rates
4 (tie)	Habitat loss (breeding range)
4 (tie)	Near limits of natural geographic range
5	Predators (native or domesticated
6 (tie)	Small native range (high endemism)
6 (tie)	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
6 Tie)	Dependence on irregular resources (cyclical annual variations0 (e.g. food, water, habitat limitede due to annual variations in availablilty
6 (tie)	Invasive/non-native species
7 (tie)	Bioaccumulation of contaminents
7 (tie)	Regulated hunting/fishing pressure (too much)
8 (tie)	Species over population
8 (tie)	Dependence on other species (mutualism, pollinators)
8 (tie)	Diseases/parasites (of the species itself)

Respondents listed no additional threats to wildlife in natural lakes habitat in Indiana.

Respondents noted top threats to wildlife in natural lake habitats in Indiana (not ranked):

- Long-term declines in water quality associated with lake eutrophication
- Annual and seasonal variations in habitat availability
- Cold, clear water is critical for cisco survival; increased runoff and nutrient loading have degraded the habitat for this species in many of the 50+ lakes it once occurred in
- Few lakes still have ciscos, and there is apparently little to no reproduction
- The deliberate stocking of predator fish in cisco lakes has been a threat to this species for years; if this hasn't been stopped, it needs to
- Loss of habitat (reproductive/feeding) that is essential for northern pike survival
- Overharvest and illegal harvest (This doesn't seem to be a major threat as of now)
- Loss of undisturbed natural lake habitat

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

Habitat threats

Respondents ranked threats to natural lakes habitat in Indiana:

Rank	Threats to natural lakes habitat
1	Habitat degradation
2	Commercial or residential development (sprawl)
3 (tie)	Nonpoint source pollution (sedimentation and nutrients)
3 (tie)	Agricultural/forestry practices
4	Drainage practices (stormwater runoff)
5	Successional change
6	Stream channelization
7 (tie)	Habitat fragmentation
7 (tie)	Invasive/non-native species
8	Point source pollution (continuing)

Respondents listed no other threats to natural lakes habitat in Indiana.

Respondents noted top threats to natural lake habitat in Indiana (not ranked):

- Habitat degradation
- Successional change
- Water quality degradation that leads to cloudy water is the key threat.
- Emergent bulrush and wetland habitat loss. It has been well documented in northern states that northern pike prefer flooded vegetation for spawning during the spring. Loss of this habitat from boating and wildlife (waterfowl and muskrat feeding) may reduce reproductive habitat for northern pike in some natural lakes.
- Bulkhead seawall development reduces emergent vegetation used by northern pike for reproduction and for cover during feeding.
- Shoreline and lakebed alterations

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

Additional research and survey efforts

Current body of research

Species research

Twenty-five percent of respondents indicated that research on wildlife in natural lake habitats in Indiana is adequate; seventy-five percent said that research was inadequate.

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

Title = Cisco population status and management in Indiana;
Author = Jed Pearson;
Date = 2001;
Publisher = Division of Fish and Wildlife

Title = Northern Pike Spawning Habitat Investigations At Two Natural Lake In Indiana;
Author = Cwalinski, Tim A.;
Date = September 2001;
Publisher = Indiana Department of Natural Resources

Title = DFW largemouth bass database;
Author = Jed Pearson;
Date = unpublished;
Publisher = unpublished

Title = Largemouth bass size limits at Indiana natural lakes - a 30-year history;
Author = Jed Pearson;
Date = 2003;
Publisher = unpublished

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research on wildlife in natural lakes habitat. There were no responses.

Habitat research

Respondents indicated that research on natural lake habitat in Indiana is inadequate (75%) or nonexistent (25%).

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

Title = Cisco population status and management in Indiana;
Author = Jed Pearson;
Date = 2001;
Publisher = Division of Fish and Wildlife

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research on natural lakes habitat. There were no responses.

Research needs

Species research

Respondents ranked research needs for wildlife in natural lakes habitat in Indiana:

Rank	Research needs for wildlife in natural lakes habitat
1	Limiting factors (food, shelter, water, breeding sites)
2 (tie)	Distribution and abundance
2 (tie)	Threats (predators/competition, contamination)
3 (tie)	Relationship/dependence on specific habitats
3 (tie)	Life cycle

A respondent noted that additional research needs for wildlife in natural lakes habitat in Indiana include: “limiting factors and impacts of competition and predation.”

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 natural lakes habitat. There were no responses.

Habitat research

Respondents ranked research needs for natural lake habitats in Indiana:

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

A respondent noted that additional research for natural lakes habitats in Indiana is needed regarding "water quality variations and impacts of land use and shoreline alterations."

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

Conservation actions necessary

Species actions

Respondents ranked how well conservation efforts address threats to wildlife in natural lake habitats in Indiana:

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

Respondents noted no other conservation practices for wildlife in natural lakes habitat in Indiana.

Respondents recommended the following practices to enhance wildlife in natural lakes habitat in Indiana (not ranked):

- Habitat protection and education to reduce habitat disturbance
- Assure there is no stocking of predator fish in cisco lakes
- Greatly limit/mitigate any new development on cisco lakes, particularly addressing runoff from lawns and other water quality issues
- Work to get any farmlands adjacent to cisco lakes into no-till cropland management.
- Implementation of ecozones in undeveloped areas to conserve that vegetation present.
- Implement a catch and release only regulation in lakes with low densities.

Appendix F-8: Natural Lakes

- Habitat management and harvest management

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

Habitat actions

Respondents ranked how well conservation efforts address threats to natural lakes habitat in Indiana:

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

Respondents listed no other current conservation practices for natural lakes habitat in Indiana.

Respondents recommended the following conservation actions for natural lakes habitat in Indiana (not ranked):

- Pollution reduction and land-use zoning
- Implementation of ecozones in undeveloped areas to conserve vegetation that is present
- Reduce inlet and upstream degradation
- Increase awareness and cooperation of landowners to create better shoreline and tributary habitat
- Habitat protection and restoration through regulation

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

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents are aware of the following monitoring by state agencies for wildlife in natural lakes habitat in Indiana (not ranked):

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

Twenty-five percent of respondents are aware of the following monitoring by organizations for wildlife in natural lakes habitat in Indiana (not ranked):

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

Respondents ranked these regional or local monitoring efforts by state agencies for their importance for wildlife conservation in natural lakes habitat in Indiana:

Rank	Regional or local monitoring efforts by state agencies for wildlife in natural lakes habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Regional or local once-a-year monitoring
4	Regional or local year-round monitoring
5	Occasional statewide (less than once a year and not regularly scheduled) monitoring

Respondents listed regional or local monitoring efforts by state agencies for wildlife in natural lakes habitat in Indiana (not ranked):

- Northeast Indiana (DFW)
- Standardized largemouth bass sampling protocols (DFW)
- Tournament fishing (DFW)
- Cisco lakes (DFW)
- Northern Pike are monitored via general fish surveys conducted to update lake status. There is now monitoring of northern pike on a general schedule
- There was a tracking study conducted in two Indiana natural lakes in the late 1990's to better understand reproductive habitat of northern pike (DFW)
- Water quality monitoring (IDEM)

Appendix F-8: Natural Lakes

Respondents noted no regional or local monitoring efforts by other organizations for wildlife in natural lakes habitat in Indiana.

A respondent listed the following organizations that conduct regional or local monitoring for wildlife in natural lakes habitat in Indiana:

- Bass fishing clubs who hold tournaments on Lake Wawasee and Syracuse Lake

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

Respondents ranked current monitoring techniques for wildlife in natural lakes habitat in Indiana:

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

Respondents recommended these monitoring techniques for wildlife in natural lakes habitat in Indiana (not ranked):

- Occasional gillnetting to verify presence followed by intensive netting to confirm low levels or absence
- Large fyke-nets are used in Lake Webster (Kosciusko County) to collect brood stock for muskellunge. These nets would be useful in capturing northern pike as well. This would allow biologist to capture enough fish to get a representative sample of adult fish. There is still no effective method of sampling young esocids without mortality
- Springtime dc electrofishing according to DFW standard protocol
- Standard DFW creel survey procedures
- Tournament monitoring by the DFW and bass clubs

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in natural lakes habitat. There were no responses.

Habitat inventory and assessment

Respondents are aware of these inventory and assessment efforts by state agencies for natural lakes habitat in Indiana (not ranked):

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies
- Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies

Respondents are aware of these inventory and assessment efforts by other organizations for natural lakes habitat in Indiana (not ranked):

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

Respondents ranked inventory and assessment by state agencies by their level of importance to conserve natural lakes habitat in Indiana:

Rank	Inventory and assessment by state agencies for natural lakes habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies
3	Regional or local once a year inventory and assessment conducted by state agencies
4	Regional or local year-round inventory and assessment conducted by state agencies

Respondents listed no inventory and assessment conducted by other organizations as “very crucial” or “somewhat crucial” for natural lakes habitat in Indiana. Twenty-five percent of respondents listed the following effort as “slightly crucial:”

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

Respondents listed regional or local inventory and assessment conducted by state agencies for natural lakes habitat in Indiana (not ranked):

- Northeast Indiana (DFW)
- Recently the IDNR began sampling/mapping emergent plant species in some Indiana natural lakes. These plants may be used as reproductive habitat for northern pike

Respondents listed no regional or local inventory and assessment conducted by other organizations for natural lakes habitat in Indiana, nor did they list organizations involved in these efforts.

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

Respondents ranked inventory and assessment techniques for natural lakes habitat in Indiana. No techniques were listed as "frequently used."

Rank	Inventory and assessment techniques for natural lakes habitat	Occasionally Used	Not used but possible with existing technology and data	Not economically feasible
	GIS mapping	X	X	
	Aerial photography and analysis	X		
	Systematic sampling	X	X	
	Property tax estimates			X
	State revenue data			X
	Regulatory information			X
	Participation in landuse programs	X		X
	Modeling		X	
	Voluntary landowner reporting	X	X	

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for natural lakes habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended these monitoring techniques for effective conservation of the Wildlife in Natural Lakes Habitat in Indiana? (not ranked):

- Occasional gillnetting to verify presence followed by intensive netting to confirm low levels or absence

- Large fyke-nets are used in Lake Webster (Kosciusko County) to collected brood stock for muskellunge. These nets would be useful in capturing northern pike as well. This would allow biologists to capture enough fish to get a representative sample of adult fish. There is still no effective method of sampling young esocids without mortality
- Springtime dc electrofishing according to DFW standard protocol
- Standard DFW creel survey procedures
- Tournament monitoring by the DFW and bass clubs

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

Habitat inventory and assessment

Respondents recommended these inventory and assessment techniques for natural lakes habitat in Indiana (not ranked):

- Emergent bulrush and wetland monitoring and protection via ecozones.
- Evaluate land and water use practices to reduce in lake and upstream degradation of vegetation and shoreline.
- Unknown

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for natural lakes habitat. There were no responses

OXBOWS / BACKWATERS / SLOUGHS / EMBAYMENTS HABITAT NARRATIVE

Habitats description

Oxbows, backwaters, sloughs, and embayments are naturally occurring standing water bodies that were formed in association with flowing waters (rivers and streams).

Problems affecting species and habitats

Species threats

Respondents ranked threats to wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana:

Rank	Threats to wildlife in oxbows / backwaters / sloughs / embayments habitat
1	Near limits of natural geographic range
2	Invasive/non-native species
3 (tie)	Habitat loss (breeding range)
3 (tie)	Habitat loss (feeding/foraging areas)
4 (tie)	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
4 (tie)	High sensitivity to pollution
4 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
5 (tie)	Small native range (high endemism)
5 (tie)	Bioaccumulation of contaminants
5 (tie)	Viable reproductive population size or availability

A respondent indicated that “stream channelization” is another specific threat to wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana.

Respondents noted top threats to wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Habitats loss and habitats degradation
- Sediment deposition

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

- Yes. However,the representative species should have included birds such as wood duck and prothonotary warbler.

Habitats threats

Respondents ranked threats to oxbows/backwaters/sloughs/embayments habitat in Indiana:

Rank	Threats to oxbows/backwaters/sloughs/embayments habitat
1 (tie)	Habitat degradation
1 (tie)	Nonpoint source pollution (sedimentation and nutrients)
2	Agricultural/forestry practices
3	Stream channelization
4 (tie)	Habitat fragmentation
4 (tie)	Drainage practices (stormwater runoff)
4 (tie)	Invasive/non-native species
5 (tie)	Impoundment of water/flow regulation
5 (tie)	Mining/acidification
7 (tie)	Commercial or residential development (sprawl)

Respondents noted no other threats to oxbows/backwaters/sloughs/embayments habitat in Indiana.

A respondent noted that the top threat to oxbows/backwaters/sloughs/embayments habitat in Indiana is “habitat loss and degradation.”

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

- Yes

Additional research and survey efforts

Current body of research

Species research

Respondents indicated that research on wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana is inadequate.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in oxbows/backwaters/sloughs/embayments habitats in Indiana.

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research on wildlife in oxbows/backwaters/sloughs/embayments habitats. Their responses included:

- No.There must be study data available for specific river and stream systems related to mussel populations.

Habitats research

Respondents indicated that research on oxbows/backwaters/sloughs/embayments habitat in Indiana is inadequate.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of oxbows/backwaters/sloughs/embayments habitats in Indiana.

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research for oxbows/backwaters/sloughs/embayments habitats. Their responses included:

- No, there must be more but without doing a search I cannot list others.

Research needs

Species research

Respondents ranked research needs for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana:

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

A respondent noted other research needs for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana: "Very little is known about the basic natural history, population ecology and abundance in Indiana of the lesser siren."

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 oxbows/backwaters/sloughs/embayments habitats. Their responses included:

- Yes.

Habitats research

Respondents ranked research needs for oxbows/backwaters/sloughs/embayments habitat in Indiana:

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

A respondent listed other research needs for oxbows/backwaters/sloughs/embayments habitat in Indiana:

- Factors that limit the distribution of sirens in Indiana

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

- No, more research is needed to identify the rate of loss of this habitat through increased erosion and sedimentation from increased runoff and continual installation of new drainage tile in the watershed. Research studies are needed to monitor restoration of this habitat type.

Conservation actions necessary

Species actions

Respondents indicated that "habitat protection" is the only conservation effort to address threats to wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana.

Respondents noted no other conservation practices for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana.

Respondents recommended the following to enhance wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana:

- Habitat protection is the key, but it is also necessary to better understand factors that limit siren abundance and distribution

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation effort to address threats to wildlife in oxbows/backwaters/sloughs/embayments habitats. Their responses included:

- Absolutely not. Habitat restoration studies of techniques and monitoring of changes occurring from watershed influences is a must.

Habitats actions

Respondents ranked conservation efforts by how well they address threats to oxbows/backwaters/sloughs/embayments habitat in Indiana:

Rank	Conservation efforts for oxbows/backwaters/sloughs/embayments habitat
1 (tie)	Habitat protection through regulation
1 (tie)	Habitat protection on public lands
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Habitat restoration through regulation
2 (tie)	Habitat restoration on public lands
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Managing water regimes
2 (tie)	Pollution reduction
2 (tie)	Land use planning
2 (tie)	Cooperative land management agreements (conservation easements)

Respondents listed no other conservation practices for oxbows/backwaters/sloughs/embayments habitat in Indiana.

Respondents indicated that the following conservation actions are needed for oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Habitat protection -- More research is needed to address the effectiveness of habitat restoration on siren conservation
- Corridor protection

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the following conservation efforts to oxbows/backwaters/sloughs/embayments habitats. Their responses included:

- Yes.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana:

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Regional or local year-round monitoring conducted by other organizations
- Regional or local once-a-year monitoring conducted by other organizations
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations

Respondents considered no monitoring efforts by state agencies to be "very crucial" for conservation of wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana. The following was considered "somewhat crucial:"

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

Respondents ranked monitoring efforts by other organizations for conservation of wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana:

Rank	Monitoring efforts for oxbows/backwaters/sloughs/embayments habitat
1	Regional or local year-round monitoring conducted by other organizations
2	Regional or local once-a-year monitoring conducted by other organizations
3 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations
3 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations

Appendix F-9: Oxbows/Backwaters/Sloughs/Embayments

Respondents listed the following monitoring efforts by state agencies for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana

- Patoka River watershed

Respondents listed regional or local monitoring efforts by other organizations for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana:

- Newton, Jasper, Pulaski, Starke, Lake and Porter Counties

Respondents listed known organizations conducting regional or local monitoring efforts for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Robert Brodman, Saint Joseph's College
- IDNR Division of Fish and Wildlife

Respondents considered monitoring techniques for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana as follows:

Monitoring techniques for wildlife in oxbows/backwaters/sloughs/embayments habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	X
Modeling	--	X	--
Spot mapping	--	X	--
Mark and recapture	--	X	X
Professional survey/census	X	--	--
Volunteer survey/census	--	X	--
Trapping (by any technique)	X	--	--
Representative sites	X	X	--
Probabilistic sites	X	--	--

Respondents listed no additional monitoring techniques for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana.

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

- Aerial photography to denote changes in acreage, water levels and vegetation cover every other year could provide important insight into habitat impacts such as the effects of beaver impoundments in regulating water levels and vegetation changes.

Habitats inventory and assessment

Respondents were not aware of any habitats and inventory assessment efforts conducted by state agencies for oxbows/backwaters/sloughs/embayments habitat in Indiana.

Respondents were aware of inventory and assessment efforts by other organizations for oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Regional or local year-round inventory and assessment conducted by other organizations
- Regional or local once-a-year inventory and assessment conducted by other organizations
- Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations
- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations

Respondents marked no inventory and assessment efforts conducted by state agencies as "very crucial" or "somewhat crucial" for oxbows/backwaters/sloughs/embayments habitat in Indiana. The following was called "slightly crucial:"

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

Respondents ranked inventory and assessment efforts by other organizations by their importance to conservation of oxbows/backwaters/sloughs/embayments habitat in Indiana:

Rank	Inventory and assessment efforts for oxbows/backwaters/sloughs/embayments habitat
1	Regional or local year-round monitoring conducted by other organizations
2	Regional or local once-a-year monitoring conducted by other organizations
3 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations
3 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations

The respondents noted no regional or local inventory and assessment by state agencies for oxbows/backwaters/sloughs/embayments habitat in Indiana.

Respondents noted regional or local inventory and assessment by other organizations oxbows/backwaters/sloughs/embayments habitat in Indiana:

- Newton, Jasper, Starke, Pulaski, Lake and Porter counties

Respondents noted organizations that monitor oxbows/backwaters/sloughs/embayments habitat in Indiana:

- Robert Brodman, Saint Joseph's College

Respondents considered inventory and assessment techniques for oxbows/backwaters/sloughs/embayments habitat in Indiana as follows:

Inventory and assessment techniques for oxbows/ backwaters/sloughs/ embayments habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	--	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	X	--	--
Modeling	--	X	--

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for oxbows/backwaters/sloughs/embayments habitats. Their responses included:

- Yes.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for wildlife in oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Minnow trapping and either mark recapture or telemetry
- Trap nets
- Electrofishing

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

- Mussel surveys.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for oxbows/backwaters/sloughs/embayments habitat in Indiana (not ranked):

- Survey (intensive)
- GIS mapping (less intensive)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for oxbows/backwaters/sloughs/embayments habitats. Their responses included:

Appendix F-9: Oxbows/Backwaters/Sloughs/Embayments

- Aerial photography would be the most efficient way of monitoring changes in this habitat.

RIVERS AND STREAMS HABITAT NARRATIVE

Habitat description

This broad habitat type is characterized by flowing water of various width, depth and discharge volume.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in rivers and streams habitat in Indiana:

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

Respondents offered no additional threats to wildlife in rivers and streams habitat in Indiana.

Respondents listed top threats to wildlife in rivers and streams habitat in Indiana (not ranked):

- Habitat loss
  - Loss of large nesting trees
  - Loss of high quality nesting and brood rearing habitat
- Degradation of movement/migration routes

- Mink: Although not habitat specific, the inability to responsibly and proactively manage mink according to the wildlife conservation model (as opposed to reactive measures through nuisance practices) is a concern regarding mink conservation. This concern applies across the landscape, not just in urban and suburban environments.

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

Habitat threats

Respondents ranked threats to rivers and streams habitat in Indiana:

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

Respondents noted no other habitat threats to rivers and streams habitat in Indiana.

Respondents listed top threats to rivers and streams habitat in Indiana (not ranked):

- Stream channelization
  - Moves nesting sites and destroys brood habitat
  - Removes or changes vegetative and invertebrate communities
  - Alters water flow which results in a much degraded habitat
- Soil run-off
  - Due to urban development and agricultural practices
- Loss of bottomland hardwoods
  - Provides high quality food source and nesting habitat for wood ducks
- Drainage practices

A respondent made additional comments: “The participant is forced to speculate about the meaning of successional and climate change. Agriculture/Forestry practices have different effects.

Grouping these practices as a single category does not appropriately represent the individual practice. Point and nonpoint pollution may have a positive or negative impact."

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

Additional research and survey efforts

Current body of research

Species research

One third of respondents stated that the current body of science for wildlife in rivers and streams habitat in Indiana is complete, up-to-date and extensive; one third stated that the current body of science is nonexistent.

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

Title = Ecology and Management of the Wood Duck;
Author = Bellrose and Holm;
Date = 1994;
Publisher = Stackpole Books

Title = Ducks, Geese and Swans of North america;
Author = Bellrose;
Date = 1976;
Publisher = Stackpole Books

I'm am not aware of any literature on mink focused strictly to rivers and streams.

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

Habitat research

One third of respondents stated that the current body of science for rivers and streams habitat in Indiana is nonexistent. Two-thirds stated that that "The body of science is better than adequate, it is quite extensive and up to date, but by no means, is it complete."

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

Title = Wetlands;
Author = Mitsch & Gosselink;
Date = 1993;
Publisher = Van Nostrand Rheinhold

Title = Southern Forested Wetlands;
Author = Messina & Conner;
Date = 1998;
Publisher = CRC Press LLC

I am not aware of any literature on mink focused strictly to rivers and streams.

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

Research needs

Species research

Respondents ranked research needs for wildlife in rivers and streams habitat in Indiana:

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

A respondent noted additional research needs for wildlife in rivers and streams habitat in Indiana:

- Research needs are not limited to river and stream habitats

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 rivers and streams habitat. There were no responses.

Habitat research

Respondents ranked research needs for rivers and streams habitat in Indiana:

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

conditions

A respondent noted additional research needs for rivers and streams habitat in Indiana:

- Affects of channelization on streambank communities and the affects on adjacent oxbows, bottomland hardwoods and other riparian areas

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

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in rivers and streams habitat in Indiana:

Rank	Conservation efforts for wildlife in rivers and streams habitat
1 (tie)	Habitat protection (use below for details)
1 (tie)	Regulation of collecting
2	Population management (hunting, trapping)
3	Protection of migration routes
4 (tie)	Food plots
4 (tie)	Limiting contact with pollutants/contaminants
4 (tie)	Public education to reduce human disturbance
4 (tie)	Exotic/invasive species control
4 (tie)	Threats reduction
4 (tie)	Native predator control

Respondents noted no other current conservation practices for wildlife in rivers and streams habitat in Indiana.

Respondents recommended these practices for more effective conservation of wildlife in rivers and streams habitat in Indiana (not ranked):

- To best benefit the wood duck, one must first improve the habitat
- Habitat protection
- Nest boxes
- Although not habitat specific, outreach programs are needed to effectively and accurately educate citizens about wildlife (game and nongame), the wildlife conservation model (for game and nongame), and the need for effective mink management programs

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

Habitat actions

Respondents ranked conservation efforts by how well they address threats to rivers and streams habitat in Indiana:

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

Respondents listed no other current habitat conservation practices for rivers and streams habitat in Indiana.

Respondents recommended the following conservation practices for rivers and streams habitat in Indiana (not ranked):

- Elimination or reduction of stream channelization
- Restoration of bottomland hardwoods through the Farm Bill and other incentive programs

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

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in rivers and streams habitat in Indiana (not ranked):

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in rivers and streams habitat in Indiana (not ranked):

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

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in rivers and streams habitat in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in rivers and streams habitat
1	Statewide year-round monitoring
2	Regional or local once-a-year monitoring
3	Regional or local year-round monitoring
4	Statewide once-a-year monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in rivers and streams habitat in Indiana:

Rank	Monitoring efforts by other organizations for conservation of wildlife in rivers and streams habitat
1	Statewide year-round monitoring
2	Regional or local year-round monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in rivers and streams habitat in Indiana (not ranked):

- State monitoring: Banding and nest box surveys
- Several fish and wildlife areas perform annual wood duck banding. Properties include Hovey Lake, Glendale, Minnihaha, Willow Slough, Jasper-Pulaski, LaSalle, Pigeon River, and Tri-County FWAs. There might be others.
- Fish and wildlife areas [not specific in types of monitoring or species being monitored]: Hovey Lake, Tri-County, Jasper-Pulaski, Winamac, Willow Slough, LaSalle

Respondents listed regional or local monitoring by other organizations for wildlife in rivers and streams habitat in Indiana:

- Muscatatuck NWR
  - Conducts wood duck banding operations

Respondents listed organizations that monitor wildlife in rivers and streams habitat in Indiana (not ranked):

- USFWS
- IDNR – Division of Fish and Wildlife
  - Population monitoring efforts at state, regional and local scales to monitor annual trends. Monitoring programs are not limited to river and stream habitats for mink.

Respondents considered monitoring techniques for wildlife in rivers and streams habitat in Indiana:

Monitoring techniques for wildlife in rivers and streams habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	--
Modeling	X	--	--
Driving a survey route	--	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	--	--
Mark and recapture	X	--	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	X	--	--

Respondents noted another monitoring techniques for wildlife in rivers and streams habitat in Indiana:

- Nest box surveys

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in rivers and streams habitat. There were no responses.

Habitat inventory and assessment

Appendix F-10: Rivers and Streams

Respondents were aware of the following inventory and assessment efforts by state agencies for rivers and streams habitat in Indiana:

- Statewide annual inventory and assessment
- Regional or year-round inventory and assessment

Respondents were aware of the following inventory and assessment efforts by other organizations for rivers and streams habitat in Indiana:

- Statewide annual inventory and assessment
- Regional or year-round inventory and assessment

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of rivers and streams habitat in Indiana:

Rank	Inventory and assessment by state agencies for conservation of rivers and streams habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
3 (tie)	Statewide annual inventory and assessment
3 (tie)	Statewide once-a-year inventory and assessment
4 (tie)	Regional or local year-round inventory and assessment
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
5	Regional or local once-a-year inventory and assessment
6	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of rivers and streams habitat in Indiana:

Rank	Inventory and assessment by other organizations for conservation of rivers and streams habitat
1 (tie)	Statewide annual inventory and assessment
1 (tie)	Regional or local year-round inventory and assessment

A respondent listed regional or local inventory and assessment by state agencies for rivers and streams habitat in Indiana:

- Nearly all river and stream habitats in Indiana fall under state and/or federal jurisdiction, so obtaining and maintaining accurate and current information on these habitats is always occurring on a statewide basis

A respondent listed regional or local inventory and assessment by other organizations agencies for rivers and streams habitat in Indiana:

- Many local zoning boards, planning commissions and drainage boards also keep and maintain their own records regarding land use patterns within these habitats

A respondent listed organizations that monitor rivers and streams habitat in Indiana (not ranked):

- IDNR
- USFWS
- USDA
- IDEM
- USACOE
- EPA
- Local government entities (area plan commissions, zoning boards, etc.)

Respondents considered inventory and assessment techniques for rivers and streams habitat in Indiana:

Inventory and assessment techniques for rivers and streams habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	--	--
Aerial photography and analysis	X	--	--
Systematic sampling	--	X	--
Property tax estimates	X	--	--
Regulatory information	X	--	--
Participation in land use programs	X	--	--

Respondents listed no additional inventory and assessment techniques for rivers and streams habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for rivers and streams habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in rivers and streams habitat in Indiana (not ranked):

- Brood surveys
- Continued participation in HIP is perhaps the most cost effective method for monitoring the flyway population.
- Banding operations help determine status of local and statewide populations
- Increased banding efforts

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

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of rivers and streams habitat in Indiana (not ranked):

- GIS mapping
  - Developing and maintaining accurate GIS data sets on habitat is important
- Aerial photography and analysis
- Spring, summer, fall and winter surveys

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

GREAT RIVERS OF GREAT LAKES DRAINAGE HABITAT NARRATIVE

Habitat description

The Great Lakes drainage of Indiana includes waters that flow into Lake Michigan and Lake Erie and are located in extreme northern Indiana and northeast Indiana. Great rivers are those having a drainage area of > 1,999 mi^2. This includes all of the St. Joseph River in St. Joseph and Elkhart counties (Lake Michigan drainage), and the lower section of the Maumee River in Allen County (Lake Erie drainage). Great Rivers of the Great Lakes drainage of Indiana are of low to medium gradient and characterized by sandy/rocky bottoms.

Problems affecting species and habitats

Species threats

The respondent ranked the following as "critical threat" to wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- High sensitivity to pollution

The respondent ranked the following as "serious threat:"

- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent ranked the following as "somewhat of a threat" (not ranked):

- Habitat loss (breeding range, feeding/foraging areas)
- Viable reproductive population size or availability
- Bioaccumulation of contaminants

The respondent ranked the following as "slight threat" to wildlife in great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Regulated hunting/fishing pressure (too much)
- Small native range (high endemism)
- Specialized reproductive behavior or low reproductive rates

The respondent offered no additional threats to wildlife in great rivers of Great Lakes drainage habitat in Indiana.

The respondent listed top threats to wildlife in great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Past pollution problems
- Dams on rivers block migration

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in great rivers of Great Lakes drainage habitat. There were no responses.

Habitat threats

The respondent ranked the following as “serious threat” to great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Nonpoint source pollution (sedimentation and nutrients)
- Impoundment of water/flow regulations

The respondent ranked the following as “somewhat of a threat” (not ranked):

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

The respondent ranked the following as “slight threat” to great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Habitat degradation
- Agricultural/forestry practices
- Point source pollution (continuing)

The respondent noted no additional threats to great rivers of Great Lakes drainage habitat in Indiana.

The respondent listed top threats to great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Sedimentation
- Dams fragmenting habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to great rivers of Great Lakes drainage habitat. There were no responses.

Additional research and survey efforts

Current body of research

Species research

The respondent stated that the current body of science is nonexistent for wildlife in great rivers of Great Lakes drainage habitat in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of wildlife in great rivers of Great Lakes drainage habitat in Indiana.

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

Habitat research

The respondent stated that the current body of science is nonexistent for great rivers of Great Lakes drainage habitat in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of great rivers of Great Lakes drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science in great rivers of Great Lakes drainage habitat. There were no responses.

Research needs

Species research

The respondent ranked research as "greatly needed" for wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- Distribution and abundance

The respondent ranked research as "needed" (not ranked):

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

The respondent ranked research as "slightly needed" (not ranked):

- Threats (predators/competition, contamination)
- Population health

The respondent noted no additional research needs for wildlife in great rivers of Great Lakes drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wildlife in great rivers of Great Lakes drainage habitat. There were no responses.

Habitat research

The respondent listed the following research as "greatly needed" for great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Distribution and abundance (fragmentation)
- Threats (land use change/competition, contamination/global warming)

The respondent listed the following research as "slightly needed" (not ranked):

- Relationship/dependence on specific site conditions
- Growth and development of individual components of the habitat

The respondent noted no additional research needs for great rivers of Great Lakes drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for great rivers of Great Lakes drainage habitat. There were no responses.

Conservation actions necessary

Species actions

The respondent listed the following conservation efforts as working "somewhat" to address threats to wildlife in great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Regulation of collecting
- Protection of migration routes

The respondent noted no other current conservation practices for wildlife in great rivers of Great Lakes drainage habitat in Indiana.

The respondent recommended these practices for more effective conservation of wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- Protection of migration routes

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in great rivers of Great Lakes drainage habitat. There were no responses.

Habitat actions

The respondent listed the following conservation efforts as working "somewhat" to address threats to great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Protection of adjacent buffer zone
- Land use planning

The respondent listed or recommended no other current conservation practices for great rivers of Great Lakes drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for great rivers of Great Lakes drainage habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

The respondent was aware of the following monitoring efforts by state agencies for wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- Periodic regional or local (less than once a year but still regularly scheduled) monitoring

The respondent was aware of the following monitoring efforts by other organizations for wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- Regional or local once-a-year monitoring

The respondent ranked the following monitoring efforts by state agencies and other organizations as "slightly crucial" for conservation of wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- Regional or local once-a-year monitoring

The respondent listed regional or local monitoring by state agencies for wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- IDEM annual ecoregion sampling

The respondent listed no regional or local monitoring by other organizations for wildlife in great rivers of Great Lakes drainage habitat in Indiana.

Appendix F-11: Rivers and Streams Great Lakes Drainage Great River

The respondent listed organizations that monitor wildlife in great rivers of Great Lakes drainage habitat in Indiana:

- City of Elkhart (Elkhart and St. Joseph counties)

The respondent considered monitoring techniques for wildlife in great rivers of Great Lakes drainage habitat in Indiana:

Monitoring techniques for wildlife in great rivers of Great Lakes drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	--
Modeling	--	X	--
Mark and recapture	--	X	--
Professional survey/census	--	X	--
Trapping (by any technique)	--	X	--
Representative sites	--	X	--
Probabilistic sites	--	X	--

The respondent noted no other monitoring techniques for wildlife in great rivers of Great Lakes drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in great rivers of Great Lakes drainage habitat. There were no responses.

Habitat inventory and assessment

The respondent was aware of no inventory and assessment efforts by state agencies or other organizations for great rivers of Great Lakes drainage habitat in Indiana.

The respondent listed the following inventory and assessment efforts by state agencies as “slightly crucial” for conservation great rivers of Great Lakes drainage habitat in Indiana:

- Regional or local once-a-year inventory and assessment

The respondent listed no inventory and assessment efforts by other organizations as crucial for conservation of great rivers of Great Lakes drainage habitat in Indiana.

The respondent listed no regional or local inventory and assessment by state agencies or other organizations for great rivers of Great Lakes drainage habitat in Indiana. The respondent listed no organizations involved with inventory and assessment efforts.

The respondent considered inventory and assessment techniques for great rivers of Great Lakes drainage habitat in Indiana:

Inventory and assessment techniques for great rivers of Great Lakes drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	--	X	--
Aerial photography and analysis	--	X	--
Property tax estimates	--	--	X
State revenue data	--	--	X
Regulatory information	--	--	X
Participation in land use programs	--	--	X
Modeling	--	X	--
Voluntary landowner reporting	--	--	X

The respondent listed no additional inventory and assessment techniques for great rivers of Great Lakes drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for great rivers of Great Lakes drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

The respondent recommended the following monitoring techniques for effective conservation of wildlife in great rivers of Great Lakes drainage habitat in Indiana (not ranked):

- Radio telemetry
- Mark and recapture

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in great rivers of Great Lakes drainage habitat. There were no responses.

Habitat inventory and assessment

The respondent recommended the following inventory and assessment techniques for effective conservation of great rivers of Great Lakes drainage habitat in Indiana:

- GIS mapping and aerial photography

Appendix F-11: Rivers and Streams Great Lakes Drainage Great River

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of great rivers of Great Lakes drainage habitat. There were no responses.

HEADWATERS OF GREAT LAKES DRAINAGE HABITAT NARRATIVE

Habitat description

The Great Lakes drainage of Indiana includes waters that flow into Lake Michigan and Lake Erie and are located in extreme northern Indiana and northeast Indiana. Headwater streams are those having a drainage area of < 20 mi^2. Headwater streams of the Great Lakes drainage of Indiana are of low to medium gradient, with sandy/rocky bottoms and are highly associated with the extensive natural lakes and wetlands of the region. Many have been channelized and highly modified for drainage to maintain agricultural lands.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in headwaters of Great Lakes drainage habitat:

Rank	Threats to wildlife in headwaters of Great Lakes drainage habitat
1 (tie)	Invasive/non-native species
1 (tie)	High sensitivity to pollution
2 (tie)	Habitat loss (breeding range)
2 (tie)	Habitat loss (feeding/foraging areas)
3	Predators (native or domesticated)

Respondents offered no additional threats to wildlife in headwaters of Great Lakes drainage habitat.

Respondents listed top threats for wildlife in headwaters of Great Lakes drainage habitat (not ranked):

- Exotic species competition, specifically the round goby
- Habitat degradation
- Pollution
  - Non-point source run-off resulting from loss of riparian buffers due to development
  - High sediment loads during spring rains

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

Habitat threats

Respondents ranked threats to headwaters of Great Lakes drainage habitat:

Rank	Threats to headwaters of Great Lakes drainage habitat
1	Stream channelization
2 (tie)	Commercial or residential development (sprawl)

2 (tie)	Habitat degradation
2 (tie)	Invasive/non-native species
2 (tie)	Nonpoint source pollution (sedimentation and nutrients)
3	Habitat fragmentation
4 (tie)	Agricultural/forestry practices
4 (tie)	Successional change
4 (tie)	Drainage practices (stormwater runoff)
5 (tie)	Impoundment of water/flow regulation
5 (tie)	Residual contamination
5 (tie)	Point source pollution (continuing)

Respondents noted no additional habitat threats to headwaters of Great Lakes drainage habitat.

Respondents listed top threats to headwaters of Great Lakes drainage habitat (not ranked):

- Invasive species competition, specifically round goby interactions
- Stream channelization
- Nonpoint source pollution
- Sedimentation
- Loss of habitat due to development

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

Additional research and survey efforts

Current body of research

Species research

One third of respondents stated that the current body of science is non-existent for wildlife in headwaters of Great Lakes drainage habitat; two-thirds indicated "other" including that it is "Unknown in the larger scale" or "Under development. Survey completed but data not processed yet."

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

Title = Fisheries Survey of the East Branch of the Little Calumet River Watershed;
Author = Neil Ledet;
Date = 1978;
Publisher = IDNR Fisheries Section

Title = Stream Survey of the East Arm of the Little Calumet River;
Author = Edward Braun;
Date = 1974;
Publisher = IDNR Division of Fish and Wildlife

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

Habitat research

One third of respondents stated that the current body of science is non-existent for headwaters of Great Lakes drainage habitat, one third indicated that it was Inadequate; one-third indicated that it is "Unknown in the larger scale".

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of the headwaters of Great Lakes drainage habitats in Indiana.

Title = Fisheries Survey of the East Branch of the Little Calumet River Watershed;
Author = Neil Ledet;
Date = 1978;
Publisher = IDNR-Fish and Wildlife

Title = Stream Survey-Little Calument River East Arm;
Author = Edward Braun;
Date = 1974;
Publisher = IDNR-Fish and Wildlife

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

Research needs

Species research

Respondents ranked research needs for wildlife in headwaters of Great Lakes drainage habitat:

Rank	Research needs for wildlife in headwaters of Great Lakes drainage habitat
1	Threats (predators/competition, contamination)
2 (tie)	Distribution and abundance
2 (tie)	Limiting factors (food, shelter, water, breeding sites)
2 (tie)	Relationship/dependence on specific habitats
3	Life cycle
4	Population health (genetic and physical)

Respondents noted no additional research needs for wildlife in headwaters of Great Lakes drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the additional research needs for wildlife in headwaters of Great Lakes drainage habitat. There were no responses.

Habitat research

Respondents ranked research needs for headwaters of Great Lakes drainage habitat:

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

Respondents noted no additional research needs for headwaters of Great Lakes drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the additional research needs for headwaters of Great Lakes drainage habitat. There were no responses.

Conservation actions necessary

Species actions

The respondents noted the following conservation efforts that address threats to wildlife in forested wetland habitats in Indiana:

- Habitat protection (use below for details)
- Limiting contact with pollutants/contaminants
- Exotic/invasive species control

Respondents noted no other conservation practices for wildlife in headwaters of Great Lakes drainage habitat.

Respondents recommended these practices for more effective conservation of wildlife in headwaters of Great Lakes drainage habitat (not ranked):

- Land use planning and education
- Habitat protection through land use regulation
- Agricultural run-off protection through education and land use planning

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in headwaters of Great Lakes drainage habitat. There were no responses.

Habitat actions

The respondents recommended these practices to address threats to headwaters of Great Lakes drainage habitat:

- Habitat protection through regulation
- Land use planning
- Corridor development/protection
- Pollution reduction
- Protection of adjacent buffer zone
- Habitat restoration on public lands
- Managing water regimes
- Restrict public access and disturbance
- Habitat protection on public lands
- Cooperative land management agreements (conservation easements)

Respondents listed no additional current conservation practices for headwaters of Great Lakes drainage habitat.

Respondents recommended the following conservation practices for more effective conservation of headwaters of Great Lakes drainage habitat:

- Protection of habitat through land use planning. Currently most headwaters run through agricultural areas and need to maintain riparian buffer strips

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

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in headwaters of Great Lakes drainage habitat:

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in headwaters of Great Lakes drainage habitat:

- Periodic regional or local (less than once a year but still regularly scheduled) monitoring

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in headwaters of Great Lakes drainage habitat:

Rank	Monitoring efforts by state agencies for conservation of wildlife in headwaters of

Appendix F-12: Rivers and Streams Great Lakes Drainage Headwater

	Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Regional or local once-a-year monitoring
4	Regional or local year-round monitoring
5 (tie)	Statewide year-round monitoring
5 (tie)	Periodic statewide (less than once a year but still regularly scheduled)
5 (tie)	Occasional statewide (less than once a year and not regularly scheduled)

A respondent ranked the following monitoring effort by other organizations as “slightly crucial” for conservation of wildlife in headwaters of Great Lakes drainage habitat:

- Periodic regional or local (less than once a year but still regularly scheduled) monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in headwaters of Great Lakes drainage habitat (not ranked):

- Headwater streams surveys were conducted in 2001 through 2004 by IDNR – Division of Fish and Wildlife, Lake Michigan Fisheries Office
- IDEM ecoregion sampling

Respondents listed regional or local monitoring by other organizations for wildlife in headwaters of Great Lakes drainage habitat:

- City of Elkhart (Elkhart and St. Joseph counties)

Respondents listed organizations that monitor wildlife in headwaters of Great Lakes drainage habitat:

- IDNR – Division of Fish and Wildlife

Respondents considered monitoring techniques for wildlife in headwaters of Great Lakes drainage habitat:

Monitoring techniques for wildlife in headwaters of Great Lakes drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasibe
Radio telemetry and tracking	--	--	X
Modeling	--	X	X

Coverboard routes	--	--	X
Spot mapping	--	X	X
Driving a survey route	--	--	X
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	--	--	X
Mark and recapture	--	X	X
Professional survey/census	X	X	--
Volunteer survey/census	--	--	X
Trapping (by any technique)	X	X	--
Representative sites	X	X	--
Probabilistic sites	--	X	--

Respondents noted no other monitoring techniques for wildlife in headwaters of Great Lakes drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in headwaters of Great Lakes drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for headwaters of Great Lakes drainage habitat (not ranked):

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

Respondents were aware of the following inventory and assessment efforts by other organizations for headwaters of Great Lakes drainage habitat:

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of headwaters of Great Lakes drainage habitat:

Rank	Inventory and assessment for conservation of headwaters of Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Regional or local once-a-year inventory and assessment
4	Regional or local year-round inventory and assessment
5	Statewide annual inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of headwaters of Great Lakes drainage habitat:

Rank	Inventory and assessment for conservation of headwaters of Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Regional or local once-a-year inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for headwaters of Great Lakes drainage habitat (not ranked):

- Trail Creek
- East Branch of Little Calumet River
- West Branch of Little Calumet River
- Reynolds Creek
- Salt Creek
- Deep River
- IDEM ecoregion surveys

Respondents listed regional or local inventory and assessment by other organizations agencies for headwaters of Great Lakes drainage habitat:

- City of Elkhart

Respondents listed organizations that monitor headwaters of Great Lakes drainage habitat (not ranked):

- IDNR – Division of Fish and Wildlife (Lake Michigan Fisheries Office)
- IDEM (ecoregion surveys)
- U.S. Fish and Wildlife Service

Respondents considered inventory and assessment techniques for headwaters of Great Lakes drainage habitat:

Inventory and assessment techniques for headwaters of Great Lakes drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	--
Aerial photography and analysis	X	--	--
Systematic sampling	X	X	--
Participation in land use programs	--	X	--
Modeling	--	X	X
Voluntary landowner reporting	--	--	X

Respondents listed additional inventory and assessment techniques for headwaters of Great Lakes drainage habitat (not ranked):

- IBI
- QHEI

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for headwaters of Great Lakes drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in headwaters of Great Lakes drainage habitat (not ranked):

- Stream sampling using electrofishing techniques and seining: This should be done every five years to get a clear picture of changes that occur to habitat, water quality and invasive species introductions and distribution
- Rotational sampling at reference sites along the headwaters: Historical comparisons from the early 80's will be compared with the sampling that was completed 2001 through 2004

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in headwaters of Great Lakes drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of headwaters of Great Lakes drainage habitat (not ranked):

Appendix F-12: Rivers and Streams Great Lakes Drainage Headwater

- Sampling using electrofishing and seining in headwater areas
- Completing IBI, QHEI and water quality analysis for these sites

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of headwaters of Great Lakes drainage habitat. There were no responses.

