ALL FISH IN ALL HABITATS NARRATIVE

Problems affecting species and habitats

Species threats

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

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

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

- Stream channelization
- High stream flows following spawning can seriously reduce year class strength. Reducing ditching in headwaters, installing grass waterways and WASCOBS, and maintaining riparian corridors, can reduce this threat. All of these measures will slow stream flows and reduce siltation
- Egg predation, nutritional requirements, early mortality syndrome
- Commercial fishing and overexploitation
    - Results in low spawner stock abundance
- Orangethroat darter
    - 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 species colonization include aquatic passage problems through culverts
    - Threats to the species watersheds include such as pollution, clearing of the riparian vegetation, creek gravel mining and channelization

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

- Habitat loss, destruction and degradation
    - Loss of instream cover (snagging and log removal), riparian destruction which allows water to warm and will reduce opportunity for logs and woody debris to enter stream
    - Many reservoirs are getting very old and the once abundant standing timber is now diminishing which reduces cover for white crappie
    - Channelization
    - Loss of undisturbed natural lake habitat
    - Habitat loss is serious threat to rock bass: They relate closely to structure/cover therefore any habitat loss is a threat
    - Annual and seasonal variations in habitat availability
    - Loss of 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 of riparian vegetation
    - Habitat loss due to dredging (removal of aquatic vegetation and increasing depth of ditch)
    - Degradation of stream channel will also increase the velocity of the current (if straightened or cleared of debris) which will remove tadpole madtoms' preferred current-free, quiet habitat
    - Point and nonpoint source pollution (see below)
    - Causes migration/passage problems. (See "Threats to migration/aquatic passage problems" below)

- Habitat loss or degradation, causing loss of spawning/feeding habitat

- Northern 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 instream an emergent wetland vegetation throughout the majority of the watershed
- 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
- Breeding and feeding/foraging habitat loss due to sedimentation from farm fields and stream banks as well as the removal of natural riparian vegetation
- Tadpole madtoms feed in dense vegetation and hide from predators in the leaf litter, dead wood and other cover. By removing vegetation and cover in the stream, tadpole madtoms also loses spawning areas (tadpole madtoms typically lay eggs under submerged objects)
- Slough darter prefers a mud or silt bottom with little current velocity and vegetation to deposit eggs on. They also spawn few eggs so reproduction is lower in places where vegetation is lacking
- 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
- Siltation of small headwater streams is limiting the population of southern redbelly dace because the species spawn over gravel substrates. Also, the removal of vegetation could decrease food availability to the herbivorous species. They occupy streams that have a permanent flow of clear water; thus siltation or alterations in flow regimes could also affect the species
- Degradation of nesting and staging sites: pools or riffles with slow current beneath flat rocks
- Some fish require shallow clear water with little current in weedy areas over gravel, sand, and silt to feed on insects and lay reproduce
- Pollution (see below)

- Point and nonpoint pollution; loss of water quality
  - 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
  - Possible sensitivity to pollution as indicated by some fish species rarity in the Ohio River reach in Indiana
  - Long-term declines in water quality associated with lake eutrophication
  - Nonpoint sources runoff resulting from loss of riparian buffers due to development
  - High sediment loads during spring rains
  - Runoff (increases flow of stream, turbidity and siltation of needed substrates)
  - Pesticides
  - Point sources of pollution particularly sewage and spills of chemicals being transported along roads and railroads
  - Siltation which reduces spawning areas and fills pools

  - Pollution which triggers fish kills or repels smallmouth from the area
  - Point source pollution which triggers fish kills or repels rock bass from the area
  - 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

- Low reproduction rates/reproductive issues
  - Eastern sand darter: Low reproductive rates/small populations since darters reach maturity at age one, but only live a few years
  - Lack of successful spawning, possibly related to bioenergetics; too much egg predation
  - Possible lack of reproductive success as indicated by poor length frequency distribution
  - Year class failure related to low spawner stock abundance
  - Eastern sand darter has low reproductive rates: Males reach sexual maturity at two while females can reproduce at one, and they only have a life span of about three years

- Threats to migration/aquatic passage problems
  - Orangethroat darter: Experiences aquatic passage problems through stream crossing structures
  - Water level control regimes at impoundments
  - Dams on rivers block migration

- 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

- Predation, competition and invasive species
  - 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
  - Competition with invasives, namely gizzard shad
  - Competition with non-native species for limited available food resources
  - Exotic species competition, specifically the round goby
  - Hornyhead chub experience competition from other species better adapted to muddy and silty stream conditions
  - Slough darter competes with other darters for insects and high mortality due to stagnation and freezing in the pools they desire to live in

- Harvesting
  - Overharvest by commercial anglers

  - Mortality immature or male fish as commercial by catch
  - Northern pike: Over harvest and illegal harvest (This doesn't seem to be a major threat as of now)
  - Commercial fishing
- Overpopulation

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

- Yes, however, surprised there was not direct mention of Asian Carp, they will be a major threat to juvenile fish of all type...especially in the Ohio River Basin

Habitat threats

Respondents ranked threats to all fish habitats in Indiana:

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

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

- Riparian corridor destruction
- Loss of shading
- Sedimentation
- Competition with round goby for nearshore habitat
- Dumping refuge in sinkholes; these often contain persistent toxins associated with transformers, tires, appliances, pesticide containers and electronic devices

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

- Habitat loss, alteration, fragmentation and degradation
  - Sedimentation
    - Results in smothering of substrates and turbidity
  - Channelization
    - Channelization of many streams in the upper Kankakee watershed and associated fragmentation of wetland habitat has altered severely the state of aquatic habitat in general
    - Eastern sand darter: Stream channelization will directly affect sediment transfer and microhabitat
    - Development in Ohio River drainage habitats in Indiana
    - Destruction of clear shaded waters
  - Cover/debris removal
    - Removal of debris speeds up transfer of water off the land and into the receiving stream
    - Removal of natural riparian vegetation, especially through drainage maintenance activities
  - Riparian removal/loss of riparian zone
  - Loss of high quality riffles and outside bend deep fast runs
  - Removal of vegetation and shallow water
  - Shoreline and lakebed alterations
  - Dams fragmenting habitats in Indiana
  - Loss of habitat due to development in headwater areas
  - Crappie: The natural decomposition of flooded timber and woody debris is lessening available cover for crappie. Also, siltation covers root wads left in bottom of impoundments, eliminating useable crappie cover
  - Agricultural practices causing a variety of habitat loss, pollution and degradation
    - Destruction of clear, shaded waters
  - Removal of substrate for spawning and sedimentation for covering substrate needed to spawn
  - Northern pike: Emergent bulrush and wetland habitat loss. It is well documented in northern states that northern pike prefer flooded vegetation for spawning during spring. Loss of this habitat from boating and wildlife (waterfowl and muskrat feeding) may reduce reproductive behavior for northern pike in some natural lakes
  - Pollution (see below)

- Regulation of impounded