WADEABLE/LARGE RIVERS OF GREAT LAKES DRAINAGE HABITAT NARRATIVE

Habitat description

The Great Lakes drainage of Indiana includes waters that flow into Lake Michigan and Lake Erie and are located in extreme northern Indiana and northeast Indiana. Wadeable/large rivers are those having a drainage area of > 19 < 2,000 mi^2. Wadeable rivers and streams of the Great Lakes drainage of Indiana are of low to medium gradient, with sandy/rocky bottoms and are highly associated with the extensive natural lakes and wetlands of the region.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in wadeable/large rivers of Great Lakes drainage habitat:

Rank	Threats to wildlife in wadeable/large rivers of Great Lakes drainage habitat
1	Habitat loss (feeding/foraging areas)
2 (tie)	High sensitivity to pollution
2 (tie)	Habitat loss (breeding range)
2 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
2 (tie)	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
3 (tie)	Specialized reproductive behavior or low reproductive rates
3 (tie)	Bioaccumulation of contaminants
3 (tie)	Invasive/non-native species
4	Regulated hunting/fishing pressure (too much)
5 (tie)	Predators (native or domesticated)
5 (tie)	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
5 (tie)	Dependence on other species (mutualism, pollinators)
5 (tie)	Viable reproductive population size or availability

Respondents offered no other threats to wildlife in wadeable/large rivers of Great Lakes drainage habitat.

Respondents listed top threats to wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Acute effects of toxicants are recognized as a threat to organisms, but there is little knowledge on ecosystems or regional effects on chronic insults. Toxicants are more destructive to the embrolarva stages, but these are poorly documented. Pollution controls do not have definite focus on chronic effects
- Habitat loss and alteration (siltation, run-off, instream modifications, pollution)
    - Hornyhead chub are sight-feeders and mound builders for spawning; thus, muddy water will hamper their chances of survival. If the silt covers gravel and their nest, chances for successful reproduction are limited. Chub also suffer from competition from other species better adapted to muddy and silty stream conditions

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Habitat threats

Respondents ranked threats to wadeable/large rivers of Great Lakes drainage habitat:

Rank	Threats to wadeable/large rivers of Great Lakes drainage habitat
1	Stream channelization
2 (tie)	Nonpoint source pollution (sedimentation and nutrients)
2 (tie)	Agricultural/forestry practices
2 (tie)	Habitat degradation
3	Commercial or residential development (sprawl)
4	Drainage practices (stormwater runoff)
5	Habitat fragmentation
6	Point source pollution (continuing)
7 (tie)	Invasive/non-native species
7 (tie)	Mining/acidification
8	Impoundment of water/flow regulation
9	Residual contamination (persistent toxins)

Respondents noted additional threats to wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Riparian corridor destruction.
- Loss of shading
- Sedimentation

Respondents listed top threats to wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Habitat degradation

- Nonpoint source pollution (sedimentation)
- Agricultural practices (sedimentation)
- Loss of riparian corridor
- Run-off

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Additional research and survey efforts

Current body of research

Species research

Respondents stated that the current body of science is inadequate for wildlife in wadeable/large rivers of Great Lakes drainage habitat.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in wadeable/large rivers of Great Lakes drainage habitats in Indiana.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Habitat research

Respondents stated that the current body of science is inadequate for wadeable/large rivers of Great Lakes drainage habitat.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wadeable/large rivers of Great Lakes drainage habitats in Indiana.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Hist. Survey

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Research needs

Species research

Respondents ranked research needs for wildlife in wadeable/large rivers of Great Lakes drainage habitat:

Rank	Research needs for wildlife in wadeable/large rivers of Great Lakes drainage habitat
1 (tie)	Threats (predators/competition, contamination)
1 (tie)	Relationship/dependence on specific habitats
2 (tie)	Distribution and abundance
2 (tie)	Limiting factors (food, shelter, water, breeding sites)
3	Life cycle
4 (tie)	Population health (genetic and physical)

Respondents noted no other research needs for wildlife in wadeable/large rivers of Great Lakes drainage habitat.

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 wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Habitat research

Respondents ranked research needs for wadeable/large rivers of Great Lakes drainage habitat:

Rank	Research needs for wadeable/large rivers of Great Lakes drainage habitat
1	Threats (land use change/competition, contamination/global warming)
2	Relationship/dependence on specific site conditions
3	Distribution and abundance (fragmentation)
4	Successional changes

A respondent noted no additional research needs for wadeable/large rivers of Great Lakes drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in wadeable/large rivers of Great Lakes drainage habitat:

Rank	Conservation efforts for wildlife in wadeable/large rivers of Great Lakes drainage habitat
1 (tie)	Habitat protection
1 (tie)	Limiting contact with pollutants/contaminants
1 (tie)	Public education to reduce human disturbance
2 (tie)	Population management (hunting, trapping)
2 (tie)	Regulation of collecting

A respondent noted additional conservation efforts for wildlife in wadeable/large rivers of Great Lakes drainage habitat, focusing on hornyhead chub (not ranked):

- Habitat protection to greatly reduce turbidity in streams for hornyhead chub feeding and breeding behaviors
- Exotic/invasive species control would help the hornyhead population
- Pollution control -- The hornyhead chub is sensitive to pollution so limiting contact with pollutants/contaminants would benefit the species
- Regulation of collecting -- The hornyhead chub is also a popular bait fish, so regulation of collecting would be beneficial

Respondents recommended these practices for more effective conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Habitat protection (erosion controls)
- Public education
- Exotic species - Possession of exotic species should be illegal (must dispose of fish properly and not release back to stream)
- Intensive quantitative sampling of known populations. (Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogram 8)
- Less intensive qualitative sampling of new or not recently surveyed areas. (Need to determine distribution and status of the clubshell. See same for protocols)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Habitat actions

Respondents ranked conservation efforts by how well they address threats to wadeable/large rivers of Great Lakes drainage habitat:

Rank	Conservation efforts for wadeable/large rivers of Great Lakes drainage habitat
1	Managing water regimes
2 (tie)	Pollution reduction
2 (tie)	Protection of adjacent buffer zone
3 (tie)	Habitat protection through regulation
3 (tie)	Habitat protection on public lands
3 (tie)	Habitat protection incentives (financial)
3 (tie)	Cooperative land management agreements (conservation easements)
3 (tie)	Habitat restoration on public lands
3 (tie)	Habitat restoration incentives (financial)
3 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
3 (tie)	Habitat restoration through regulation
3 (tie)	Corridor development/protection
3 (tie)	Land use planning
3 (tie)	Technical assistance

Respondents listed additional current conservation practices for wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Habitat protection and restoration on all lands by any means necessary would benefit all species (except those that are exotic and more tolerant than others), not just the hornyhead chub
- Pollution reduction, protection of adjacent buffer zone, land use planning, and conservation easements would all be beneficial to the hornyhead chub

Respondents recommended the following conservation practices for wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Protection and restoration of buffer zones/adjacent buffer zones
- Nonpoint source pollution reduction
- Assess riparian corridor
- Water quality monitoring (See Watters, 2000. Proc. 1st FMCS Symposium)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Regional or local once-a-year monitoring

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

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

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat.

Rank	Monitoring efforts by state agencies for conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Regional or local once-a-year monitoring
4 (tie)	Statewide year-round monitoring
4 (tie)	Statewide once-a-year monitoring
4 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring
4 (tie)	Regional or local year-round monitoring
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat:

Rank	Monitoring efforts by other organizations for conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Regional or local once a year monitoring
3	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
4 (tie)	Statewide year-round monitoring
4 (tie)	Statewide once a year monitoring
4 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring

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

4 (tie) Regional or local year-round monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- IDNR periodically conducts fish stream surveys
- IDEM conducts stream health surveys using fish and invertebrates
- IDEM monitors the Great Lakes Drainage once every five years; they may have data available for hornyhead chub captured in the basin as part of the fish community assessments.
- IDNR may also sample fish communities in Great Lakes Drainage and have data on the hornyhead chub
- Maumee system

Respondents listed regional or local monitoring by other organizations for wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- In some cities stream health is also assessed by fish and invertebrate surveys
- Elkhart Public Works and Utilities has a fisheries biologist on staff that actively collects fish community samples from the Great Lakes Basin (1-2 times in the summer). He may have data on the hornyhead chub as well
- Maumee system

Respondents listed organizations that monitor wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- IDNR
- IDEM
- City of Elkhart
- City of South Bend
- TNC

Respondents considered monitoring techniques for wildlife in wadeable/large rivers of Great Lakes drainage habitat:

Monitoring techniques for wildlife in wadeable/large rivers of Great Lakes drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	X
Modeling	X	X	--
Spot mapping	X	--	--
Reporting from harvest, depredation, or	X	X	--

unintentional take (road kill, by-catch)			
Mark and recapture	X	X	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	X	--	--
Representative sites	X	--	--
Probabilistic sites	X	X	--

Respondents noted no other monitoring techniques for wildlife in wadeable/large rivers of Great Lakes drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for conservation of wadeable/large rivers of Great Lakes drainage habitat (not ranked):

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

Respondents were aware of the following inventory and assessment efforts by other organizations for conservation of wadeable/large rivers of Great Lakes drainage habitat (not ranked):

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of wadeable/large rivers of Great Lakes drainage habitat:

Rank	Inventory and assessment by state agencies for conservation of wadeable/large rivers of Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2 (tie)	Regional or local once-a-year inventory and assessment

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

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of wadeable/large rivers of Great Lakes drainage habitat:

Rank	Inventory and assessment by other organizations for conservation of wadeable/large rivers of Great Lakes drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2 (tie)	Regional or local once-a-year inventory and assessment
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3 (tie)	Statewide annual inventory and assessment
3 (tie)	Statewide once-a-year inventory and assessment
3 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
3 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
3 (tie)	Regional or local year-round inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- In all major tributaries of Lake Michigan
- IDEM, IDNR and Elkhart use Quality Habitat Evaluation Index (QHEI) to assess habitat in streams

Respondents listed regional or local inventory and assessment by other organizations agencies for wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- St. Joseph River
- Maumee River

Respondents listed organizations that monitor wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- IDNR
- IDEM
- City of Elkhart
- City of South Bend
- TNC

Respondents considered inventory and assessment techniques for wadeable/large rivers of Great Lakes drainage habitat:

Inventory and assessment techniques for wadeable/large rivers of Great Lakes drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	--	--
Aerial photography and analysis	--	X	--
Systematic sampling	X	--	--
Regulatory information	X	--	--
Participation in land use programs	X	--	--
Modeling	X	--	--
Voluntary landowner reporting	X	--	--

Respondents listed no additional inventory and assessment techniques for wadeable/large rivers of Great Lakes drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

Appendix F-13: Rivers and Streams Great Lakes Drainage Wadeable/Large River

Respondents recommended the following monitoring techniques for effective conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Professional fish surveys and creel surveys
- IDEM, IDNR, and Elkhart use electrofishing equipment to sample fish communities; however, a seine could probably be used as well as tagging and radio telemetry to track the species movement
- Intensive quantitative sampling of known populations. (Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogram 8)
- Less intensive qualitative sampling of new or not recently surveyed areas. (Need to determine distribution and status of the clubshell. See same for protocols)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of wadeable/large rivers of Great Lakes drainage habitat (not ranked):

- Assessment using Qualitative Habitat Evaluation Index
- Assess riparian corridor
- Water quality

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of wadeable/large rivers of Great Lakes drainage habitat. There were no responses.

HEADWATERS OF KANKAKEE RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

Rivers and streams of the Kankakee River (Illinois River) drainage are those found in northwest Indiana that flow west into Illinois and eventually the Illinois River. Headwater streams are those having a drainage area of < 20 mi^2. Headwater streams of the Kankakee River drainage are now highly modified, often manmade, sandy/muck bottom, channelized ditches, maintained to drain agricultural lands and control flooding.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in headwaters of Kankakee River drainage habitat:

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

Respondents offered no additional threats to wildlife in headwaters of Kankakee River drainage habitat.

Respondents listed top threats for wildlife in headwaters of Kankakee River drainage habitat (not ranked):

- Dredging/construction (removal of aquatic vegetation and increasing depth of ditch)
  - Pike: Pike have suffered a major loss of spawning habitat due to prevalence of dredging within the watershed. This practice, along with levee construction, has resulted in the near elimination of instream emergent wetland vegetation throughout the majority of the watershed
- Habitat loss/degradation:
  - Requires shallow clear water with little current in weedy areas over gravel, sand, and silt to feed on insects and lay reproduce
  - Tadpole madtom feeds in dense vegetation and hides from predators in the leaf litter, dead wood and other cover. By removing vegetation and cover in the stream, the tadpole madtom also loses spawning areas. (Tadpole madtoms typically lay eggs under submerged objects.)
  - Degradation of the stream channel will also increase the velocity of the current (if straightened or cleared of debris), which will remove the tadpole madtom's preferred current-free, quiet habitat
- Runoff (increases flow of stream, turbidity, and siltation of needed substrates)

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

Habitat threats

Respondents ranked threats to headwaters of Kankakee River drainage habitat:

Rank	Threats to headwaters of Kankakee River drainage habitat
1	Habitat degradation
2	Stream channelization
3	Commercial or residential development (sprawl)
4 (tie)	Nonpoint source pollution (sedimentation and nutrients)
4 (tie)	Habitat fragmentation
4 (tie)	Agricultural/forestry practices
5 (tie)	Impoundment of water/flow regulation
5 (tie)	Invasive/non-native species
6 (tie)	Successional change
6 (tie)	Drainage practices (stormwater runoff)
7	Point source pollution (continuing)
8 (tie)	Residual contamination (persistent toxins)
8 (tie)	Climate change

8 (tie) Diseases (of plants that create habitat)

Respondents noted no additional threats to headwaters of Kankakee River drainage habitat.

Respondents listed top threats to headwaters of Kankakee River drainage habitat (not ranked):

- Habitat degradation/fragmentation/channelization (removal of debris to speed up water transfer/removal of shallow water)
  - Channelization of many streams in the upper Kankakee watershed and associated fragmentation of wetland habitat has severely altered the state of aquatic habitat in general
- Non-point source pollution (sedimentation resulting in smothering of substrates and turbidity)

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

Additional research and survey efforts

Current body of research

Species research

All respondents stated that the current body of science is inadequate for wildlife in headwaters of Kankakee River drainage habitat.

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

Title = Fishery, Habitat, and Recreational Use Surveys for the Kankakee River;
Author = Price and Robertson;
Date = 2005;
Publisher = DNR - Division of Fish and Wildlife (in review)

Title = A fishery survey of the Kankakee River in Indiana;
Author = Robertson and Ledet;
Date = 1981;
Publisher = DNR - Division of Fish and Wildlife

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

Habitat research

All respondents stated that the current body of science is inadequate for headwaters of Kankakee River drainage habitat.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of headwaters of Kankakee River drainage habitats in Indiana.

Title = Fishery, Habitat, and Recreational Use Surveys for the Kankakee River;

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Author = Price and Robertson;
Date = 2005;
Publisher = DNR - Div. of F & W

Title = A Fishery survey of the Kankakee River in Indiana;
Author = Robertson and Ledet;
Date = 1981;
Publisher = DNR - Div. of F & W

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

Research needs

Species research

Respondents ranked research needs for wildlife in headwaters of Kankakee River drainage habitat:

Rank	Research needs for wildlife in headwaters of Kankakee River drainage habitat
1 (tie)	Relationship/dependence on specific habitats
1 (tie)	Limiting factors (food, shelter, water, breeding sites)
2 (tie)	Distribution and abundance
2 (tie)	Threats (predators/competition, contamination)
3	Population health (genetic and physical)
4	Life cycle

Respondents noted no other research needs for wildlife in headwaters of Kankakee River drainage habitat.

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 headwaters of Kankakee River drainage habitats. There were no responses.

Habitat research

Respondents ranked research needs for headwaters of Kankakee River drainage habitat:

Rank	Research needs for headwaters of Kankakee River drainage habitat
1 (tie)	Distribution and abundance (fragmentation)
1 (tie)	Threats (land use change/competition, contamination/global warming)
1 (tie)	Growth and development of individual components of the habitat

2	Relationship/dependence on specific site conditions
3	Successional changes

Respondent noted no additional research needs for headwaters of Kankakee River drainage habitat.

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

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in headwaters of Kankakee River drainage habitat:

Rank	Conservation efforts for wildlife in headwaters of Kankakee River drainage habitat
1	Habitat protection (use below for details)
2	Regulation of collecting
3 (tie)	Population management (hunting, trapping)
3 (tie)	Population enhancement (captive breeding and release)
3 (tie)	Reintroduction (restoration)
3 (tie)	Threats reduction
3 (tie)	Translocation to new geographic range
3 (tie)	Limiting contact with pollutants/contaminants
3 (tie)	Stocking

Respondents noted no other current conservation practices for wildlife in headwaters of Kankakee River drainage habitat.

Respondents recommended these practices for more effective conservation of wildlife in headwaters of Kankakee River drainage habitat (not ranked):

- Restoring the connection between the streams and the wetlands that were formerly associated to allow pike access to spawning areas. Current water management regimes often rely on pumping to fill restored wetlands, thus, fish passage is still restricted
- Habitat protection
- Possible reintroduction of the least darter into suitable habitats that have been restored

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

Habitat actions

Respondents ranked conservation efforts by how well they address threats to headwaters of Kankakee River drainage habitat:

Rank	Conservation efforts for headwaters of Kankakee River drainage habitat
1	Habitat restoration through regulation
2 (tie)	Protection of adjacent buffer zone
2 (tie)	Cooperative land management agreements (conservation easements)
3	Habitat protection on public lands
4 (tie)	Habitat protection through regulation
4 (tie)	Habitat protection incentives (financial)
4 (tie)	Habitat restoration on public lands
4 (tie)	Habitat restoration incentives (financial)
4 (tie)	Restrict public access and disturbance
4 (tie)	Land use planning
5 (tie)	Pollution reduction
5 (tie)	Technical assistance
5 (tie)	Managing water regimes

Respondents listed no other current conservation practices for headwaters of Kankakee River drainage habitat.

Respondents recommended the following conservation practices for headwaters of Kankakee River drainage habitat (not ranked):

- Wetland restoration projects with connectivity to the stream or corridor development that allows passage to wetlands already restored. We need to move toward natural regulation of water levels instead of artificial means
- Habitat protection (including regulation)
  Protection of adjacent buffer zone
- Restrict disturbance to habitat (dredging, removal of debris)

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

Proposed plans for monitoring

Current monitoring

Species monitoring

Appendix F-14: Rivers and Streams Kankakee River (Illinois River) Drainage Headwater

Respondents were aware of the following monitoring efforts by state agencies for wildlife in headwaters of Kankakee River drainage habitat:

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

Respondents were aware of no monitoring efforts by other organizations for wildlife in headwaters of Kankakee River drainage habitat.
Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in headwaters of Kankakee River drainage habitat:

Rank	Monitoring efforts by state agencies for conservation of wildlife in headwaters of Kankakee River drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Regional or local once a year monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife of headwaters of Kankakee River drainage habitat:

Rank	Monitoring efforts by other organizations for conservation of headwaters of Kankakee River drainage habitat
1 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring

Respondents listed regional or local monitoring by state agencies for wildlife of headwaters of Kankakee River drainage habitat (not ranked):

- IDNR fishery surveys are occasionally conducted on the Iroquois River, Yellow River, and Kankakee River
  IDEM occasionally samples fish for contaminants analysis for the annual Fish Consumption Advisory
- IDEM and IDNR collect fish community samples in this area; thus, they may have data on the distribution of least darters.
- IDEM monitors the Kankakee River basin once every five years to determine if the stream are supporting a well-balanced warmwater aquatic community. Tadpole madtoms may have been captured while sampling headwater streams.

Respondents listed no regional or local monitoring by other organizations for wildlife in headwaters of Kankakee River drainage habitat.

Respondents listed organizations that monitor wildlife in headwaters of Kankakee River drainage habitat (not ranked):

- IDNR
- IDEM

Respondents considered monitoring techniques for wildlife in headwaters of Kankakee River drainage habitat:

Monitoring techniques for wildlife in headwaters of Kankakee River drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	X	--
Reporting from harvest, depredation, or unintentional take	X	--	--
Mark and recapture	--	X	--
Professional survey/census	X	--	--
Volunteer survey/census	--	X	--
Trapping (by any technique)	X	--	--
Representative sites	X	--	--
Probabilistic sites	X	X	--

Respondents noted no other monitoring techniques for wildlife in headwaters of Kankakee River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in headwaters of Kankakee River drainage habitats. There were no responses.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for headwaters of Kankakee River drainage habitat (not ranked):

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

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

Respondents were aware of no inventory and assessment efforts by other organizations for headwaters of Kankakee River drainage habitat.

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of headwaters of Kankakee River drainage habitat:

Rank	Inventory and assessment
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Regional or local year-world inventory and assessment

Respondents listed no inventory and assessment efforts by other organizations for headwaters of Kankakee River drainage habitat.

Respondents listed regional or local inventory and assessment by state agencies for headwaters of Kankakee River drainage habitat (not ranked):

- Habitat evaluations are conducted as part of general stream surveys by DNR biologists. Such surveys have been conducted on the Iroquois River, Yellow River and Kankakee River
- IDEM conducts a habitat assessment while sampling stream for fish community assessments using the QHEI (Qualitative Habitat Evaluation Index)
    - QHEI would provide a habitat assessment for sites where least darters were collected

Respondents listed no regional or local inventory and assessment by other organizations agencies for headwaters of Kankakee River drainage habitat.

Respondents listed organizations that monitor headwaters of Kankakee River drainage habitat:

- DNR Division of Fish and Wildlife

Respondents considered inventory and assessment techniques for headwaters of Kankakee River drainage habitat:

Inventory and assessment techniques for headwaters of Kankakee River drainage habitat	Used	Not used but possible with existing	Not economically feasible

		technology and data	
GIS mapping	--	X	--
Aerial photography and analysis	--	X	--
Systematic sampling	X	--	--
Regulatory information	X	--	--
Participation in land use programs	X	--	--

Respondents listed no additional inventory and assessment techniques for headwaters of Kankakee River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for headwaters of Kankakee River drainage habitats. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in headwaters of Kankakee River drainage habitat (not ranked):

- Periodic electrofishing surveys and mark recapture techniques probably provide the best information about the pike populations
- Representative sites or look for sites where the habitat is suitable for the least darter and seine in the vegetation over rocky substrate
- Seining or kick net
- Electrofishing

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in headwaters of Kankakee River drainage habitats. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of headwaters of Kankakee River drainage habitat (not ranked):

- Systematic sampling of habitat along the length of the stream to provide baseline data for comparison across time
- GIS mapping of restored, fully connected wetland to provide an inventory of available spawning habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of headwaters of Kankakee River drainage habitats. There were no responses.

WADEABLE/LARGE RIVERS IN KANKAKEE (ILLINOIS) RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

Rivers and streams of the Kankakee River (Illinois River) drainage are those found in northwest Indiana that flow west into Illinois and eventually the Illinois River. Headwater streams are those having a drainage area of < 20 mi^2. Headwater streams of the Kankakee River drainage are now highly modified, often manmade, sandy/muck bottom, channelized ditches, maintained to drain agricultural lands and control flooding.

Problems affecting species and habitats

Species threats

The respondent listed no "critical threats" to wildlife in wadeable/large rivers of Kankakee River drainage habitat. The respondent listed the following as "serious threat" (not ranked):

- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

The respondent listed the following as "somewhat of a threat" (not ranked):

- High sensitivity to pollution
- Bioaccumulation of contaminants
- Dependence on other species (mutualism/pollinators)
- Viable reproductive population size or availability
- Specialized reproductive behavior or low reproductive rates
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed the following as "slight threat" to wildlife in wadeable/large rivers of Kankakee River drainage habitat (not ranked):

- Predators (native or domesticated)
- Unregulated collection pressure
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)

The respondent listed no other threats to wildlife in wadeable/large rivers of the Kankakee River drainage habitat.

The respondent noted top threats to wildlife in wadeable/large rivers of Kankakee River drainage habitat (not ranked):

- Habitat loss and unintentional take
  - Cleaning and dredging of streams of the Kankakee drainage can result in a large amount of creek heelsplitters being lost
  - The tadpole madtom feeds in dense vegetation and hides from predators in the leaf litter, dead wood, and other cover. By removing vegetation and cover in streams, the tadpole madtom also loses spawning areas (they typically lay eggs under submerged objects)

    - Degradation of the stream channel will also increase the velocity of the current (if straightened or cleared of debris) that removes the tadpole madtom's preferred current-free, quiet habitat.
- Dependence on other species, such as requiring a fish host to reproduce
    - If fish populations decrease for any of a variety of reasons, then creek heelsplitter reproduction could decrease substantially

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Habitat threats

The respondent ranked no "critical threats" to wadeable/large rivers of Kankakee River drainage habitat. The respondent listed the following as "serious threat" (not ranked):

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

The respondent listed the following as "somewhat of a threat" (not ranked):

- Nonpoint source pollution (sedimentation and nutrients)
- Habitat fragmentation
- Impoundment of water/flow regulation
- Drainage practices (stormwater runoff)

The respondent listed the following as "slight threat" to wadeable/large rivers of Kankakee River drainage habitat (not ranked):

- Commercial or residential development (sprawl)
- Invasive/non-native species

The respondent listed no other threats to wadeable/large rivers of the Kankakee River drainage habitat.

The respondent noted top threats to wadeable/large rivers of Kankakee River drainage habitat:

- Habitat degradation and stream channelization cause loss of habitat and impact the mussels directly by killing them or taking them out of the habitat
- Non-point source pollution (sedimentation resulting in smothering of substrates and turbidity)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Additional research and survey efforts

Current body of research

Species research

The respondent indicated that research on wildlife in wadeable/large rivers of Kankakee River drainage habitat is inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of wildlife in wadeable/large rivers of Kankakee River drainage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research for wildlife in wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Habitat research

The respondents indicated that research on wadeable/large rivers of Kankakee River drainage habitat is inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of wadeable/large rivers of Kankakee River drainage habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research for wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Research needs

Species research

The respondent listed no “urgently needed” or “greatly needed” research for wildlife in wadeable/large rivers of Kankakee River drainage habitat. The respondent noted that the following is “needed” (not ranked):

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

The respondent listed no other research needs for wildlife in wadeable/large rivers of Kankakee River drainage habitat.

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 wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Habitat research

The respondent indicated no “urgently needed” or “greatly research” for wadeable/large rivers of Kankakee River drainage habitat. The respondent cited the following research as “slightly needed:”

- Relationship/dependence on specific site conditions

The respondent listed no other research needs for wadeable/large rivers of Kankakee River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Conservation actions necessary

Species actions

The respondent indicated that no conservation efforts address threats to wildlife in wadeable/large rivers of Kankakee River drainage habitat "very well." The following addresses threats to wildlife "somewhat" (not ranked):

- Population management (hunting, trapping)
- Regulation of collecting
- Public education to reduce human disturbance

The respondent listed no other conservation practices for wildlife in wadeable/large rivers of Kankakee River drainage habitat.

The respondent recommended the following practices to enhance wildlife in wadeable/large rivers of Kankakee River drainage habitat (not ranked):

- Protect habitat by limiting the amount of dredging that occurs in the Kankakee River watershed
- Reintroduction of least darter into suitable habitats that have been restored.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wildlife in wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Habitat actions

The respondent indicated that no conservation efforts address threats to wadeable/large rivers of Kankakee River drainage habitat. The respondent offered no additional conservation efforts to address this habitat.

The respondent indicated that the following conservation actions are needed in wadeable/large rivers of Kankakee River drainage habitat (not ranked):

- Any type of habitat protection or restoration
  - Regulation
  - Protect adjacent buffer zone
- Restrict disturbance
  - Dredging
  - Removal of debris

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

The respondent indicated that the following monitoring efforts are conducted by state agencies for wildlife in wadeable/large rivers of Kankakee River drainage habitat:

- Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies

The respondent was not aware of monitoring efforts conducted by other organizations for wildlife in wadeable/large rivers of Kankakee River drainage habitat. Therefore, the respondent found no efforts conducted by other organizations to be crucial.

The respondent considered no monitoring conducted by state agencies to be "very crucial" for wildlife in wadeable/large rivers of Kankakee River drainage habitat, but the following efforts were "somewhat crucial" (not ranked):

- Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by state agencies
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies

The respondent listed the following monitoring by state agencies for wildlife in wadeable/large rivers of Kankakee River drainage habitat:

- Random locations within the Kankakee drainage

The respondents listed no monitoring efforts by other organizations for wildlife in wadeable/large rivers of Kankakee River drainage habitat.

According to the respondent, "professional survey/census" is the most "frequently used" technique for monitoring wildlife in wadeable/large rivers of Kankakee River drainage habitat. The respondent listed no techniques under categories "not used but possible with existing technology," or "not economically feasible."

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring efforts for wildlife in wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Habitat inventory and assessment

The respondent was not aware of inventory and assessment efforts for wadeable/large rivers of Kankakee River drainage habitat by state agencies or other organizations.

The respondent considered no inventory and assessment conducted by state agencies or other organizations as crucial for conservation of wadeable/large rivers of Kankakee River drainage habitat.

The respondent listed no state agencies or other organizations involved in inventory and assessment for wadeable/large rivers of Kankakee River drainage habitat.

The respondents indicated that no techniques are used for inventory and assessment of wadeable/large rivers of Kankakee River drainage habitat. The respondents listed no techniques as "possible with existing technology and data" or "not economically feasible."

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment of wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Recommended monitoring

Species monitoring

The respondents recommended the following monitoring techniques for wildlife in wadeable/large rivers of Kankakee River drainage habitat:

- Professional surveys using timed searches, systematic sampling (Strayer and Smith 2003). See A guide to sampling freshwater mussel populations. American Fisheries Society Monograph 8. American Fisheries Society. Bethesda, Maryland. 103 pp.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

Habitat inventory and assessment

The respondents recommended no inventory and assessment technique for wadeable/large rivers of Kankakee River drainage habitat. The respondent stated, "No habitat inventory of any kind is necessary for creek heelsplitter habitat in the Kankakee drainage."

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for wadeable/large rivers of Kankakee River drainage habitats. There were no responses.

HEADWATERS IN EASTERN CORNBELT/INTERIOR PLATEAU ECOREGION OF OHIO RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

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. Headwater streams are those having a drainage area of < 20 mi^2. Many headwater streams of the Eastern Corn Belt ecoregion are constructed drainage ditches or channelized streams and are intermittent. The Interior Plateau ecoregion includes Indiana's karst region and the most rugged terrain of Indiana.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in this drainage habitat in Indiana:

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

14 Regulated hunting/fishing pressure (too much)

Respondents offered additional threats to wildlife in this drainage habitat in Indiana (not ranked):

- Orangethroat darter habitat threats
  - It prefers high-functioning, high quality riffle habitat in headwater streams. Headwater streams are not always given as much protection or value as larger rivers downstream
  - Threats to the species colonization include aquatic passage problems through culverts
  - Threats to species' watersheds include pollution, clearing of the riparian vegetation, creek gravel mining and channelization

Respondents listed top threats to wildlife in this drainage habitat in Indiana (not ranked):

- Habitat modifications
  - Dredging of headwater streams
  - Alterations of hydrology and land use changes
- Runoff
- Orangethroat darter threats
  - Migration threats: Aquatic passage problems through stream crossing structures
  - Threats to breeding habitat (high quality riffles)
    - Loss of riffle habitat results from water quality degradation and stream channel stability due to dredging, channelization, roads and clearing of riparian vegetation

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

Habitat threats

Respondents ranked threats to this drainage habitat in Indiana:

Rank	Threats to this drainage habitat
1 (tie)	Habitat degradation
1 (tie)	Stream channelization
1 (tie)	Drainage practices (stormwater runoff)
2 (tie)	Commercial or residential development (sprawl)
2 (tie)	Habitat fragmentation
3 (tie)	Nonpoint source pollution (sedimentation and nutrients)
3 (tie)	Agricultural/forestry practices
4 (tie)	Impoundment of water/flow regulation
4 (tie)	Point source pollution (continuing)
5 (tie)	Successional change

5 (tie)	Residual contamination (persistent toxins)
6 (tie)	Mining/acidification
6 (tie)	Counterproductive financial incentives or regulations
7	Diseases (of plants that create habitat)
8	Climate change

Respondents noted no additional threats to this drainage habitat in Indiana.

Respondents listed top threats to this drainage habitat in Indiana (not ranked):

- Pollution
  - Runoff
  - Nonpoint source pollution (sedimentation)
- Habitat degradation
  - Channelization
  - Destruction of clear shaded waters by forestry/agricultural practices or stream channelization

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

Additional research and survey efforts

Current body of research

Species research

One third of respondents stated that the current body of science is adequate for wildlife in this drainage habitat in Indiana; two thirds said that it is inadequate.

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

Title = Occurrence and distribution of freshwater mussels in the small streams of Tippecanoe County, Indiana;
Author = Myers-Kinzie, M., S. Wente, & A. Spacie;
Date = 2001;
Publisher = Proc. Ind. Acad. Sci.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1919;
Publisher = WI Geol. Nat. Hist. Surv.

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

Habitat research

All respondents stated that the current body of science is inadequate for this drainage habitat in Indiana.

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

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Molluscs of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Sci. Surv.

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

Research needs

Species research

Respondents ranked research needs for wildlife in this drainage habitat in Indiana:

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

A respondent noted other research needs for wildlife in this drainage habitat in Indiana:

- Habitat needs are not completely understood. I have seen fresh cylindrical papershell in channelized agricultural ditches. Other small streams with good habitat have only weathered, dead fragments

Appendix F-16: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Headwater

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 this drainage habitat. There were no responses.

Habitat research

Respondents ranked research needs for this drainage habitat in Indiana:

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

A respondent noted additional research needs for this drainage habitat in Indiana:

- Effects of roads and steams crossings on some wildlife species. Is aquatic passage through culverts and other stream crossing structures adequate, or are these crossings causing aquatic habitat fragmentation?

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

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in this drainage habitat in Indiana:

Rank	Conservation efforts for wildlife in this drainage habitat
1	Regulation of collecting
2 (tie)	Habitat protection
2 (tie)	Limiting contact with pollutants/contaminants
2 (tie)	Public education to reduce human disturbance
2 (tie)	Threats reduction

A respondent noted other current conservation practices for wildlife in this drainage habitat in Indiana:

- Habitat protection occurs in the form of the Clean Water Act, National Forest Management Act and other state and federal regulations that protect aquatic habitat and aquatic species. These regulations may or may not be enough for the sake of orangethroat darter conservation

Respondents recommended these practices for more effective conservation of wildlife in this drainage habitat in Indiana (not ranked):

- For all mussel species: Educate anglers that it is illegal to use mussels as fishing bait
- CREP and other incentives for BMPs
- Limit instream modifications (See Watters, 2000. Proc. 1st FMCS Symposium)
- Orange throat darter
    - Restore stream channels so that riffle habitats are enhanced or protected
    - Restore or enhance riparian vegetation to enhance or protect stream channels from runoff or impacts to the channel
    - Maintain roads and stream crossings so that stream channel function and aquatic passage are maintained
- Habitat protection

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

Habitat actions

Respondents listed the following conservation efforts as “somewhat” addressing threats to this drainage habitat in Indiana:

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

Respondents listed no other conservation practices for this drainage habitat in Indiana.

Respondents recommended the following practices for more effective conservation of this drainage habitat in Indiana (not ranked):

- Treat small streams as biological resources and not just drainage ditches. At the very least, require that a mussel survey be done before dredging
- Promote riparian corridor
- Limit habitat modifications
- Streambank stabilization or stream restoration (reconstructing the channel to reconnect it to its natural floodplain elevation)
- Culvert or stream crossing structure improvement (replace non-functioning culverts or other crossing structures and replace with ones that function and are at the right elevation/location within the stream's longitudinal profile

- Restore riparian vegetative communities through tree planting, etc.
- Habitat protection; protection of adjacent buffer zone

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

Proposed plans for monitoring

Current monitoring

Species monitoring

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

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

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

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

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in this drainage habitat in Indiana:

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

Appendix F-16: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Headwater

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in this drainage habitat in Indiana:

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

Respondents listed regional or local monitoring by state agencies for wildlife in this drainage habitat in Indiana (not ranked):

- IDNR nongame biologist does mussel surveys. But, he is only one person and there are thousands of miles of streams in state
- Wabash system
- IDEM and the DNR Nongame program also conduct monitoring during the field season, once a year for fish. These above fish surveys are not specific to the orangethroat darter, but would include it
- IDEM monitors the health of major river basins every five years by looking at chemical, physical and biological data collected at random locations within the watershed. Southern redbelly dace have been captured in the Ohio River drainage habitat; however, specific monitoring for the species has not occurred to my knowledge by anyone state or other organization

Respondents listed regional or local monitoring by other organizations for wildlife in this drainage habitat in Indiana (not ranked):

- Commmonwealth Biomonitoring frequently does habitat evaluations in small streams as part of watershed studies. If I happen to see a shell, I make a note of it in field notes. These are not official mussel surveys
- Wabash system
- Hoosier National Forest conducts yearly fish surveys within two or more 5th level HUCs that encompass the Hoosier National Forest, which includes the Ohio River drainage, Eastern cornbelt/interior plateau ecoregions. These above fish surveys are not specific to the orangethroat darter, but would include it

Respondents listed organizations that monitor wildlife in this drainage habitat in Indiana (not ranked):

- Consultants
- TNC (possibly)
- USDA Forest Service, Hoosier National Forest
- USDI Fish and Wildlife Service
- IDEM
- IDNR

A respondent noted, “Most mussel surveys are on bigger rivers. I was contacted by a college professor who was interested in taking a class to a small stream to learn about mussels. I discouraged him from doing so unless he followed DNR regulations concerning collectors' permits. I haven't heard any more from him.”

Respondents considered monitoring techniques for wildlife in this drainage habitat in Indiana:

Monitoring techniques for wildlife in this drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	--	X
Modeling	--	X	--
Spot mapping	X	--	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	--	--	X
Mark and recapture	X	--	--
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Representative sites	X	--	--
Probabilistic sites	X	X	--

A respondent noted other monitoring techniques for wildlife in this drainage habitat in Indiana:

- Electrofishing and seining are appropriate methods for monitoring the orangethroat darter

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring efforts of wildlife in this drainage habitat. There were no responses.

Habitat inventory and assessment

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

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

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

Respondents were aware of the following inventory and assessment efforts by other organizations for this drainage habitat in Indiana (not ranked):

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of this drainage habitat in Indiana:

Rank	Inventory and assessment by state agencies for conservation of this drainage habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
3	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
4	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
5 (tie)	Statewide once-a-year inventory and assessment
5 (tie)	Regional or local once-a-year inventory and assessment
6 (tie)	Statewide annual inventory and assessment
6 (tie)	Regional or local year-round inventory and assessment

Appendix F-16: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Headwater

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of this drainage habitat in Indiana:

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

A respondent listed regional or local inventory and assessment by state agencies for this drainage habitat in Indiana:

- Wabash system

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

- Commonwealth Biomonitoring does habitat evaluations on small streams as part of watershed studies. These evaluations are not specific to mussels, but are Ohio EPA QHEI methods
- Wabash system
- Two or more 5th level HUC watersheds a year that encompass the Hoosier National Forest are sampled; a random sampling of streams found within these 5th level HUCs occurs

Respondents listed organizations that monitor this drainage habitat in Indiana (not ranked):

- Consultants
- TNC (possibly)
- IDEM
    - Qualitative Habitat Evaluations completed at sites where southern redbelly dace may have been captured as part of the fish community sampling program

- IDNR
- USDA Forest Service
- USDI Fish and Wildlife Service

Respondents considered inventory and assessment techniques for this drainage habitat in Indiana:

Inventory and assessment techniques for this drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	--
Aerial photography and analysis	--	--	X
Systematic sampling	X	--	--
Participation in land use programs	X	X	--
Modeling	X	X	--
Voluntary landowner reporting	X	--	X

A respondent listed additional inventory and assessment techniques for this drainage habitat in Indiana:

- Qualitative Habitat Evaluation Index (QHEI); REMAP protocols for northern forested Streams; stream channel cross-sections and longitudinal profiles; substrate analysis; descriptions of riparian vegetation; water quality parameters are measured using probes and hydro labs

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for this drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in this drainage habitat in Indiana (not ranked):

- Intensive quantitative sampling of known populations (Need to understand demography of species. See Strayer & Smith, 2003. AFS Monogram 8)
- Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of species. (See above for protocols.)
- Electrofishing streams
  - Take a random sampling of streams within a watershed (5th or 6th level HUC) and standardize the stream reach length for the survey, usually 15 times the stream width
- Seining is also an appropriate method for sampling, especially in riffle habitats

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

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of this drainage habitat in Indiana (not ranked):

- Assess riparian corridor presence
- Water quality
- Two protocols that I recommend for reference include the following:
    - Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. USDA Forest Service. General Technical Report RM-245. (The above reference offers useful guidance on measuring stream channel cross-sections and substrate within the stream. This information can be used to determine if a stream channel is stable and substrate available within riffle habitats, which are the preferred habitat of the orangethroat darter)
    - Simon, T. P. and P.M. Stewart. 1998. Standard Operating Procedures For Development of Watershed Indicators In REMAP: Northern Lakes and Forest Streams. (The above reference is useful for developing a watershed level sampling design and includes useful methods for measuring stream channel and stream habitat parameters.)
- Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA is a useful qualitative field method that can help prioritize sites within a watershed for stream habitat or water quality improvement

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

WADEABLE/LARGE RIVERS IN THE EASTERN CORNBELT/INTERIOR PLATEAU ECOREGIONS OF THE OHIO RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

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.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Threats to wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	High sensitivity to pollution
2	Habitat loss (breeding range)
3	Habitat loss (feeding/foraging areas)
4	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
5	Invasive/non-native species
6	Specialized reproductive behavior or low reproductive rates
7	Viable reproductive population size or availability
8 (tie)	Predators (native or domesticated)
8 (tie)	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
9	Bioaccumulation of contaminants
9	Diseases/parasites (of the species itself)
10	Small native range (high endemism)
11	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)

12	Regulated hunting/fishing pressure (too much)
13	Dependence on other species (mutualism, pollinators)
14	Near limits of natural geographic range
15	Genetic pollution (hybridization)
16	Large home range requirements
17 (tie)	Species overpopulation
17 (tie)	Unregulated collection pressure

A respondent offered additional threats to wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- High stream flow for a few months following spawning can reduce class year strength seriously. Reducing ditching in headwaters, installing grass waterways and WASCOBS and maintaining riparian corridors, can reduce the threat. All of these measures will slow stream flows and reduce siltation

Respondents listed top threats to wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Hellbenders
  - Small geographic range
  - Small population sizes

- Habitat modification, fragmentation, degradation or loss
  - In-stream modifications
  - Loss of instream cover
  - Riparian destruction
  - Channelization
  - Rock bass: Habitat loss and degradation are serious threats. They prefer silt free streams to reproduce and thrive. They also relate closely to structure/cover therefore any habitat loss is a threat
  - Eastern sand darter requires sandy bottoms in fast flowing streams to bury eggs, hide from predators, ambush prey, conserve energy and maintain position in unstable/shifting sandbars. Habitat loss is biggest threat
  - Breeding and feeding/foraging habitat loss due to sedimentation from farm fields and stream banks as well as the removal of natural riparian vegetation
  - Runoff and pollution
    - Introduction of sediments, if only temporary
    - Pollution within the Tippecanoe River system in Indiana
    - Point source pollution that triggers fish kills or repels rock bass from the area
    - Pollution which triggers fish kills or repels smallmouth from the area
    - Siltation of spawning areas and pools

- Loss of reproductive ability
  - Any factor which reduces the reproductive population size
  - Eastern sand darter: Low reproductive rates/small populations - reach maturity at age one, but only lives a few years
  - Hellbenders: In many locations there is concern about low reproductive rates, but this is unknown in Indiana populations

Appendix F-17: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Habitat threats

Respondents ranked threats to wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Threats to wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Stream channelization
2	Habitat degradation
3	Point source pollution (continuing)
4	Nonpoint source pollution (sedimentation and nutrients)
5	Agricultural/forestry practices
6	Drainage practices (stormwater runoff)
7	Habitat fragmentation
8	Commercial or residential development (sprawl)
9 (tie)	Counterproductive financial incentives or regulations
9 (tie)	Impoundment of water/flow regulation
10	Residual contamination (persistent toxins)
11	Mining/acidification
12	Invasive/non-native species
13	Successional change
14	Climate change
15	Diseases (of plants that create habitat)

Respondents noted no other threats to wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana.

Respondents listed top threats to wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Habitat degradation, alteration, loss, fragmentation
  - Instream modifications
  - Runoff
    - Agricultural
    - Residential
  - Impoundment

- Sedimentation
- Removal of natural riparian vegetation, especially through drainage and maintenance activities
- Toxins and pollutants
  - Point source pollution: These ecoregions have major threats from large cities causing fish kills from wastewater treatment plants. Also, confined feeding operations in rural areas are a major threat to stream fish communities
- Channelization
  - Which reduces the shallow (less than 1.5 feet) sand/gravel substrate can critically reduce or fragment habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Additional research and survey efforts

Current body of research

Species research

Fifty percent of respondents stated that the current body of science is adequate for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana; fifty percent stated that it is inadequate.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitats in Indiana.

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Field guide to freshwater mussels of Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Appendix F-17: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River

Title = 'Clubshell';
Author = USFW, Division of Endangered Species;
Publisher = Online

Title = A survey of fish communities and aquatic habitats at Indiana's major steams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart T. Shipman;
Date = 12/1997;
Publisher = DNR fisheries section

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance.;
Author = Stuart T. Shipman;
Date = December 1997;
Publisher = IDNR

Title = Surveys of the fish communties and aquatic habitats in 16 small streams in Indiana from 1996 through 1997.;
Author = Douglas C. Keller;
Date = 1999;
Publisher = IDNR

Title = The Fishes of Missouri;
Author = William L. Plieger;
Date = 1997;
Publisher = Missouri Conservation Commission

Title = Handbook of freshwater fishery biology;
Author = Kenneth D. Carlander;
Date = 1997;
Publisher = Iowa University Press

Title = fishes of Tennessee;
Author = Etnire and Starnes

Title = Fishes of Ohio;
Author = Milt Troutman;
Publisher = OSU Press

Title = FW fishes of Canada;
Author = Scott & Crossman

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart Shipman;
Date = 12/1997;
Publisher = DNR/Fisheries section

Title = Surveys of the fish communties and aquatic habitats in 16 small streams in Indiana from 1996 through 1997.;
Author = Douglas C. Keller;
Date = 1999;
Publisher = IDNR

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Habitat research

Fifty percent of respondents stated that the current body of science is adequate for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana; forty-two percent stated that it is inadequate or nonexistent.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1929;
Publisher = WI Geol. Nat. Sci. Surv.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Naiades of Pennsylvania;
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Date = 1999;
Publisher = IDNR

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart Shipman;
Date = 12/1997;

Publisher = DNR/Fisheries section

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Research needs

Species research

Respondents ranked research needs for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Research needs for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Limiting factors (food, shelter, water, breeding sites)
2	Relationship/dependence on specific habitats
3 (tie)	Distribution and abundance
3 (tie)	Threats (predators/competition, contamination)
4 (tie)	Life cycle
4 (tie)	Population health (genetic and physical)

A respondent noted an additional research need for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

- To find out why the clubshell has depopulated most of its former distribution in Indiana. Developing some sort of timeline (late Pleistocene, Holocene), usually archeological or historic, for relic valve distribution might narrow possibilities of critical limiting factors (post-settlement siltation, etc.)

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 wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Habitat research

Respondents ranked research needs for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Research needs for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Threats (land use change/competition,

	contamination/global warming)
2	Relationship/dependence on specific site conditions
3	Distribution and abundance (fragmentation)
4	Growth and development of individual components of the habitat
5	Successional changes

Respondents noted no additional research needs for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Conservation efforts for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Stocking
2	Reintroduction (restoration)
3 (tie)	Habitat protection
3 (tie)	Limiting contact with pollutants/contaminants
4	Translocation to new geographic range
5	Population management (hunting, trapping)
6 (tie)	Population enhancement (captive breeding and release)
6 (tie)	Threats reduction
6 (tie)	Exotic/invasive species control
6 (tie)	Regulation of collecting
6 (tie)	Disease/parasite management
6 (tie)	Public education to reduce human disturbance
6 (tie)	Culling/selective removal

Respondents noted no other current conservation practices for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana.

Appendix F-17: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River

Respondents recommended these practices for more effective conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Habitat protection, restoration and enhancement
  - Restore riparian corridors
  - Eliminate instream modifications, including impoundment
  - Pollution control
    - From wastewater treatment plants and confined feeding operations
  - Protect shallow sand/gravel habitat from siltation and channelization
  - Eastern sand darter: Reduce sedimentation covering sand substrate that darter needs to survive and reproduce. Current efforts to reduce sedimentation in streams is somewhat effective, but I'm not sure it is enough to keep the eastern sand darter from disappearing

- Regulation
  - Strict enforcement of laws regulating instream modification
  - Declare moratorium on channel/drainage improvement projects that do not mitigate losses

- Incentives
  - For farmers

- Propagation

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Habitat actions

Respondents ranked conservation efforts by how well they address threats to wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Conservation efforts for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Protection of adjacent buffer zone
2	Pollution reduction
3	Corridor development/protection
4	Habitat restoration incentives (financial)
5	Habitat protection incentives (financial)
6	Habitat protection through regulation
6	Habitat restoration through regulation
7	Habitat restoration on public lands
8	Habitat protection on public lands

9	Land use planning
10 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
10 (tie)	Managing water regimes
10 (tie)	Restrict public access and disturbance
10 (tie)	Technical assistance
10 (tie)	Cooperative land management agreements (conservation easements)

A respondent listed another current conservation practice for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

- Eastern sand darter: The best way to conserve critical habitat for the eastern sand darter would be:
  - Habitat protection on all lands
  - Habitat restoration of floodplains would be critical to the amount of sedimentation reaching the stream bed
  - Managing water regimes may impact the settling of sediments in stream (thus dam removal may be appropriate)
  - Protection of adjacent buffer zone is key to stopping deleterious effects of erosion and sedimentation in the stream
  - Land use planning and conservation easements would also keep runoff to a minimum

Respondents recommended the following practices for more effective conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Habitat protection and restoration
  - No instream modifications
  - Limit runoff through incentives or other means
  - Manage pollutants and toxins for improved water quality and fewer fish kills
  - Protect buffer/riparian zones: Leads to improved water quality and more instream cover

- Incentives
  - CREP and other incentives for BMPs
  - Increase habitat using incentives
  - To protect adjacent buffer zones

- Regulation
  - To maintain available habitat

- Technical assistance

- Land use planning

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

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

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Periodic statewide (less than once a year but still regularly scheduled) monitoring
4 (tie)	Regional or local once-a-year monitoring
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
5	Regional or local year-round monitoring
6	Statewide year-round monitoring

7	Statewide once-a-year monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Monitoring efforts by other organizations for conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring
1 (tie)	Regional or local once-a-year monitoring
1 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
3	Regional or local year-round monitoring
4	Occasional statewide (less than once a year and not regularly scheduled) monitoring
5 (tie)	Statewide year-round monitoring
5 (tie)	Statewide once-a-year monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- IDNR Division of Fish and Wildlife
- Wabash system
- Tippecanoe River, Maumee system
- Periodic (usually annual) monitoring in the Tippecanoe River by IDNR
- Blue River (Harrison County), Sugar Creek (Shelby County), Indian Creek (Greene County)
- In early to mid 1990s, Division of Fish and Wildlife conducted fish community inventories on the major streams throughout the state
- IDEM Probabilistic sampling
- Eastern sand darters
    - Indiana DNR Special Studies on T&E species: IDNR, Brant Fisher, did a study on the population of eastern sand darters in Indiana over the past five years. IDNR regional fish collection surveys may have collected some specimens
    - Indiana Department of Environmental Management (IDEM) occasionally collected eastern sand darters as part of their Surface Water Quality Monitoring Strategy evaluating fish community structure in certain watersheds every five years
    - See IDEM OWQ's Surface Water Quality Monitoring Strategy and project work plans and IDNR Fisheries Section work plans

    - In early to mid 1990's the Division of Fish and Wildlife conducted a smallmouth bass inventory
- Smallmouth bass
    - Five streams have been sampled every other year from 1998 to 2004 to estimate smallmouth bass populations to determine the effect of smallmouth bass population changes due to the imposition of a 12-inch black bass size limit in 1998
    - Game fish population estimates (including rock bass) have been conducted on five streams every other year from 1998 through 2004

Respondents listed regional or local monitoring <u>by other organizations</u> for <u>wildlife</u> in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Wabash system
- Tippecanoe River, Maumee system
- West Fork White River & tributaries (Muncie area)
- Ball State University fish sampling
- Eastern sand darter: While collecting fish community samples to evaluate the community structure and ability of the stream to support a healthy fish community, these organizations may have collected eastern sand darters:
    - Soil and Water Conservation Districts within those ecoregions
    - Purdue University
    - Wildcat Creek Watershed Alliance
    - I would check with the Scientific Collectors Permit office for a list of organizations collecting in those ecoregions and also check with the IDEM Section 319 webpage for project summaries where fish or habitat in those ecoregions were studied
- US Environmental Protection Agency
- USGS Water Resources Division
- Ohio River Valley Water Sanitation Commission
- Midwest Biodiversity Institute
- U.S. Army Corps of Engineers
- Muncie Bureau of Water Quality
- City of Elkhart Water Quality
- Universities
- Consulting firms

Respondents listed organizations that monitor <u>wildlife</u> in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Consultants
- The Nature Conservancy
- U.S. Fish and Wildlife Service
- IDNR Division of Fish and Wildlife
- Muncie Bureau of Water Quality
- Soil and Water Conservation Districts
- Purdue University
- Wildcat Creek Watershed Alliance
- US Environmental Protection Agency
- USGS Water Resources Division
- Ohio River Valley Water Sanitation Commission
- Midwest Biodiversity Institute
- U.S. Army Corps of Engineers
- Muncie Bureau of Water Quality
- City of Elkhart Water Quality

- Consulting firms

Respondents considered monitoring techniques for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

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

Respondents noted other monitoring techniques for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

- Unintentional take could be monitored from fish kill cadaver counts if officers could be trained to identify northern hog suckers instead of not counting them, or just lumping them into the generic class of “round bodied suckers”

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

Appendix F-17: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River

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

Respondents were aware of the following inventory and assessment efforts by other organizations for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Inventory and assessment by state agencies for conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
3	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
4	Regional or local once-a-year inventory and

	assessment
5	Statewide once-a-year inventory and assessment
6	Statewide annual inventory and assessment
7	Regional or local year-round inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Rank	Inventory and assessment by other organizations for conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat
1	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
4	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
5	Statewide once-a-year inventory and assessment
6	Statewide annual inventory and assessment
7	Regional or local once-a-year inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Wabash system
- Tippecanoe River and Maumee system (Usually species inventories are made, with relevant habitat information)
- Blue River (Harrison County), Sugar Creek (Shelby County), Indian Creek (Greene County)
- IDEM and IDNR (as well as other organizations) use the Qualitative Habitat Evaluation Index to document the habitat quality of the streams sampled for aquatic communities
- IDEM/OWQ/BSS
- IDNR/FWD/FS

- ORSANCO;
- Blue River (Harrison County)

Respondents listed regional or local inventory and assessment by other organizations agencies for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Wabash system
- Tippecanoe River and Maumee system
- Muncie BWQ – West Fork-White River and tributaries in the Muncie area

Respondents listed organizations that monitor the wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Consultants
- The Nature Conservancy
- U.S. Fish and Wildlife Service
- IDNR – Division of Fish and Wildlife
- Cities of Muncie
- City of Elkhart
- U.S. Geological Survey/WRD

Respondents considered inventory and assessment techniques for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana:

Inventory and assessment techniques for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	--
Aerial photography and analysis	X	X	--
Systematic sampling	X	--	--
Property tax estimates	--	--	X
State revenue data	--	--	X
Regulatory information	X	--	--
Participation in land use programs	X	X	--
Modeling	X	X	--
Voluntary landowner reporting	X	X	X

Respondents listed additional inventory and assessment techniques for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Water quality monitoring
- QHEI

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Professional Survey
- Intensive quantitative sampling of known populations. Need to understand demography of the Clubshell (See Strayer & Smith, 2003. AFS Monogr. 8.)
- Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of the Clubshell (See Strayer & Smith, 2003. AFS Monogr. 8.)
- State DNR or professional census at representative or probabilistic sites
  - Development of trained, select volunteer core to undertake surveys at probabilistic sites, particularly where some wildlife species should, or could occur and has not been documented in recent years
- Stream fish community surveys
- Rock bass population estimates
- Electrofishing surveys
  - From probabilistic and representative sites
  - Catch rate data
- Eastern sand darter: See where populations have been captured in the past and then with seines or electrofishing equipment mark and recapture the darter to document habitat characteristics, water quality information, and land use characterization where the darters occur. You will need to target the habitat and not the exact location since the sandbars will probably shift over time. Look on the web for mark and recapture surveys as well as other eastern sand darter publications. I found many by just searching the web for “eastern sand darter”
- Population estimates
- Angler creel surveys
- Smallmouth bass
  - Stream fish community surveys to determine smallmouth bass distribution and abundance. There may be a correlation of smallmouth abundance to the species richness to the overall fish community
  - Smallmouth bass population estimates

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

Appendix F-17: Rivers and Streams Ohio River Drainage Eastern Corn Belt/Interior Plateau Ecoregions Wadeable/Large River

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat in Indiana (not ranked):

- Systematic survey and GIS
  - More extensive use of GIS-modeled habitat probabilities
- Assess riparian corridor
- Water quality monitoring
- CREP, farmer incentives for no-till, riparian corridors, etc.
- Strictly control instream modifications: mining, snagging, etc.
- Qualitative Habitat Evaluation Index (QHEI) in conjunction with a stream community survey or sampling specifically for smallmouth bass. This can show which habitat components most strongly correlate with smallmouth bass abundance and or size structure

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of wadeable large rivers of the interior plateau of the eastern corn belt Ohio River drainage habitat. There were no responses.

GREAT RIVERS OF OHIO RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

Rivers and streams of the Ohio River drainage include all waters of the lower half of Indiana and a large portion of the northern half of Indiana. Great rivers are those having a drainage area of > 1,999 mi^2. This includes the Ohio River, the Wabash River upstream to the Mississinewa River, the White River upstream on the West Fork to the Johnson/Morgan county line and on the East Fork to just south of Columbus (Bartholomew County). The entire Ohio River drainage of Indiana culminates where the Wabash River meets the Ohio River in the extreme southwestern tip of Indiana.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in great rivers of Ohio River drainage habitat in Indiana.

Rank	Threats to wildlife in great rivers of Ohio River drainage habitat
1	Invasive/non-native species
2	Habitat loss (feeding/foraging areas)
3	Habitat loss (breeding range)
4	High sensitivity to pollution
5	Bioaccumulation of contaminants
6	Specialized reproductive behavior or low reproductive rates
7	Viable reproductive population size or availability
8	Dependence on other species (mutualism, pollinators)
9	Regulated hunting/fishing pressure (too much)
10	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
11	Predators (native or domesticated)

Respondents offered no additional threats to wildlife in great rivers of Ohio River drainage habitat in Indiana.

Respondents listed top threats to wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Zebra mussels

- Instream dredging and modification
- Habitat loss
- Pollution
  - Lack of reproductive success as indicated by poor length frequency distribution
  - Possible sensitivity to pollution as indicated by its rarity in the Ohio River reach in Indiana

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in great rivers of Ohio river drainage habitat. There were no responses.

Habitat threats

Respondents ranked threats to great rivers of Ohio River drainage habitat in Indiana:

Rank	Threats to great rivers of Ohio River drainage habitat
1	Stream channelization
2	Impoundment of water/flow regulation
3	Habitat degradation
4 (tie)	Mining/acidification
4 (tie)	Point source pollution (continuing)
5	Nonpoint source pollution (sedimentation and nutrients)
6 (tie)	Agricultural/forestry practices
6 (tie)	Drainage practices (stormwater runoff)
6 (tie)	Invasive/non-native species
6 (tie)	Residual contamination (persistent toxins)
7	Habitat fragmentation
8	Commercial or residential development (sprawl)
9	Counterproductive financial incentives or regulations

Respondents noted another threat to great rivers of Ohio River drainage habitat in Indiana:

- Sand and gravel operations would destroy preferred habitat

Respondents listed top threats to great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Impoundment
- Stream modifications
- Stream channelization
- Dredging
- Non-point source pollution
- Siltation
- Loss of riparian zone

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to great rivers of Ohio River drainage

habitat. There were no responses.

Additional research and survey efforts

Current body of research

Species research

Thirty percent of respondents stated that the current body of science is adequate for wildlife in great rivers of Ohio River drainage habitat in Indiana.

Seventy percent stated that the current body of science in inadequate or non-existent.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in great rivers of Ohio River drainage habitat in Indiana.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1991;
Publisher = USFWS

Title = Life history and propagation...;
Author = Jones & Neves;
Date = 2002;
Publisher = JNABS

Title = Freshwater mussels of Tennessee;
Author = Parmalee & Bogan;
Date = 1998;
Publisher = U of Tennessee Press

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Wabash River Catfish Reports;
Author = Rob Columbo;
Date = 2002,2003,2004,2005;
Publisher = SIU/INDFW

Title = numerous INDFW FMR's;
Author = numerous;
Date = numerous;
Publisher = INDFW

Title = annual Ohio River sauger reports;
Author = ORFMT;
Date = annually since 1999;
Publisher = ORFMT

Title = various INDFW FMR's;
Author = various;
Date = various;
Publisher = INDFW

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

Habitat research

All respondents stated that the current body of science is inadequate or non-existent for great rivers of Ohio River drainage habitat in Indiana.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of great rivers of Ohio River drainage habitat in Indiana.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1991;
Publisher = USFWS

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Hist. Surv.

Title = Ohio River Mainstem Study;
Author = USACOE;
Date = 2000?;
Publisher = USACOE

Title = Ohio River Mainstem Study;
Author = USACOE;
Date = 2000?;
Publisher = USACOE

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for great rivers of Ohio river drainage habitat. There were no responses.

Research needs

Species research

Respondents ranked research needs for wildlife in great rivers of Ohio River drainage habitat in Indiana:

Rank	Research needs for wildlife in great rivers of Ohio River drainage habitat
1	Life cycle
2 (tie)	Distribution and abundance

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

Respondents noted that research needs were "determining the population limiting factors in the Ohio River" for wildlife in great rivers of Ohio River drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wildlife in great rivers of Ohio river drainage habitat. There were no responses.

Habitat research

Respondents ranked research needs for great rivers of Ohio River drainage habitat in Indiana:

Rank	Research needs for great rivers of Ohio River drainage habitat
1 (tie)	Distribution and abundance (fragmentation)
1 (tie)	Threats (land use change/competition, contamination/global warming)
2	Growth and development of individual components of the habitat
3	Relationship/dependence on specific site conditions

A respondent noted additional research need for great rivers of Ohio River drainage habitat in Indiana:

- Water quality requirements

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for great rivers of Ohio river drainage habitat. There were no responses.

Conservation actions necessary

Species actions

Respondents listed these conservation efforts that address threats to wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Habitat protection
- Public education to reduce human disturbance
- Limiting contact with pollutants/contaminants
- Population management (hunting, trapping)

- Regulation of collecting

Respondents noted no other conservation practices for wildlife in great rivers of Ohio River drainage habitat in Indiana.

Respondents recommended these practices for more effective conservation of wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Limit instream modifications
- Restore free-flowing systems
- Remove dams whenever possible
- Public education
- Regulation of collecting
- Habitat protection/restoration
- Pollution control

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in great rivers of Ohio river drainage habitat. There were no responses.

Habitat actions

Respondents ranked conservation efforts by how well they address threats to great rivers of Ohio River drainage habitat in Indiana:

Rank	Conservation efforts for great rivers of Ohio River drainage habitat
1	Pollution reduction
2 (tie)	Habitat protection through regulation
2 (tie)	Protection of adjacent buffer zone
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Land use planning
2 (tie)	Cooperative land management agreements (conservation easements)
2 (tie)	Habitat protection on public lands
2 (tie)	Habitat restoration through regulation
2 (tie)	Habitat restoration on public lands
2 (tie)	Technical assistance
2 (tie)	Corridor development/protection
2 (tie)	Managing water regimes
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)

Respondents listed no other conservation practices for great rivers of Ohio River drainage habitat in Indiana.

Respondents recommended the following conservation practices for great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Eliminated habitat modifications
  - Instream dredging
  - Channelization
- Restore free-flowing systems
- Install buffer strips and stabilize banks
- Reduce non-point source pollution
- Riparian conservation easements

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for great rivers of Ohio River drainage habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

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

Respondents ranked monitoring efforts by state agencies based on their importance for wildlife in great rivers of Ohio River drainage habitat in Indiana:

Rank	Monitoring efforts by state agencies for wildlife in great rivers of Ohio River drainage habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) monitoring

2	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
3	Regional or local once-a-year monitoring
8	Statewide once-a-year monitoring
4	Periodic statewide (less than once a year but still regularly scheduled) monitoring
5	Occasional statewide (less than once a year and not regularly scheduled) monitoring
7	Regional or local year-round monitoring
6	Statewide year-round monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for wildlife in great rivers of Ohio River drainage habitat in Indiana:

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

Respondents listed regional or local monitoring by state agencies for wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Ohio River, Cannelton Pool (IDFW 2004)
- Wabash River (IDFW 1999)
- White River, West Fork (IDFW 2004)
- White River, East Fork (IDFW 2003)
- White River, Main Stem (IDFW 2004)
- Patoka River (IDFW 1993)
- Occasional stream surveys
- Annual commercial fish harvest monitoring
- Ohio River, Newburgh and McApline Tailwater fall/winter annual monitoring

Respondents listed regional or local monitoring by other organizations for wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Ohio River
- Wabash River
- Ohio River

Respondents listed organizations that monitor wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- USFWS
- Consultants
- IDNR, DFW
- Electric utilities
- Ball State University
- Purdue University

Respondents considered monitoring techniques for wildlife in great rivers of Ohio River drainage habitat in Indiana as follows:

Monitoring techniques for wildlife in great rivers of Ohio River drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	X	X	X
Modeling	X	--	--
Spot mapping	X	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	X	--
Mark and recapture	X	X	X
Professional survey/census	X	--	--
Volunteer survey/census	X	--	--
Trapping (by any technique)	X	--	--
Representative sites	X	--	--
Probabilistic sites	X	X	--

Respondents noted other monitoring techniques for wildlife in great rivers of Ohio River drainage habitat in Indiana:

- Larval sampling to check for reproduction

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in great rivers of Ohio River drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for great rivers of Ohio River drainage habitat in Indiana (not ranked):

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

Respondents were aware of the following inventory and assessment efforts by other organizations for great rivers of Ohio River drainage habitat in Indiana (not ranked):

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of great rivers of Ohio River drainage habitat in Indiana:

Rank	Inventory and assessment by state agencies for great rivers of Ohio River drainage habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2	Statewide once-a-year inventory and assessment
3	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
5	Regional or local once-a-year inventory and assessment
4 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
4 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
6	Statewide annual inventory and assessment
7	Regional or local year-round inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of great rivers of Ohio River drainage habitat in Indiana:

Rank	Inventory and assessment by other	Score

	organizations for great rivers of Ohio River drainage habitat	
1	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment	3.88
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment	2.88
2 (tie)	Regional or local once-a-year inventory and assessment	2.88
3 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment	2.63
3 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment	2.63
3 (tie)	Regional or local year-round inventory and assessment	2.63
3 (tie)	Statewide once-a-year inventory and assessment	2.63
4	Statewide year-round inventory and assessment	2.37

Respondents listed regional or local inventory and assessment by state agencies for great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Ohio River
- Wabash River
- White River, West Fork
- White River, East Fork

Respondents listed regional or local inventory and assessment by other organizations agencies for great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Ohio River (USACOE)
- Wabash River
- White River, West Fork
- White River, East Fork

Respondents listed organizations that monitor great rivers of Ohio River drainage habitat in Indiana (not ranked):

- USFWS
- Consultants
- IDNR, DFW
- USACOE (Ohio River)

Respondents considered inventory and assessment techniques for great rivers of Ohio River drainage habitat in Indiana as follows:

Inventory and assessment techniques for great rivers of Ohio River drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	X
Aerial photography and analysis	X	X	--
Systematic sampling	X	--	--
Participation in land use programs	X	--	--
Modeling	X	--	--
Voluntary landowner reporting	X	--	--

Respondents listed additional inventory and assessment techniques for great rivers of Ohio River drainage habitat in Indiana:

- QHEI

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for great rivers of Ohio River drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Intensive quantitative sampling of known populations. (Need to understand demography of species. See Strayer & Smith, 2003. AFS Monogram 8)
- Less intensive qualitative sampling of new or not recently surveyed areas. (Need to determine distribution and status of species. See same for protocols.)
- Electrofishing (riverwide and swift water habitats)
- Hoop nets
- Periodic stream surveys
- Fall/winter Ohio River tailwater sampling and occasional stream surveys

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in great rivers of Ohio river drainage habitat. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of great rivers of Ohio River drainage habitat in Indiana (not ranked):

- Assess zebra mussel infestations. (Contact P. Morrison, USFWS, Parkersburg, WV)
- QHEI
- Record habitat when the wildlife species is collected during a survey.
- GIS mapping and aerial photography and analysis

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of great rivers of Ohio river drainage habitat. There were no responses.

HEADWATERS IN THE INTERIOR RIVER LOWLAND OF OHIO RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

Streams of the Ohio River drainage, Interior River Lowland ecoregion are found in southwestern Indiana. Headwater streams are those having a drainage area of < 20 mi^2. Headwater streams of the Interior River Lowland have been heavily modified for agricultural purposes and many are intermittent.

Problems affecting species and habitats

Species threats

The respondent listed the following as "critical threat" to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

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

The respondent listed the following as "serious threat" to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat:

- High sensitivity to pollution

The respondent listed the following as "slight threat" to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

- Bioaccumulation of contaminants
- Predators (native or domesticated)
- Dependence on other species (mutualism, pollinators)
- Diseases/parasites (of the species itself)
- Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)

The respondent offered no additional threats to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat.

The respondent listed top threats to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

- Degradation of nesting and staging sites: pools or riffles with slow current beneath flat rocks
- Low reproductive rates: Males reach sexual maturity at two years of age while females can reproduce at one year, and they only have a life span of about three years

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Habitat threats

The respondent listed the following as "critical threat" to interior lowland headwaters of Ohio River drainage habitat (not ranked):

- Commercial or residential development (sprawl)
- Nonpoint source pollution (sedimentation and nutrients)
- Habitat fragmentation
- Habitat degradation

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

- Stream channelization
- Impoundment of water/flow regulation
- Drainage practices (stormwater runoff)

The respondent listed the following as "somewhat of a threat" (not ranked):

- Successional change
- Climate change
- Agricultural/forestry practices
- Mining/acidification

The respondent listed the following as "slight threat" to interior lowland headwaters of Ohio River drainage habitat (not ranked):

- Invasive/non-native species
- Residual contaminants (persistent toxins)
- Point source pollution (continuing)

The respondent noted no additional threats to interior lowland headwaters of Ohio River drainage habitat.

The respondent listed top threats to interior lowland headwaters of Ohio River drainage habitat:

- Habitat degradation in terms of removal of substrate for spawning and sedimentation for covering the substrate needed to spawn

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Additional research and survey efforts

Current body of research

Species research

The respondent stated that the current body of science is inadequate for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Habitat research

The respondent stated that the current body of science is inadequate for interior lowland headwaters of Ohio River drainage habitat.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of headwaters of the interior river lowland of the Ohio River drainage habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Research needs

Species research

The respondent listed the following research for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat as “urgently needed” (not ranked):

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

The respondent listed the following research as “slightly needed” (not ranked):

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

The respondent listed no research as “greatly needed” or “needed.”

The respondent noted no other research needs for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat.

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 headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Habitat research

The respondent listed the following research as “urgently needed” for interior lowland headwaters of Ohio River drainage habitat (not ranked):

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

The respondent listed “successional changes” as “needed” research.

The respondent noted no other additional research needs for interior lowland headwaters of Ohio River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the additional research needs for headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Conservation actions necessary

Species actions

The respondent did not respond to the question regarding how well practices address threats to wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. The respondent listed no current conservation practices for wildlife in this habitat.

The respondent recommended the following specific practices for more effective conservation of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

- Habitat protection
- Threats reduction

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the effective conservation of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Habitat actions

The respondent did not answer the question asking how well practices address threats to interior lowland headwaters of Ohio River drainage habitat. The respondent listed no current conservation practices for this habitat.

The respondent recommended the following practices for more effective conservation of interior lowland headwaters of Ohio River drainage habitat (not ranked):

- Habitat protection
- Threats reduction

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

The respondent was aware of the following monitoring efforts by state agencies for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

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

The respondent was aware of no monitoring efforts by other organizations for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat.

The respondent listed the following monitoring efforts by state agencies as "very crucial" for conservation of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

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

The respondent listed no monitoring efforts by other organizations as crucial for conservation of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat.

The respondent listed regional or local monitoring by state agencies for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat (not ranked):

- I believe IDNR has conducted special studies on the Spottail Darter
- IDEM has a record of the Spottail Darter being caught in that area

The respondent listed no regional or local monitoring by other organizations for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. The respondent listed no organizations that conduct such monitoring.

The respondent considered current monitoring techniques for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat as follows:

Monitoring techniques for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
Representative sites	X	--	--
Probabilistic sites	X	--	--

The respondent noted no other monitoring techniques for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Habitat inventory and assessment

The respondent was aware of the following inventory and assessment efforts by state agencies for interior lowland headwaters of Ohio River drainage habitat:

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

The respondent ranked the above inventory and assessment efforts as “somewhat crucial” for conservation of this habitat.

The respondent was aware of no following inventory and assessment efforts by other organizations for interior lowland headwaters of Ohio River drainage habitat. Therefore, no efforts are considered crucial.

The respondent listed no regional or local inventory and assessment by state agencies or other organizations agencies for interior lowland headwaters of Ohio River drainage habitat.

The respondent listed organizations that monitor interior lowland headwaters of Ohio River drainage habitat:

- IDEM performs habitat assessments in this area

The respondent did not answer the question regarding use or feasibility of inventory and assessment techniques for interior lowland headwaters of Ohio River drainage habitat.

The respondent listed no additional inventory and assessment techniques for interior lowland headwaters of Ohio River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Recommended monitoring

Species monitoring

The respondent recommended the following monitoring techniques for effective conservation of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat:

- Seining at representative sites

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

Habitat inventory and assessment

The respondent recommended no inventory and assessment techniques for effective conservation of interior lowland headwaters of Ohio River drainage habitat.

Appendix F-19: Rivers and Streams Ohio River Drainage Interior River Lowland Headwater

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of headwaters of the interior river lowland of the Ohio River drainage habitat. There were no responses.

WADEABLE/LARGE RIVERS IN INTERIOR LOWLAND OF OHIO RIVER DRAINAGE HABITAT NARRATIVE

Habitat description

Streams of the Ohio River drainage, Interior River Lowland ecoregion are found in southwestern Indiana. Wadeable/large rivers are those having a drainage area of > 19 < 2,000 mi^2. Streams of the Interior River Lowland ecoregion are heavily impacted by the low, nearly level flood plains associated with the great rivers of the region.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

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

12 (tie) Diseases/parasites (of the species itself)

12 (tie) Unregulated collection pressure

Respondents offered no additional threats to wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents listed top threats to wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- Predation by raccoons (and possibly by coyotes)
  - Predation on nests and eggs
  - Predation on adults
- Nest/embryo/hatchling loss associated with attraction to row crop land for nesting
- Loss of adults to road kill
- Extant population (if any) far below level for unassisted recovery
- Commercial type fishing devices: trot lines, branch lines, big nets, other passive fishing
- Ensuring that populations maintain critical larva-host connections
- Habitat loss for breeding, feeding and foraging areas:
  - Slough darter: It prefers a mud or silt bottom with little current velocity and vegetation to deposit eggs. They spawn few eggs, so reproduction is lower in places where vegetation is lacking. They compete with other darters for insects and have a high mortality due to stagnation and freezing in pools

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- Yes, for those representative species listed but I don't think the list of species is adequate. Paddlefish depend on flooded bottomland habitat for heavy spring feeding to build body fats for successful egg production. Blue suckers. Louisiana waterthrush, crayfish are just a few to be considered. Habitat loss and degradation should be the highest ranked threats.

Habitat threats

Respondents ranked threats to wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Threats to wadeable/large rivers in interior lowland of Ohio River drainage habitat
1	Stream channelization
2	Habitat degradation
3	Point source pollution (continuing)
4	Residual contamination (persistent toxins)
5 (tie)	Agricultural/forestry practices
5 (tie)	Nonpoint source pollution (sedimentation and nutrients)
6 (tie)	Commercial or residential development (sprawl)

6 (tie)	Drainage practices (stormwater runoff)
7 (tie)	Mining/acidification
7 (tie)	Habitat fragmentation
8	Impoundment of water/flow regulation
9	Successional change
10	Invasive/non-native species
11	Climate change
12 (tie)	Diseases (of plants that create habitat)
12 (tie)	Counterproductive financial incentives or regulations

Respondents noted no additional threats for wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents listed top threats to wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- Habitat degradation
  - Channelization
  - Development
  - Drain/cut off oxbow pond
  - Trampling sandbars or removing nesting areas along banks
  - Eliminating flows that create point bars on rivers
  - Row crop practices: Crushing nests during ground insect/weed control; crushing overwinter hatchlings during harvest and early spring plowing
  - There are large expanses in the Wabash and East Fork White River where relic valves were common, but the living species is absent
- Pollutants and toxins

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- Yes.

Additional research and survey efforts

Current body of research

Species research

Forty percent of respondents stated that the current body of science is adequate, and sixty percent said it is inadequate for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitats in Indiana.

Author = Minton;
Date = 2001

Author = reviewed in Minton;
Date = 2001
Title = (Numerous internet sites, including USF&W)

Title = Freshwater Mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = Illinois Natural History Survey

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart Shipman;
Date = 12/1997;
Publisher = DNR/Fisheries section

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- No. The fisheries dynamics are poorly understood as it relates to impacts on populations from on-going water quality degradation and flow rate changes from agricultural drainage efforts.

Habitat research

Forty percent of respondents stated that the current body of science is adequate, forty percent said it is inadequate and twenty percent indicated “other” – that it was not their area of expertise for wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of wadeable/large rivers in interior lowland of Ohio River drainage habitats in Indiana.

Title = ??? Sugar Creek???;
Author = ?;
Date = late 1970s/early 1980s;
Publisher = PhD thesis IU Bloomington

Title = Not my expertise. Looks for historical;
Author = accounts of river geography &;
Date = physiography + hydrology

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the current body of science for wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- No.

Research needs

Species research

Respondents ranked research needs for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Research needs for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat
1	Threats (predators/competition, contamination)
2	Limiting factors (food, shelter, water, breeding sites)
3	Distribution and abundance
4	Population health (genetic and physical)
5 (tie)	Life cycle
5 (tie)	Relationship/dependence on specific habitats

Respondents noted additional research needs for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- Cost effectiveness and periodic effective duration of local raccoon elimination
- Socio-economic impacts of terminating commercial fishing use of commercial equipment in the lower West Fork and Middle East Fork White River
- Whether genetic stock from northern Arkansas will suffice for reintroduction. Will farmed stock from Arkansas or Louisiana suffice

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 wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- Yes.

Habitat research

Respondents ranked research needs for wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Research needs for wadeable/large rivers in interior lowland of Ohio River drainage habitat
1	Threats (land use change/competition, contamination/global warming)
2 (tie)	Distribution and abundance (fragmentation)
2 (tie)	Growth and development of individual components of the habitat

3	Successional changes
4	Relationship/dependence on specific site conditions

A respondent noted additional research need for wadeable/large rivers in interior lowland of Ohio River drainage habitat:

- Cost effectiveness and periodic effective duration of local raccoon elimination
- Socio-economic impacts of terminating commercial fishing use of commercial equipment in the lower West Fork and Middle East Fork White River
- Whether genetic stock from northern Arkansas will suffice for reintroduction. Will farmed stock from Arkansas or Louisiana suffice

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses:

- Yes

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Conservation efforts for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat
1 (tie)	Reintroduction (restoration)
1 (tie)	Translocation to new geographic range
1 (tie)	Limiting contact with pollutants/contaminants
1 (tie)	Stocking
1 (tie)	Threats reduction
1 (tie)	Native predator control
1 (tie)	Population enhancement (captive breeding and release)
2 (tie)	Population management (hunting, trapping)
2 (tie)	Public education to reduce human disturbance
3	Habitat protection (use below for details)
4 (tie)	Regulation of collecting
4 (tie)	Protection of migration routes

Respondents noted other current conservation practices for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

- Some wildlife species are listed as endangered and illegal to take/collect. People need to be reminded of this

Respondents recommended these practices for more effective conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- Raccoon management:
  - Expand and liberalize the taking of raccoons so as to greatly reduce numbers associated with river cooter habitat. (Raccoon reduction is used regarding sea turtles in Florida and endangered Illinois mud turtle in IA; it is proposed for alligators in Louisiana)
- Restocking
  - Too few if any turtles remain
  - Local restocking where raccoons reduced numbers should hasten delisting criteria
- End use of commercial fishing equipment
- Protect habitat against pollutants and toxins
- Habitat protection
  - Cease any future channelization plans and restore existing oxbow ponds -- provide landowner financial incentives
- Threats reduction

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the practices for more effective conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- Without a change in the fur market,controlling raccoons by volunteer trapping efforts is not a viable alternative and it is never ending.Let's look at how the coon and cooters coexisted prior to the impacts of man and determine what habitat changes are needed such as contaminant reduction from farmland, sewer systems and mine runoff.

Habitat actions

Respondents ranked conservation efforts by how well they address threats to wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Conservation efforts for wadeable/large rivers in interior lowland of Ohio River drainage habitat
1 (tie)	Habitat restoration incentives (financial)
1 (tie)	Protection of adjacent buffer zone
1 (tie)	Cooperative land management agreements (conservation easements)
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Habitat restoration on public lands
2 (tie)	Land use planning
3 (tie)	Corridor development/protection
3 (tie)	Restrict public access and disturbance
4 (tie)	Habitat restoration through regulation

4 (tie) Pollution reduction

5 (tie) Habitat protection through regulation

5 (tie) Habitat protection on public lands

5 (tie) Artificial habitat creation (artificial reefs, nesting platforms)

5 (tie) Managing water regimes

5 (tie) Technical assistance

Respondents listed no additional conservation practices for wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents recommended the following conservation practices for wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- Habitat protection and restoration
  - Provide oxbow pond conservation easements and restoration (prime feeding habitat)
  - Encourage return to natural meander channel (within flood control)
  - Let dead trees in river stay; perhaps add some
  - Enhance natural river channel evolution including point bar development and snags (downed trees in the water); provides basking sites and nesting habitat away from row crop agriculture
  - Protection of adjacent buffer zones
- Manage water quality and pollutants

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- No. Increased funding for sewage systems enhancements and additional abandoned mineland reclamation is critical to enhancing river habitat and water quality to benefit wildlife in this geographic region.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

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

Respondents were aware of no monitoring efforts by other organizations for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Monitoring efforts by state agencies for conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Periodic statewide (less than once a year but still regularly scheduled) monitoring

Respondents listed the following monitoring effort by other organizations as "somewhat crucial" for conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

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

Respondents listed regional or local monitoring by state agencies for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- IDNR nongame biologists continually monitor fishes and mussels throughout the state, including Yellow Sandshell habitat. Two surveys have been done -- ten years apart, completed last year -- by IDNR biologists in the Wabash and Tippecanoe rivers, and East Fork of White River; results are pending. This is prime Yellow Sandshell habitat
- Blue River (Harrison County)
- East Fork, White River
- West Fork, White River

Respondents listed no regional or local monitoring by other organizations for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Respondents listed organizations that monitor wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- IDEM monitors fish communities, not particular species; however, the slough darter has been captured by electrofishing in Ohio River drainage habitat
- IDNR – Division of Fish and Wildlife

Respondents considered monitoring techniques for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Monitoring techniques for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage	Used	Not used but possible with existing	Not economically feasible

habitat		technology and data	
Radio telemetry and tracking	--	X	--
Modeling	--	X	--
Coverboard routes	--	X	--
Driving a survey route	--	X	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	--	--
Mark and recapture	X	X	--
Professional survey/census	X	--	--
Volunteer survey/census	X	X	--
Representative sites	X	--	--
Probabilistic sites	X	X	--

Respondents noted no other monitoring techniques for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- No. Contaminant surveys by the Bloomington Ecological Services Office has been on-going in the Patoka River since the early 1990's. Detailed information has been collected and printed in regards to contaminants and wildlife species present. Mussel survey has also been contracted by the Patoka River NWR and published report is available. Water quality monitoring on a regular recurring basis is required to know what is happening in regards to wildlife populations. The base of the food chain needs the most monitoring as a barometer of impacts up the chain.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

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

Respondents were aware of no inventory and assessment efforts by other organizations for wadeable/large rivers in interior lowland of Ohio River drainage habitat.

Appendix F-20: Rivers and Streams Ohio River Drainage Interior River Lowland Wadeable/Large River

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Rank	Inventory and assessment for conservation of wadeable/large rivers in interior lowland of Ohio River drainage habitat
1 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
1 (tie)	Regional or local once-a-year inventory and assessment
2	Regional or local year-round inventory and assessment
3 (tie)	Statewide annual inventory and assessment conducted by state agencies
3 (tie)	Statewide once a year inventory and assessment conducted by state agencies
3 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment

Respondents listed no inventory and assessment efforts by other organizations that are crucial for conservation of wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Respondents listed regional or local inventory and assessment by state agencies for wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- If any inventory is occurring, it's for water quality or fish contamination
- I am assuming that the governmental division responsible for water pollution control conducts some sampling regarding organic and heavy metal toxins in the water
- IDNR primarily monitors mussel species, making habitat notations. No real habit monitors made.
- Indiana Department of Environmental Management, IDNR Division of Water do monitor water quality (as a component of habitat)
- Blue River (Harrison County)

Respondents listed regional or local inventory and assessment by other organizations agencies for wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- If any inventory is occurring, it’s for water quality or fish contamination
- Occasional grants to universities

Respondents listed organizations that monitor wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- IDEM makes assessments of habitat while doing fish community surveys in Ohio River drainage habitat

- IDNR – Division of Fish and Wildlife
- Whoever samples for state water pollution control

Respondents considered inventory and assessment techniques for wadeable/large rivers in interior lowland of Ohio River drainage habitat:

Inventory and assessment techniques for wadeable/large rivers in interior lowland of Ohio River drainage habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	--
Aerial photography and analysis	X	--	--

A respondent listed additional inventory and assessment techniques for wadeable/large rivers in interior lowland of Ohio River drainage habitat:

- QHEI

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- No. The Contaminant Monitoring Surveys conducted by Bloomington Ecological Services need to be recognized and repeated on other river systems with important wildlife resource values. These need to be scheduled for repetition over a period of years to monitor real change in the base habitat.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- Occasional censusing with very large, heavily baited hoop nets left out overnight
  - Do not set during rising waters
  - Check within 12 hours
- Search for nests in June (after determining any adults present). See methods used in Florida and Louisiana for nests, in Arkansas and Louisiana for capturing adults
- Looking for basking individuals with a spotting scope
- Perhaps use of fyke nets with big leads, or basking traps to estimate numbers after visual spotting determines presence
- Systematic monitoring of probabilistic sites (professional)
- Use of volunteer census/monitoring
- Seining or electrofishing representative sites using professionals
- Electrofishing catch rates
- Population estimates

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- Yes but monitoring of the base of the food chain is perhaps more important since the base affects everything up the food chain. You have to understand impacts to the system to understand the population dynamics of higher elements.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of wadeable/large rivers in interior lowland of Ohio River drainage habitat (not ranked):

- GIS/high resolution aerial photography during low water -- digitized for GIS to locate:
  - Deep river holes with woody debris (favored by adults)
  - Health/permanence of oxbow ponds/how lasting are oxbow ponds during droughts
  - Nesting habitat
  - Occasional site visits to assess vegetation quality for this herbivorous turtle
  - To look at saturation of potential habitat: With GIS construction of existing potential habitat (based upon known factors) and overlaying the current distribution of the Yellow Sandshell
- QHEI

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of wadeable/large rivers in interior lowland of Ohio River drainage habitat. Their responses included:

- Yes, with the inclusion of water quality monitoring program.

ALL BARREN LANDS HABITAT NARRATIVE

Habitat description

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 rock/sand/clay habitats are perennially barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, beaches and other accumulations of earthen material.

Quarries/strip mines/gravel pits habitats are areas of extractive mining activities with significant surface expression.

Transitional habitats include areas of sparse vegetative cover (less than 25 percent) that are changing dynamically from one land cover to another, often because of land use activities. Examples include forest clearcuts; transition phases between forest and agricultural land; temporary clearing of vegetation; and changes due to natural causes (e.g. fire, flood).

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in all barren lands habitat in Indiana:

Rank	Threats to wildlife in all barren lands habitat
1	Viable reproductive population size or availability
2	Diseases/parasites (of the species itself)
3	Habitat loss (feeding/foraging areas)
4 (tie)	Habitat loss (breeding range)
4 (tie)	Near limits of natural geographic range
5 (tie)	Small native range (high endemism)
5 (tie)	Predators (native or domesticated)
5 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
6	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
7	Invasive/non-native species
8 (tie)	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-

	catch, harvesting equipment, land preparation machinery)
8 (tie)	Specialized reproductive behavior or low reproductive rates
9	Unregulated collection pressure
10	Large home range requirements

Respondents offered no additional threats to wildlife in all barren lands habitat in Indiana.

Respondents listed top threats to wildlife in all barren lands habitat in Indiana (not ranked):

- Quality of habitat
- Low population size/edge of range
- Green salamander threats:
  - Found only at two sites in Indiana
  - Are at edge of geographic range
  - Habitat specialists
- Allegheny woodrat threats (habitat fragmentation/loss of corridor/predators/disease)
  - The Allegheny woodrat occupies cliffs, caves and other rocky habitats in deciduous forests. When forests become fragmented, several negative impacts to woodrat populations can result
    - First, loss of mature mast-producing trees can occur; changes in forest composition can also result
    - Woodrats may have to cross non-forested areas to reach preferred feeding areas (i.e., hard mast or soft mass crops)
    - In crossing non-forested areas, they may become exposed to ubiquitous predators (great horned owls, raccoons)
    - Raccoon densities may be higher in non-forested settings (such as farmed areas on top of cliffs), which could expose woodrats to higher levels of raccoon roundworm
- Black kingsnake threats:
  - Human collection
  - Habitat loss

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

Habitat threats

Respondents ranked threats to all barren lands habitat in Indiana:

Rank	Threats to all barren lands habitat
1	Habitat degradation
2 (tie)	Counterproductive financial incentives or regulations
2 (tie)	Habitat fragmentation

3	Invasive/non-native species
4	Commercial or residential development (sprawl)
5	Agricultural/forestry practices
6	Successional change
7 (tie)	Nonpoint source pollution (sedimentation and nutrients)
7 (tie)	Point source pollution (continuing)
7 (tie)	Drainage practices (storm water runoff)
8	Residual contamination (persistent toxins)

Respondents noted no other threats to all barren lands habitat in Indiana.

Respondents listed top threats to all barren lands habitat in Indiana (not ranked):

- Cliff and rocky outcrops threats
  - Habitat loss, degradation, deforestation, development and fragmentation
  - Cliff habitat is somewhat secure, except for quarrying operations along Ohio River. Forested communities in association with cliffs are vulnerable to development, fragmentation, loss of hard mast producing species, etc.
- Dunes threats (specific dune habitat configuration)
  - Threats by gulls
  - Human disturbance

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

Additional research and survey efforts

Current body of research

Species research

One quarter of respondents stated that the current body of science is adequate; seventy-five percent say that it is inadequate for wildlife in all barren lands habitat in Indiana.

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

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

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

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

Title = Discovery of green salamanders in Indiana and a distributional survey. In Status & Conservation of Midwestern Amphibians;
Author = Robert Madej;
Date = 1998;
Publisher = University of Iowa Press, Iowa City

Title = Green salamander: Family plethodontidae, Aneides aeneus Cope and Packard, 1881.;
Author = Pauley, T. K. and M.B. Watson;
Date = 2005;
Publisher = In: Amphibian Declines: The Conservation Status of United States Species. M. Lannoo, (ed.), University of

Title = Reassessment of the Allegheny woodrat in Indiana;
Author = Scott Johnson;
Date = 2002;
Publisher = Proceedings of the Indiana Academy of Science 111:56-66.

Title = 2002 Allegheny woodrat monitoring program;
Author = Scott Johnson, Heather Walker, Cassie Conrad, Aaron Holbrook;
Date = 2003;
Publisher = Indiana Department of Natural Resources (internal report)

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

Habitat research

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

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

Title = Natural Features of Indiana?;
Author = Alton Lindsey (editor);
Date = 1966;
Publisher = Indiana Academy of Science

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

Research needs

Species research

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

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

A respondent noted additional research needs for wildlife in all barren lands habitat in Indiana:

- Black kingsnakes: More information is needed for all topics concerning black kingsnakes in Indiana. However, this species is not endangered and this information is not urgently needed

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

Habitat research

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

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

Respondents noted no additional research needs for all barren lands habitat in Indiana.

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

Conservation actions necessary

Species actions

Appendix F-21: Aggregated Barren Lands

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

Rank	Conservation efforts for wildlife in all barren lands habitat
1	Habitat protection (use below for details)
2 (tie)	Regulation of collecting
2 (tie)	Reintroduction (restoration)
2 (tie)	Threats reduction
2 (tie)	Native predator control
2 (tie)	Exotic/invasive species control
2 (tie)	Translocation to new geographic range
2 (tie)	Protection of migration routes
2 (tie)	Limiting contact with pollutants/contaminants
2 (tie)	Public education to reduce human disturbance
2 (tie)	Population enhancement (captive breeding and release)

Respondents no additional current conservation practices for wildlife in all barren lands habitat in Indiana. A respondent commented, “There are no current conservation practices for woodrats in place in Indiana at this time. Monitoring population levels and trying to determine factors limiting woodrats have been focus of work in state.”

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

- Protection of habitat
- Collection regulation
- Green salamander:
  - The main threat to green salamander populations is deforestation resulting in habitat loss, degradation or fragmentation. Logging activities should be managed to keep at least 100 meters of buffered forest habitat around rock outcrops and barren lands cliffs
  - Little is known about the population biology, lifespan, mortality rates, dispersal, colonization of habitats, metapopulation dynamics, and the extent of arboreal activity
- Allegheny woodrats:
  - Research aimed to identify factors that limit woodrat populations is a high priority
  - Periodic monitoring of extant populations
  - Revisit previously occupied sites to assess recolonization potential
- Piping plover:
  - Limit disturbance by humans and predators if birds ever recolonize Indiana’s Lake Michigan shoreline

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

Habitat actions

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

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

Respondents listed no other current conservation practices for all barren lands habitat in Indiana.

Respondents recommended the following conservation practices for all barren lands habitat in Indiana (not ranked):

- Green salamander:
  - The main threat to green salamander populations is deforestation resulting in habitat loss, degradation or fragmentation. Logging activities should be managed to keep at least 100 meters of buffered forest habitat around rock outcrops and barren lands cliffs
- Encourage retention and development of hard mast trees (oaks, hickories) in close proximity to woodrat cliffs
- Habitat protection and management

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

Proposed plans for monitoring

Current monitoring

Species monitoring

Appendix F-21: Aggregated Barren Lands

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

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

Respondents were aware of the following monitoring efforts by other organizations for wildlife in all barren lands habitat in Indiana:

- Regional or local year-round monitoring

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

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

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in all barren lands habitat in Indiana:

Rank	Monitoring efforts by other organizations for conservation of wildlife in all barren lands habitat
1	Regional or local once a year monitoring
2 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
2 (tie)	Regional or local year-round monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2 (tie)	Occasional regional or local (less than once a

year and not regularly scheduled) monitoring

3 (tie) Statewide year-round monitoring

3 (tie) Statewide once a year monitoring

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

- Harrison and Crawford counties
- Reports by bird watchers

Respondents listed regional or local monitoring by other organizations for wildlife in all barren lands habitat in Indiana:

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

Respondents listed organizations that monitor wildlife in all barren lands habitat in Indiana (not ranked):

- Indiana DNR
- Bird watchers
- USGS biologists

Respondents considered monitoring techniques for wildlife in all barren lands habitat in Indiana:

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

Trapping (by any technique)	X	X	--
Representative sites	X	X	--
Probabilistic sites	X	X	--

Respondents noted other monitoring techniques for wildlife in all barren lands habitat in Indiana:

- Allegheny woodrats: Presence/absence can be determined generally by searching cliff lines for fresh signs (latrines, food caches, maintained nests) usually in fall. Research is underway in other areas to determine if woodrats can be genotyped through scats

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

Habitat inventory and assessment

Respondents were aware of no inventory and assessment efforts by state agencies for all barren lands habitat in Indiana.

Respondents were aware of the following inventory and assessment efforts by other organizations for all barren lands habitat in Indiana:

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

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

Rank	Inventory and assessment for conservation of all barren lands habitat
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment

A respondent listed the following inventory and assessment efforts by other organizations as "somewhat crucial" for conservation of all barren lands habitat in Indiana:

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

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

- IDNR – Division of Nature Preserves might have a decent inventory of cliff habitat
- IDNR – Division of Fish and Wildlife has inventory of cliff habitat occupied by Allegheny woodrats
- Lake Michigan shoreline

- Gibson Lake

Respondents listed regional or local inventory and assessment by other organizations agencies for all barren lands habitat in Indiana:

- Lake Michigan shoreline

Respondents were unaware of organizations that monitor all barren lands habitat in Indiana.

Respondents considered inventory and assessment techniques for all barren lands habitat in Indiana:

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

Respondents listed no additional inventory and assessment techniques for all barren lands habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for all barren lands habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in all barren lands habitat in Indiana:

- Systematic surveys in and near rocky outcrops
- Standardized, live trapping for two nights is effective for determining distribution and relative abundance

- Allegheny woodrat: Searches for sign at new sites or previously-occupied sites to assess recolonization potential
- Black kingsnakes: Monitoring black kingsnakes through professional or volunteer survey would be the best for Indiana. This could be done through representative sites or on volunteer chosen routes
- Piping plover: Because this species rarely occurs in Indiana, keep track of all reports by birders and have Indiana Dunes personnel systematically survey appropriate habitat along Lake Michigan

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

Habitat inventory and assessment

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

- Systematic sampling
- GIS
  - GIS is the best tool available to depict/inventory cliffs, outcrops, talus slopes, caves or other rocky habitats within the range of the Allegheny woodrat
- Aerial photography and ground visits to determine habitat suitability

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

BARREN LANDS HABITAT NARRATIVE

Habitat description

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

Problems affecting species and habitats

Species threats

The respondent cited no “critical threats” or “serious threats” to wildlife in barren lands habitat in Indiana. The respondent stated that the following are “somewhat of a threat” (not ranked):

- Unintentional take/direct mortality (e.g. vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
- Unregulated collection pressure
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)

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

- Predators (native or domesticated)
- Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
- Large home range requirements
- Specialized reproductive behavior or low reproductive rates
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed no additional threats to wildlife in barren lands habitat in Indiana.

The respondent listed top threats to wildlife in barren lands habitat in Indiana: “The top two threats to the black kingsnake include human collection and habitat loss. How these factors affect kingsnake populations in Indiana is unknown”

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

Habitat threats

The respondent listed no “critical” or “serious threat” to barren lands habitat in Indiana. The respondent listed as “somewhat of a threat” (not ranked):

- Commercial or residential development (sprawl)
- Invasive/non-native species
- Nonpoint source pollution (sedimentation and nutrients)
- Habitat fragmentation
- Successional change

The respondent listed the following as “slight threat” to barren lands habitat in Indiana:

- Agricultural/forestry practices

- Residual contamination (persistent toxins)

The respondent listed no other threats to barren lands habitat in Indiana.

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

Additional research and survey efforts

Current body of research

Species research

The respondent listed current body of science as inadequate for wildlife in barren lands habitat in Indiana.

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

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

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

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

Habitat research

The respondent listed current body of science as Unknown for barren lands habitat in Indiana.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of barren lands habitats in Indiana.

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

Research needs

Species research

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

- Life cycle

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

The respondent listed additional research needs for wildlife in barren lands habitat in Indiana: "I believe more information is needed for all topics concerning the black kingsnake in Indiana. However this species is not currently endangered and this information is not urgently needed."

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

Habitat research

The respondent listed no research needs for barren lands habitat in Indiana.

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

Conservation actions necessary

Species actions

The respondent stated that none of the listed conversation efforts address threats to wildlife in barren lands habitat "very well." The respondent stated the following efforts address threats "somewhat" (not ranked):

- Habitat protection
- Regulation of collecting
- Public education to reduce human disturbance

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

The respondent recommended the following practices for more effective conservation of wildlife in barren lands habitat in Indiana (not ranked):

- Habitat protection
- Collection regulation

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

Habitat actions

The respondent did not know how listed conservation efforts address threats to barren lands habitat in Indiana or did not supply answers.

The respondent listed no other conservation practices for barren lands habitat in Indiana, and recommended no specific practices for more effective conservation.
Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for barren lands habitat. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

The respondent was aware of no current monitoring efforts by state agencies or other organizations for wildlife in barren lands habitat in Indiana.

The respondent listed no monitoring efforts by state agencies or other organizations as "very crucial" for conservation of wildlife in barren lands habitat in Indiana.

The respondent listed as "slightly crucial" the following efforts by agencies and organizations (not ranked):

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

The respondent was not aware of regional or local monitoring by state agencies or other organizations for wildlife in barren lands habitat in Indiana.

The respondent listed no current monitoring techniques for wildlife in barren lands habitat in Indiana that are "frequently used," "occasionally used" or "not economically feasible." The respondent indicated the that following monitoring techniques are "not used but possible with existing technology and data" (not ranked):

- Radio telemetry and tracking
- Modeling
- Coverboard routes
- Spot mapping
- Mark and recapture
- Professional survey/census
- Volunteer survey/census
- Trapping (by any technique)
- Representative sites
- Probabilistic sites

The respondent listed no other monitoring techniques for wildlife in barren lands habitat in Indiana.

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

Habitat inventory and assessment

The respondent was aware of no current inventory and assessment efforts by state agencies or other organizations for barren lands habitat in Indiana.

The respondent listed no inventory and assessment efforts by state agencies or other organizations as "crucial" for conservation of barren lands habitat in Indiana.

The respondent was not aware of regional or local inventory and assessment by state agencies or other organizations for barren lands habitat in Indiana.

The respondent did not rank the feasibility or use of current inventory and assessment techniques for barren lands habitat in Indiana.

The respondent was not aware of other inventory and assessment techniques for effective conservation of barren lands habitat in Indiana.

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

Recommended monitoring

Species monitoring

The respondent listed the following monitoring techniques for effective conservation of wildlife in barren lands habitat in Indiana: "Monitoring black kingsnakes through professional or volunteer survey would be the best for Indiana. This could be done through the use of representative sites or on volunteer chosen routes."

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

Habitat inventory and assessment

The respondent had no recommendations for inventory and assessment techniques for effective conservation of barren lands habitat in Indiana.

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

Appendix F-23: Active Quarries

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

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

6. Please rank the following threats to ALL mussels in ALL habitats in Indiana.

	Critical threat	Serious threat	Somewhat of a threat	Slight threat	No threat	Unknown	Response Total
Invasive/non-native species	20% (2)	10% (1)	20% (2)	40% (4)	10% (1)	0% (0)	**10**
High sensitivity to pollution	0% (0)	70% (7)	30% (3)	0% (0)	0% (0)	0% (0)	**10**
Bioaccumulation of contaminants	0% (0)	0% (0)	20% (2)	0% (0)	0% (0)	80% (8)	**10**
Predators (native or domesticated)	0% (0)	0% (0)	30% (3)	50% (5)	20% (2)	0% (0)	**10**
Dependence on other species (mutualism, pollinators)	20% (2)	30% (3)	20% (2)	10% (1)	20% (2)	0% (0)	**10**
Diseases/parasites (of the species itself)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (10)	**10**
Regulated hunting/fishing pressure (too much)	0% (0)	0% (0)	20% (2)	0% (0)	80% (8)	0% (0)	**10**
Species over population	0% (0)	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)	10% (1)	60% (6)	10% (1)	0% (0)	20% (2)	0% (0)	**10**
Unregulated collection pressure	0% (0)	0% (0)	0% (0)	20% (2)	80% (8)	0% (0)	**10**
Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)	0% (0)	0% (0)	10% (1)	30% (3)	0% (0)	60% (6)	**10**
						Total Respondents	**110**

7. Please also rank these threats to ALL mussels in ALL habitats in Indiana.

	Critical threat	Serious threat	Somewhat of a threat	Slight threat	No threat	Unknown	Response Total
Habitat loss (breeding range)	30% (3)	60% (6)	10% (1)	0% (0)	0% (0)	0% (0)	**10**
Habitat loss (feeding/foraging areas)	30% (3)	60% (6)	10% (1)	0% (0)	0% (0)	0% (0)	**10**
Small native range (high endemism)	10% (1)	0% (0)	0% (0)	10% (1)	80% (8)	0% (0)	**10**
Near limits of natural geographic	0% (0)	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**

range							
Large home range requirements	0% (0)	0% (0)	0% (0)	0% (0)	90% (9)	10% (1)	**10**
Viable reproductive population size or availability	30% (3)	30% (3)	20% (2)	10% (1)	0% (0)	10% (1)	**10**
Specialized reproductive behavior or low reproductive rates	20% (2)	70% (7)	10% (1)	0% (0)	0% (0)	0% (0)	**10**
Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)	0% (0)	0% (0)	10% (1)	0% (0)	40% (4)	50% (5)	**10**
Genetic pollution (hybridization)	0% (0)	0% (0)	20% (2)	10% (1)	50% (5)	20% (2)	**10**
Unknown	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (7)	**7**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (2)	**2**
					Total Respondents		**99**

8. Other threats to ALL mussels in ALL habitats in Indiana.

No responses were entered for this question.

Total Respondents **0**

(skipped this question) 10

9. Please briefly describe the top two threats to ALL mussels in ALL habitats in Indiana identified above.

1. dredging of headwater streams

   alterations of hydrology from land-use changes

2. 1. Runoff introducing sediments, even if onl;y temporary
   2. In-stream modifications

3. 1. Zebra mussels
   2. Instream dredging

4. 1. Zebra mussels
   2. Instream modifications

5. 1. Runoff
   2. Habitat modification

6. 1. Runoff, mostly agricultural
   2. Instream modifications

7.	1. Runoff 2. Habitat modification
8.	1. Pollution within the Tippecanoe River system in Indiana. 2. Any factor which reduces the reproductive population size.
9.	1. Insuring that populations maintain critical larva-host connections.
10.	habitat loss/unintential take-'cleaning' and dredging of streams of the Kankakee drainage can result in a large amount of creek heelsplitters being lost dependence on other species-require fish host to reproduce; if fish populations decrease for any of a variety of reasons, then creek heelsplitter reproduction could decrease substantially
	Total Respondents **10**

10. Please rank the following threats to the HABITAT of ALL mussels in ALL habitats in Indiana.

	Critical threat	Serious threat	Somewhat of a threat	Slight threat	No threat	Unknown	Response Total
Commercial or residential development (sprawl)	10% (1)	30% (3)	20% (2)	40% (4)	0% (0)	0% (0)	**10**
Counterproductive financial incentives or regulations	10% (1)	0% (0)	0% (0)	0% (0)	0% (0)	90% (9)	**10**
Invasive/non-native species	20% (2)	0% (0)	0% (0)	60% (6)	20% (2)	0% (0)	**10**
Nonpoint source pollution (sedimentation and nutrients)	30% (3)	50% (5)	20% (2)	0% (0)	0% (0)	0% (0)	**10**
Habitat fragmentation	20% (2)	50% (5)	20% (2)	10% (1)	0% (0)	0% (0)	**10**
Successional change	0% (0)	10% (1)	0% (0)	10% (1)	50% (5)	30% (3)	**10**
Diseases (of plants that create habitat)	0% (0)	0% (0)	10% (1)	0% (0)	20% (2)	70% (7)	**10**
Habitat degradation	40% (4)	50% (5)	0% (0)	10% (1)	0% (0)	0% (0)	**10**
Climate change	0% (0)	0% (0)	0% (0)	10% (1)	90% (9)	0% (0)	**10**
Stream channelization	40% (4)	50% (5)	0% (0)	10% (1)	0% (0)	0% (0)	**10**
Impoundment of water/flow regulation	30% (3)	20% (2)	20% (2)	30% (3)	0% (0)	0% (0)	**10**
Agricultural/forestry practices	10% (1)	60% (6)	20% (2)	10% (1)	0% (0)	0% (0)	**10**
Residual contamination (persistent toxins)	20% (2)	0% (0)	10% (1)	0% (0)	0% (0)	70% (7)	**10**

Point source pollution (continuing)	20% (2)	60% (6)	20% (2)	0% (0)	0% (0)	0% (0)	**10**
Mining/acidification	10% (1)	40% (4)	10% (1)	20% (2)	20% (2)	0% (0)	**10**
Drainage practices (stormwater runoff)	20% (2)	40% (4)	40% (4)	0% (0)	0% (0)	0% (0)	**10**
Unknown	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (7)	**7**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (2)	**2**
						Total Respondents	**169**

11. Other HABITAT threats to ALL mussels in ALL habitats in Indiana.

No responses were entered for this question.

Total Respondents **0**

(skipped this question) 10

12. Please briefly describe the top two HABITAT threats to ALL mussels in ALL habitats in Indiana identified above.

1. 1. Agricultural runoff
2. Impoundment

2. 1. Impoundment
2. Instream modifications

3. 1. Dredging (mining, COE)
2. Impoundment

4. 1. Runoff, mostly agricultural
2. Channelization

5. 1. Loss of riparian corridor
2. Runoff

6. 1. Instream modifications
2. Runoff, both agricultural and residential

7. 1. Any significant sedimentation into the stream can become a major threat.
2. Any toxins or pollutants are a critical threat.
3. Any channelization which reduces the shallow (less than 1.5 feet) sand/gravel substrate can critically reduce or fragment habitat.

8. 1. Pollutants and toxins are major threats.
2. Habitat degradation may be a factor, since there are large expanses in the Wabash and East Fork White River where relic valves are common, but the living species is absent.

	White River where relic valves are common, but the living species is absent.		
9.	habitat degradation, stream channelization-cause temporary loss of habitat and impact the mussels directly by killing them or taking them out of the habitat		
		Total Respondents	**9**
		(skipped this question)	1

13. What current monitoring efforts by state agencies are you aware of for ALL mussels in ALL habitats in Indiana?

	Yes, these efforts occur	Not aware of these efforts occuring	Response Total
Statewide year-round monitoring conducted by state agencies	0% (0)	100% (10)	**10**
Statewide once a year monitoring conducted by state agencies	0% (0)	100% (10)	**10**
Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by state agencies	0% (0)	100% (10)	**10**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies	30% (3)	70% (7)	**10**
Regional or local year-round monitoring conducted by state agencies	0% (0)	100% (10)	**10**
Regional or local once a year monitoring conducted by state agencies	0% (0)	100% (10)	**10**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies	0% (0)	100% (10)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies	90% (9)	10% (1)	**10**
		Total Respondents	**80**

14. What current monitoring efforts by other organizations are you aware of for ALL mussels in ALL habitats in Indiana?

	Yes, these efforts occur	Not aware of these efforts occuring	Response Total
Statewide year-round monitoring conducted by other organizations	0% (0)	100% (10)	**10**
Statewide once a year monitoring conducted by other organizations	10% (1)	90% (9)	**10**

Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by other organizations	0% (0)	100% (10)	**10**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by other organizations	0% (0)	100% (10)	**10**
Regional or local year-round monitoring conducted by other organizations	0% (0)	100% (10)	**10**
Regional or local once a year monitoring conducted by other organizations	10% (1)	90% (9)	**10**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations	0% (0)	100% (10)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations	80% (8)	20% (2)	**10**
		Total Respondents	**80**

15. How crucial are these monitoring efforts by state agencies for the conservation of ALL mussels in ALL habitats in Indiana?

	Very crucial	**Somewhat crucial**	**Slightly crucial**	**Not crucial**	**Unknown**	**Response Total**
Statewide year-round monitoring conducted by state agencies	0% (0)	0% (0)	40% (4)	60% (6)	0% (0)	**10**
Statewide once a year monitoring conducted by state agencies	20% (2)	20% (2)	30% (3)	30% (3)	0% (0)	**10**
Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by state agencies	20% (2)	50% (5)	30% (3)	0% (0)	0% (0)	**10**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies	0% (0)	60% (6)	10% (1)	30% (3)	0% (0)	**10**
Regional or local year-round monitoring conducted by state agencies	0% (0)	20% (2)	50% (5)	30% (3)	0% (0)	**10**
Regional or local once a year monitoring conducted by state agencies	10% (1)	30% (3)	30% (3)	30% (3)	0% (0)	**10**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies	10% (1)	60% (6)	20% (2)	10% (1)	0% (0)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies	30% (3)	40% (4)	0% (0)	30% (3)	0% (0)	**10**

Total Respondents	**80**

16. How crucial are these monitoring efforts by other organizations for the conservation of ALL mussels in ALL habitats in Indiana?

	Very crucial	Somewhat crucial	Slightly crucial	Not crucial	Unknown	Response Total
Statewide year-round monitoring conducted by other organizations	0% (0)	0% (0)	60% (6)	40% (4)	0% (0)	**10**
Statewide once a year monitoring conducted by other organizations	10% (1)	0% (0)	50% (5)	40% (4)	0% (0)	**10**
Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by other organizations	0% (0)	10% (1)	50% (5)	40% (4)	0% (0)	**10**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by other organizations	0% (0)	10% (1)	50% (5)	40% (4)	0% (0)	**10**
Regional or local year-round monitoring conducted by other organizations	0% (0)	0% (0)	60% (6)	40% (4)	0% (0)	**10**
Regional or local once a year monitoring conducted by other organizations	10% (1)	0% (0)	50% (5)	40% (4)	0% (0)	**10**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations	0% (0)	30% (3)	30% (3)	40% (4)	0% (0)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations	20% (2)	40% (4)	20% (2)	20% (2)	0% (0)	**10**
					Total Respondents	**80**

17. Regional or local state agency monitoring for ALL mussels in ALL habitats in Indiana.

1. IDNR non-game biologist does mussel surveys. But, he is only one person and there are thousands of miles of streams in state.
2. Tippecanoe River, Maumee system
3. Ohio River, Wabash system
4. Ohio River, Wabash

5. ? Wabash system

6. Maumee system

7. Wabash system

8. Periodic (usually annual) monitoring in the Tippecanoe River by IDNR.

9. IDNR nongame biologist continually monitors fishes and mussels throughout the state, including Yellow Sandshell habitat. Two surveys have been done- ten years apart, completed last year - by IDNR biologists in the Wabash, Tippecanoe, and East Fork White Rivers; results are pending. This is in prime Yellow Sandshell habitat.

10. random locations within the Kankakee drainage

Total Respondents **10**

18. Regional or local monitoring by other organizations for ALL mussels in ALL habitats in Indiana.

1. Commmonwealth Biomonitoring frequently does habitat evaluations in small streams as part of watershed studies. If I happen to see a shell, I make a note of it in field notes. These are NOT official mussel surveys.

2. Tippecanoe River, Maumee system

3. Ohio River

4. Ohio River, Wabash

5. ? Wabash system

6. Maumee system

7. Wabash system

8. Uncertain.

9. none

Total Respondents **9**

(skipped this question) 1

19. Please list organizations that are monitoring ALL mussels in ALL habitats in Indiana.

1. None than I know of. Most mussel surveys are on bigger rivers. I was contacted by a college prof. interested in taking a class out to a small stream to learn about mussels. I discouraged him from doing so unless he followed DNR regulations concerning collectors' permits. I haven't heard any

doing so unless he followed DNR regulations concerning collectors' permits. I haven't heard any more from him.

2. TNC, USFWS

3. USFWS

4. USFWS
consultants

5. consultants, perhaps TNC

6. TNC

7. consultants
TNC

8. Uncertain.

9. none

Total Respondents	**9**
(skipped this question)	1

20. What are the current monitoring techniques for ALL mussels in ALL habitats in Indiana?

	Frequently used	Occasionally used	Not used but possible with existing technology and data	Not used and not possible with existing technology and data	Not economically feasible	Unknown	Response Total
Radio telemetry and tracking	0% (0)	0% (0)	0% (0)	0% (0)	88% (7)	12% (1)	**8**
Modeling	0% (0)	11% (1)	22% (2)	44% (4)	0% (0)	22% (2)	**9**
Coverboard routes	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (6)	**6**
Spot mapping	11% (1)	56% (5)	0% (0)	0% (0)	0% (0)	33% (3)	**9**
Driving a survey route	14% (1)	0% (0)	0% (0)	14% (1)	0% (0)	71% (5)	**7**
Reporting from harvest, depredation, or unintentional take (road kill, bycatch)	0% (0)	0% (0)	0% (0)	75% (6)	12% (1)	12% (1)	**8**

Mark and recapture	0% (0)	78% (7)	0% (0)	0% (0)	0% (0)	22% (2)	**9**
Professional survey/census	10% (1)	90% (9)	0% (0)	0% (0)	0% (0)	0% (0)	**10**
Volunteer survey/census	0% (0)	67% (6)	22% (2)	0% (0)	0% (0)	11% (1)	**9**
Trapping (by any technique)	0% (0)	0% (0)	0% (0)	20% (1)	0% (0)	80% (4)	**5**
Representative sites	12% (1)	88% (7)	0% (0)	0% (0)	0% (0)	0% (0)	**8**
Probabilistic sites	22% (2)	11% (1)	56% (5)	0% (0)	0% (0)	11% (1)	**9**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (4)	**4**
						Total Respondents	**101**

21. Other monitoring techniques for ALL mussels in ALL habitats in Indiana.

No responses were entered for this question.

Total Respondents **0**

(skipped this question) 10

22. What one or two monitoring techniques would you recommend for effective conservation of ALL mussels in ALL habitats in Indiana?

1. 1. Intensive quantitative sampling of known populations. Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogr. 8.
2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of the clubshell. See same for protocols.

2. 1. Intensive quantitative sampling of known populations. Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogr. 8.
2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of the clubshell. See same for protocols.

3. 1. Intensive quantitative sampling of known populations. Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogr. 8.
2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of the clubshell. See same for protocols.

4. 1. Intensive quantitative sampling of known populations. Need to understand demography of the clubshell.See Strayer & Smith, 2003. AFS Monogr. 8.
2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of some mussels. See same for protocols.

5.	1. Intensive quantitative sampling of known populations. Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogr. 8. 2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of some mussels. See same for protocols.
6.	1. Intensive quantitative sampling of known populations. Need to understand demography of the clubshell. See Strayer & Smith, 2003. AFS Monogr. 8. 2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of the clubshell. See same for protocols.
7.	1. State DNR or professional census at representative or probabilistic sites. 2. Development of trained, select volunteer core to undertake surveys at probabilistic sites, particularly where the species should, or could occur and has not been documented in recent years.
8.	1. Systematic monitoring of probabilistic sites (professional). 2. Use of volunteer census/monitoring.
9.	professional surveys using timed searches, systematic sampling (Strayer and Smith 2003)-A guide to sampling freshwater mussel populations. American Fisheries Society Monograph 8. American Fisheries Society. Bethesda, Maryland. 103 pp.

Total Respondents	**9**
(skipped this question)	1

23. What current HABITAT inventory and assessment efforts or activities by state agencies are you aware of for ALL mussels in ALL habitats in Indiana?

	Yes, these efforts occur	No effort that I'm aware of	Response Total
Statewide annual inventory and assessment conducted by state agencies	0% (0)	100% (10)	**10**
Statewide once a year inventory and assessment conducted by state agencies	0% (0)	100% (10)	**10**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	0% (0)	100% (10)	**10**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	0% (0)	100% (10)	**10**
Regional or local year-round inventory and assessment conducted by state agencies	0% (0)	100% (9)	**9**
Regional or local once a year inventory and assessment conducted by state agencies	0% (0)	100% (10)	**10**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by	0% (0)	100% (10)	**10**

state agencies			
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	70% (7)	30% (3)	**10**
		Total Respondents	**79**

24. What current HABITAT inventory and assessment efforts or activities by other organizations are you aware of for ALL mussels in ALL habitats in Indiana?

	Yes, these efforts occur	No effort that I'm aware of	Response Total
Statewide year-round inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Statewide once a year inventory and assessment conducted by other organizations	0% (0)	100% (9)	**9**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Regional or local year-round inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Regional or local once a year inventory and assessment conducted by other organizations	0% (0)	100% (9)	**9**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	70% (7)	30% (3)	**10**
		Total Respondents	**78**

25. How crucial are these HABITAT efforts by state agencies for the conservation of ALL mussels in ALL habitats in Indiana?

	These efforts are very crucial for this HABITAT	These efforts are somewhat crucial for this HABITAT	These efforts are slightly crucial for this HABITAT	These efforts are not crucial for this HABITAT	Unknown	Response Total
Statewide annual inventory and						

assessment conducted by state agencies						
Statewide once a year inventory and assessment conducted by state agencies	20% (2)	20% (2)	20% (2)	40% (4)	0% (0)	**10**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	30% (3)	30% (3)	20% (2)	20% (2)	0% (0)	**10**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	20% (2)	20% (2)	30% (3)	30% (3)	0% (0)	**10**
Regional or local year-round inventory and assessment conducted by state agencies	0% (0)	20% (2)	40% (4)	40% (4)	0% (0)	**10**
Regional or local once a year inventory and assessment conducted by state agencies	10% (1)	20% (2)	40% (4)	30% (3)	0% (0)	**10**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	10% (1)	40% (4)	30% (3)	20% (2)	0% (0)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	30% (3)	30% (3)	20% (2)	20% (2)	0% (0)	**10**
				Total Respondents		**80**

26. How crucial are these HABITAT efforts by other organizations for the conservation of ALL mussels in ALL habitats in Indiana?

	These efforts are very crucial for this HABITAT	These efforts are somewhat crucial for this HABITAT	These efforts are slightly crucial for this HABITAT	These efforts are not crucial for this HABITAT	Unknown	Response Total
Statewide year-round inventory and assessment conducted by other organizations	0% (0)	20% (2)	50% (5)	20% (2)	10% (1)	**10**
Statewide once a year inventory and assessment conducted by other organizations	10% (1)	20% (2)	40% (4)	20% (2)	10% (1)	**10**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	20% (2)	20% (2)	30% (3)	20% (2)	10% (1)	**10**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	10% (1)	20% (2)	40% (4)	20% (2)	10% (1)	**10**
Regional or local year-round inventory and assessment conducted by other organizations	0% (0)	20% (2)	50% (5)	20% (2)	10% (1)	**10**
Regional or local once a year inventory and assessment conducted by other organizations	11% (1)	22% (2)	33% (3)	22% (2)	11% (1)	**9**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	20% (2)	30% (3)	20% (2)	20% (2)	10% (1)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	40% (4)	30% (3)	0% (0)	20% (2)	10% (1)	**10**
					Total Respondents	**79**

27. Regional or local state agency HABITAT inventory and assessment for ALL mussels in ALL habitats in Indiana.

1. ? Tippecanoe River and Maumee system

2. ? Ohio River, Wabash system

3. Ohio River, Wabash

4. ? Wabash system

5. Maumee system

6. Wabash system

7. (Usually wildlife species inventories are made, with relevant habitat information)

8. IDNR primarily monitors mussel species, making habitat notations. No real habit monitors made. However, Indiana Department of Environmental Management, IDNR Division of Water do monitor water quality (as a component of habitat).

9. none

Total Respondents	**9**
(skipped this question)	1

28. Regional or local HABITAT inventory and assessment by other organizations for ALL mussels in ALL habitats in Indiana.

1. We (Commonewealth Biomonitoring) do habitat evaluations on small streams as part of watershed studies. These evaluations are not specific to mussels, but are Ohio EPA QHEI methods.

2. ? Tippecanoe River and Maumee system

3. Ohio River

4. Ohio River, Wabash

5. ? Wabash system

6. Maumee system

7. Wabash system

8. none

Total Respondents	**8**
(skipped this question)	2

29. Please list organizations that are monitoring this HABITAT for ALL mussels in ALL habitats in Indiana.

1. TNC, USFWS
2. USFWS
3. USFWS
consultants
4. consultants, perhaps TNC
5. TNC
6. consultants
TNC
7. none

Total Respondents	**7**
(skipped this question)	3

30. What are the current HABITAT inventory and/or assessment techniques for ALL mussels in ALL habitats in Indiana?

	Frequently used	Occasionally used	Not used but possible with existing technology and data	Not used and not possible with existing technology and data	Not economically feasible	Unknown	Response Total
GIS mapping	0% (0)	70% (7)	10% (1)	0% (0)	0% (0)	20% (2)	**10**
Aerial photography and analysis	0% (0)	0% (0)	0% (0)	50% (5)	10% (1)	40% (4)	**10**
Systematic sampling	0% (0)	70% (7)	0% (0)	0% (0)	0% (0)	30% (3)	**10**
Property tax estimates	0% (0)	0% (0)	0% (0)	0% (0)	11% (1)	89% (8)	**9**
State revenue data	0% (0)	0% (0)	0% (0)	0% (0)	11% (1)	89% (8)	**9**
Regulatory information	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (9)	**9**
Participation in landuse programs	0% (0)	67% (6)	11% (1)	0% (0)	0% (0)	22% (2)	**9**
Modeling	0% (0)	67% (6)	11% (1)	0% (0)	0% (0)	22% (2)	**9**

Voluntary landowner reporting	0% (0)	67% (6)	0% (0)	0% (0)	22% (2)	11% (1)	**9**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (4)	**4**
						Total Respondents	**88**

31. Other HABITAT inventory and assessment techniques for ALL mussels in ALL habitats in Indiana.

1. Water quality monitoring

Total Respondents **1**

(skipped this question) 9

32. What one or two HABITAT inventory and assessment techniques would you recommend for effective conservation of ALL mussels in ALL habitats in Indiana?

1. 1. CREP, farmer incentives for no-till, riparian corridors, etc.
   2. Strictly control instream modifications: mining, snagging, etc.
2. 1. Assess zebra mussel infestations. Contact P. Morrison, USFWS, Parkersburg, WV
3. 1. Zebra mussel assessment. Contact P. Morrison, USFWS, Parkersburg, WV
4. 1. Assess riparian corridor presence
   2. Water quality
5. 1. Assess riparian corridor
   2. Water quality
6. 1. Assess riparian corridor
   2. Water quality monitoring
7. 1. More extensive use of GIS- modeled habitat probabilities.
8. 1. To look at saturation of potential habitat: with GIS construction of existing potential habitat(based upon known factors)and overlaying the current distribution of the Yellow Sandshell.
9. don't really think that a habitat inventory of any kind is necessary for creek heelsplitter habitat in the Kankakee drainage

Total Respondents **9**

(skipped this question) 1

33. What is the current body of science for ALL mussels in ALL habitats in Indiana?

	Response Total	Response Percent
Complete, up to date and extensive	0	0 %
Adequate	2	20 %
Inadequate	8	80 %
Nonexistent	0	0 %
Other (please explain below)	0	0 %
Total Respondents		10

34. Please provide a citation (title, author, date, publisher) that would give the best overview of ALL mussels in ALL habitats in Indiana, if available. This resource may be used if further detail is needed.

Title = Occurrence and distribution of freshwater mussels in the small streams of Tippecanoe County, Indiana;
Author = Myers-Kinzie, M., S. Wente, & A. Spacie;
Date = 2001;
Publisher = Proc. Ind. Acad. Sci.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Freshwater mussels of Tennessee;
Author = Parmalee & Bogan;
Date = 1998;
Publisher = U of Tennessee Press

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = 'Clubshell';
Author = USFW, Division of Endangered Species;
Publisher = Online

Title = (Numerous internet sites, including USF&W)

35. If possible, please provide a second citation (title, author, date, publisher) that would give another good overview of ALL mussels in ALL habitats in Indiana. This resource may also be used if further detail is needed.

Title = Field guide to freshwater mussels of Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Life history and propagation...;
Author = Jones & Neves;
Date = 2002;
Publisher = JNABS

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1919;
Publisher = WI Geol. Nat. Hist. Surv.

36. What is the current HABITAT body of science for ALL mussels in ALL habitats in Indiana?

	Response Total	Response Percent
Complete, up to date and extensive	0	0 %
Adequate	3	30 %
Inadequate	7	70 %
Nonexistent	0	0 %
Other (please explain below)	0	0 %
	Total Respondents	10

37. Please provide a citation (title, author, date, publisher) that would give the best HABITAT overview of ALL mussels in ALL habitats in Indiana, if available. This resource may be used if further detail is needed.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1991;
Publisher = USFWS

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Hist. Surv.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

38. If possible, please provide a second citation (title, author, date, publisher) that would give another good HABITAT overview of ALL mussels in ALL habitats in Indiana. This resource may also be used if further detail is needed.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Molluscs of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Sci. Surv.

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1929;
Publisher = WI Geol. Nat. Sci. Surv.

39. What are the research needs for ALL mussels in ALL habitats in Indiana?

	Urgently needed	Greatly needed	Needed	Slightly needed	Not needed	Unknown	Response Total
Life cycle	40% (4)	10% (1)	20% (2)	20% (2)	10% (1)	0% (0)	**10**
Distribution and abundance	30% (3)	0% (0)	70% (7)	0% (0)	0% (0)	0% (0)	**10**
Limiting factors (food, shelter, water, breeding sites)	20% (2)	30% (3)	50% (5)	0% (0)	0% (0)	0% (0)	**10**
Threats (predators/competition,	20% (2)	40% (4)	30% (3)	10% (1)	0% (0)	0% (0)	**10**

contamination)							
Relationship/dependence on specific habitats	10% (1)	30% (3)	60% (6)	0% (0)	0% (0)	0% (0)	**10**
Population health (genetic and physical)	20% (2)	30% (3)	50% (5)	0% (0)	0% (0)	0% (0)	**10**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (5)	**5**
						Total Respondents	**65**

40. Other research needs for ALL mussels in ALL habitats in Indiana.

1. Habitat needs are not completely understood. I have seen fresh dead cylindrical papershell in channelized ag ditches. Other small streams with good habitat have only weathered dead fragments.

2. To find out why the Clubshell has depopulated most of its former distribution in Indiana. Developing some sort of timeline (late Pleistocene, Holocene (usually archaeological), or historic) for relic valve distribution might narrow the possibilities of critical limiting factors (post-settlement siltation,etc.).

Total Respondents	**2**
(skipped this question)	8

41. What are the HABITAT research needs for ALL mussels in ALL habitats in Indiana?

	Urgently needed	Greatly needed	Needed	Slightly needed	Not needed	Unknown	Response Total
Successional changes	0% (0)	0% (0)	10% (1)	20% (2)	60% (6)	10% (1)	**10**
Distribution and abundance (fragmentation)	30% (3)	30% (3)	20% (2)	0% (0)	10% (1)	10% (1)	**10**
Threats (land use change/competition, contamination/global warming)	30% (3)	50% (5)	10% (1)	0% (0)	10% (1)	0% (0)	**10**
Relationship/dependence on specific site conditions	10% (1)	30% (3)	50% (5)	10% (1)	0% (0)	0% (0)	**10**
Growth and development of individual components of the habitat	0% (0)	10% (1)	60% (6)	20% (2)	10% (1)	0% (0)	**10**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (5)	**5**
						Total Respondents	**55**

42. Other HABITAT research needs for ALL mussels in ALL habitats in Indiana.

No responses were entered for this question.

Total Respondents	**0**
(skipped this question)	10

43. How well do the following conservation efforts address the threats to ALL mussels in ALL habitats in Indiana?

	Very well	Somewhat	Not at all	Not used	Unknown	Response Total
Habitat protection (use below for details)	0% (0)	60% (6)	10% (1)	10% (1)	20% (2)	**10**
Population management (hunting, trapping)	0% (0)	20% (2)	0% (0)	60% (6)	20% (2)	**10**
Population enhancement (captive breeding and release)	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Reintroduction (restoration)	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Food plots	0% (0)	0% (0)	0% (0)	40% (4)	60% (6)	**10**
Threats reduction	0% (0)	50% (5)	0% (0)	30% (3)	20% (2)	**10**
Native predator control	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Exotic/invasive species control	0% (0)	0% (0)	50% (5)	30% (3)	20% (2)	**10**
Regulation of collecting	0% (0)	30% (3)	60% (6)	0% (0)	10% (1)	**10**
Disease/parasite management	0% (0)	0% (0)	0% (0)	70% (7)	30% (3)	**10**
Translocation to new geographic range	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Protection of migration routes	0% (0)	0% (0)	0% (0)	30% (3)	70% (7)	**10**
Limiting contact with pollutants/contaminants	0% (0)	70% (7)	10% (1)	10% (1)	10% (1)	**10**
Public education to reduce human disturbance	0% (0)	70% (7)	10% (1)	0% (0)	20% (2)	**10**
Culling/selective removal	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Stocking	0% (0)	0% (0)	0% (0)	100% (10)	0% (0)	**10**
Other (please specify below)	0% (0)	0% (0)	0% (0)	20% (1)	80% (4)	**5**
					Total Respondents	**165**

44. Other current conservation practices for ALL mussels in ALL habitats in Indiana.

Total Respondents	**0**
(skipped this question)	10

45. What one or two specific practices would you recommend for more effective conservation of ALL mussels in ALL habitats in Indiana?

1. The following applies to all mussel species. Educate anglers that it is ILLEGAL to use mussels as fishing bait.

2. 1. Strict enforcement of laws regulating instream modification; incentives to farmers.
2. Propagation

3. 1. Strictly limit instream modifications
2. Remove existing dams wherever possible
See Watters, 2000. Proc. 1st FMCS Symposium

4. 1. Limit instream modification.
2. Restore free-flowing systems
See Watters, 2000. Proc. 1st FMCS Symposium

5. 1. CREP, other incentives for BMP's
2. Limit instream modifications
See Watters, 2000. Proc. 1st FMCS Symposium

6. 1. Intensive quantitative sampling of known populations. Need to understand demography of species. See Strayer & Smith, 2003. AFS Monogr. 8.
2. Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of species. See same for protocols.

7. 1. Eliminate instream modifications, including inpoundment
2. Restore riparian corridor
See Watters, 2000. Proc. 1st FMCS Symposium

8. Protect the shallow sand/gravel habitat from siltation and channelization, and keep the waters free of pollutants and toxins.

9. 1. Protection of the habitat against pollutants and toxins.

10. protect habitat by limiting the amount of dredging that occurs in the Kankakee watershed

Total Respondents	**10**

46. How well do the following conservation efforts address the HABITAT threats to ALL mussels in ALL habitats in Indiana?

	Very	Somewhat	Not at all	Not used	Unknown	Response

	well					Total
Habitat protection through regulation	0% (0)	60% (6)	10% (1)	0% (0)	30% (3)	**10**
Habitat protection on public lands	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Habitat protection incentives (financial)	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Habitat restoration through regulation	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Habitat restoration on public lands	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Habitat restoration incentives (financial)	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Artificial habitat creation (artificial reefs, nesting platforms)	0% (0)	0% (0)	0% (0)	90% (9)	10% (1)	**10**
Selective use of functionally equivalent exotic species in place of extirpated natives	0% (0)	0% (0)	0% (0)	90% (9)	10% (1)	**10**
Succession control (fire, mowing)	0% (0)	0% (0)	0% (0)	90% (9)	10% (1)	**10**
Corridor development/protection	0% (0)	70% (7)	0% (0)	10% (1)	20% (2)	**10**
Managing water regimes	0% (0)	60% (6)	0% (0)	10% (1)	30% (3)	**10**
Pollution reduction	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Protection of adjacent buffer zone	0% (0)	70% (7)	0% (0)	10% (1)	20% (2)	**10**
Restrict public access and disturbance	0% (0)	30% (3)	10% (1)	40% (4)	20% (2)	**10**
Land use planning	0% (0)	70% (7)	0% (0)	0% (0)	30% (3)	**10**
Technical assistance	0% (0)	70% (7)	0% (0)	10% (1)	20% (2)	**10**
Cooperative land management agreements (conservation easements)	10% (1)	60% (6)	0% (0)	0% (0)	30% (3)	**10**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	100% (4)	**4**
				Total Respondents		**174**

47. Other current HABITAT conservation practices for ALL mussels in ALL habitats in Indiana.

No responses were entered for this question.

Total Respondents **0**

(skipped this question) 10

48. What one or two specific HABITAT practices would you recommend for more effective conservation of ALL mussels in ALL habitats in Indiana?

1. Treat small streams as biological resources and not just drainage ditches. At the very least, require that a mussel survey be done before dredging.

2. 1. No instream modifications.
2. Limit runoff through incentives or other means.
See Watters, 2000. Proc. 1st FMCS Symposium.

3. 1. Restrict instream modifications
2. Restore free-flowing systems

4. 1. Eliminate habitat modifications (in-stream dredging, channelization, etc.)
See Watters, 2000. Proc. 1st FMCS Symposium

5. 1. Promote riparian corridor
2. Limit habitat modifications

6. 1. Assess riparian corridor
2. Water quality monitoring
See Watters, 2000. Proc. 1st FMCS Symposium

7. 1. CREP and other incentives for BMP's
2. Restrict instream modifications
See Watters, 2000. Proc. 1st FMCS Symposium

8. Manage pollutants and toxins, maintain available habitat through regulation and buffer zones, increase habitat through incentives, technical assistance and restoration.

9. 1. Manage water quality and pollutants.
2. Protection of adjacent buffer zones.

10. any type of habitat protection/restoration-eliminate dredging

Total Respondents **10**

49. Do you have any additional comments or information on ALL mussels in ALL habitats that you feel would be useful in the development of the Indiana Comprehensive Wildlife Strategy?

1. N/A

2. N/A

3. N/A

4. N/A

5. N/A

6. N/A

1. To find out just why the Clubshell depopulated so much of its former range, which once included much of the interior of Indiana. Knowing this "why" should disclose a critical limiting factor, and

8.	much of the interior of Indiana. Knowing this "why" should disclose a critical limiting factor, and could lead to its future preservation. 2. There is a great potential source for select avocational technical assistance (= volunteers) to undertake monitoring and survey where funding falls short. The Yellow Sandshell appears to be a resilient species that is relatively tolerant of some silt; it has ezpanded beyond rivers and streams and has taken up residence in reservoirs. If we afford it the broad protection (i.e., against pollutants and habitat destruction)that we attempt to give to mussels in general and to other components of our wildlife and environment, it should do well.	
	Total Respondents	**8**
	(skipped this question)	2

6. Please rank the following threats to ALL reptiles in ALL habitats in Indiana.

	Critical threat	Serious threat	Somewhat of a threat	Slight threat	No threat	Unknown	Response Total
Invasive/non-native species	0% (0)	15% (2)	8% (1)	23% (3)	31% (4)	23% (3)	**13**
High sensitivity to pollution	0% (0)	0% (0)	8% (1)	31% (4)	15% (2)	46% (6)	**13**
Bioaccumulation of contaminants	0% (0)	0% (0)	8% (1)	17% (2)	0% (0)	75% (9)	**12**
Predators (native or domesticated)	15% (2)	8% (1)	23% (3)	38% (5)	0% (0)	15% (2)	**13**
Dependence on other species (mutualism, pollinators)	0% (0)	8% (1)	8% (1)	15% (2)	46% (6)	23% (3)	**13**
Diseases/parasites (of the species itself)	0% (0)	0% (0)	8% (1)	38% (5)	0% (0)	54% (7)	**13**
Regulated hunting/fishing pressure (too much)	8% (1)	0% (0)	8% (1)	0% (0)	46% (6)	38% (5)	**13**
Species over population	0% (0)	0% (0)	0% (0)	0% (0)	69% (9)	31% (4)	**13**
Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)	38% (5)	31% (4)	23% (3)	0% (0)	0% (0)	8% (1)	**13**
Unregulated collection pressure	8% (1)	8% (1)	46% (6)	15% (2)	15% (2)	8% (1)	**13**
Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)	0% (0)	15% (2)	8% (1)	31% (4)	23% (3)	23% (3)	**13**
						Total Respondents	**142**

7. Please also rank these threats to ALL reptiles in ALL habitats in Indiana.

	Critical threat	Serious threat	Somewhat of a threat	Slight threat	No threat	Unknown	Response Total
Habitat loss (breeding range)	38% (5)	38% (5)	23% (3)	0% (0)	0% (0)	0% (0)	**13**
Habitat loss (feeding/foraging areas)	31% (4)	54% (7)	15% (2)	0% (0)	0% (0)	0% (0)	**13**
Small native range (high endemism)	0% (0)	8% (1)	15% (2)	15% (2)	38% (5)	23% (3)	**13**
Near limits of natural geographic range	17% (2)	8% (1)	17% (2)	8% (1)	33% (4)	17% (2)	**12**

Large home range requirements	8% (1)	15% (2)	8% (1)	46% (6)	0% (0)	23% (3)	**13**
Viable reproductive population size or availability	31% (4)	15% (2)	23% (3)	0% (0)	0% (0)	31% (4)	**13**
Specialized reproductive behavior or low reproductive rates	31% (4)	23% (3)	23% (3)	8% (1)	0% (0)	15% (2)	**13**
Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)	8% (1)	38% (5)	15% (2)	8% (1)	0% (0)	31% (4)	**13**
Genetic pollution (hybridization)	0% (0)	0% (0)	8% (1)	23% (3)	38% (5)	31% (4)	**13**
Unknown	0% (0)	0% (0)	0% (0)	14% (1)	43% (3)	43% (3)	**7**
Other (please specify below)	0% (0)	25% (2)	0% (0)	0% (0)	38% (3)	38% (3)	**8**
						Total Respondents	**131**

8. Other threats to ALL reptiles in ALL habitats in Indiana.

1. Artificial manipulation of water levels in wetlands seems 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. Both activities are likely to kill over wintering snakes.

2. 1. Abrupt changes in drainage patterns due to development. Kirtland's snakes preferr moist soils that support earthworms.
2. Mowing, or moving or clearing of debris (cover items) on the ground as Kirtland's snakes are found in moist open environments; but, often under natural and man-made debris on the ground

Total Respondents **2**

(skipped this question) 11

9. Please briefly describe the top two threats to ALL reptiles in ALL habitats in Indiana identified above.

1. 1) commercial type fishing devices - trot lines, branch lines, big nets, other passive fishing
2) extreme depredation by overabundant raccoons (on eggs) - maybe by cayotes, too.
3) extant population (if any) far below level for unassisted recovery.

2. 1) nest depredation mainly by raccoons = very low recruitment.
2) nest/embryo/hatchling loss assiciated with attraction to rowcrop land for nesting.
3) potential loss of adults to road kill and to rogue raccoons (kill adults for their eggs)

3. 1) loss of permanent wetland areas that include huge open/prairie buffer zones for nesting.
2) overland movement for nesting invites road kill of otherwise longlived adults

	2) overland movement for nesting invites road kill of otherwise longlived adults suboptimal size nesting areas focuses nest depredation Inappropriate management of nesting areas – sandy fire breaks in managed areas are disked at inappropriate times, or are managed in inappropriate cover types
4.	Fragmentation of populations due to habitat loss. Wetlands are managed as landscape scale systems relative to Blanding's turtle, resulting in metapopulation disruption and potential metapopulation decline. Because of low densities and small population sizes, populations that have become isolated are likely not viable.
5.	Artificial manipulation of water levels in wetlands seems 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. Both activities are likely to kill over wintering snakes. Inappropriate management of sandy fire breaks in managed areas that are disked at inappropriate times, or are managed in inappropriate cover types. I have seen dead massasauga that have been disked on DNR lands
6.	Populations seem to be in steep decline due to habitat fragmentation (from landuse change and inappropriate management – eg – fire suppression). Most known populations seem to occur at such low densities that mating seems a remote possiblility. All the problems associated with small population size and low reproductive rate seem likely to plague the Ornate box turtle. Most populations seem likely to be in a slow-motion death spiral at the moment.
7.	habitat loss and fragmentation, loss of connectivity
8.	The top two threats to timber rattlesnakes in this habitat are habitat loss and human persecution. Timber rattlesnakes are often killed because they are large venomous snakes. There is also a market for this species in illegal trade. Individual take coupled with low reproductive rates pose a serious threat for this species.
9.	The top two threats to the eastern box turtle are habitat loss, road mortality, and human collection.
10.	1. Developement of drainage areas and flood plains, including development of park-like areas in which natural or man-made cover is removed. 2. Habitat fragmentation that disrupts gene flow and re-colonization.
11.	I believe the top two threats to the black kingsnake include human collection and habitat loss. How these factors have effected kingsnake populations in Indiana is unknown.
12.	Little is known concerning the crowned snake in Indiana. I believe the top threats to this species in Indiana include habitat destruction, habitat fragmentation, and accidental take.

Total Respondents	**12**
(skipped this question)	1

10. Please rank the following threats to the HABITAT of ALL reptiles in ALL habitats in Indiana.

	Critical	Serious	Somewhat	Slight	No	Unknown	Response

Appendix E-78: Reptiles

	threat	threat	of a threat	threat	threat		Total
Commercial or residential development (sprawl)	0% (0)	33% (4)	33% (4)	33% (4)	0% (0)	0% (0)	**12**
Counterproductive financial incentives or regulations	0% (0)	8% (1)	25% (3)	33% (4)	8% (1)	25% (3)	**12**
Invasive/non-native species	0% (0)	15% (2)	15% (2)	31% (4)	23% (3)	15% (2)	**13**
Nonpoint source pollution (sedimentation and nutrients)	0% (0)	0% (0)	25% (3)	42% (5)	8% (1)	25% (3)	**12**
Habitat fragmentation	23% (3)	46% (6)	31% (4)	0% (0)	0% (0)	0% (0)	**13**
Successional change	8% (1)	31% (4)	23% (3)	23% (3)	0% (0)	15% (2)	**13**
Diseases (of plants that create habitat)	0% (0)	0% (0)	0% (0)	25% (3)	17% (2)	58% (7)	**12**
Habitat degradation	17% (2)	50% (6)	8% (1)	8% (1)	0% (0)	17% (2)	**12**
Climate change	0% (0)	0% (0)	0% (0)	8% (1)	17% (2)	75% (9)	**12**
Stream channelization	17% (2)	17% (2)	0% (0)	8% (1)	25% (3)	33% (4)	**12**
Impoundment of water/flow regulation	17% (2)	8% (1)	25% (3)	17% (2)	25% (3)	8% (1)	**12**
Agricultural/forestry practices	8% (1)	25% (3)	50% (6)	8% (1)	0% (0)	8% (1)	**12**
Residual contamination (persistent toxins)	0% (0)	0% (0)	8% (1)	33% (4)	0% (0)	58% (7)	**12**
Point source pollution (continuing)	0% (0)	0% (0)	17% (2)	25% (3)	0% (0)	58% (7)	**12**
Mining/acidification	8% (1)	0% (0)	0% (0)	17% (2)	25% (3)	50% (6)	**12**
Drainage practices (stormwater runoff)	0% (0)	17% (2)	0% (0)	25% (3)	25% (3)	33% (4)	**12**
Unknown	0% (0)	0% (0)	0% (0)	0% (0)	38% (3)	62% (5)	**8**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	38% (3)	62% (5)	**8**
					Total Respondents		**211**

11. Other HABITAT threats to ALL reptiles in ALL habitats in Indiana.

1. Although I marked invasive/non-native species as a slight threat, the impact of non-native earthworms should be closely monitored as the Kirtland's snake's natural diet is believed to be comprised predominately of earthworms and slugs. The ecological impact of some non-native invertebrates has not be adequately studied

2. Although the Southeastern crowned snake is found in conjunction with upland forested habitats in Indiana, the species prefers sand and siltstone glades

Total Respondents	**2**
(skipped this question)	11

12. Please briefly describe the top two HABITAT threats to ALL reptiles in ALL habitats in Indiana identified above.

1. 1) channelization
2) drain/cut off oxbow ponds
3) trample sandbars or remove other nesting areas along banks

2. 1) habitat loss through channelization and draining of oxbow ponds and elimination of flows that create point bars on rivers.
2) rowcrop practices: crushing nests during ground insect/weed control; crushing overwinter hatchlings during harvest & early spring plowing

3. 1) Habitat loss through wetland drainage/ tiny stream ditching.
2) conversion of sand prairie nesting habitat to cropland or something else (e.g. forestation via fire prevention)

4. Manipulation of natural wetlands for management of other species has a disruptive impact on natural wetland dynamics. This may include reduced survival of Blanding's or reduced productivity of the habitat.

Loss of adjacent uplands or inappropriate cover/management. Blanding's requires nesting habitats that are secure from disturbance and that are within a reasonable distance to wetland habitats. Loss of appropriate habitat (ether due to tradition conversion to agriculture or to conversion of inappropriate conservation cover types) is negatively impacting reproductive success in this species. Long-distance movements

Fire suppression in graminoid wetland habitat creates late successional wetlands that are not appropriate habitat. Conversely, late spring fire in these habitats is likely to cause direct adult mortality.

5. Artificial manipulation of water levels in wetlands seems 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. Both activities are likely to kill over wintering snakes. IN addition, herbaceous wetland are lost under this management regime, replaced by open water wetlands.

6. Fragmentation – most habitats are now old dunes with overgrown savanna. Flat ground that was habitat is largely under row crop agriculture. Populations seem highly fragmented, and while population size estimates are tough to come by, populations seem small. Small isolated populations ale likely to be subject to inbreeding and are at increased risk for local extinction.

From personal experience, m edges on old dunes or in high-quality oak savanna habitats. Fire suppression has changed the nature of these plant communities on private and public lands (with the exception of nature preserves). It seems likely that continued fire suppression will degrade additional habitat as time passes.

7. Fragmentation and small habitat size – most habitats are small remnants of native grassland, surrounded by either agriculture of fire-suppressed oak savanna. Habitat size needs to be expanded at sites which support seemingly salvageable populations of the Ornate box turtle

8. Much potentially suitable habitat has been lost though succession to exotic species and oak woodland. This turtle requires expansive open grassland. Lack of habitat management, or in the case of invasive species, because of the purposeful introduction of invasive shrubs, has resulted in open native grassland being lost to shrub land and oak woodland.

9. coal mining, agriculture

10. The top two habitat threats to the timber rattlesnake include forest fragmentation and habitat loss. The timber rattlesnakes need large continuous blocks of forest habitat. When these areas are lost rattlesnakes become susceptible to human and predator encounters.

11. The largest threat to the box turtle habitat is fragmentation and urbanization.

12. 1. Developement of drainage areas and flood plains, including development of park-like areas in which natural or man-made cover is removed.
2. Habitat fragmentation that disrupts gene flow and re-colonization.

Threats to some reptiles habitat include invasive species encroachment and habitat destruction.

Total Respondents	**12**
(skipped this question)	1

13. What current monitoring efforts by state agencies are you aware of for ALL reptiles in ALL habitats in Indiana?

	Yes, these efforts occur	Not aware of these efforts occuring	Response Total
Statewide year-round monitoring conducted by state agencies	8% (1)	92% (12)	**13**
Statewide once a year monitoring conducted by state agencies	8% (1)	92% (12)	**13**
Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by state agencies	0% (0)	100% (13)	**13**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies	15% (2)	85% (11)	**13**
Regional or local year-round monitoring conducted by state agencies	8% (1)	92% (12)	**13**
Regional or local once a year monitoring conducted by state agencies	8% (1)	92% (12)	**13**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state	0% (0)	100% (13)	**13**

agencies			
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies	54% (7)	46% (6)	**13**
		Total Respondents	**104**

14. What current monitoring efforts by other organizations are you aware of for ALL reptiles in ALL habitats in Indiana?

	Yes, these efforts occur	Not aware of these efforts occuring	Response Total
Statewide year-round monitoring conducted by other organizations	0% (0)	100% (13)	**13**
Statewide once a year monitoring conducted by other organizations	0% (0)	100% (12)	**12**
Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by other organizations	0% (0)	100% (13)	**13**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by other organizations	8% (1)	92% (12)	**13**
Regional or local year-round monitoring conducted by other organizations	0% (0)	100% (13)	**13**
Regional or local once a year monitoring conducted by other organizations	0% (0)	100% (12)	**12**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations	0% (0)	100% (13)	**13**
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations	38% (5)	62% (8)	**13**
		Total Respondents	**102**

15. How crucial are these monitoring efforts by state agencies for the conservation of ALL reptiles in ALL habitats in Indiana?

	Very crucial	Somewhat crucial	Slightly crucial	Not crucial	Unknown	Response Total
Statewide year-round monitoring conducted by state agencies	0% (0)	23% (3)	8% (1)	69% (9)	0% (0)	**13**
Statewide once a year monitoring conducted by state agencies	0% (0)	31% (4)	15% (2)	54% (7)	0% (0)	**13**
Periodic statewide (less than once a year						

but still regularly scheduled) monitoring conducted by state agencies						
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies	15% (2)	23% (3)	31% (4)	31% (4)	0% (0)	**13**
Regional or local year-round monitoring conducted by state agencies	8% (1)	8% (1)	15% (2)	54% (7)	15% (2)	**13**
Regional or local once a year monitoring conducted by state agencies	0% (0)	8% (1)	31% (4)	46% (6)	15% (2)	**13**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies	8% (1)	23% (3)	31% (4)	23% (3)	15% (2)	**13**
Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies	15% (2)	46% (6)	8% (1)	23% (3)	8% (1)	**13**
					Total Respondents	**104**

16. How crucial are these monitoring efforts by other organizations for the conservation of ALL reptiles in ALL habitats in Indiana?

	Very crucial	**Somewhat crucial**	**Slightly crucial**	**Not crucial**	**Unknown**	**Response Total**
Statewide year-round monitoring conducted by other organizations	0% (0)	0% (0)	8% (1)	69% (9)	23% (3)	**13**
Statewide once a year monitoring conducted by other organizations	0% (0)	8% (1)	8% (1)	62% (8)	23% (3)	**13**
Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by other organizations	15% (2)	0% (0)	15% (2)	46% (6)	23% (3)	**13**
Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by other organizations	15% (2)	0% (0)	15% (2)	46% (6)	23% (3)	**13**
Regional or local year-round monitoring conducted by other organizations	8% (1)	0% (0)	8% (1)	50% (6)	33% (4)	**12**
Regional or local once a year monitoring conducted by other organizations	0% (0)	0% (0)	18% (2)	55% (6)	27% (3)	**11**
Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations	15% (2)	8% (1)	23% (3)	15% (2)	38% (5)	**13**
Occasional regional or local (less than once a year and not regularly scheduled)	15% (2)	23% (3)	23% (3)	15% (2)	23% (3)	**13**

monitoring conducted by other organizations

Total Respondents **101**

17. Regional or local state agency monitoring for ALL reptiles in ALL habitats in Indiana.

1. I'm unaware of any. Perhaps some occur coincident with large fish survey.
2. Ask Zack Walker
I believe there was an accidental capture near Shoals
3. I'd guess that agencies that issue drainage permits are relevant here.
4. Fish Creek, Patoka River, Pigeon Creek
5. IDNR has monitored timber rattlesnake in Brown, Monroe, and Morgan counties.
6. The state is monitoring box turtles in Martin, Brown, and Morgan counties.
7. Kirtland snake encounters are reported to the Indiana Natural Hertiage Database on a sporatic basis by citizens and scientist. Although sporatic these reports are often sufficient to demonstrate persistent Kirtland snake occupied sites. However, the environmental parameters of these sites have not been adeqately studied or described to reveal important micro-habitat associations.
8. I am not aware of any agency monitoring black kingsnakes in Indiana.
9. The DNR occasionaly monitors some reptiles.

Total Respondents **9**

(skipped this question) 4

18. Regional or local monitoring by other organizations for ALL reptiles in ALL habitats in Indiana.

1. I'm unaware of any.
2. "BioBlitz" in Lake Co.
Herp Center at IUPFW - I presume they've done something in Steuben and La Grange Cos.
3. Fish Creek, Patoka River, Pigeon Creek, Muscatatuck River
4. The USFS has contracted out survey work in the southern portions of the Hoosier National Forest.
5. I am not sure who else might be monitoring box turtle in Indiana
6. None known.

7. I am not aware of any agency monitoring black kingsnakes in Indiana.

8. The Nature Conservancy occasionaly montiors for some reptiles.

Total Respondents **8**

(skipped this question) 5

19. Please list organizations that are monitoring ALL reptiles in ALL habitats in Indiana.

1. None?

2. What I know is above.

3. TNC has funded some work at Cline Lake Fen to better understand population dynamics, habitat use, etc...

4. TNC- funded research at Cline Lake Fen

5. Bruce Kingsbury, IUPU Fort Wayne,

6. USFS

7. None know to be "monitoring" the Wildlife Diversity Section of the Indiana Division of Fish and Wildlife accepts sighting information as does the Divsion of Nature Preserves for inclusion in the Hertiage Database.

8. I am not aware of any agency monitoring black kingsnakes in Indiana.

Total Respondents **8**

(skipped this question) 5

20. What are the current monitoring techniques for ALL reptiles in ALL habitats in Indiana?

	Frequently used	Occasionally used	Not used but possible with existing technology and data	Not used and not possible with existing technology and data	Not economically feasible	Unknown	Response Total
Radio telemetry and tracking	21% (3)	29% (4)	29% (4)	7% (1)	0% (0)	14% (2)	**14**
Modeling	0% (0)	15% (2)	46% (6)	0% (0)	0% (0)	38% (5)	**13**
Coverboard routes	0% (0)	0% (0)	55% (6)	9% (1)	0% (0)	36% (4)	**11**

Spot mapping	8% (1)	38% (5)	31% (4)	0% (0)	0% (0)	23% (3)	**13**
Driving a survey route	0% (0)	0% (0)	60% (6)	0% (0)	0% (0)	40% (4)	**10**
Reporting from harvest, depredation, or unintentional take (road kill, bycatch)	7% (1)	14% (2)	14% (2)	14% (2)	0% (0)	50% (7)	**14**
Mark and recapture	23% (3)	15% (2)	31% (4)	0% (0)	0% (0)	31% (4)	**13**
Professional survey/census	25% (3)	42% (5)	17% (2)	0% (0)	0% (0)	17% (2)	**12**
Volunteer survey/census	0% (0)	31% (4)	31% (4)	0% (0)	0% (0)	38% (5)	**13**
Trapping (by any technique)	0% (0)	31% (4)	23% (3)	0% (0)	0% (0)	46% (6)	**13**
Representative sites	0% (0)	38% (5)	23% (3)	0% (0)	0% (0)	38% (5)	**13**
Probabilistic sites	0% (0)	0% (0)	45% (5)	0% (0)	0% (0)	55% (6)	**11**
Other (please specify below)	0% (0)	0% (0)	25% (2)	0% (0)	0% (0)	75% (6)	**8**
						Total Respondents	**158**

21. Other monitoring techniques for ALL reptiles in ALL habitats in Indiana.

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

Total Respondents **1**

(skipped this question) 12

22. What one or two monitoring techniques would you recommend for effective conservation of ALL reptiles in ALL habitats in Indiana?

1. 1) Occasional censusing with very large, heavily bated hoop nets left out overnight.
a) do not set during rising waters.
b) check within 12 hours.
2) Search for nests in June (after determining any adults present at all)
methods used inFL and LA for nests, in AR and LA for capturing adults

2.	1) looking for basking individuals with a spotting scope. 2) perhaps use of fyke nets with big leads, or basking traps to estimate numbers after visual spotting determines presence.
3.	1) radiotrack females to nesting sites. 2) monitor nests for depredation (Both somewhat labor-intensive for at least one person.)
4.	Population recruitment needs to be assessed at sites, which are likely to be identified for the conservation of the Blanding's turtle. Because of the long life-span of this turtle, it is unclear if seemingly robust populations are in fact, recruiting new members, or are simply on a long slide towards population senescence.
5.	I'm not sure if a salvageable population exists in the State of Indiana. It would be critical to survey know populations to determine population structure, density and potential for recruitment. This information could then be used to plan and implement a conservation effort geared towards the Ornate box turtle.
6.	I would recommend the use of radio-telemetry, mark recapture techniques, and transect surveys. Due to the cryptic nature of these snakes, locating individuals without the help of telemetry is extremely difficult. Many studies conducted locally and nationally have included telemetry in their methods. ; I would recommend the use of radio-telemetry, mark recapture techniques, and transect surveys. Due to the cryptic nature of these snakes, locating individuals without the help of telemetry is extremely difficult. Many studies conducted locally and nationally have included telemetry in their methods.
7.	I would recommend long-term surveys and radio-telemetry of box turtle. Surveys would include mark recapture methods.
8.	I do not believe that an effective nationally or regionally accepted monitoring technique exist. This should be identified as a need in the CWS.
9.	I believe monitoring black kingsnakes through professional or volunteer survey would be the best for Indiana. This could be done through the use of representative sites or on volunteer chosen routes.
10.	I would recommend the use of professional surveys and test the effectiveness of cover objects for "trapping" some reptiles.
	Total Respondents **11**
	(skipped this question) 2

23. What current HABITAT inventory and assessment efforts or activities by state agencies are you aware of for ALL reptiles in ALL habitats in Indiana?

	Yes, these efforts occur	No effort that I'm aware of	Response Total
Statewide annual inventory and assessment conducted by	10% (1)	90% (9)	**10**

state agencies			
Statewide once a year inventory and assessment conducted by state agencies	0% (0)	100% (9)	**9**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	0% (0)	100% (9)	**9**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	11% (1)	89% (8)	**9**
Regional or local year-round inventory and assessment conducted by state agencies	10% (1)	90% (9)	**10**
Regional or local once a year inventory and assessment conducted by state agencies	11% (1)	89% (8)	**9**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	20% (2)	80% (8)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	44% (4)	56% (5)	**9**
		Total Respondents	**75**

24. What current HABITAT inventory and assessment efforts or activities by other organizations are you aware of for ALL reptiles in ALL habitats in Indiana?

	Yes, these efforts occur	**No effort that I'm aware of**	**Response Total**
Statewide year-round inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Statewide once a year inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Regional or local year-round inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**
Regional or local once a year inventory and assessment conducted by other organizations	0% (0)	100% (10)	**10**

Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	10% (1)	90% (9)	**10**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	30% (3)	70% (7)	**10**
		Total Respondents	**80**

25. How crucial are these HABITAT efforts by state agencies for the conservation of ALL reptiles in ALL habitats in Indiana?

	These efforts are very crucial for this HABITAT	These efforts are somewhat crucial for this HABITAT	These efforts are slightly crucial for this HABITAT	These efforts are not crucial for this HABITAT	Unknown	Response Total
Statewide annual inventory and assessment conducted by state agencies	0% (0)	10% (1)	20% (2)	30% (3)	40% (4)	**10**
Statewide once a year inventory and assessment conducted by state agencies	0% (0)	11% (1)	11% (1)	33% (3)	44% (4)	**9**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	22% (2)	0% (0)	22% (2)	22% (2)	33% (3)	**9**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	22% (2)	33% (3)	11% (1)	11% (1)	22% (2)	**9**
Regional or local year-round inventory and assessment conducted by state agencies	0% (0)	0% (0)	33% (3)	11% (1)	56% (5)	**9**
Regional or local once a year inventory and assessment conducted by state agencies	0% (0)	0% (0)	33% (3)	11% (1)	56% (5)	**9**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by state agencies	22% (2)	11% (1)	44% (4)	0% (0)	22% (2)	**9**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies	11% (1)	22% (2)	33% (3)	0% (0)	33% (3)	**9**

Total Respondents	**73**

26. How crucial are these HABITAT efforts by other organizations for the conservation of ALL reptiles in ALL habitats in Indiana?

	These efforts are very crucial for this HABITAT	These efforts are somewhat crucial for this HABITAT	These efforts are slightly crucial for this HABITAT	These efforts are not crucial for this HABITAT	Unknown	Response Total
Statewide year-round inventory and assessment conducted by other organizations	0% (0)	0% (0)	33% (3)	22% (2)	44% (4)	**9**
Statewide once a year inventory and assessment conducted by other organizations	0% (0)	0% (0)	33% (3)	22% (2)	44% (4)	**9**
Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	11% (1)	11% (1)	22% (2)	22% (2)	33% (3)	**9**
Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	22% (2)	22% (2)	22% (2)	33% (3)	**9**
Regional or local year-round inventory and assessment conducted by other organizations	0% (0)	0% (0)	22% (2)	11% (1)	67% (6)	**9**
Regional or local once a year inventory and assessment conducted by other organizations	0% (0)	0% (0)	22% (2)	11% (1)	67% (6)	**9**
Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment conducted by other organizations	11% (1)	0% (0)	22% (2)	0% (0)	67% (6)	**9**
Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by other organizations	0% (0)	11% (1)	22% (2)	0% (0)	67% (6)	**9**
				Total Respondents		**72**

27. Regional or local state agency HABITAT inventory and assessment for ALL reptiles in ALL habitats in Indiana.

1. If any inventory is occurring, it's for water quality or fish contamination.

2. I am assuming that the govermental division responsible for water pollution control conducts some sampling regarding organic and heavy metal toxins in the water.
I'm unclear as to whether there is any survey on silting in or natural changes in river channels

3. These habitat assessments might occur in Indiana, but I am not positive how often these activities take place.

4. I am not aware of what efforts are being made to monitor these habitats

5. None known:
At this time, the habitat characterists of Kirtland's snake are not sufficiently defined as to be monitoried by general habitat measures (such as habitat classification based on remote sensing). More information on Kirtland's snake habitat requirements is needed to define a reseasonable habitat model for this species and to monitor the distribution and abudance of suitable habitat in the state.

6. I am not knowledgeable of the monitoring efforts being preformed by state or nonprofit agencies.

7. I am not sure how often state agencies survey the crowned snakes habitat. The division of nature preserves monitors these habitats.

Total Respondents	**7**
(skipped this question)	6

28. Regional or local HABITAT inventory and assessment by other organizations for ALL reptiles in ALL habitats in Indiana.

1. If any inventory is occurring, it's for water quality or fish contamination.

2. Occasional grants to universities - ???

3. IUPU-FW faculty and students work in wetlands with some reptiles in NE Indiana

4. TNC has been focused on sand savanna and sand prairie conservation in the NW for over a decade. These include some efforts to look for landscape scale opportunities for restoration and conservation of the habitat for some reptiles.

5. These habitat assessments might occur in Indiana, but I am not positive how often these activities take place.

6. None known

7. I am not knowledgeable of the monitoring efforts being preformed by state or nonprofit agencies.

Total Respondents	**7**
(skipped this question)	6

29. Please list organizations that are monitoring this HABITAT for ALL reptiles in ALL habitats in Indiana.

1. whoever samples for state water pollution control.
Fish quality? State board of health??
2. Because something is known about wetland loss in Indiana, I presume the state is keeping track of something.
3. I would assume the Nature Conservancy, IDNR, USFS, and other organizations monitor these habitats
4. I would assume the Nature Conservancy, IDNR, and other Federal Agencies monitor these habitats
5. None known.
6. I am not knowledgeable of the monitoring efforts being preformed by state or nonprofit agencies.
7. Nature Conservancy and IDNR nature preserves.

Total Respondents	**7**
(skipped this question)	6

30. What are the current HABITAT inventory and/or assessment techniques for ALL reptiles in ALL habitats in Indiana?

	Frequently used	Occasionally used	Not used but possible with existing technology and data	Not used and not possible with existing technology and data	Not economically feasible	Unknown	Response Total
GIS mapping	0% (0)	44% (4)	22% (2)	0% (0)	0% (0)	33% (3)	**9**
Aerial photography and analysis	0% (0)	33% (3)	22% (2)	0% (0)	0% (0)	44% (4)	**9**
Systematic sampling	10% (1)	0% (0)	10% (1)	10% (1)	10% (1)	60% (6)	**10**
Property tax estimates	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (9)	**9**
State revenue data	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	100% (8)	**8**
Regulatory information	0% (0)	12% (1)	0% (0)	0% (0)	0% (0)	88% (7)	**8**

Participation in landuse programs	0% (0)	12% (1)	0% (0)	0% (0)	0% (0)	88% (7)	**8**
Modeling	0% (0)	0% (0)	12% (1)	0% (0)	0% (0)	88% (7)	**8**
Voluntary landowner reporting	0% (0)	12% (1)	0% (0)	0% (0)	0% (0)	88% (7)	**8**
Other (please specify below)	11% (1)	0% (0)	0% (0)	0% (0)	0% (0)	89% (8)	**9**
						Total Respondents	**86**

31. Other HABITAT inventory and assessment techniques for ALL reptiles in ALL habitats in Indiana.

1. I am not sure what techniques are being applied to assess this habitat
2. I am not sure of the techniques to monitor this habitat
3. Insufficient data on Kirtland's snake habitat.
4. I am not knowledgeable of the monitoring efforts being preformed by state or nonprofit agencies.
5. I believe this habitat "siltstone glade in upland forest" is monitored through surveys preformed in this habitat.

Total Respondents	**5**
(skipped this question)	8

32. What one or two HABITAT inventory and assessment techniques would you recommend for effective conservation of ALL reptiles in ALL habitats in Indiana?

1. High resolution aerial photography DURING LOW WATER - digitized for GIS. locate:
1) Deep river holes with woody debris (favored by adults)
2) health/permanence of oxbow ponds
3) nesting habitat

2. 1) high resolution aerial photography during low water periods - digitize and use in GIS - re. how lasting are oxbow ponds during droughts.
2) occasional site visits to assess vegetation quality for this herbivorous turtle.

3. 1) High resolution aerial photography at normal marsh water levels - digitize for GIS.
2) Monitor wetland vegetation - blandings prefer floating emergents (e.g. duck weed) and get crowded out by cattail expansion.

4. Insufficient data on Kirtland's snake habitat.

5. I am not knowledgeable of the monitoring efforts being preformed by state or nonprofit agencies.

Total Respondents	**5**
(skipped this question)	8

33. What is the current body of science for the in Indiana?

	Response Total	Response Percent
Complete, up to date and extensive	**0**	**0%**
Adequate	**2**	**15%**
Inadequate	**10**	**77%**
Nonexistent	**0**	**0%**
Other (please explain below)	**1**	**8%**
Total Respondents		**13**

The science in adequate in some aspects of the turtles life history, but inadequate in others

34. Please provide a citation (title, author, date, publisher) that would give the best overview of ALL reptiles in ALL habitats in Indiana, if available. This resource may be used if further detail is needed.

Author = review Minton's guide;
Date = 2001;
Publisher = Get BioBlitz & IUPFW reports from DNR

Title = various theses;
Author = Bruce Kingsbury et al

Title = Status and Distribution of candidate endangered herpetofauna in the Fish Creek watershed;
Author = Bruce Kingsbury, Spencer Cortwright;
Date = 1994;
Publisher = IDNR Division of Fish and Wildlife

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

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

Title = Conservation Assessment for Kirtland's Snake (Clonophis kirtlandii);

Author = Jonanna Gibson and Bruce Kingsbury;
Date = 2004;
Publisher = USDA Forest Service, Eastern Region

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

35. If possible, please provide a second citation (title, author, date, publisher) that would give another good overview of ALL reptiles in ALL habitats in Indiana. This resource may also be used if further detail is needed.

Title = ongoing background work in NE & MN

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

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

Title = Kirtland's Snake;
Author = www.natureserve.org

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

36. What is the current HABITAT body of science for ALL reptiles in ALL habitats in Indiana?

	Response Total	Response Percent
Complete, up to date and extensive	0	0 %
Adequate	3	23 %
Inadequate	6	46 %
Nonexistent	0	0 %
Other (please explain below)	4	31 %

1. not my expertise - look for historical geography/hydrology
2. I am not sure on the habitat's body of science... I would assume complete and up to date
3. unknown
4. Unknown

Total Respondents **13**

37. Please provide a citation (title, author, date, publisher) that would give the best HABITAT overview of ALL reptiles in ALL habitats in Indiana, if available. This resource may be used if further detail is needed.

Title = ??? Sugar Creek???;
Author = ?;
Date = late 1970s/early 1980s;
Publisher = PhD thesis IU Bloomington

Title = Not my expertise. Looks for historical;
Author = accounts of river geography &;
Date = physiography + hydrology

Title = Not my expertise;
Author = contact JW Lang for NE & MN

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

38. If possible, please provide a second citation (title, author, date, publisher) that would give another good HABITAT overview of ALL reptiles in ALL habitats in Indiana. This resource may also be used if further detail is needed.

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

39. What are the research needs for ALL reptiles in ALL habitats in Indiana?

	Urgently needed	Greatly needed	Needed	Slightly needed	Not needed	Unknown	Response Total
Life cycle	8% (1)	15% (2)	62% (8)	15% (2)	0% (0)	0% (0)	**13**
Distribution and abundance	23% (3)	15% (2)	46% (6)	15% (2)	0% (0)	0% (0)	**13**
Limiting factors (food, shelter, water, breeding sites)	23% (3)	38% (5)	38% (5)	0% (0)	0% (0)	0% (0)	**13**
Threats (predators/competition, contamination)	23% (3)	15% (2)	54% (7)	8% (1)	0% (0)	0% (0)	**13**
Relationship/dependence on specific habitats	15% (2)	15% (2)	46% (6)	23% (3)	0% (0)	0% (0)	**13**
Population health (genetic and physical)	23% (3)	23% (3)	38% (5)	8% (1)	0% (0)	8% (1)	**13**
Other (please specify below)	0% (0)	12% (1)	25% (2)	0% (0)	0% (0)	62% (5)	**8**
						Total Respondents	**86**

40. Other research needs for ALL reptiles in ALL habitats in Indiana.

1. 1) cost effectiveness and periodic effective duration of local raccoon elimination
2) socioecomonic impacts of terminating commercial fishing use of commercial equipment in the lower West Fork and Middle East Fork White River.
3) Whether genetic stock from northern Arkansas will suffice for re-intoduction - or will farmed stock from AR or LA will suffice.

2. 1) Longterm fidelity to specific sites.
2) Limits to sand prairie needs for nesting.
3) Limits to recruitment when forced to nest in rowcrop areas.

3. I believe more information is needed for all topics concerning the black kingsnake in Indiana. However, this species is not currently endangered and this information is not urgently needed.

4. General life history information is needed for the Southeastern crowned snake in Indiana. Due to some reptiles secretive nature, little is known about Indiana's populations.

Total Respondents **4**

(skipped this question) 9

41. What are the HABITAT research needs for ALL reptiles in ALL habitats in Indiana?

	Urgently needed	Greatly needed	Needed	Slightly needed	Not needed	Unknown	Response Total
Successional changes	0% (0)	60% (6)	40% (4)	0% (0)	0% (0)	0% (0)	**10**
Distribution and abundance (fragmentation)	0% (0)	70% (7)	30% (3)	0% (0)	0% (0)	0% (0)	**10**
Threats (land use change/competition, contamination/global warming)	10% (1)	40% (4)	40% (4)	10% (1)	0% (0)	0% (0)	**10**
Relationship/dependence on specific site conditions	20% (2)	40% (4)	20% (2)	10% (1)	0% (0)	10% (1)	**10**
Growth and development of individual components of the habitat	0% (0)	50% (5)	30% (3)	10% (1)	0% (0)	10% (1)	**10**
Other (please specify below)	20% (1)	20% (1)	20% (1)	0% (0)	0% (0)	40% (2)	**5**
						Total Respondents	**55**

42. Other HABITAT research needs for ALL reptiles in ALL habitats in Indiana.

1. Same as on previous panel
2. Prairie restoration & fire management to perpetuate small sand blowouts
3. The relationship between upland nesting habitat, dispersal distance, barriers to dispersal etc may be critical information for the conservation of this turtle.
4. Spatial relationships between occupied wetlands relative to population dynamics

   Physical characteristics of over wintering sites
5. Understanding the successional dynamics of sand systems relative to the habitat requirements of some reptiles
6. The highest priority should be to understand why Kirtland's snake occur where we are currently finding them. With that information, we can maintain current populations before we determine the feasibility of increasing their numbers and distribution.

Total Respondents	**6**
(skipped this question)	7

43. How well do the following conservation efforts address the threats to ALL reptiles in ALL habitats in Indiana?

Appendix E-78: Reptiles

	Very well	Somewhat	Not at all	Not used	Unknown	Response Total
Habitat protection (use below for details)	23% (3)	77% (10)	0% (0)	0% (0)	0% (0)	**13**
Population management (hunting, trapping)	0% (0)	8% (1)	8% (1)	85% (11)	0% (0)	**13**
Population enhancement (captive breeding and release)	8% (1)	0% (0)	0% (0)	77% (10)	15% (2)	**13**
Reintroduction (restoration)	8% (1)	0% (0)	0% (0)	77% (10)	15% (2)	**13**
Food plots	0% (0)	0% (0)	23% (3)	69% (9)	8% (1)	**13**
Threats reduction	8% (1)	15% (2)	0% (0)	77% (10)	0% (0)	**13**
Native predator control	8% (1)	0% (0)	0% (0)	92% (12)	0% (0)	**13**
Exotic/invasive species control	15% (2)	8% (1)	8% (1)	54% (7)	15% (2)	**13**
Regulation of collecting	8% (1)	77% (10)	0% (0)	0% (0)	15% (2)	**13**
Disease/parasite management	0% (0)	8% (1)	0% (0)	38% (5)	54% (7)	**13**
Translocation to new geographic range	8% (1)	0% (0)	0% (0)	85% (11)	8% (1)	**13**
Protection of migration routes	0% (0)	8% (1)	8% (1)	54% (7)	31% (4)	**13**
Limiting contact with pollutants/contaminants	8% (1)	0% (0)	0% (0)	38% (5)	54% (7)	**13**
Public education to reduce human disturbance	8% (1)	46% (6)	0% (0)	8% (1)	38% (5)	**13**
Culling/selective removal	0% (0)	0% (0)	8% (1)	77% (10)	15% (2)	**13**
Stocking	8% (1)	0% (0)	0% (0)	77% (10)	15% (2)	**13**
Other (please specify below)	14% (1)	0% (0)	14% (1)	29% (2)	43% (3)	**7**
					Total Respondents	**215**

44. Other current conservation practices for ALL reptiles in ALL habitats in Indiana.

1. The species is listed as endangered and illegal to take/"collect."
People need to be reminded of this.

2. Invasive species control (buckthorn, autumn olive, phargimtes) to keep open herbaceous habitat suitable for massasauga

Total Respondents **2**

(skipped this question) 11

45. What one or two specific practices would you recommend for more effective conservation of ALL reptiles in ALL habitats in Indiana?

1. 1) restock, as too few if any turtles remain
2) end use of commercial fishing equipment
3) Do periodic local removal of raccoons

2. 1) Expand and liberalize the taking of raccoons so as to greatly reduce numbers asssociated with river cooter habitat. Raccoon reduction used re. sea turtles in FL and endangered Illinois mud turtle in IA, proposed for alligaror s. in LA
2) Cease any furture channelization plans and restore existing oxbow ponds - provide landowner financial incentive.
3) local restocking where raccoons reduced should hasten delisting criteria.

3. 1) Restoration in new, very large natural areas in NW Indiana.
2) Raccoon reduction near constrained (small) areas of occupied habitat in NE Indiana.

4. Design and management of conservation areas that specifically incorporate life history requirements of the Blanding's turtle across relatively large habitats (>1,000 acres). The Blanding's turtle is often subjected to management decisions that favor other species, and these often have a negative impact on available wetland and nesting habitat. In some cases, these management decisions seem likely to result in direct mortality of adults and eggs.

5. Design and management of conservation areas that specifically incorporate life history requirements of the species across relatively large habitats (>1,000 acres). Some reptiles is too often subjected to management decisions that favor other species, and these often have a negative impact on available wetland and nesting habitat. In some cases (water level manipulations , late spring prescribed fire), these management decisions seem likely to result in direct mortality of adults.

6. Increasing habitat via restoration seems like a simple approach that would add sand prairie habitat to the fringes of savanna

Understanding the potential impacts of disked fire breaks on Slender glass lizard could be important. This practice seems likely to result in direct adult and juvenile mortality

7. Restoration of grassland habitats adjacent to known population sites would be a great start. Restoration could involve creation of native grassland system from adjacent agricultural fields, wit the restoration designed to create habitat specifically for this and other species.

Restoration of oak savanna at known sites would involve opening the canopy in oak woodlands to ~50% cover and control of invasive exotic shrubs. This would restore connectivity between potentially occupied habitat patches at larger public lands, and expand potential habitat.

8. Restoration of habitat and connectivity

9. I would recommend public education and habitat protection.

10. I would recommend preserving large contionous blocks of forested habitat and prohibiting the collection of box turtles. If possible, I would attempt to lower meso predator numbers and protect nest cavaties.

11. When areas known or suspected to have Kirtlans's snakes are threatened with development, seek to have the developer include shrubs and rock features near drainages to provide cover and to reduce mowing in areas Kirtland's snakes are likely to use.

12. I would recommend habitat protection and collection regulation.

13. Habitat protection and research of general life history requirements.

Total Respondents **13**

46. How well do the following conservation efforts address the HABITAT threats to ALL reptiles in ALL habitats in Indiana?

	Very well	Somewhat	Not at all	Not used	Unknown	Response Total
Habitat protection through regulation	9% (1)	45% (5)	9% (1)	18% (2)	18% (2)	**11**
Habitat protection on public lands	27% (3)	45% (5)	9% (1)	0% (0)	18% (2)	**11**
Habitat protection incentives (financial)	18% (2)	27% (3)	0% (0)	0% (0)	55% (6)	**11**
Habitat restoration through regulation	20% (2)	30% (3)	0% (0)	10% (1)	40% (4)	**10**
Habitat restoration on public lands	50% (5)	20% (2)	20% (2)	0% (0)	10% (1)	**10**
Habitat restoration incentives (financial)	33% (3)	22% (2)	0% (0)	0% (0)	44% (4)	**9**
Artificial habitat creation (artificial reefs, nesting platforms)	0% (0)	30% (3)	0% (0)	40% (4)	30% (3)	**10**
Selective use of functionally equivalent exotic species in place of extirpated natives	0% (0)	0% (0)	30% (3)	70% (7)	0% (0)	**10**
Succession control (fire, mowing)	20% (2)	20% (2)	10% (1)	50% (5)	0% (0)	**10**
Corridor development/protection	10% (1)	20% (2)	10% (1)	40% (4)	20% (2)	**10**
Managing water regimes	0% (0)	20% (2)	40% (4)	30% (3)	10% (1)	**10**
Pollution reduction	0% (0)	30% (3)	0% (0)	20% (2)	50% (5)	**10**
Protection of adjacent buffer zone	30% (3)	30% (3)	10% (1)	20% (2)	10% (1)	**10**
Restrict public access and disturbance	20% (2)	20% (2)	0% (0)	10% (1)	50% (5)	**10**
Land use planning	10% (1)	20% (2)	10% (1)	0% (0)	60% (6)	**10**
Technical assistance	0% (0)	10% (1)	10% (1)	0% (0)	80% (8)	**10**
Cooperative land management agreements (conservation easements)	20% (2)	30% (3)	0% (0)	0% (0)	50% (5)	**10**
Other (please specify below)	0% (0)	0% (0)	0% (0)	0% (0)	100% (4)	**4**

Total Respondents **176**

47. Other current HABITAT conservation practices for ALL reptiles in ALL habitats in Indiana.

No responses were entered for this question.

Total Respondents **0**

(skipped this question) 13

48. What one or two specific HABITAT practices would you recommend for more effective conservation of ALL reptiles in ALL habitats in Indiana?

1. 1) Encourage return to natural meander channel (within flood control).
2) Let dead trees in river stay; perhaps add some.
3) rehabilitate drained oxbow ponds through conservation easment.

2. 1) oxbow pond conservation easements and restoration - prime feeding habitat.
2) enhance natural river channel evolution including point bar development and snags (downed trees in the water) - provides basking sites and nesting habitat away from row crop agriculture

3. 1) Use fire to maintain large sand prairies near appropriate wetlands
2) Acquire/purchase easments on additional blocks of land that have permanent wetlands associated with large sandy uplands.

4. Protection, restoration and appropriate management of adjacent uplands as nesting habitat around known populations

5. Increasing habitat via restoration seems like a simple approach that would add sand prairie habitat to the fringes of savanna

Understanding the potential impacts of disked fire breaks on some reptiles could be important. This practice seems likely to result in direct adult and juvenile mortality

6. restore habitat and connectivity, allow beaver activity

7. Preserve large tracts of forested habitat.

8. Reduction of development along the upper reaches of drainages.
Development of mowing protocols relative to mowing schedules to reduce snake/mower encounters.

Total Respondents **8**

(skipped this question) 5

49. Do you have any additional comments or information on ALL reptiles in ALL habitats that you feel would be useful in the development of the Indiana Comprehensive Wildlife Strategy?

Appendix E-78: Reptiles

1.	1) Convince DNR that some restocking will be necessary (only known capture in Indiana in last 50 years died on DNR watch). 2) Convince DNR that raccoon population reduction will be critical during early rehab (and important later on - increase recreational harvest). 3) Put lower West Fork and Middle East Forks White River off limits to commercial fishing. Forget about Ohio R & lower Wabash (State cannot control).
2.	As with alligator snapping turtle, persuade DNR to take measures for significant raccoon reduction in/near river cooter habitat. Assuming cooter populations then increase, raccoon control remains desirable but less important. This species is herbivorous and thus not attracted to fish bait. Use of giant nets in oxbow ponds would trap cooters, which might then drown.
3.	Contiguous blandings populations have 4000 >yearling turtles in Minnesota and 140000 >yearling turtles in Nebraska, among the largest for any turtle in the USA. Main habitat components include big shallow but permanent wetlands, and very large sand prairies for nesting - so large as to be non-economical for regular raccoon use (some foxes & others use). These places have excellent juvenile recruitment, evidently not seen in other habitat. Take it from here.
4.	Protection, restoration and appropriate management of adjacent uplands as nesting habitat around known populations Ornate box turtles are too often taken for granted on managed lands. Populations may be senescent due to loss or inappropriate management of adjacent nesting habitat. Management activities in wetlands and adjacent uplands may contribute directly to increased mortality.
5.	Some reptiles are too often taken for granted on managed lands. Management activities in wetlands and adjacent uplands (water level manipulations , late spring prescribed fire) contribute directly to increased mortality.
6.	Some reptiles are too often taken for granted on managed lands. Populations that were once among the best in the state may be senescent or extinct due to loss or inappropriate management of habitat. Loss of early successional native grasslands, due to uncontrolled succession or invasion of purposefully introduced invasive shrubs, are the likely culprits. Some reptiles need to be explicitly incorporated into management plans for public lands where it still persists.

Total Respondents	**6**
(skipped this question)	7

AGRICULTURAL HABITATS NARRATIVE

Habitat Description

Agricultural land habitats include row crops, cereal grains, vineyards, feedlots, residue management, confined livestock operations and orchards.

Problems affecting species and habitats

Species threats

Respondents ranked the top threats to wildlife in agricultural habitats in Indiana:

Rank	Threats to wildlife in agricultural habitats
1	Habitat loss (breeding range)
2	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
3	Habitat loss (feeding/foraging areas)
4 (tie)	Predators (native or domesticated)
4 (tie)	Invasive/non-native species
5	Bioaccumulation of contaminants
6 (tie)	Small native range (high endemism)
6 (tie)	Near limits of natural geographic range
7 (tie)	High sensitivity to pollution
7 (tie)	Dependence on other species (mutualism, pollinators)
8 (tie)	Unintentional take/direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
8 (tie)	Genetic pollution (hybridization)

A respondent listed additional threats to wildlife in agricultural habitats in Indiana:
Sporadic occurrence of early and mid successional fields is the greatest deterrent to higher abundance

Respondents listed top threats to wildlife in agricultural habitats in Indiana (not ranked):
Loss of ephemeral and semi-permanent wetlands
Lack and distance apart of available patches of habitat. These habitats are ephemeral

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

- Yes, if lack of early/mid successional habitat is included. Also, under Habitat description: "residue management" is not a habitat type, it is a management strategy used on row crops.
- Yes

Habitat threats

Respondents ranked the top threats to agricultural habitats in Indiana:

Rank	Threats to agricultural habitats
1	Habitat fragmentation
2	Habitat degradation
3	Commercial or residential development (sprawl)
4	Agricultural/forestry practices
5	Successional change
6 (tie)	Mining/acidification
6 (tie)	Drainage practices (stormwater runoff)
6 (tie)	Invasive/non-native species
7 (tie)	Counterproductive financial incentives or regulations
7 (tie)	Point source pollution (continuing)
8 (tie)	Nonpoint source pollution (sedimentation and nutrients)
8 (tie)	Residual contamination (persistent toxins)

Respondents did not offer additional threats to agricultural habitats in Indiana.

Respondents listed top threats to agricultural habitats in Indiana (not ranked):
Habitat loss and degradation
Farming practices and succession (Suitable land is ephemeral and spread out)
Ephemeral wetland loss and fragmentation

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

- Yes

- Agricultural practices should be ranked as No.1 threat to agricultural habitats due to incessant efforts to tile and drain more land and clear out all odd areas or adjacent wildlife habitat such as fencerows.

Additional research and survey efforts
Current body of research

Species research

Two-thirds of respondents indicated that the current body of research is adequate for wildlife in agricultural habitats in Indiana. One-third indicated that species research is inadequate.

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

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Title = Multivariate analyses of the influences of water chemistry and habitat parameters on the abundances of pond-breeding amphibians;
Author = Robert Brodman et al;
Date = 2003;
Publisher = Journal of Freshwater Ecology 18: 425-436.

Title = The Status of Amphibians in Rural Northwest Indiana;
Author = Brodman, R., and M. Kilmurry;
Date = 1998;
Publisher = Iowa University Press, Iowa City, Iowa

Title = Distribution of the western harvest mouse in Indiana;
Author = Leibacher and Whitaker;
Date = 1998;
Publisher = Ind, Acad. Sci. 107:167-170

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

- Sadly, it might be.
- No, this is inadequate list of research on wildlife use of ag land.

Habitat research

All respondents stated that the current body of science for agricultural habitats in Indiana is inadequate.

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

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

- Yes

- The above list has to be inadequate just from the standpoint of research on contaminants such as chemical herbicides, soil erosion and livestock runoff.

Research needs

Species research

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

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

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 agricultural habitats. Their responses included:

- Yes
- Need more research identifying impacts to wildlife related to creation of large, featureless fields with ditched and straightened creeks. Need research to show impacts to nesting birds, small game and reptiles/amphibians related to the timing of tillage practices and technique such as mechanical vs chemical preparation.

Habitat research

Respondents ranked research needs for agricultural habitats in Indiana:

Rank	Research needs for agricultural habitats
1 (tie)	Threats (land use change/competition, contamination/global warming)
1 (tie)	Relationship/dependence on specific site conditions
2	Successional changes

3	Distribution and abundance (fragmentation)
4	Growth and development of individual components of habitat

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

- Yes, including Distribution and dispersal factors with regard to habitat factors including streams [and] larger rivers

- Yes

A respondent specified research needed about agricultural habitats in Indiana:
Distribution and dispersal factors with regard to habitat factors including streams [and] larger rivers

Conservation actions necessary

Species actions

Of existing conservation efforts to address threats to wildlife in agricultural habitats in Indiana, two-thirds of respondents ranked “habitat protection” as the top method. One-third of respondents ranked “exotic/invasive species control” as “somewhat” effective. Respondents generally stated that other listed efforts did not address threats, were not used, or they were not aware of their use or impact.

Respondents listed no other current conservation practices for wildlife in agricultural habitats in Indiana.

Respondents recommended the following for more effective conservation of wildlife in agricultural habitats in Indiana (not ranked):
Protection of fishless, breeding habitat and wetland restoration
Manage succession so that proper habitat was more abundant and closer together
Protection of ephemeral wetlands and control of purple loosestrife

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

- Yes, including Protection of fishless, breeding habitat and wetland restoration
  · Manage succession so that proper habitat was more abundant and closer together
  · Protection of ephemeral wetlands

- No, increase of filter strips and maintenance of non-tilled riparian habitat strips for fixed widths along every stream drainage should become mandatory. Ditching and straightening of streams should be prohibited and channel sinuosity restored through farm subsidy requirements.

Habitat actions

Respondents ranked conservation efforts that address threats to agricultural habitats best:

Rank	Conservation efforts for agricultural habitats
1 (tie)	Habitat protection through regulation
1 (tie)	Habitat protection on public lands
1 (tie)	Habitat restoration on public lands
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
2 (tie)	Cooperative land management agreements (conservation easements)
2 (tie)	Habitat restoration through regulation

Respondents listed no other current conservation practices for agricultural habitats in Indiana.

Respondents recommended these practices for more effective conservation of agricultural habitats in Indiana (not ranked):
Habitat protection and restoration
Ephemeral wetland protection and restoration

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

- No, I don't agree with the ranking or that protection/restoration on public land will solve agricultural habitat problems.
- Education ("making the case") is an overarching component of habitat protection, particularly when it involves regulation or public purchase.
- Habitat restoration through financial incentives is the only way any ag habitat is going to be restored.

Partner agencies/organizations

The following organizations indicated that they work in Agricultural habitats.

Organization	Percent of time spent in Agricultural

Appendix F-1: Agriculture

	habitats
ACRES, Inc.	15
American Consulting, Inc.	5
American Society of Landscape Architects, Indiana Chapter	
Arrow Head Country Resource Conservation & Development Area, Inc.	10
Big Oaks National Wildlife Refuge, USFWS	5
Cinergy Corp.	5
Clark's Valley Land Trust	50
Division of Fish and Wildlife	28
Federal Highway Administration (FHWA)	?
fish lake conservancy district	5
Fur Takers of America	
fur takers of america chapter 7-E north west in.	?
Great Lakes Commission	NA
Hoosier Environmental Council	10
Hoosier Heartland Resource Conservation and Education council	10
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)	15
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	~5
Indiana Beaglers Alliance	10
Indiana Beef Cattle Association	
Indiana Chamber of Commerce	15
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	1
Indiana Division of the Izaak Walton League of America	1
Indiana Environmental Institute	10
Indiana Land Resources Council	
Indiana Pork Producers Association	100
Indiana Quail Unlimited	45
Indiana Soybean Board (ISB) & Indiana Soybean Growers Association (ISGA)	100
Indiana state trappers assoc	40
Kankakee River Basin Commission	
Lake Maxinkuckee Environmental Council (LMEC)	5
Lincoln Hills RC&D	30
Lost River Conservation Association	7
Mason & Hanger Corp. Newport Chemical Depot	50
Merry Lea Environmental Learning Center of Goshen College	1
National Wild Turkey Federation	30
Pheasants Forever Inc.	40
Robert Cooper Audubon Society	5
Sierra Club Hoosier Chapter	15
St. Joseph County Soil & Water Conservation District (SWCD)	70
St. Joseph River Watershed Initiative	35

Sycamore Land Trust	10
The Nature Conservancy	10
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	10
USDA Natural Resources Conservation Service	
Veolia Water Indianapolis, LLC	10
Wabash River Heritage Corridor Commission	10

Proposed plans for monitoring

Current monitoring

Species monitoring

One-third of respondents were aware of the following monitoring effort by state agencies for wildlife in agricultural habitats in Indiana:
Statewide once-a-year monitoring

Respondents indicated awareness of monitoring efforts conducted by other organizations for wildlife in agricultural habitats in Indiana (not ranked):

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

One-third of respondents ranked "statewide once-a-year monitoring" by state agencies as "very crucial" to wildlife conservation in agricultural habitats in Indiana.

Respondents ranked the importance of monitoring efforts by other organizations for wildlife conservation in agricultural habitat in Indiana:

Rank	Monitoring by other organizations for wildlife in agricultural habitats
1	Regional or local once-a-year monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled)
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled)

A respondent listed Indiana DNR's NAAMP frog call program as a method of regional or local monitoring by state agencies for wildlife in agricultural habitats in Indiana.

Appendix F-1: Agriculture

Respondents listed the following regional or local monitoring by other organizations for wildlife in agricultural habitats in Indiana (not ranked):
Robert Brodman, St. Joseph's College
Monitored twice, 1975 by Ford, and 1998 by Leibacher and Whitaker
Chicago Wilderness

Respondents cited the following organizations that monitor wildlife in agricultural habitats in Indiana (not ranked):
Indiana State University
Robert Brodman, St. Joseph's College

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

Respondents considered current monitoring techniques for wildlife in agricultural habitats in Indiana as follows:

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

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

- Don't know

Appendix F-1: Agriculture

- Monitoring with infrared cameras for nighttime surveillance of wildlife using cropfields and stream pathways and thermographic imagers for locating nesting birds in pasture,haylands and grasslands.

Respondents cited no other monitoring techniques for wildlife in agricultural habitats in Indiana.

Habitat inventory and assessment

Respondents were aware of these inventory and assessment efforts of agricultural habitats in Indiana by state agencies (not ranked):

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

Respondents were aware of the following inventory and assessment of agricultural habitats in Indiana by other organizations (not ranked):

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

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

Rank	Inventory and assessment efforts by state agencies for agricultural habitats
1	Statewide annual inventory and assessment
2 (tie)	Statewide once-a-year inventory and assessment
2 (tie)	Regional or local year-round inventory and assessment
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
3 (tie)	Periodic statewide (less than once a year and still regularly scheduled) inventory and assessment
3 (tie)	Occasional statewide (less than once a year and still regularly scheduled) inventory and assessment
3 (tie)	Regional or local once-a-year inventory and assessment

3 (tie)	Periodic regional or local (less than once a year and still regularly scheduled) inventory and assessment

Respondents ranked the importance of these inventory and assessment efforts by other organizations for conservation of agricultural habitats in Indiana:

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

A respondent listed the following regional or local inventory and assessment of agricultural habitats in Indiana by state agencies:
Frog call surveys include rural and agricultural areas throughout the state

A respondent listed the following organizations that conduct regional or local inventory and assessment of agricultural habitats in Indiana (not ranked):
Robert Brodman, northwest Indiana, St. Joseph's College
Chicago Wilderness and St. Joseph's College have frog call monitoring programs in northwest Indiana.

A respondent listed the following organizations that monitor agricultural habitats in Indiana (not ranked):
ISU; 1975 and 1995 by Ford
1998 by Leibacher and Whitaker

Appendix F-1: Agriculture

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

Respondents ranked current inventory and assessment techniques for agricultural habitats in Indiana as follows:

Inventory and assessment techniques for agricultural habitats	Used	Not used but possible with existing technology or data	Not economically feasible
GIS mapping		X	
Aerial photography and analysis	X	X	
Systematic sampling	X		
Modeling		X	

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

- Don't know
- Yes

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in agricultural habitats in Indiana (not ranked):
Aquatic surveys for eggs and larva; trapping during breeding migration
Trap periphery of known range in Indiana
Frog call and tadpole surveys

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

- No, it needs to include many more agricultural habitat species, especially birds, bats, and native pollinators.
- No, need to make more use of infrared cameras and thermographic imagers to verify presence and use of ag lands by wildlife.

Habitat inventory and assessment

Appendix F-1: Agriculture

Respondents recommended the following inventory and assessment techniques for effective conservation of agricultural habitats in Indiana (not ranked):
Systematic sampling and GIS
Same as currently used
Frog call surveys that include rural and agricultural areas throughout the state

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

- Unsure
- May want to consider monitoring particular types of threats such as development. Some of this will be useful across habitats and for non-habitat analysis.
- Aerial photography to monitor changes in habitat acres should be included as a standard inventory and assessment technique.

Technical experts and conservation organizations offered the following additional comments:

- USDA Natural Resources Conservation Service percent of time spent in Agricultural habitats = 85%
- You could add the Indiana Land Use Consortium as an organization that works on this habitat. It is a component of the work and discussions we have about agriculture and land use more generally. It would be appropriate to say we work on it 5%.
- 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 also restores wetland and forested habitat on private agricultural lands through the Fish and Wildlife Services Private Lands Program.

ALL AQUATIC SYSTEMS HABITATS NARRATIVE

Habitat description

This habitat is comprised of all water, both flowing and stationary, habitats in Indiana.

Problems affecting species and habitats

Species threats

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

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

Appendix F-2: Aggregated Aquatic Systems

Respondents offered additional threats to wildlife in all aquatic systems habitats in Indiana (not ranked):

- River otters: As adjacent states initiate harvest seasons for otters, there might be added pressure to take otters accidentally trapped in Indiana across state lines to market fur. However, I wouldn't expect this to have a significant impact at a statewide or even regional scale
- Disturbance by recreational boating.
- Commercial over-exploitation resulting in low spawner stock abundance
- Egg predators predation, nutritional requirements, early mortality syndrome
- Stream channelization
- Threats to the orangethroat darter are related to threats to the habitat
    - It prefers high-functioning, high quality riffle habitat in headwater streams. Headwater streams, are not always given as much protection or value as larger rivers downstream
    - Threats to the species colonization, such as aquatic passage problems through culverts
    - Threats to the species watersheds, such as pollution, clearing of the riparian vegetation, creek gravel mining and channelization
- High stream flows for a few months following spawning can seriously reduce year class strength. Reducing ditching in headwaters, installing grass waterways and WASCOBS and maintaining riparian corridors and cut down this threat. All of these measures will slow stream flows and reduce siltation

Respondents listed top threats to wildlife in all aquatic systems habitats in Indiana (not ranked):

- Habitat loss, degradation and fragmentation
    - Of wetlands
    - Los due to urban sprawl and other development
    - Degradation of migration routes due to development
    - Loss of feeding areas: Many reservoirs are getting very old and the once abundant standing timber is now diminishing which is reducing cover for white crappie
    - Loss or degradation of brood-rearing and foraging areas
    - Annual and seasonal variations in habitat availability
    - Losses impact northern pike survival
    - Loss of undisturbed natural lake habitat
    - Loss of large nesting trees
    - Caused by instream modifications
    - Pike have suffered a major loss of spawning habitat due to the prevalence of dredging within the watershed. This practice along with levee construction has resulted in the near elimination of in-stream and emergent wetland vegetation
    - Some wildlife species requires shallow clear water with little current in weedy areas over gravel, sand, and silt to feed on insects and lay reproduce
    - Caused by dredging (removal of aquatic vegetation and increasing depth of ditch)
    - Cleaning and dredging streams of the Kankakee drainage can result in a large amount of creek heelsplitters being lost
    - Orangethroat darter
        - Threats to migration (aquatic passage problems through stream crossing structures)
        - Threats to breeding habitat (high quality riffles). Threats to riffle habitat result from water quality degradation and loss of stream channel stability due to land management activities such as dredging, channelization, roads and clearing riparian vegetation

  - Habitat loss and degradation are serious threats to rock bass. They prefer silt free streams to reproduce and thrive. They also relate closely to structure/cover therefore any habitat loss is a threat
  - Eastern Sand darter requires sandy bottoms in fast flowing streams to bury eggs, hide from predators, ambush prey, conserve energy, and maintain position in unstable/shifting sandbars
  - Slough darter prefers a mud or silt bottom with little current velocity and vegetation to deposit eggs on

- Pollution/degradation/water quality issues
  - River otters: Reproductive performance of otters can be compromised by high levels of PCBs, heavy metals, etc. that bioaccumulate in the aquatic food chain. Direct loss of aquatic habitats such as wetlands
  - Long-term declines in water quality associated with lake eutrophication
  - Cold, clear water is critical for cisco survival; increased runoff and nutrient loading have degraded the habitat for this species in many of the 50+ lakes it once occurred in. Few lakes still have the species, and there is apparently little to no reproduction
  - Sedimentation caused by heavy spring rains
  - Nonpoint sources runoff resulting from loss of riparian buffers due to development
  - The acute effects of toxicants are recognized as a threat to organisms, but there is little knowledge on ecosystems or regional effects on chronic insults. Toxicants are more destructive to the embrolarva stages, but these are poorly documented. Pollution controls do not have definite focus on chronic effects
  - Runoff due to agricultural practices
  - Hornyhead chub are sight-feeders and mound builders for spawning; thus, muddy water will hamper their chances of survival and if the silt covers gravel and their nest, chances for successful reproduction will be limited
  - Alterations of hydrology from land-use changes
  - Pollution within the Tippecanoe River system in Indiana
  - Point source pollution, which triggers fish kills or repels rock bass from the area

- Dependence on irregular sources
  - In many reservoirs, shad is the dominant forage base for crappie. If shad are growing extremely fast, crappie can only utilize shad for a short period of time before the shad outgrow the size crappie can consume

- Habitat management issues
  - Water level control regimes at impoundments
  - Mink: Although not habitat specific, the inability to responsibly and proactively manage mink according to the wildlife conservation model, as opposed to reactive measures through nuisance practices, is a concern regarding the conservation of mink. This concern applies across the landscape, not just in urban and suburban environments
  - Fish passage problems: dams on rivers block migration

- Competition with invasive or predator species
  - Gizzard shad
  - The deliberate stocking of predator fish in cisco lakes has been a threat to this species for years; if this hasn't been stopped, it needs to
  - Round goby
  - Hornyhead chub: Competition from other species better adapted to muddy and silty stream conditions
  - Extreme depredation by overabundant raccoons (on eggs), maybe by coyotes, too

  - Potential loss of adults to road kill and to rogue raccoons (kill adults for their eggs)
  - Slough darter compete with other darters for insects and have a high mortality due to stagnation and freezing in the pools they desire to live in.

- Human disturbance and impacts
  - Over harvest and illegal harvest (This doesn't seem to be a major threat as of now)
  - Heelsplitters: Unintentional take is a threat, as well as habitat alteration by dredging
  - Commercial type fishing devices: Trot lines, branch lines, big nets, other passive fishing

- Overpopulation

- Reproductive issues/small population size
  - Year class failure related to low spawner stock abundance; competition with nonnative species for limited available food resources
  - Lack of successful spawning, possibly related to bioenergetics. Too much egg predation
  - Any factor which reduces the reproductive population size
  - Eastern sand darters: Have low reproductive rates/small populations; they reach maturity at age one, but only lives a few years
  - Possible lack of reproductive success as indicated by poor length frequency distribution
  - Low reproductive rates: Males reach sexual maturity at two while females can reproduce at one; they only have a life span of about three years
  - Hellbenders have a small geographic range and population sizes in Indiana. In many locations there is concern about low reproductive rates, but this is unknown in Indiana populations
  - Extant population (if any) far below level for unassisted recovery
  - Very low recruitment
  - Nest/embryo/hatchling loss associated with attraction to row crop land for nesting
  - Insuring that populations maintain critical larva-host connections
  - Slough darters spawn few eggs so reproduction is lower in places where vegetation is lacking

- Dependence on other species
  - Heelsplitters require fish host to reproduce; if fish populations decrease for any of a variety of reasons, then creek heelsplitter reproduction could decrease substantially

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

Habitat threats

Respondents ranked threats to all aquatic systems habitats in Indiana:

Rank	Threats to all aquatic systems habitats
1	Stream channelization
2	Habitat degradation

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

Respondents noted additional threats to all aquatic systems habitats in Indiana (not ranked):

- Competition with round goby for near-shore habitat
- Riparian corridor destruction. Loss of shading and sedimentation
- Sand and gravel operations could destroy preferred habitat

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

- Habitat loss, degradation and fragmentation
    - Affects beavers: Habitat loss caused by urban sprawl
    - Loss of wetland habitats reduces amount of suitable habitat for river otters
    - Modification of stream shoreline habitats
    - Affects crappie: Natural decomposition of flooded timber and woody debris is lessening the available cover for crappie. Siltation covers root wads left in the bottom of an impoundment, which eliminates useable crappie cover
    - Residential development around lake shorelines. Degradation of aquatic plants and wetlands around lake shorelines
    - Due to development: agricultural, urbanization and residential development
    - Successional change
    - Emergent bulrush and wetland habitat loss. It has been well documented in northern states that northern pike prefer flooded vegetation for spawning during the spring. Loss of this habitat from boating and wildlife (waterfowl and muskrat feeding) may reduce reproductive habitat for northern pike in some natural lakes
    - Bulkhead seawall development reduces emergent vegetation used by northern pike for reproduction and for cover during feeding
    - Shoreline and labeled alterations
    - Dams fragmenting habitat
    - Stream channelization removing nesting sites and destroying brood habitat. It removes and/or changes the vegetative and invertebrate communities.

    - Channelization also alters the natural water flow that results in a much degraded habitat
    - Loss of bottomland hardwoods continues to be a threat. These area provide a high quality food source and nesting sites for wood ducks
    - Loss of riparian corridor
    - Channelization of many streams in the upper Kankakee watershed
    - Affects eastern sand darter
    - Impoundments
    - Drain/cut off oxbow ponds
    - Trample sandbars or remove other nesting areas along banks
    - Row crop practices: crushing nests during ground insect/weed control
    - Crushing overwinter hatchlings during harvest and early spring plowing
    - Habitat degradation may be a factor, since there are large expanses in the Wabash and East Fork White River where relic valves are common, but the living species is absent
    - Habitat degradation and stream channelization as development continues in the Ohio River drainage habitat

- Regulations
    - Beaver: Regulations that allow loss of habitat. The human/beaver interface usually results with either the habitat being eliminated or the beaver being eradicated
    - Regulation of impounded water: Extreme water fluctuations in mainly U.S. Army Corps of Engineers reservoirs can negatively effect crappie populations especially if water fluctuations occur during spawning

- Water pollution/water quality
    - River otters: Water quality not only impacts otter reproduction, but may also impact the quantity/quality of aquatic prey for otters
    - Water quality degradation that leads to cloudy water
    - Soil runoff caused by poor agricultural practices and urban development
    - Nonpoint source

- Factors that affect food availability

- Competition with invasives and predators
    - Competition with non-native species for habitat. Need a quality place to live that is not in competition with round goby

- Identification of habitat along Indiana's near-shore area

- Invasive species/predators/competition
    - Specifically round goby interactions

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

Additional research and survey efforts

Current body of research

<u>Species research</u>

Appendix F-2: Aggregated Aquatic Systems

Thirty-eight percent of respondents stated that the current body of science is complete, up to date and extensive/adequate for wildlife in all aquatic systems habitats in Indiana; fifty-eight percent of respondents state that the current body of science is inadequate/nonexistent.

The respondent identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in ALL Aquatic system habitats in Indiana.

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

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Title = Ten- to eleven-year population trends of two pond-breeding amphibian species, red-spotted newts and green frogs. In Status & Conservation of Midwester;
Author = Spencer Cortwright;
Date = 1998;
Publisher = University of Iowa Press, Iowa City

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

Title = Indiana River Otter Reintroduction Program, 2000-2001;
Author = Scott A. Johnson;
Date = November 2001;
Publisher = Internal report, Indiana Department of Natural Resources, Bloomington, IN

Title = Restoring river otters in Indiana;
Author = Scott A. Johnson and Kim A. Berkley;
Date = 1999;
Publisher = Wildlife Society Bulletin 27:419-427.

Title = Many in AFS journal of fish management and transactions of AFS

Title = Impoundments Strategic Plan;
Author = IDNR - Fish and Wildlife;
Date = 1997;
Publisher = IDNR - Fish and Wildlife

Title = Ducks, Geese & Swans of North America;
Author = Frank C. Bellrose;
Date = 1976;
Publisher = Stackpole Books

Title = Waterfowl & Wetlands an Integrated review;
Author = Theodore A. Bookout;
Date = 1979;
Publisher = LaCrosse Printing

Appendix F-2: Aggregated Aquatic Systems

Title = Preliminary Results of 2004 Ball State University Yellow Perch Research in Indiana Waters of Lake Michigan;
Author = Paul Allen and Thomas Lauer;
Date = October 2004;
Publisher = Ball State University

Title = Yellow Perch Research and Management in Lake Michigan, Evaluating Progress in a Cooperative Effort, 1997-2001;
Author = David Clapp and John Dettmers;
Date = November 2004;
Publisher = American Fisheries Society, Fisheries

Title = Lake Trout Restoration Plan;
Date = In progress

Title = Lake Trout Impediments Document;
Author = Numerous,;
Date = 2003;
Publisher = Lake Trout Task group/LMTC

Title = Cisco population status and management in Indiana;
Author = Jed Pearson;
Date = 2001;
Publisher = Division of Fish and Wildlife

Title = Northern Pike Spawning Habitat Investigations At Two Natural Lake In Indiana;
Author = Cwalinski, Tim A.;
Date = September 2001;
Publisher = Indiana Department of Natural Resources

Title = DFW largemouth bass database;
Author = Jed Pearson;
Date = unpublished;
Publisher = unpublished

Title = Largemouth bass size limits at Indiana natural lakes - a 30-year history;
Author = Jed Pearson;
Date = 2003;
Publisher = unpublished

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1991;
Publisher = USFWS

Title = Life history and propagation...;
Author = Jones & Neves;
Date = 2002;
Publisher = JNABS

Title = Freshwater mussels of Tennessee;
Author = Parmalee & Bogan;
Date = 1998;
Publisher = U of Tennessee Press

Title = Freshwater mussels of the Midwest;

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Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Wabash River Catfish Reports;
Author = Rob Columbo;
Date = 2002,2003,2004,2005;
Publisher = SIU/INDFW

Title = numerous INDFW FMR's;
Author = numerous;
Date = numerous;
Publisher = INDFW

Title = annual Ohio River sauger reports;
Author = ORFMT;
Date = annually since 1999;
Publisher = ORFMT

Title = various INDFW FMR's;
Author = various;
Date = various;
Publisher = INDFW

Title = Occurrence and distribution of freshwater mussels in the small streams of Tippecanoe County, Indiana;
Author = Myers-Kinzie, M., S. Wente, & A. Spacie;
Date = 2001;
Publisher = Proc. Ind. Acad. Sci.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1919;
Publisher = WI Geol. Nat. Hist. Surv.

Title = Fisheries Survey of the East Branch of the Little Calumet River Watershed;
Author = Neil Ledet;
Date = 1978;
Publisher = IDNR Fisheries Section

Title = Stream Survey of the East Arm of the Little Calumet River;
Author = Edward Braun;
Date = 1974;
Publisher = IDNR Division of Fish and Wildlife

Title = Fishery, Habitat, and Recreational Use Surveys for the Kankakee River;
Author = Price and Robertson;
Date = 2005;
Publisher = DNR - Division of Fish and Wildlife (in review)

Title = A fishery survey of the Kankakee River in Indiana;
Author = Robertson and Ledet;

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Date = 1981;
Publisher = DNR - Division of Fish and Wildlife

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Title = Ecology and Management of the Wood Duck;
Author = Bellrose and Holm;
Date = 1994;
Publisher = Stackpole Books

Title = Ducks, Geese and Swans of North america;
Author = Bellrose;
Date = 1976;
Publisher = Stackpole Books

I'm am not aware of any literature on mink focused strictly to rivers and streams.

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Field guide to freshwater mussels of Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = 'Clubshell';
Author = USFW, Division of Endangered Species;
Publisher = Online

Title = A survey of fish communities and aquatic habitats at Indiana's major steams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart T. Shipman;
Date = 12/1997;
Publisher = DNR fisheries section

Appendix F-2: Aggregated Aquatic Systems

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance.;
Author = Stuart T. Shipman;
Date = December 1997;
Publisher = IDNR

Title = Surveys of the fish communties and aquatic habitats in 16 small streams in Indiana from 1996 through 1997.;
Author = Douglas C. Keller;
Date = 1999;
Publisher = IDNR

Title = The Fishes of Missouri;
Author = William L. Plieger;
Date = 1997;
Publisher = Missouri Conservation Commission

Title = Handbook of freshwater fishery biology;
Author = Kenneth D. Carlander;
Date = 1997;
Publisher = Iowa University Press

Title = fishes of Tennessee;
Author = Etnire and Starnes

Title = Fishes of Ohio;
Author = Milt Troutman;
Publisher = OSU Press

Title = FW fishes of Canada;
Author = Scott & Crossman

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart Shipman;
Date = 12/1997;
Publisher = DNR/Fisheries section

Title = Surveys of the fish communties and aquatic habitats in 16 small streams in Indiana from 1996 through 1997.;
Author = Douglas C. Keller;
Date = 1999;
Publisher = IDNR

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Author = Minton;
Date = 2001

Author = reviewed in Minton;
Date = 2001
Title = (Numerous internet sites, including USF&W)

Title = Freshwater Mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = Illinois Natural History Survey

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart Shipman;
Date = 12/1997;
Publisher = DNR/Fisheries section

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

Habitat research

Twenty percent of respondents stated that the current body of science is adequate for all aquatic systems habitats in Indiana; seventy-two percent of respondents state that the current body of science is inadequate/nonexistent.

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

Title = Mammals of Indiana;
Author = Russell E. Mumford;
Date = 1982;
Publisher = Bloomington Indiana University Press

Title = Soil Survey's of Indiana Counties;
Author = U.S. Dept. of Agriculture, SCS;
Date = 1990;
Publisher = U.S. Dept. of Agriculture

Title = Management of Seasonally Flooded Impoundments;
Author = Leigh H. Fredrickson, T. Scott Taylor;
Date = 1982;
Publisher = U.S. Fish and Wildlife Service

Title = Cisco population status and management in Indiana;
Author = Jed Pearson;
Date = 2001;
Publisher = Division of Fish and Wildlife

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1991;

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Publisher = USFWS

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Hist. Surv.

Title = Ohio River Mainstem Study;
Author = USACOE;
Date = 2000?;
Publisher = USACOE

Title = Ohio River Mainstem Study;
Author = USACOE;
Date = 2000?;
Publisher = USACOE

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Molluscs of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Sci. Surv.

Title = Fisheries Survey of the East Branch of the Little Calumet River Watershed;
Author = Neil Ledet;
Date = 1978;
Publisher = IDNR-Fish and Wildlife

Title = Stream Survey-Little Calument River East Arm;
Author = Edward Braun;
Date = 1974;
Publisher = IDNR-Fish and Wildlife

Title = Fishery, Habitat, and Recreational Use Surveys for the Kankakee River;
Author = Price and Robertson;
Date = 2005;
Publisher = DNR - Div. of F & W

Title = A Fishery survey of the Kankakee River in Indiana;
Author = Robertson and Ledet;
Date = 1981;
Publisher = DNR - Div. of F & W

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Appendix F-2: Aggregated Aquatic Systems

Title = Wetlands;
Author = Mitsch & Gosselink;
Date = 1993;
Publisher = Van Nostrand Rheinhold

Title = Southern Forested Wetlands;
Author = Messina & Conner;
Date = 1998;
Publisher = CRC Press LLC

I'm am not aware of any literature on mink focused strictly to rivers and streams.

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1929;
Publisher = WI Geol. Nat. Sci. Surv.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = A survey of fish communities and aquatic habitatts at Indiana's major streams with emphasis on smallmouth bass distribution and abundance.;
Author = Stuart T. Shipman;
Date = December 1997;
Publisher = IDNR

Title = Surveys of the fish communities and aquatic habitats in 16 small streams in Indiana from 1996 through 1997.;
Author = Douglas C. Keller;
Date = 1999;
Publisher = IDNR

Title = A survey of fish communities and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance;
Author = Stuart Shipman;
Date = 12/1997;
Publisher = DNR/Fisheries section

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;

Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Hist. Survey

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

Research needs

Species research

Respondents ranked research needs for wildlife in all aquatic systems habitats in Indiana:

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

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

- Relationship(s) between population levels and population indices
- How to produce more, larger crappie
- Harvest
- Survival/nest success
- Limiting factors and impacts of competition and predation
- Very little is known about the basic natural history, population ecology and abundance in Indiana of the lesser siren
- Research needs are not limited to river and stream habitats
- Habitat needs are not completely understood. I have seen fresh dead cylindrical papershell in channelized agricultural ditches. Other small streams with good habitat have only weathered dead fragments
- To find out why the clubshell has depopulated most of its former distribution in Indiana. Developing some sort of timeline (late Pleistocene, Holocene (usually archaeological), or historic) for relic valve distribution might narrow the possibilities of critical limiting factors (post-settlement siltation, etc.)
- Determine population-limiting factors in the Ohio River
- Cost effectiveness and periodic effective duration of local raccoon elimination
- Socio-economic impacts of terminating commercial fishing use of commercial equipment in the lower West Fork and Middle East Fork White River
  Whether genetic stock from northern Arkansas will suffice for re-introduction, or will farmed stock from Arkansas or Louisiana will suffice

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

Habitat research

Respondents ranked research needs for all aquatic systems habitats in Indiana:

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

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

- Water quality variations and impacts of land us and shoreline alterations
- Factors that limit the distribution of sirens in Indiana
- Affects of channelization on streambank communities and the affects on adjacent oxbows, bottomland hardwoods and other riparian areas
- Effects of roads and stream crossings. Is aquatic passage through culverts and other stream crossing structures adequate or are these crossings causing aquatic habitat fragmentation?
- Water quality requirements

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

Conservation actions necessary

Species actions

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

Rank	Conservation efforts for wildlife in all aquatic systems habitats
1	Reintroduction (restoration)
2	Population management (hunting, trapping)
3	Translocation to new geographic range

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

Respondents noted other conservation practices for all wildlife in all aquatic systems habitats in Indiana (not ranked):

- Regulation of sport harvest. Closure of commercial fishery to allow spawning stock biomass to increase, thus allowing for the production of offspring that can eventually add to the spawning stock biomass
- Habitat protection if it greatly reduced the turbidity in streams for hornyhead chub feeding and breeding behaviors. Also, exotic/invasive species control would help the hornyhead population. The hornyhead chub is sensitive to pollution so limiting contact with pollutants/contaminants would benefit the species. The hornyhead chub is also a popular bait fish, so regulation of collecting would be beneficial to the species
- Habitat protection occurs in the form of the Clean Water Act, National Forest Management Act and other state and federal regulations that protect aquatic habitat and aquatic species. These regulations may or may not be enough for the sake of orangethroat darter conservation
- Wildlife species that are listed as endangered and illegal to take/"collect." People need to be reminded of this

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

- Habitat management, protection and conservation
    - Protection of aquatic and riverine habitats is essential
    - Prevention of stream channelization and other (pollution) habitat factors
    - Limit disturbance in nesting/migration habitat
    - Habitat enhancement by adding more woody cover to the old impoundments where the former woody cover has decomposed
    - Needed for mallard management
    - Protect migration routes
    - Create buffer zones
    - Create hen houses

    - Create nest boxes
    - Protection of migration routes
    - Restore free-flowing systems
    - Restore aquatic passage
        - Restoring connection between the streams and the wetlands that were formerly associated with them to allow pike access to spawning areas. Current water management regimes often rely on pumping to fill restored wetlands, thus, fish passage is still restricted
        - Maintain roads and stream crossings so that stream channel function and aquatic passage are maintained
        - Remove dams when possible
    - Enhance and protect riffle habitats
    - Restore riparian vegetation
    - Protect sand and gravel habitats
    - Eastern sand darter: Reduce sedimentation covering the sand substrate that the darter needs to survive and reproduce. Current efforts to reduce sedimentation in streams is somewhat effective, but I'm not sure if it is enough to keep the eastern sand darter from disappearing

- Regulations and policy
    - Regulated trapping and nuisance animal control policies
    - Completely eliminate commercial fishing. This appears to have reduced the spawning stock to a level that could not maintain a fishery
    - Mallards: Make use of surplus numbers and regulate take (Reference: "The Mallard" by John Madson, Olin Mathieson Chemical Corporation)
    - Cisco
        - Assure there is no stocking of predator fish in cisco lakes
        - Greatly limit/mitigate any new development on cisco lakes, particularly addressing runoff from lawns and other water quality issues
        - Work to get any farmlands adjacent to cisco lakes into no-till
    - Implementation of ecozones in undeveloped areas to conserve that vegetation present
    - Implement a catch and release only regulation in lakes with low densities
    - Harvest management
    - Land use planning and regulation
    - Agricultural runoff protection through land use planning
    - Erosion controls
    - Make possession of exotic species illegal (must dispose of fish properly and not release back to stream)
    - Limit the amount of dredging that occurs in the Kankakee watershed
    - Incentives to farmers
    - Strict enforcement of laws regulating instream modification
    - Regulation of collecting
    - CREP, other incentives for BMPs
    - Limit instream modifications
    - More programs or efforts to restore lost or degraded systems would be beneficial
    - Declare moratorium on channel/drainage improvement projects that do not mitigate losses
    - End use of commercial fishing equipment
    - Provide landowner financial incentives to cease any future channelization plans and restore existing oxbow ponds

- Research and surveys
    - We need to better understand factors that limit siren abundance and distribution

    - Intensive quantitative sampling of known populations. Need to understand demography of the Clubshell. (See Strayer & Smith, 2003. AFS Monogram. 8)
    - Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of the Clubshell. See same for protocols

- Outreach and public education
    - Mink: Outreach programs are needed to effectively and accurately educate citizens about wildlife (game and non-game), the wildlife conservation model (for game and non-game), and the need for effective mink management programs
    - Agricultural runoff protection through education
    - Educate anglers that it is illegal to use mussels as fishing bait
    - Educational programs aimed to reduce incidental take would also benefit otters especially where population densities are lower

- Invasive species/predators/competition
    - Do periodic local removal of raccoons
    - Expand and liberalize the taking of raccoons so to greatly reduce numbers associated with river cooter habitat
    - Raccoon reduction used regarding sea turtles in Florida and endangered Illinois mud turtle in Iowa, proposed for alligators in Louisiana
    - Zebra mussels

- Propagation and stocking
    - Restock, as too few if any turtles remain
    - Local restocking where raccoons reduced should hasten delisting criteria

- Pollution control
    - From waste water treatment plants and confined feeding operations
    - Protection of the habitat against pollutants and toxins

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

Habitat actions

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

Rank	Conservation efforts for all aquatic systems habitats
1	Habitat restoration incentives (financial)
2	Protection of adjacent buffer zone
3	Habitat restoration on public lands
4	Cooperative land management agreements (conservation easements)
5	Habitat protection on public lands
6	Habitat protection incentives (financial)
7 (tie)	Managing water regimes
7 (tie)	Pollution reduction

7 (tie)	Restrict public access and disturbance
8	Corridor development/protection
9 (tie)	Land use planning
9 (tie)	Habitat restoration through regulation
10	Succession control (fire, mowing)
11	Artificial habitat creation (artificial reefs, nesting platforms)
12	Habitat protection through regulation
13	Technical assistance
14	Selective use of functionally equivalent exotic species in place of extirpated natives

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

- Limiting disturbance through the construction (DOW) permit process
- Hornyhead chub
  - Habitat protection and restoration on all lands by any means necessary would benefit all species (except those that are exotic and more tolerant than others) not just the hornyhead chub
  - Pollution reduction, protection of adjacent buffer zone, land use planning, and conservation easements would all be beneficial practices to the hornyhead chub
- Eastern sand darter
  - Habitat protection
  - Restoring floodplain would affect amount of sedimentation reaching the stream bed; managing water regimes may impact settling of sediments in streams (thus dam removal may be appropriate)
  - Protect adjacent buffer zone is key to stopping deleterious effects of erosion and sedimentation in the stream
  - Land use planning and conservation easements would also keep runoff to a minimum

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

- Habitat protection, restoration and management
  - River otters: Proper land use planning, at a watershed scale, would not only benefit otters but other aquatic and riparian species
  - Water regime management for migration habitat
  - Protect nesting habitat along streams
  - Improve land use practices in watershed will reduce sedimentation in impoundments and reduce nutrient inputs
  - Restore woody debris habitats
  - Purchase more public land
  - Create and restore buffer zones
  - Habitat creation, i.e., artificial structures during lake construction projects
  - Reduce inlet and upstream degradation
  - Corridor protection
  - Eliminate or reduce stream channelization and ditches

    - Restore aquatic passage: Wetland restoration projects with connectivity to the stream or corridor development that allows passage to wetlands already restored; we need to move toward natural regulation of water levels instead of artificial means
    - Treat small streams as biological resources and not just drainage ditches
    - Culvert or stream crossing structure improvement (replace non-functioning culverts or other crossing structures and replace with ones that function and are at the right elevation/location within the stream's longitudinal profile)
    - Restore riparian vegetative communities through tree planting, etc.
    - Streambank stabilization or stream restoration (reconstructing the channel to reconnect it to its natural floodplain elevation)
    - Restore riparian zones; riffle protection/restoration
    - Encourage return to natural meander channel (within flood control)
    - Let dead trees in river stay; perhaps add some
    - Enhance natural river channel evolution including point bar development and snags (downed trees in the water); this provides basking sites and nesting habitat

- Regulation and policy
    - River otters: Strict enforcement of existing pollution regulations, and if needed, development of stricter laws would be beneficial
    - In Army Corps of Engineers impoundments alterations in water level control would benefit crappie
    - Habitat protection through regulation (only sure way to protect habitat without public ownership)
    - Habitat protection through regulation; (less intensive) cover a large geographic area. (Ducks, Geese & Swans of North America, Bellrose)
    - Habitat protection through incentives, (intensive), best landowner cooperation
    - Habitat conservation regulations
    - Land use zoning
    - Protect habitat through land use planning. Currently most headwaters areas run through agricultural areas and need to maintain riparian buffer strips
    - Implement ecozones in undeveloped areas to conserve that vegetation present
    - Restore bottomland hardwoods through Farm Bill and other incentive programs
    - Require that a mussel survey be done before dredging
    - CREP and other incentives for BMPs
    - Manage available habitat through regulation and buffer zones, increase habitat through incentives, technical assistance and restoration
    - Limit runoff through incentives or other means
    - Riparian conservation easements
    - Protect adjacent buffer zones (riparian corridor). More participation would likely occur with financial incentives
    - Rehabilitate drained oxbow ponds through conservation easement

- Pollution management
    - Reducing nutrient inputs will allow a deeper thermocline that is important for crappie growth. Crappie growth suffers when water temperatures become too high
    - Point and nonpoint pollution controls
    - Pollution reduction means improved water quality and fewer fish kills

- Public education and technical assistance
    - Increase awareness and cooperation of landowners to create better shoreline and tributary habitat
    - Provide technical assistance

- Research

- More research is needed to address the effectiveness of habitat restoration on siren conservation
- Assess riparian corridor and water quality monitoring (see Watters, 2000. Proc. 1st FMCS Symposium)

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

Partner agencies/organizations

The following organizations indicated that they work in Aquatic habitats.

Organization	Percent of time spent in Aquatic habitats
Aquatic Weed Control	100
Central Indiana Trout Unlimited	100
Hamilton Lake Conservancy District	100
fish lake conservancy district	90
Lake Bruce Conservancy district	90
Indiana Bass Chapter Federation	80
Indiana Smallmouth Club (ISC)	80
Northeastern Indiana Trout Association	80
Lake Lemon Conservancy District	75
Steelheaders of Northwest Indiana (Northwest Indiana Steelheaders)	70
Cordry Sweetwater Conservancy District	50
Four Rivers Resource Conservation & Development Area	50
Lake Maxinkuckee Environmental Council (LMEC)	50
Indiana Chamber of Commerce	45
Veolia Water Indianapolis, LLC	45
EnviroScience Incorporated	40
Hoosier Environmental Council	40
Sierra Club Hoosier Chapter	40
Wabash River Heritage Corridor Commission	40
St. Joseph River Watershed Initiative	36
Save the Dunes Conservation Fund	35
ACRES, Inc.	30
Arrow Head Country Resource Conservation & Development Area, Inc.	30
Indiana Environmental Institute	30
MWH Americas, Inc.	30
Valparasio Chain of Lakes Watershed Group, Inc.	30
Division of Fish and Wildlife	28
Robert Cooper Audubon Society	28
Northwestern Indiana Regional Planning Commission (NIRPC)	25
Sassafras Audubon Society	25

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Trillium Land Conservancy, Inc.	25
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	25
Valparaiso Lakes Area Conservancy District	25
Cinergy Corp.	20
Hoosier Heartland Resource Conservation and Education council	20
Indiana Division of the Izaak Walton League of America	20
Patoka River National Wildlife Refuge & Management Area	20
South Bend-Elkhart Audubon Society	10-20
American Consulting, Inc.	15
Pheasants Forever Inc.	15
Clark's Valley Land Trust	10
DNR Division of Nature Preserves	10
Ducks Unlimited, Inc.	10
Earth Source, Inc.	10
Indiana Deer Hunters Association	10
Indiana Association of Cities and Towns	10
Indiana Association of Soil and Water Conservation Districts	10
Indiana state trappers assoc	10
JFNew and Associates	10
Lost River Conservation Association	10
Midwest Peregrine Falcon Recovery Project	10
Summit Lake State Park	10
The Nature Conservancy	10
Wawasee Area Conservancy Foundation, Inc.	10
Whitewater Valley Land Trust, Inc.	10
Big Oaks National Wildlife Refuge, USFWS	5
Blue Heron Ministries, Inc.	5
Ducks Unlimited	5
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)	5
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	~5
Indiana Dunes National Lakeshore	5
Indianapolis Power & Light Co.	5
Muscatatuck National Wildlife Refuge US FWS	5
Naval Support Activity Crane	5
NICHES Land Trust	5
U.S. Department of Agriculture, Forest Service Hoosier National Forest	5
Merry Lea Environmental Learning Center of Goshen College	4
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	3
St. Joseph County Soil & Water Conservation District (SWCD)	3
American Society of Landscape Architects, Indiana Chapter	

amos w butler audubon society
Central Hardwoods Joint Venture/American Bird Conservancy
Federal Highway Administration (FHWA)
Fur Takers of America
fur takers of america chapter 7-E north west in.
Great Lakes Commission
Indiana Michigan Power and affiliate of American Electric Power; Land Management Department
Indiana Watershed Leadership (new initiative)with Purdue University
Indianapolis Flycasters
Kankakee River Basin Commission
LAKE MCCOY CONSERVANCY DISTRICT
Law Enforcement Division, Indiana Department of Natural Resources
National Audubon Society - Indiana Important Bird Areas Program (IBA)
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.)
USDA Natural Resources Conservation Service

Proposed plans for monitoring

Current monitoring

Species monitoring

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

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

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

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

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

Appendix F-2: Aggregated Aquatic Systems

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

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

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

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

- Indiana Department of Natural Resources
    - Beavers
        - State and county highway department monitor beaver activity only as flooding of roadways occur

        - IDNR property monitor and attempt to eliminate problems associated with flooding of adjacent private property
        - State furbearer biologist tracks and monitors trapping harvest data
    - River otters
        - IDNR personnel monitor otter mortality (road-kills, trap-related, etc.) at a statewide level
        - IDNR personnel conduct winter bridge/stream surveys for otter sign. These are conducted on a county basis at a statewide level
        - Patoka Lake; Hovey Lake; Dogwood Lake; Lake Sullivan; many other lakes
    - Many impoundments throughout the state have general fisheries survey conducted on them and crappie are caught during these
    - Fish and Wildlife properties in northern Indiana
    - Tri-County Fish and Wildlife Area
    - Spring assessment out of Michigan City: Fall spawning assessment, Indiana waters of Lake Michigan; 9-month creel survey for harvest information. These efforts are conducted by IDNR Division of Fish and Wildlife
    - Indiana Division of Fish and Wildlife at cisco lakes
    - Northeast Indiana by Division of Fish and Wildlife (Jed Pearson)
    - Northern pike
        - Monitored via general fish surveys conducted to update lake status. There is now monitoring of northern pike on a general schedule
        - There was a tracking study conducted in two Indiana natural lakes in the late 1990s by the IDNR to better understand reproductive habitat of northern pike
    - Division of Fish and Wildlife standardized largemouth bass sampling protocol
    - Tournament fishing monitoring by the Division of Fish and Wildlife
    - Several fish and wildlife areas perform annual wood duck banding. These properties include Hovey Lake, Glendale, Minnihaha, Willow Slough, Jasper-Pulaski, LaSalle, Pigeon River, Tri-County fish and wildlife areas; there may be others
    - Many fish and wildlife areas also conduct nest box monitoring activities on an annual basis
    - Indiana participates in the Harvest Information Program which can provide information about migration, population index and/or trends, as well as information about the amount of hunting pressure
    - Hovey Lake, Tri-county, Jasper-Pulaski, Pigeon River, Winimac, Willow Slough and LaSalle fish and wildlife areas
    - Headwater streams surveys were conducted in 2001 through 2004 by IDNR - Division of Fish and Wildlife, Lake Michigan Fisheries Office
    - State monitoring: Banding and nest box surveys
    - IDNR periodically conducts fish stream surveys
    - DNR fishery surveys are occasionally conducted on the Iroquois River, Yellow River, and Kankakee River
    - IDEM and IDNR collect fish community samples in this area; thus, they may have data on the distribution of least darters
    - IDNR non-game biologist does mussel surveys. But, he is only one person and there are thousands of miles of streams in state
    - IDEM and the DNR Nongame program also conduct monitoring during the field season, once a year for fish. These above fish surveys are not specific to the orangethroat darter, but would include the orangethroat darter
    - Periodic (usually annual) monitoring in the Tippecanoe River by IDNR
    - In early to mid-1990s, Division of Fish and Wildlife conducted fish community inventories on the major streams throughout the state
    - Indiana DNR conducts special studies on threatened and endangered species: IDNR, Brant Fisher, did a study on the population of eastern sand darters in Indiana over

the past five years. IDNR regional fish collection surveys may have collected some specimens of the eastern sand darter
    - See IDNR Fisheries Section work plans
    - In early to mid-1990s the Division of Fish and Wildlife conducted a smallmouth bass inventory
    - Five streams have been sampled every other year from 1998 to 2004 to estimate smallmouth bass populations to determine the effect of smallmouth bass population changes due to the imposition of a 12-inch black bass size limit in 1998
    - Game fish population estimates (including rock bass) have been conducted on 5 streams every other year from 1998 through 2004
    - 1999 Wabash River, 2003 East Fork White River, 2004 West Fork White River, 2004 Main Stem White River, 1993 Patoka River, 2004 Ohio River Cannelton Pool, annual commercial fish harvest monitoring
    - IDNR I believe has conducted special studies on this species
    - IDNR nongame biologist continually monitors fishes and mussels throughout the state, including yellow sandshell habitat. Two surveys have been done ten years apart and completed last year by IDNR biologists in the Wabash, Tippecanoe and East Fork White Rivers; results are pending. This is in prime yellow sandshell habitat

- Indiana Department of Environmental Management
    - Ecoregion sampling
    - Water quality monitoring
    - IDEM conducts stream health surveys using fish and invertebrates
    - IDEM monitors the Great Lakes Drainage once every five years; thus, they may have data available for hornyhead chub captured in the basin as part of the fish community assessments. IDNR may also sample fish communities in this area and have data on the hornyhead chub
    - IDEM occasionally samples fish for contaminants analysis for the annual Fish Consumption Advisory
    - IDEM and IDNR collect fish community samples in this area; thus, they may have data on the distribution of least darters
    - IDEM monitors the Kankakee River basin once every five years to determine if the stream are supporting a well-balanced warm water aquatic community. Tadpole madtoms may have been captured while sampling headwater streams
    - IDEM and the DNR Nongame program also conduct monitoring during the field season, once a year for fish. These above fish surveys are not specific to the orangethroat darter, but would include the orangethroat darter
    - IDEM monitors the health of major river basins every five years by looking at chemical, physical and biological data collected at random locations within the watershed. Southern redbelly dace have been captured in the Ohio River drainage habitat; however, specific monitoring for the species has not occurred to my knowledge by anyone state or other organization
    - Various streams throughout the region, some are sampled more regularly than others IDEM probabilistic sampling
    - See IDEM OWQ's surface water quality monitoring strategy work plans
    - IDEM has record of some wildlife species being caught in that area

- Patoka River watershed
- Maumee system
- Breeding Bird Atlas statewide every 20 years
- Random locations within the Kankakee drainage
- Wabash system
- Tippecanoe River, Maumee system
- Blue River (Harrison County); Sugar Creek (Shelby County); Indian Creek (Greene County)

Appendix F-2: Aggregated Aquatic Systems

- Blue River (Harrison County)
- Ohio River, Wabash system
- Wabash River; West Fork White River; East Fork White River; Ohio River
- Ohio, White and Wabash rivers
- Occasional stream surveys
- Ohio River, Newburgh and McApline tailwater fall/winter annual monitoring; occasional stream surveys
- Blue River (Harrison County); East Fork White River; West Fork White River

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

- Joseph Brodman, Saint Joseph's College
- Cortwright, IUN
- Federal Breeding Bird Survey, state May Day counts, summer bird counts
- Division of Fish and Wildlife properties in northern Indiana, natural lakes, nature preserves
- Out of Michigan City and near Gary by Ball State University
- U.S. Fish and Wildlife Service and Illinois Natural History Survey complete egg and fry assessments at the Port of Indiana. This is part of a Fish and Wildlife Restoration Grant
- Newton, Jasper, Pulaski, Starke, Lake and Porter counties
- Muscatatuck National Wildlife Refuge performs wood duck banding operations
- In some cities, stream health is also assessed by fish and invertebrate surveys
- Elkhart Public Works and Utilities has a fisheries biologist who collects fish community samples from the Great Lakes Basin (one to two times in the summer). He may have data on the hornyhead chub as well
- Maumee system
- Commonwealth Biomonitoring frequently does habitat evaluations in small streams as part of watershed studies. If I happen to see a shell, I make a note of it in field notes. These are not official mussel surveys
- Wabash system
- Hoosier National Forest conducts yearly fish surveys within two or more 5th level HUCs that encompass the Hoosier National Forest, which includes the Ohio River drainage, eastern cornbelt/interior plateau ecoregions. These above fish surveys are not specific to the orangethroat darter, but would include it
- Tippecanoe River, Maumee system
- West Fork White River and tributaries (Muncie area)
- Ball State University fish sampling
- While collecting fish community samples to evaluate the community structure and ability of the stream to support a healthy fish community, these organizations may have collected eastern sand darters: Soil and Water Conservation Districts within those Ecoregions, Purdue University, Wildcat Creek Watershed Alliance. I would check with the Scientific Collectors Permit office for a list of organizations collecting in those ecoregions and also check with the IDEM Section 319 webpage for project summaries where fish or habitat in those ecoregions were studied
- U.S. Environmental Protection Agency; USGS Water Resources Division; Ohio River Valley Water Sanitation Commission; Midwest Biodiversity Institute, U.S. Army Corps of Engineers; Muncie Bureau of Water Quality; City of Elkhart Water Quality; various universities; various consulting firms
- Ohio, White and Wabash rivers

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

Appendix F-2: Aggregated Aquatic Systems

- Cortwright, IUN
- U.S. Geological Survey (Breeding Bird Survey) and volunteers with Indiana Audubon Society
- Indiana Department of Natural Resources - Division of Fish and Wildlife
- Audubon Society
- Ducks Unlimited
- Ball State University
- University of Michigan through a coastal program grant
- Illinois Natural History Survey
- U.S. Fish and Wildlife Service
- Bass fishing clubs who hold tournaments on Lake Wawasee and Syracuse Lake
- Robert Brodman, Saint Joseph's College
- City of Elkhart (Elkhart and St. Joseph counties)
- Indiana Department of Environmental Management
- The Nature Conservancy
- Consultants
- USDA Forest Service, Hoosier National Forest
- Muncie Bureau of Water Quality.
- Electric utilities
- Ball State University
- Purdue University

Respondents considered monitoring techniques for wildlife in all aquatic systems habitats in Indiana:

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

technique)			
Representative sites	X	X	--
Probabilistic sites	X	X	--

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

- Aerial surveys
- Long-term monitoring through gillnets; trawling has been conducted at three sites along the Lake Michigan lakefront since the mid-1970s by Ball State University during the summer season. Creel census has been conducted by IDNR – Division of Fish and Wildlife for approximately 20 years. Commercial monitoring was conducted until the halt of the commercial fishing industry in 1996
- Nest box surveys
- Electrofishing and seining are appropriate methods for monitoring the orangethroat darter
- Unintentional take could be monitored from fish kill cadaver counts if the officers could be trained to identify northern hog suckers instead of not counting them or just lumping them into the generic class of round bodied suckers
- Larval sampling to check for reproduction

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in all aquatic systems habitats. There were no responses.

Habitat inventory and assessment

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

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

Respondents were aware of the following inventory and assessment efforts by other organizations for all aquatic systems habitats in Indiana (not ranked):

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

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

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

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

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

Rank	Inventory and assessment by other organizations for conservation of all aquatic systems habitats
1	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
3	Regional or local once-a-year inventory and assessment

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

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

- Natural lakes in northern Indiana
- Lake Michigan proper along the shoreline in nearshore area less than 30 feet in depth
- Habitat mapping and shoreline aerial imagery
- Northeast Indiana, Indiana Division of Fish and Wildlife (Jed Pearson)
- Recently the IDNR has begun sampling/mapping emergent plant species in some Indiana natural lakes. These plants may be used as reproductive habitat for northern pike
- Nearly all of the river and stream habitats in Indiana fall under state and/or federal jurisdiction, so obtaining and maintaining accurate and current information on these habitats is always occurring on a statewide basis
- Trail Creek, East Branch of Little Calumet River, Reynolds Creek, Salt Creek, West Branch of Little Calumet River, Deep River
- IDEM ecoregion surveys
- In all major tributaries of Lake Michigan
- IDEM, IDNR and City of Elkhart use the QHEI (Qualitative Habitat Evaluation Index) to assess habitat in streams
- Maumee system
- Habitat evaluations are conducted as part of general stream surveys by DNR biologists. Such surveys have been conducted on the Iroquois River, the Yellow River, and the Kankakee River
- Wabash system
- Tippecanoe River and Maumee system
- Blue River (Harrison County), Sugar Creek (Shelby County), Indian Creek (Greene County)
- Indiana Department of Environmental Management
- ORSANCO
- Blue River (Harrison County)
- Ohio River, Wabash system
- West Fork White River, East Fork White River, Wabash River
- I am assuming that the governmental division responsible for water pollution control conducts some sampling regarding organic and heavy metal toxins in the water
- IDNR primarily monitors mussel species, making habitat notations. No real habit monitors made. Indiana Department of Environmental Management, IDNR Division of Water do monitor water quality (as a component of habitat)

Appendix F-2: Aggregated Aquatic Systems

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

- Brodman, Saint Joseph's College, in northern Indiana
- Cortwright, IUN in Brown County
- Lake Michigan proper along the shoreline in nearshore area less than 30 feet in depth
- Newton, Jasper, Starke, Pulaski, Lake and Porter counties
- Many local zoning boards, planning commissions and drainage boards also keep and maintain their own records in regard to land use patterns within these habitats
- City of Elkhart
- St. Joseph River
- Maumee system
- Commonwealth Biomonitoring does habitat evaluations on small streams as part of watershed studies. These evaluations are not specific to mussels, but are Ohio EPA QHEI methods
- Wabash system
- Two or more 5th level HUC watersheds a year that encompass the Hoosier National Forest are sampled; a random sampling of streams found within these 5th level HUCs occurs
- Wabash system
- Tippecanoe River and Maumee system
- Muncie BWQ monitors West Fork White River and tributaries in the Muncie area
- Ohio River
- U.S. Army Corps of Engineers in Ohio River
- Occasional grants to universities

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

- Indiana Division of Fish and Wildlife
- Ball State University
- University of Michigan
- U.S. Fish and Wildlife Service
- Robert Brodman, Saint Joseph's College
- U.S. Department of Agriculture
- Indiana Department of Environmental Management
- U.S. Army Corps of Engineers
- Environmental Protection Agency
- Local government entities (area plan commissions, zoning boards etc…)
- City of Elkhart and South Bend
- The Nature Conservancy
- Consultants
- City of Muncie
- U.S. Geological Survey/WRD
- State Board of Health

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

Inventory and assessment techniques for all aquatic systems habitat	Used	Not used but possible with existing technology and data	Not economically feasible

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

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

- Bottom mapping of habitat
- IBI and QHEI for representative sites
- QHEI; REMAP protocols for northern forested streams; stream channel cross-sections and longitudinal profiles; substrate analysis; descriptions of riparian vegetation; water quality parameters are measured using probes and Hydro-labs
- Water quality monitoring

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for all aquatic systems habitats. There were no responses.

Recommended monitoring

Species monitoring

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

- Minnow traps
- Regulated trapping
- Directed surveys (canoe surveys, migration counts) most intensive; general breeding bird surveys less intensive
- Electrofishing survey
- Trap netting survey
- Gill netting surveys
- Angler creel surveys
- Reporting from harvest (angler creel surveys) to show angler exploitation
- Professional survey (fish management surveys) to show size structure, relative abundance, and provide age and growth information
- Professional surveys or counts on fish and wildlife areas during migration periods (tracts annual migration trends and is index to population levels). Harvest surveys on fish and wildlife areas (tracts annual numbers taken) ("Wildlife Investigational Techniques" by The Wildlife Society)

- Brood surveys
- Occasional gill-netting to verify presence followed by intensive netting to confirm low levels or absence
- Large fyke-nets are used in Lake Webster (Kosciusko County) to collected brood stock for muskellunge. These nets would be useful in capturing northern pike as well. This would allow biologist to capture enough fish to get a representative sample of adult fish. There is still no effective method of sampling young esocids without mortality
- Fall trawl sampling for young of the year production. Possible incorporation of hydracoustic models for the nearshore area
- Stream sampling using electrofishing techniques and seining. This should be done every five years to get a clear picture of changes that occur to habitat, water quality and invasive species introductions and distribution
- Rotational sampling at reference sites along the headwaters. Historical comparisons from the early 1980s will be compared with the sampling that was completed 2001 to 2004
- Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of some wildlife species
- Periodic electrofishing surveys and mark recapture techniques probably provide the best information about the pike populations
- Professional surveys using timed searches, systematic sampling (Strayer and Smith 2003, A guide to sampling freshwater mussel populations American Fisheries Society Monograph 8. American Fisheries Society. Bethesda, Maryland. 103 pp)
- Intensive quantitative sampling of known populations. Need to understand demography of some wildlife species. (Strayer & Smith, 2003. AFS Monogram. 8.)
- Electrofishing streams. Take a random sampling of streams within a watershed (5th or 6th level HUC) and standardize the stream reach length for the survey, usually 15 times the stream width. Seining is also an appropriate method for sampling, especially in the riffle habitats
- River otters
  - Stream surveys for otter sign
  - Reporting (number, location, etc.) of unintentional take and biological data obtained from recovered specimens (reproductive parameters)
    - REFERENCE: Melquist, W.E., P.J. Polechla, Jr., and D. Toweill. 2003. River Otter. Pages 708-734 in Wild Mammals of North America: biology, management, and conservation. 2nd edition. G.A. Feldhamer, B.C. Thompson, and J.A. Chapman (eds.), John Hopkins University Press, Baltimore, MD, 1216 pages
- Population estimates
- Mark/recapture and banding (intensive) (Ducks, Geese and Swans of North America, Frank C. Bellrose); harvest data collection (less intensive) (Wildlife Management Volume 2, Reuben Edwin Trippensee)
- Banding
- I would like to see all the lake trout stocked in Lake Michigan to be coded wire tagged. That will allow for better understanding of survival after stocking and movement of the fish. It will also allow for better understanding of spawning site fidelity
- Tournament monitoring by the Division of Fish and Wildlife and bass clubs
- Minnow trapping and either mark recapture or telemetry
- Continued participation in HIP is perhaps the most cost effective method for monitoring the flyway population
- Representative sites or look for sites where the habitat is suitable for the least darter and seine in the vegetation over rocky substrate
- Development of trained, select volunteer core to undertake surveys at probabilistic sites, particularly occurance has not been documented in recent years

- Stream community surveys
  Rock bass population estimates
- See where populations of the darter have been captured in the past and then with seines or electrofishing equipment mark and recapture the darter to document habitat characteristics, water quality information, and land use characterization where the darters occur. You will need to target the habitat and not the exact location since the sandbars will probably shift over time. Look on the web for mark and recapture surveys as well as other eastern sand darter publications. I found many by just searching the web for eastern sand darter
- Hoop-netting by scientists and commercial fishermen
- Fall/winter Ohio River tailwater sampling and occasional stream surveys
- Occasional censusing with very large, heavily bated hoop nets left out overnight. Do not set during rising waters. Check within 12 hours.
- Search for nests in June (after determining any adults present at all) methods used in Florida and Louisiana for nests, in Arkansas and Louisiana for capturing adults
- Looking for basking individuals with a spotting scope
- Use fyke nets with big leads, or basking traps to estimate numbers after visual spotting determines presence

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of wildlife in all aquatic systems habitats. There were no responses.

Habitat inventory and assessment

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

- GIS appears to be the most feasible means for inventory and assessment of otter habitat at a statewide scale. I suspect analysis of aerial photos could be useful also, perhaps at a local scale
- GIS mapping of restored, fully connected wetland to provide an inventory of available spawning habitat
- GIS mapping (electronic data base of current habitat), aerial photography and analysis (examine changes in habitat)
- Digital satellite imagery to conduct bottom contour mapping in nearshore spawning areas
- GIS (intensive) (Wildlife Management Techniques Manual, Fourth Edition, Sanford D. Schemnitz); aerial (less intensive)
- Aerial imagery to identify and quantify habitat
- Systematic sampling would probably be best to determine the abundance of cover that is available, but could be very difficult as most of the habitat is hidden under the surface of the water
- "Wildlife Investigational Techniques" by The Wildlife Society
- Spring counts (aerial)
- Lidar mapping would help identify spawning areas within the nearshore zone along Indiana's coastline
- Emergent bulrush and wetland monitoring and protection via ecozones
- Evaluate land and water use practices to reduce in lake and upstream degradation of vegetation and shoreline
- Spring, summer, fall and winter surveys
- Sampling using electrofishing and seining in headwater areas. Completing IBI and QHEI and water quality analysis for these sites
- Assess riparian corridor and water quality

- Systematic sampling of the habitat along the length of the stream to provide baseline data for comparison across time
- Assess riparian corridor presence
- Orangethroat darter
  - Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. USDA Forest Service. General Technical Report RM-245. The reference offers useful guidance on measuring stream channel cross-sections and substrate within the stream. This information can be used to determine if a stream channel is stable and if the substrate is available within riffle habitats, which are the preferred habitat of the orangethroat darter
  - Simon, T. P. and P.M. Stewart. 1998. Standard Operating Procedures For Development of Watershed Indicators In REMAP: Northern Lakes and Forest Streams The above reference is very useful for developing a watershed level sampling design and includes useful methods for measuring stream channel and stream habitat parameters
- Water quality monitoring.
- CREP, farmer incentives for no-till, riparian corridors, etc.
- Strictly control instream modifications: mining, snagging, etc.
- Assess zebra mussel infestations. Contact P. Morrison, USFWS, Parkersburg, WV.
- Record habitat when the species is collected during a survey
- High-resolution aerial photography during low water, digitized for GIS. Goal is to locate: 1) Deep river holes with woody debris (favored by adults); 2) health/permanence of oxbow ponds; 3) nesting habitat
- Occasional site visits to assess vegetation quality for this herbivorous turtle
- To look at saturation of potential habitat using GIS construction of existing potential habitat (based upon known factors) and overlaying the current distribution of the yellow sandshell

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation for all aquatic systems habitats. There were no responses.

AQUATIC SYSTEMS HABITAT NARRATIVE

Habitat description

This habitat is comprised of all water, both flowing and stationary, habitats in Indiana.

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to wildlife in aquatic systems habitat in Indiana:

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

Respondents offered no additional threats to wildlife in aquatic systems habitat in Indiana. One respondent commented, "As adjacent states initiate harvest seasons for otters, there might be added pressure to take otters accidentally trapped in Indiana across state lines to market fur. However, I wouldn't expect this to have a significant impact on a statewide or even regional scale."

Respondents listed top threats to wildlife in aquatic systems habitat in Indiana (not ranked):

- Wetland loss and degradation; degradation of migration routes
  - Due to urban sprawl and development
  - Due to pollution: Reproductive performance of otters can be compromised by high levels of PCBs, heavy metals, etc. that bioaccumulate in the aquatic food chain. Direct loss of aquatic habitats such as wetlands, marshes, etc. also impact otters, but not to the extent pollutants could

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

Habitat threats

Respondents ranked threats to aquatic systems habitat in Indiana:

Rank	Threats to aquatic systems habitat
1 (tie)	Habitat degradation
1 (tie)	Counterproductive financial incentives or regulations
2	Commercial or residential development (sprawl)
3 (tie)	Point source pollution (continuing)
3 (tie)	Mining/acidification
4	Residual contamination (persistent toxins)
5 (tie)	Stream channelization
5 (tie)	Habitat fragmentation
6	Nonpoint source pollution (sedimentation and nutrients)
7 (tie)	Impoundment of water/flow regulation
7 (tie)	Invasive/non-native species
7 (tie)	Agricultural/forestry practices
7 (tie)	Drainage practices (stormwater runoff)

Respondents noted no additional threats to aquatic systems habitat in Indiana.

Respondents listed top threats to aquatic systems habitat in Indiana (not ranked):

- Habitat degradation and fragmentation
  - Due to regulations that allow loss of habitat

- Due to urban sprawl/development
- Due to water pollution: Pollution not only impacts otter reproduction, but also may impact the quantity/quality of aquatic prey for otters. Loss of wetland habitats reduces the amount of suitable habitat for otters

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

Additional research and survey efforts

Current body of research

Species research

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

Title = Amphibians and reptiles from 23 counties of Indiana.;
Author = Robert Brodman;
Date = 2003;
Publisher = Proceedings of the Indiana Academy of Science, 112: 43-54.

Title = Ten- to eleven-year population trends of two pond-breedong amphibian species, red-spotted newts and green frogs. In Status & Conservation of Midwester;
Author = Spencer Cortwright;
Date = 1998;
Publisher = University of Iowa Press, Iowa City

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

Title = Indiana River Otter Reintroduction Program, 2000-2001;
Author = Scott A. Johnson;
Date = November 2001;
Publisher = Internal report, Indiana Department of Natural Resources, Bloomington, IN

Title = Restoring river otters in Indiana;
Author = Scott A. Johnson and Kim A. Berkley;
Date = 1999;
Publisher = Wildlife Society Bulletin 27:419-427.

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

Habitat research

(Q36) Fifty percent of respondents stated that the current body of science is adequate for aquatic systems habitat in Indiana; twenty-five percent say that it is inadequate.

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

Title = Mammals of Indiana;
Author = Russell E. Mumford;
Date = 1982;
Publisher = Bloomington Indiana University Press

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

Research needs

Species research

Respondents ranked research needs for wildlife in aquatic systems habitat in Indiana:

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

Respondents noted additional research needs for wildlife in aquatic systems habitat in Indiana:

- Relationships between population levels and population indices

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 aquatic systems habitat. There were no responses.

Habitat research

Respondents ranked research needs for aquatic systems habitat in Indiana:

Rank	Research needs for aquatic systems habitat
1	Threats (land use change/competition, contamination/global warming)

2	Distribution and abundance (fragmentation)
3	Relationship/dependence on specific site conditions
4	Growth and development of individual components of the habitat
5	Successional changes

Respondents noted no additional research needs for aquatic systems habitat in Indiana.

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

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to wildlife in aquatic systems habitat in Indiana:

Rank	Conservation efforts for wildlife in aquatic systems habitat
1 (tie)	Reintroduction (restoration)
1 (tie)	Culling/selective removal
2	Population management (hunting, trapping)
3	Habitat protection
4 (tie)	Limiting contact with pollutants/contaminants
4 (tie)	Public education to reduce human disturbance
4 (tie)	Threats reduction
4 (tie)	Regulation of collecting
4 (tie)	Protection of migration routes

Respondents noted no additional conservation practices for wildlife in aquatic systems habitat in Indiana.

Respondents recommended these practices for more effective conservation of wildlife in aquatic systems habitat in Indiana (not ranked):

- Habitat protection (aquatic and riverine habitats)
  - Need programs to restore lost or degraded habitats
- Regulated trapping and nuisance control species policies
- Education programs
  - To reduce incidental take. This would also benefit otters, especially where population densities are lower

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

Habitat actions

Respondents ranked conservation efforts by how well they address threats to aquatic systems habitat in Indiana:

Rank	Conservation efforts for aquatic systems habitat
1	Habitat protection on public lands
2 (tie)	Habitat restoration on public lands
2 (tie)	Protection of adjacent buffer zone
3 (tie)	Pollution reduction
3 (tie)	Habitat protection through regulation
3 (tie)	Habitat protection incentives (financial)
3 (tie)	Technical assistance
3 (tie)	Cooperative land management agreements (conservation easements)
3 (tie)	Habitat restoration incentives (financial)
3 (tie)	Managing water regimes
3 (tie)	Corridor development/protection
3 (tie)	Habitat restoration through regulation
3 (tie)	Land use planning

Respondents listed no other current conservation practices for aquatic systems habitat in Indiana.

Respondents recommended the following practices for more effective conservation of aquatic systems habitat in Indiana (not ranked):

- Habitat protection
- Proper land use planning: At a watershed scale, proper land use planning would not only benefit otters, but other aquatic and riparian species.
- Strict enforcement of existing pollution regulations; development of stricter laws, if needed

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

Partner agencies/organizations

Organization	Percent of time spent in Aquatic habitats
Great Lakes Commission	NA

Appendix F-3: Aquatic Systems

South Bend-Elkhart Audubon Society	10-20?
Federal Highway Administration (FHWA)	?
fur takers of america chapter 7-E north west in.	?
Aquatic Weed Control	100
Central Indiana Trout Unlimited	100
Hamilton Lake Conservancy District	100
fish lake conservancy district	90
Lake Bruce Conservancy district	90
Indiana Bass Chapter Federation	80
Northeastern Indiana Trout Association	80
Lake Lemon Conservancy District	75
Steelheaders of Northwest Indiana (Northwest Indiana Steelheaders)	70
Cordry Sweetwater Conservancy District	50
Four Rivers Resource Conservation & Development Area	50
Lake Maxinkuckee Environmental Council (LMEC)	50
Indiana Chamber of Commerce	45
Veolia Water Indianapolis, LLC	45
EnviroScience Incorporated	40
Hoosier Environmental Council	40
Sierra Club Hoosier Chapter	40
Wabash River Heritage Corridor Commission	40
St. Joseph River Watershed Initiative	36
Save the Dunes Conservation Fund	35
ACRES, Inc.	30
Arrow Head Country Resource Conservation & Development Area, Inc.	30
MWH Americas, Inc.	30
Valparasio Chain of Lakes Watershed Group, Inc.	30
Division of Fish and Wildlife	28
Robert Cooper Audubon Society	28
Northwestern Indiana Regional Planning Commission (NIRPC)	25
Sassafras Audubon Society	25
Trillium Land Conservancy, Inc.	25
US Fish and Wildlife Service Ecological Services (does not include national wildlife refuges)	25
Valparaiso Lakes Area Conservancy District	25
Cinergy Corp.	20
Hoosier Heartland Resource Conservation and Education council	20
Indiana Division of the Izaak Walton League of America	20
Patoka River National Wildlife Refuge & Management Area	20
American Consulting, Inc.	15
Pheasants Forever Inc.	15
Clark's Valley Land Trust	10
DNR Division of Nature Preserves	10

Appendix F-3: Aquatic Systems

Ducks Unlimited, Inc.	10
Earth Source, Inc.	10
Indiana Association of Cities and Towns	10
Indiana state trappers assoc	10
JFNew and Associates	10
Lost River Conservation Association	10
Midwest Peregrine Falcon Recovery Project	10
Summit Lake State Park	10
The Nature Conservancy	10
Wawasee Area Conservancy Foundation, Inc.	10
Big Oaks National Wildlife Refuge, USFWS	5
Blue Heron Ministries, Inc.	5
Ducks Unlimited	5
IDNR- Division of Forestry- Cooperative Forest Management Section (Private Lands)	5
Indiana Dunes National Lakeshore	5
Indianapolis Power & Light Co.	5
Naval Support Activity Crane	5
NICHES Land Trust	5
U.S. Department of Agriculture, Forest Service Hoosier National Forest	5
Merry Lea Environmental Learning Center of Goshen College	4
Indiana Department of Natural Resources Division of Forestry, Properties Section (State Forests)	3
St. Joseph County Soil & Water Conservation District (SWCD)	3
American Society of Landscape Architects, Indiana Chapter	
amos w butler audubon society	
Central Hardwoods Joint Venture/American Bird Conservancy	
Fur Takers of America	
Indiana Michigan Power and affiliate of American Electric Power; Land Management Department	
Indiana Watershed Leadership (new initiative)with Purdue University	
Indianapolis Flycasters	
Kankakee River Basin Commission	
LAKE MCCOY CONSERVANCY DISTRICT	
Law Enforcement Division, Indiana Department of Natural Resources	
National Audubon Society - Indiana Important Bird Areas Program (IBA)	
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.)	
USDA Natural Resources Conservation Service	
IN DNR, Division of State Parks & Reservoirs, Interpretive Services	~5
Indiana Smallmouth Club (ISC)	80
Indiana Environmental Institute	30

Imdian Deer Hunters Association	10
Indiana Association of Soil and Water Conservation Districts	10
Whitewater Valley Land Trust, Inc.	10
Muscatatuck National Wildlife Refuge US FWS	5

Proposed plans for monitoring

Current monitoring

Species monitoring

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

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

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

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

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of wildlife in aquatic systems habitat in Indiana:

Rank	Monitoring efforts by state agencies for conservation of wildlife in aquatic systems habitat
1 (tie)	Statewide year-round monitoring
1 (tie)	Statewide once-a-year monitoring
2	Periodic statewide (less than once a year but still regularly scheduled) monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of wildlife in aquatic systems habitat in Indiana:

Rank	Monitoring efforts by other organizations for conservation of wildlife in aquatic systems habitat
1	Regional or local once-a-year monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3	Occasional regional or local (less than once a

year and not regularly scheduled) monitoring

Respondents listed regional or local monitoring by state agencies for wildlife in aquatic systems habitat in Indiana (not ranked):

- Beavers
  - State and county highway departments monitor beaver activity only as flooding of roadways occur
  - IDNR properties monitor and attempt to eliminate problems associated with flooding of adjacent private property. State furbearer biologist tracks and monitors trapping harvest data
- Otters
  - IDNR personnel monitor otter mortality (road kills, trap related, etc.) at a statewide level
  - IDNR personnel conduct winter bridge/stream surveys for otter sign. These are conducted on a county basis at a statewide level

Respondents listed regional or local monitoring by other organizations for wildlife in aquatic systems habitat in Indiana (not ranked):

- Robert Brodman, St. Joseph's College
- Cortwright, IUN

Respondents listed organizations that monitor wildlife in aquatic systems habitat in Indiana (not ranked):

- Robert Brodman, St. Joseph's College
- Cortwright, IUN
- IDNR

Respondents considered monitoring techniques for wildlife in aquatic systems habitat in Indiana:

Monitoring techniques for wildlife in aquatic systems habitat	**Used**	**Not used but possible with existing technology and data**	**Not economically feasible**
Radio telemetry and tracking	--	X	--
Modeling	X	X	--
Coverboard routes	--	X	--
Spot mapping	--	X	--
Driving a survey route	X	X	--

Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	--	--
Mark and recapture	--	X	--
Professional survey/census	X	X	--
Volunteer survey/census	X	X	--
Trapping (by any technique)	X	X	--
Representative sites	X	X	--
Probabilistic sites	X	X	--

Respondents noted no other monitoring techniques for wildlife in aquatic systems habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in aquatic systems habitat. There were no responses.

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for aquatic systems habitat in Indiana:

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

Respondents were aware of the following inventory and assessment efforts by other organizations for aquatic systems habitat in Indiana (not ranked):

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

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of aquatic systems habitat in Indiana:

Rank	Inventory and assessment by state agencies for conservation of aquatic systems habitat
1 (tie)	Statewide once-a-year inventory and assessment
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
2 (tie)	Periodic statewide (less than once a year but

	still regularly scheduled) inventory and assessment
2 (tie)	Statewide annual inventory and assessment

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of aquatic systems habitat in Indiana:

Rank	Inventory and assessment by other organizations for conservation of aquatic systems habitat
1	Regional or local once-a-year inventory and assessment
2 (tie)	Statewide annual inventory and assessment
2 (tie)	Statewide once-a-year inventory and assessment
2 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

A respondents listed regional or local inventory and assessment by state agencies for aquatic systems habitat in Indiana:

- Otters: I suspect some state agencies monitor and assess aquatic habitats at a statewide level, maybe not on an annual basis, but perhaps every few years. No agency comes to mind though that does it. Nonetheless, this is an important component of inventorying otter habitat in Indiana

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

- Robert Brodman, St. Joseph's College
- Cortwright, IUN

Respondents listed no organizations that monitor aquatic systems habitat in Indiana (not ranked).

Respondents considered inventory and assessment techniques for aquatic systems habitat in Indiana:

Inventory and assessment techniques for aquatic systems habitat	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	--	X	--
Aerial photography and analysis	--	X	--
Systematic sampling	X	--	--
Property tax estimates	--	--	X
State revenue data	--	--	X
Participation in land use programs	--	X	--
Modeling	--	X	--

Respondents listed no additional inventory and assessment techniques for aquatic systems habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for aquatic systems habitat. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of wildlife in aquatic systems habitat in Indiana (not ranked):

- Aquatic surveys and minnow traps
- Regulated trapping
- Otters
    - Stream surveys for otter sign
    - Reporting (number, location, etc.) of unintentional take and biological data obtained from recovered specimens (reproductive parameters)

  (REFERENCE: Melquist, W.E., P.J. Polechla, Jr., and D. Toweill. 2003. River Otter. Pages 708-734 in Wild Mammals of North America: biology, management, and conservation. 2nd edition. G.A. Feldhamer, B.C. Thompson, and J.A. Chapman (eds.), John Hopkins University Press, Baltimore, MD, 1216 pages)

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

Habitat inventory and assessment

Appendix F-3: Aquatic Systems

Respondents recommended the following inventory and assessment techniques for effective conservation of aquatic systems habitat in Indiana:

- Systematic sampling and GIS
  - GIS technology appears to be the most feasible means for inventory and assessment of otter habitat on a statewide scale. Analysis of aerial photos could be useful also, perhaps on a local scale

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

DUNES AND SHORELINES HABITAT

Habitat description

Dunes and shoreline systems are located along the coastline of Lake Michigan and associated interior areas formed by either eroded glacial drift along the coast by wave activity or eroded from inland deposits and carried by rivers and streams.

Problems affecting species and habitats

Species threats

The respondent listed no "critical" or "serious threats" for wildlife in dunes and shorelines habitat in Indiana. The respondent indicated the following as "somewhat of a threat" (not ranked):

- High sensitivity to pollution
- Bioaccumulation of contaminants
- Predators (native or domesticated)
- Habitat loss (breeding range)
- Habitat loss (feeding/foraging areas)
- Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)

The respondent listed no other threats to wildlife in dunes and shorelines habitat in Indiana.

The respondent listed the top threats to wildlife in dunes and shorelines habitat in Indiana as "human disturbance" and "modification/degradation of habitats."

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

Habitat threats

The respondent listed no "critical threats" to dunes and shorelines habitat in Indiana. Respondents indicated the following as serious "threats" (not ranked):

- Stream channelization
- Impoundment of water/flow regulation

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

- Commercial or residential development (sprawl)
- Counterproductive financial incentives or regulations
- Nonpoint source pollution (sedimentation and nutrients)
- Successional change
- Habitat degradation
- Agricultural/forestry practices
- Residual contamination (persistent toxins)
- Point source pollution
- Mining/acidification

- Drainage practices (stormwater runoff)

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

The respondents noted that top threats to dunes and shorelines habitat in Indiana are (not ranked):

- Factors that affect food availability
- Modification of stream shoreline habitats

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

Additional research and survey efforts

Current body of research

Species research

The respondent indicated that the current body of science for dunes and shorelines wildlife species is adequate.

The respondent identified the following citations (title, author, date, publisher) that would give the best overview of wildlife in dunes and shorelines habitats in Indiana.

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

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

Habitat research

The respondent indicated that the current body of science for dunes and shorelines habitat is inadequate.

The respondent indicated to see previous citation (title, author, date, publisher) that would give the best overview of dunes and shorelines habitats in Indiana.

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

Research needs

Species research

The respondent indicated that no research need is either “urgently needed” or “greatly needed” for wildlife in dunes and shorelines habitat in Indiana. The respondent stated that research is “needed” in the following areas (not ranked):

- Life cycle

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

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

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

Habitat research

The respondent indicated that no research need is either "urgently needed" or "greatly needed" for dunes and shorelines habitat in Indiana. The respondent stated that research is needed in the following areas (not ranked):

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

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

Conservation actions necessary

Species actions

The respondent indicated how well conservation efforts address the threats to wildlife in early dunes and shorelines habitat in Indiana. The following efforts address threats "very well" (not ranked):

- Habitat protection
- Protection of migration routes

The respondent stated that these conservation efforts address threats to wildlife in dunes and shorelines habitat in Indiana "somewhat" (not ranked):

- Threats reduction
- Regulation of collecting
- Limiting contact with pollutants/contaminants
- Public education to reduce disturbance

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

The respondent recommended these practices for more effective conservation of wildlife in dunes and shorelines habitat in Indiana (not ranked):

- Prevention of stream channelization
- Prevention of other (pollution) habitat factors

- Limit disturbance in nesting/migration habitat

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

Habitat actions

The respondent indicated that the following conservation efforts address threats to dunes and shorelines habitat in Indiana "very well" (not ranked):

- Habitat restoration on public lands
- Habitat restoration incentives (financial)
- Managing water regimes
- Restrict public access and disturbance

The respondent indicated that the following conservation efforts address threats to dunes and shorelines habitat in Indiana "somewhat" (not ranked):

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

The respondent listed no other conservation practices for dunes and shorelines habitat in Indiana.

The respondent recommended "water regime management for migration habitat" and "protection of nesting habitat along streams" for more effective conservation of dunes and shorelines habitat in Indiana.

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

Proposed plans for monitoring

Current monitoring

Species monitoring

The respondent indicated that this monitoring effort is conducted by state agencies for wildlife in dunes and shorelines habitat in Indiana:

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

Appendix F-4: Dunes and Shorelines

The respondent indicated that this monitoring effort is conducted by other organizations for wildlife in dunes and shorelines habitat in Indiana (not ranked):

- Statewide once a year monitoring
- Periodic regional or local (less than once a year and not regularly scheduled) monitoring

The respondent considered no monitoring efforts considered "very crucial" or "somewhat crucial" by state agencies for wildlife in dunes and shorelines habitat in Indiana. "Slightly crucial" monitoring efforts include:

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

The respondent considered no monitoring efforts considered "very crucial" or "somewhat crucial" by other organizations for wildlife in dunes and shorelines habitat in Indiana. "Slightly crucial" monitoring efforts include:

- Statewide once-a-year monitoring

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

- Breeding Bird Atlas statewide every 20 years

The respondent listed the following regional or local monitoring efforts by organizations for wildlife in dunes and shorelines habitat in Indiana (not ranked):

- Federal Breeding Bird Survey
- State May Day counts
- Summer bird counts

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

- USGS (Breeding Bird Survey)
- Volunteers with Indiana Audubon Society

According to the respondent, the most "frequently used" monitoring techniques for wildlife in dunes and shorelines habitat in Indiana are (not ranked):

- Driving a survey route
- Volunteer survey/census

The respondent indicated that the following techniques are "not used but possible with existing technology and data" for wildlife in dunes and shorelines habitat in Indiana (not ranked):

- Radio telemetry and tracking
- Modeling
- Spot mapping
- Mark and recapture
- Trapping (by any technique)
- Representative sites
- Probabilistic sites

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

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

Habitat inventory and assessment

The respondent indicated awareness of no inventory and assessment efforts by state agencies and other organizations for dunes and shorelines habitat in Indiana.

The respondent indicated that no inventory and assessment efforts conducted by state agencies and other organizations are "very crucial" or "somewhat crucial" for dunes and shorelines habitat in Indiana. Listed as "slightly crucial" are (not ranked):

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

The respondent was not aware of regional or local inventory and assessment efforts by state agencies or organizations for dunes and shorelines habitat in Indiana. The respondent was not aware of organizations involved in habitat monitoring.

The respondent listed no inventory and assessment techniques as "frequently used" and cited the following as "occasionally used" for dunes and shorelines habitat in Indiana (not ranked):

- GIS mapping
- Aerial photography and analysis
- Systematic sampling
- Voluntary landowner reporting
- Modeling

The respondent listed no other inventory and assessment techniques for dunes and shorelines habitat in Indiana.

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

Recommended monitoring

Species monitoring

Appendix F-4: Dunes and Shorelines

The respondent recommended the following monitoring techniques for wildlife in dunes and shorelines habitat in Indiana (not ranked):

- Directed surveys (canoe surveys, migration counts) most intensive
- General breeding bird surveys less intensive

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

Habitat inventory and assessment

The respondent recommended the following inventory and assessment technique for dunes and shorelines habitat in Indiana:

- Aerial imagery to identify and quantify habitat

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

AQUATIC SYSTEMS IMPOUNDMENTS HABITATS NARRATIVE

Habitat description

Impoundments are artificially constructed or maintained standing or flowing water bodies.

Problems affecting species and habitats

Species threats

Respondents ranked threats to wildlife in aquatic systems impoundments habitats in Indiana:

Rank	Threats to wildlife in aquatic systems impoundments habitats
1	Species overpopulation
2	Invasive/non-native species
3	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
4	Habitat loss (feeding/foraging areas)
5 (tie)	Habitat loss (breeding range)
5 (tie)	Degradation of movement/migration routes (overwintering habitats, nesting and staging sites)
5 (tie)	High sensitivity to pollution
6	Predators (native and domesticated)
7 (tie)	Bioaccumulation of contaminants
7 (tie)	Regulated hunting and fishing (too much)

Respondents did not note additional threats to wildlife in aquatic systems impoundments habitat in Indiana.

Respondents listed top threats to wildlife in aquatic systems impoundments habitat in Indiana (not ranked):

- Overpopulation
- Habitat loss (feeding areas) -- many reservoirs are getting very old and the once-abundant standing timber is now diminishing which is reducing cover for white crappie
- Dependence on irregular sources -- in many reservoirs, shad is the dominant forage base for crappie. If shad are growing extremely fast, crappie can only utilize shad for a short period of time before the shad outgrow the size crappie can consume
- Competition with invasives, namely gizzard shad
- Water level control regimes at impoundments

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

- Yes

Habitat threats

Respondents ranked threats for aquatic systems impoundments habitat in Indiana:

Rank	Threats for impoundment habitats
1	Nonpoint source pollution (sedimentation and nutrients)
2	Habitat degradation
3	Point source pollution (continuing)
4	Impoundment of water/flow regulation
5 (tie)	Agricultural/forestry practices
5 (tie)	Drainage practices (stormwater runoff)
6	Stream channelization
7 (tie)	Invasive/non-native species
7 (tie)	Residual contamination (persistent toxins)
7 (tie)	Commercial or residential development (sprawl)
8	Mining/acidification

Respondents did not note additional threats to aquatic systems impoundments habitat in Indiana.

Respondents noted top threats to aquatic systems impoundments habitat in Indiana (not ranked):

- Regulation of impounded water: Extreme water fluctuations in mainly the Army Corps reservoirs can negatively effect crappie populations especially if the water fluctuations occur during spawning
- Habitat degradation: The natural decomposition of flooded timber and woody debris is lessening available cover for crappie. Also, siltation covers root wads left in the bottom of an impoundment which eliminates useable crappie cover
- Habitat loss/degradation due to a variety of circumstances

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

- Yes

Additional research and survey efforts

Current body of research

Species research

All respondents indicated that research about wildlife in aquatic systems impoundments habitat in Indiana is adequate.

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

Title = Many in AFS journal of fish management and transactions of AFS

Title = Impoundments Strategic Plan;
Author = IDNR - Fish and Wildlife;
Date = 1997;
Publisher = IDNR - Fish and Wildlife

Habitat research

Two-thirds of respondents indicated that research on aquatic systems impoundments habitat in Indiana is Inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of aquatic systems impoundments habitats in Indiana.

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

- Yes

Research needs

Species research

Respondents ranked research needs for wildlife in aquatic systems impoundments habitat in Indiana:

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

One respondent stated that research was needed for wildlife in aquatic systems impoundments habitat in Indiana regarding “how to produce more, larger crappie.”

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 aquatic systems impoundments habitats. Their responses included:

- Yes

Habitat research

Respondents indicated the following research needs for aquatic systems impoundments habitat in Indiana:

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

Respondents did not list other research needs for aquatic systems impoundments habitat in Indiana.

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

- Yes

Conservation actions necessary

Species actions

Respondents ranked the following conservation efforts by how well they address threats to wildlife in aquatic systems impoundments habitat in Indiana:

Rank	Conservation efforts for wildlife in impoundments habitat
1 (tie)	Limiting contact with pollutants/contaminants
1 (tie)	Population management (hunting, trapping)

2	Reintroduction (restoration)
3 (tie)	Habitat protection (use below for details)
3 (tie)	Stocking
4	Culling/selective removal
5	Regulation of collecting
6	Translocation to new geographic range

Respondents listed no other current conservation practices for wildlife in aquatic systems impoundments habitat in Indiana.

Respondents recommended the following practices for more effective conservation of wildlife in aquatic systems impoundments habitat in Indiana:

- Habitat protection -- Actually, habitat enhancement by adding more woody cover to the old impoundments where the former woody cover has decomposed

One respondent stated that fish and wildlife in impoundment habitat "does not need [conservation practices]."

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

- Yes

Habitat actions

Respondents ranked the following conservation efforts by how well they address threats to aquatic systems impoundments habitat in Indiana:

Rank	Conservation efforts for impoundments habitat
1	Managing water regimes
2	Pollution reduction
3	Protection of adjacent buffer zone
4	Land use planning
5	Habitat protection on public lands
6 (tie)	Cooperative land management agreements (conservation easements)
6 (tie)	Habitat restoration on public lands
7 (tie)	Habitat protection through regulation
7 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
7 (tie)	Corridor development/protection

7 (tie) Technical assistance

Respondents listed no other conservation practices for aquatic systems impoundments habitat in Indiana.

Respondents indicated that the following conservation actions are needed for aquatic systems impoundments habitat in Indiana (not ranked):

- Improve land use practices in watershed will reduce sedimentation in impoundments and reduce nutrient inputs. Reducing nutrient inputs will allow a deeper thermocline, which is important for crappie growth. Crappie growth suffers when water temperatures become too high
- Habitat restoration in the form of woody debris
- In Army Corps of Engineers impoundments alterations in water level control would likely benefit crappie

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

- Yes

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents indicated knowledge about the following monitoring efforts conducted by state agencies for wildlife in aquatic systems impoundments habitat in Indiana (not ranked):

- Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies
- Regional or local once a year monitoring conducted by state agencies

Respondents indicated that they were not aware of any monitoring efforts conducted by other organizations for wildlife in aquatic systems impoundments habitat in Indiana.

Respondents ranked monitoring efforts by state agencies by their importance in conserving wildlife in aquatic systems impoundments habitat in Indiana:

Rank	Monitoring by state agencies for impoundments habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies

2 (tie) Regional or local once a year monitoring conducted by state agencies

2 (tie) Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies

3 Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies

Respondents did not consider monitoring efforts by other organizations crucial for conservation of wildlife in aquatic systems impoundments habitat in Indiana.

Respondents listed the following regional or local monitoring efforts by state agencies for wildlife in aquatic systems impoundments habitat in Indiana:

- IDNR - Division of Fish and Wildlife monitoring at
  - Patoka Lake
  - Hovey Lake
  - Dogwood Lake
  - Lake Sullivan
  - Many other lakes
- Many impoundments throughout the state have general fisheries survey conducted on them and crappie are caught during these

Respondents listed no regional or local species monitoring efforts by other organizations for wildlife in aquatic systems impoundments habitat in Indiana.

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

Respondents ranked current monitoring techniques for wildlife in aquatic systems impoundments habitat in Indiana:

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

Mark and recapture	X	
Professional survey/census	X	
Volunteer survey/census	X	X
Trapping (by any technique)	X	
Representative sites	X	
Probabilistic sites		X

Respondents listed no other monitoring techniques for wildlife in aquatic systems impoundments habitat in Indiana.

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

- Yes

Habitat monitoring

Respondents indicated that neither state agencies nor other organizations currently conduct inventory and assessment of aquatic systems impoundments habitat in Indiana.

Respondents considered no inventory and assessment efforts by state agencies "very crucial" for aquatic systems impoundments habitat in Indiana. However, one-third felt the following efforts were somewhat crucial (not ranked):

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

Respondents listed no inventory and assessment efforts by other organizations crucial for aquatic systems impoundments habitat in Indiana.

Respondents were not aware regional or local inventory and assessment by state agencies or other organizations for aquatic systems impoundments habitat in Indiana. Respondents listed no organizations involved in habitat inventory and assessment.

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

Respondents considered current inventory and assessment techniques for aquatic systems impoundments habitat in Indiana as follows:

Current inventory and assessment techniques for	Frequently / Occasionally	Not used but	Not economically

aquatic systems impoundments habitat	used	possible with existing technology or data	feasible
GIS mapping		X	
Aerial photography and analysis		X	
Systematic sampling		X	
Property tax estimates			X
State revenue data			X
Regulatory information			X
Participation in landuse programs			X
Modeling			X
Voluntary landowner reporting			X

Respondents noted no other inventory and assessment techniques for aquatic systems impoundments habitat in Indiana.

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

- Yes

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for wildlife in aquatic systems impoundments habitat in Indiana (not ranked):

- Electrofishing surveys
- Trap netting surveys
- Gill netting surveys
- Angler creel surveys
- Population estimates
- Reporting from harvest (angler creel surveys) - This survey will show angler exploitation
- Professional survey (fish management surveys) - This survey will show size structure, relative abundance, and provide age and growth information

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

- Yes

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for aquatic systems impoundments habitat in Indiana:

- Systematic sampling would probably be best to determine the abundance of cover that is available, but could be very difficult as most of the habitat is hidden under the surface of the water

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for aquatic systems impoundments habitats. Their responses included:

- Yes

KETTLE LAKES HABITAT NARRATIVE

Habitat description

Kettle lakes are naturally occurring standing water bodies that were formed by glacial activity.

Problems affecting species and habitats

Species threats

Respondents ranked threats to wildlife in kettle lakes habitat in Indiana:

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

Respondents identified “Disturbance by recreational boating” as an additional threat to wildlife in Kettle lake habitats in Indiana.

Respondents noted top threats to wildlife in kettle lake habitats in Indiana (not ranked):

- Habitat loss due to urbanization
- Habitats lost for breeding, feeding, and foraging
- Loss or degradation of nesting habitat

- Loss or degradation of brood-rearing and foraging areas
- Degradation of movement/migration routes

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

Habitat threats

Respondents ranked threats to kettle lakes habitat in Indiana:

Rank	Threats to kettle lakes habitats
1	Commercial or residential development (sprawl)
2	Habitat degradation
3	Habitat fragmentation
4	Stream channelization
4	Agriculture/forestry practices
4	Counterproductive financial incentives or regulations
5	Invasive/non-native species
6	Nonpoint source pollution (sedimentation and nutrients)
6	Impoundment of water/flow regulation
7	Residual contamination (persistent toxins)
7	Successional change
7	Point source pollution
8	Drainage practices (stormwater runoff)

Respondents noted no other threats to kettle lakes habitat in Indiana.

Respondents noted top threats to kettle lakes habitat in Indiana (not ranked):

- Habitat fragmentation
- Degradation of aquatic plants and wetlands around lake shorelines.
- Urban Development
- Residential development around lake shorelines
- Commercial and or residential development
- Agricultural Practices

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

Additional research and survey efforts

Current body of research

Species research

Respondents were divided equally across three responses, indicating that research about wildlife in kettle lake habitats is adequate, inadequate or nonexistent.

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

Title = Ducks, Geese & Swans of North America;
Author = Frank C. Bellrose;
Date = 1976;
Publisher = Stackpole Books

Title = Waterfowl & Wetlands an Intergarted review;
Author = Theodore A. Bookout;
Date = 1979;
Publisher = LaCrosse Printing

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

Habitat research

Two-thirds of respondents indicated that research on kettle lake habitat is inadequate with one-third suggesting that such research is nonexistent.

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

Title = Soil Survey's of Indiana Counties;
Author = U.S. Dept. of Agriculture, SCS;
Date = 1990;
Publisher = U.S. Dept. of Agriculture

Title = Management of Seasonally Flooded Impoundments;
Author = Leigh H. Fredrickson, T. Scott Taylor;
Date = 1982;
Publisher = U.S. Fish and Wildlife Service

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

Research needs

Species research

Respondents ranked research needs for wildlife in kettle lakes in Indiana:

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

One respondent stated that research was needed on “harvest” and “survival/nest success” for wildlife in kettle lakes habitat in Indiana.

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

Habitat research

Respondents indicated the research needs for kettle lakes habitat in Indiana:

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

Respondents did not list other research needs for kettle lakes habitat in Indiana.

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

Conservation actions necessary

Species actions

Respondents indicated how well conservation efforts address the threats to wildlife in kettle lake habitats in Indiana:

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

Respondents listed no other current conservation practices for wildlife in kettle lakes habitat in Indiana.

Respondents recommended the following conservation practices to enhance wildlife in kettle lakes habitat in Indiana (not ranked):

- Habitat protection (without habitat the mallard won't do well)
- Population management (makes use of surplus numbers and regulates take)
- Habitat protection (intensive)
- Reproduction and protection
- Protection of migrating routes (intensive)
- Hen houses
- Habitat conservation
- Buffer zones

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

Habitat actions

Respondents indicated how well the following conservation efforts address threats to kettle lakes habitat in Indiana:

Rank	Conservation efforts for kettle lakes habitats
1	Habitat protection on public lands
2 (tie)	Habitat protection through regulation
2 (tie)	Habitat restoration on public lands
3 (tie)	Habitat restoration incentives (financial)
3 (tie)	Land use planning

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

Respondents noted no other conservation practices for kettle lakes habitat in Indiana.

Respondents indicated that the following conservation actions are needed in kettle lakes habitat in Indiana (not ranked):

- Habitat protection through regulation (only sure way to protect habitat without public ownership)
- Purchase more public land.
- Habitat protection through regulation, (less intensive) cover a large geographic area
- Habitat Protection through incentives, (intensive), best landowner cooperation
- Landowner programs
- Buffers
- Habitat conservation regulations

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

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents indicated awareness of the following monitoring efforts conducted by state agencies for wildlife in kettle lakes habitat in Indiana (not ranked):

- Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies
- Statewide once a year monitoring conducted by state agencies

- Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by state agencies
- Regional or local once a year monitoring conducted by state agencies
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies
- Statewide year-round monitoring conducted by state agencies

Respondents indicated awareness of the following monitoring efforts conducted by other organizations for wildlife in kettle lakes habitat in Indiana (not ranked):

- Statewide once-a-year monitoring conducted by other organizations
- Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by other organizations
- Regional or local once-a-year monitoring conducted by other organizations
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations

Respondents ranked the importance of monitoring efforts by state agencies for wildlife in kettle lakes habitat in Indiana:

Rank	Monitoring by state agencies for wildlife in kettle lakes habitat
1 (tie)	Statewide year-round monitoring conducted by state agencies
1 (tie)	Statewide once-a-year monitoring conducted by state agencies
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by state agencies
1(tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by state agencies
2 (tie)	Regional or local once-a-year monitoring conducted by state agencies
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies
3	Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by state agencies

Respondents ranked the importance of monitoring efforts by other organizations for wildlife in kettle lakes habitat in Indiana:

Rank	Monitoring by other organizations for wildlife in kettle lakes habitat
1 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring conducted by other organizations

Appendix F-6: Kettle Lakes

1 (tie) Occasional regional or local (less than once a year and not regularly scheduled) monitoring conducted by other organizations

2 Statewide once-a-year monitoring conducted by other organizations

3 (tie) Periodic statewide (less than once a year but still regularly scheduled) monitoring conducted by other organizations

3 (tie) Regional or local once-a-year monitoring conducted by other organizations

3 (tie) Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations

Respondents listed the following regional or local monitoring efforts by state agencies for wildlife in kettle lakes habitat in Indiana (not ranked):

- Fish and Wildlife properties in northern Indiana
- Tri-County Fish and Wildlife Area, Division of Fish and Wildlife

Respondents listed regional or local monitoring by other organizations for wildlife in kettle lakes habitat in Indiana (not ranked):

- IDNR Division of Fish and Wildlife properties in northern Indiana
- Natural lakes
- Nature preserves

Organizations that monitor wildlife in kettle lakes habitat in Indiana include (not ranked):

- Audubon Society
- Ducks Unlimited
- Indiana Division of Fish and Wildlife
- Breeding Bird Survey

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

Respondents ranked current monitoring techniques for wildlife in kettle lakes habitats in Indiana:

Rank	Monitoring techniques for wildlife in kettle lakes habitat	Used	Not used but possible with existing technology or data
	Radio tracking and telemetry		X
	Modeling	X	

Driving a survey route	X	
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	X	
Mark and recapture	X	
Professional survey/census	X	
Volunteer survey/census	X	X
Trapping (by any technique)	X	X

Respondents listed no other monitoring techniques for wildlife in kettle lakes habitat in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in kettle lakes habitats. There were no responses.

Habitat inventory and assessment

One-third of respondents indicated knowledge of inventory and assessment efforts by state agencies for kettle lakes habitat in Indiana (not ranked):

- Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies
- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment conducted by state agencies

Respondents were not aware of other organizations that conduct habitat and inventory assessment efforts for kettle lakes habitat in Indiana.

One-third of respondents considered the following as “very crucial” by state agencies for conservation of kettle lakes habitat in Indiana:

- Statewide once-a-year inventory and assessment

Fifty-percent of respondents consider the following as “somewhat crucial” by state agencies for conservation of kettle lakes habitat in Indiana (not ranked):

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

Appendix F-6: Kettle Lakes

Respondents did not know about monitoring efforts conducted by other organizations for kettle lakes habitat in Indiana.

A respondent listed the following regional or local inventory and assessment by state agencies for kettle lakes habitat in Indiana:

- Natural lakes in northern Indiana

A respondent listed no regional or local inventory and assessment by other organizations for kettle lakes habitat in Indiana.

Respondents listed no organizations other than the IDNR Division of Fish and Wildlife as involved in inventory and assessment for kettle lakes habitat in Indiana.

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

Respondents listed current inventory and assessment techniques for kettle lakes habitats in Indiana. (No respondents listed techniques as "frequently used" or "not economically feasible.")

Rank	Inventory and assessment techniques for kettle lakes habitats	Occasionally used	Not used, but possible with existing technology and data
	GIS mapping	X	X
	Aerial photography and analysis	X	X
	Regulatory information	X	X
	Voluntary landowner reporting	X	X
	Systematic sampling	X	X
	Participation in land use programs	X	X
	Modeling	X	X

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for kettle lakes habitats. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for wildlife in kettle lakes habitat in Indiana (not ranked):

- Professional surveys or counts on F&W areas during migration periods (tracts annual migration trends and is index to population levels)

- Harvest surveys on F&W areas (tracts annual numbers taken)
- Mark/recapture banding (intensive)
- Harvest data collection (less intensive)
- Banding
- Brood surveys

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in kettle lakes habitats. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for kettle lakes habitat in Indiana (not ranked):

- GIS mapping (electronic data base of current habitat; intensive)
- Aerial photography and analysis (examine changes in habitat; less intensive)
- Spring counts (aerial)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for kettle lakes habitats. There were no responses.

LAKE MICHIGAN HABITAT NARRATIVE

Habitat description

Lake Michigan is Indiana's largest natural lake, although Indiana can only lay claim to about 1% (224 mi^2) 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.

Problems affecting the species and habitats

Species threats

Respondents ranked threats to wildlife in Lake Michigan habitat in Indiana:

Rank	Threats to wildlife in Lake Michigan habitat
1	Invasive/non-native species
2 (tie)	Viable reproductive population size or availability
2 (tie)	Specialized reproductive behavior or low reproductive rates
3 (tie)	Predators (native or domesticated)
3 (tie)	Dependence on irregular resources (cyclical annual variations) (e.g., food, water, habitat limited due to annual variations in availability)
4 (tie)	Bioaccumulation of contaminants
4 (tie)	Diseases/parasites (of the species itself)
4 (tie)	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
4 (tie)	Habitat loss (breeding range)
4 (tie)	Habitat loss (feeding/foraging areas)
4 (tie)	Small native range (high endemism)
5 (tie)	High sensitivity to pollution
5 (tie)	Regulated hunting/fishing (too much)

Respondents listed additional threats to wildlife in Lake Michigan habitat in Indiana: (not ranked):

- Commercial over exploitation resulting in low spawner stock abundance
- Egg predators predation, nutritional requirements, early mortality syndrome

Respondents noted top threats to wildlife in Lake Michigan habitat in Indiana (not ranked):

- Year class failure related to low spawner stock abundance
- Competition with non-native species for limited available food resources
- Lack of successful spawning, possibly related to bioenergetics
- Too much egg predation

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

Habitat threats

Respondents ranked the following habitat threats in Lake Michigan in Indiana:

Rank	Threats to Lake Michigan habitat
1	Invasive/non-native species
2	Residual contamination (persistent toxins)
3 (tie)	Nonpoint source pollution (sedimentation and nutrients)
3 (tie)	Habitat degradation
4 (tie)	Habitat fragmentation
4 (tie)	Point source pollution (continuing)
4 (tie)	Drainage practices (stormwater runoff)
5	Climate change

A respondent listed “competition with round goby for nearshore habitat” as an additional threat to Lake Michigan habitat in Indiana.

Respondents noted that the top threats to Lake Michigan habitat in Indiana are (not ranked):

- Identification of habitat along Indiana's nearshore area
- Competition with non-native species for habitat. Need a quality place to live that is not in competition with round goby

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

Additional research and survey efforts

Current body of research

Species research

The respondents were equally divided, indicating that research about wildlife in Lake Michigan habitat in Indiana is both adequate and inadequate.

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

Title = Preliminary Results of 2004 Ball State University Yellow Perch Research in Indiana Waters of Lake Michigan;
Author = Paul Allen and Thomas Lauer;
Date = Cctober 2004;
Publisher = Ball State University

Title = Yellow Perch Research and Management in Lake Michgian, Evaluating Progress in a Cooperative Effort, 1997-2001;
Author = David Clapp and John Dettmers;
Date = November 2004;
Publisher = American Fisheries Society, Fisheries

Title = Lake Trout Restoration Plan;
Date = In progress

Title = Lake Trout Impediments Docuement;
Author = Numerous,;
Date = 2003;
Publisher = Lake Trout Task group/LMTC

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

Habitat research

All respondents indicated that research on Lake Michigan habitat in Indiana is inadequate.

Respondents did not identify citations (title, author, date, publisher) that would give the best overview of Lake Michigan habitats in Indiana.

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

Research needs

Species research

Respondents ranked the following research needs for wildlife in Lake Michigan habitat in Indiana:

Rank	Research needs for wildlife in Lake Michigan habitat
1	Threats (predators/competition, contamination)
2 (tie)	Distribution and abundance
2 (tie)	Limiting factors (food, shelter, water, breeding sites)

2 (tie)	Relationship/dependence on specific habitats
2 (tie)	Population health (genetic and physical)
3	Life cycle

Respondents listed no other research needs for wildlife in Lake Michigan habitat in Indiana. Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the research needs for wildlife in Lake Michigan habitats. There were no responses.

Habitat research

Respondents ranked the importance of research for Lake Michigan habitat in Indiana:

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

Respondents listed no research needs for Lake Michigan habitat in Indiana.

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

Conservation actions necessary

Species actions

Respondents listed no conservation efforts that address threats to wildlife in Lake Michigan habitat in Indiana "very well." Respondents believe that these efforts protect wildlife in Lake Michigan habitat in Indiana "somewhat:"

Rank	Efforts to address threats to wildlife in Lake Michigan habitats
1 (tie)	Habitat protection
1 (tie)	Population management (hunting, trapping)
1 (tie)	Threats reduction
1 (tie)	Regulation of collecting
1 (tie)	Public education to reduce human disturbance
2 (tie)	Population enhancement (captive breeding and release)

2 (tie) Disease/parasite management

2 (tie) Limiting contact with pollutants/contaminants

2 (tie) Stocking

A respondent listed this additional conservation practice for wildlife in Lake Michigan habitat in Indiana (not ranked):

- Regulation of sport harvest
- Closure of commercial fishery to allow spawning stock biomass to increase, thus allowing for the production of offspring that can eventually add to the spawning stock biomass

A respondent recommended the following practices to enhance wildlife in Lake Michigan habitat in Indiana:

- Completely eliminate commercial fishing. This appears to have reduced the spawning stock to a level that could not maintain a fishery

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

Habitat actions

Respondents indicated that no conservation efforts address threats to Lake Michigan habitat in Indiana "very well," but the following work addresses threats "somewhat well:"

Rank	Efforts to address threats to Lake Michigan habitats
1 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
1 (tie)	Habitat protection through regulation
1 (tie)	Technical assistance
2 (tie)	Habitat restoration through regulation
2 (tie)	Land use planning
2 (tie)	Pollution reduction

A respondent indicated that "limiting disturbance through the construction permit process administered by the IDNR Division of Water" would address threats to Lake Michigan habitat in Indiana.

A respondent recommended the following for more effective conservation of Lake Michigan habitat in Indiana:

- Habitat creation, such as placement of artificial structures during lake construction projects

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation efforts for Lake Michigan habitats. There were no responses.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents are aware of monitoring efforts conducted by state agencies for wildlife in Lake Michigan habitat in Indiana (not ranked):

- Regional or local year-round monitoring conducted by state agencies
- Regional or local once-a-year monitoring conducted by state agencies
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies

All respondents are aware of the following monitoring efforts by organizations for wildlife in Lake Michigan habitat in Indiana (not ranked):

- Regional or local year-round monitoring conducted by other organizations
- Regional or local once-a-year monitoring conducted by other organizations
- Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations

Respondents ranked the importance of monitoring efforts by state agencies for conservation of wildlife in Lake Michigan habitat in Indiana:

Rank	Monitoring efforts by state agencies for wildlife in Lake Michigan habitat
1	Regional or local year-round monitoring conducted by state agencies
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by state agencies
2 (tie)	Regional or local once-a-year monitoring conducted by state agencies

Respondents ranked the importance of monitoring efforts by organizations for conservation of wildlife in Lake Michigan habitat in Indiana:

Rank	Monitoring efforts by organizations for wildlife in Lake Michigan habitat
1	Periodic regional or local (less than once a year but still regularly scheduled) monitoring conducted by other organizations
2	Regional or local once a year monitoring conducted by other organizations

Respondents listed regional or local monitoring efforts for wildlife in Lake Michigan habitat in Indiana, conducted by a state agency (not ranked):

- IDNR Division of Fish and Wildlife
  - Lake Michigan proper out of Michigan City

- Spring assessment out of Michigan City
- Fall spawning assessment, Indiana waters of Lake Michigan
- Nine-month creel survey for harvest information

Respondents listed the following regional or local monitoring efforts by other organizations for wildlife in Lake Michigan habitat in Indiana (not ranked):

- Out of Michigan City and near Gary by Ball State University
- USFWS and Illinois natural history survey egg and fry assessments at the Port of Indiana as part of a Fish and Wildlife Restoration Grant.

Respondents listed organizations that conduct regional or local species monitoring efforts for wildlife in Lake Michigan habitat in Indiana (not ranked):

- IDNR-Fish and Wildlife
- Ball State University
- University of Michigan through a coastal program grant
- USFWS
- Indiana DNR Division of Fish and Wildlife
- Illinois Natural History Survey, USFWS

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

Respondents considered current monitoring techniques for wildlife in Lake Michigan habitat in Indiana:

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

Respondents listed other monitoring techniques for wildlife in Lake Michigan habitat in Indiana (not ranked):

- Long-term monitoring through gillnets
- Trawling has been conducted at 3 sites along the Lake Michigan lakefront since the mid 1970s by Ball State University during the summer season
- Creel census has been conducted by IDNR Division of Fish and Wildlife for approximately 20 years
- Commercial monitoring was conducted until the halt of the commercial fishing industry in 1996

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in Lake Michigan habitats. There were no responses.

Habitat inventory and assessment

Respondents are aware of inventory and assessment conducted by state agencies for Lake Michigan habitat in Indiana (not ranked):

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

Respondents are aware of inventory and assessment conducted by other organizations for Lake Michigan habitat in Indiana:

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

Respondents considered no inventory and assessment conducted by state agencies as “very crucial” to monitor Lake Michigan habitat in Indiana. One of two of respondents considered “regional or local once-a-year inventory and assessment” as “somewhat crucial.” A sole respondent stated that “regional or local year-round inventory and assessment” was “slightly crucial” for Lake Michigan habitat in Indiana.

Respondents cited no inventory and assessment efforts conducted by organizations as “very crucial” for Lake Michigan habitat in Indiana. Fifty-percent respondents considered the following as “somewhat crucial” (not ranked):

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

The sole respondent believed these inventory and assessment efforts are “slightly crucial” for Lake Michigan habitat in Indiana (not ranked):

- Regional or local once-a-year inventory and assessment
- Regional or local year-round inventory and assessment

Appendix F-7: Lake Michigan

Respondents indicated the following regional or local inventory and assessments are conducted by state agencies for Lake Michigan habitat in Indiana (not ranked):

- Lake Michigan proper along the shoreline in nearshore area less than 30 feet in depth
- Habitat mapping and shoreline aerial imagery

Respondents listed regional or local inventory and assessment by other organizations for Lake Michigan habitat in Indiana:

- Lake Michigan proper along the shoreline in nearshore area less than 30 feet in depth

Respondents listed organizations involved in monitoring Lake Michigan habitat in Indiana (not ranked):

- IDNR Division of Fish and Wildlife
- U.S. Fish and Wildlife Service
- Great Lakes Fishery Commission
- Ball State University
- University of Michigan

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

Respondents considered current inventory and assessment techniques for Lake Michigan habitat in Indiana:

	Used
GIS mapping	X
Aerial photography and analysis	X
Systematic sampling	X
Property tax estimates	
State revenue data	
Regulatory information	X
Participation in landuse programs	
Modeling	X
Voluntary landowner reporting	
Other (please specify below)	

Respondents noted that no techniques fit into categories of “not used but possible with existing technology and data” or “not economically feasible.”

A respondent listed other habitat monitoring techniques for Lake Michigan habitat in Indiana:

- Bottom mapping of habitat

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for Lake Michigan habitats. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for wildlife in Lake Michigan habitat in Indiana (not ranked):

- Fall trawl sampling for young of the year production
- Possible incorporation of hydracoustic models for the near shore area
- Coded wire tags used on lake trout stocked in Lake Michigan to allow better understanding of survival after stocking and movement of the fish and of spawning site fidelity

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for wildlife in Lake Michigan habitats. There were no responses.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for Lake Michigan habitat in Indiana (not ranked):

- Lidar mapping would help identify spawning areas within the nearshore zone along Indiana's coastline
- Digital satellite imagery to conduct bottom contour mapping in nearshore spawning areas

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for Lake Michigan habitats. There were no responses.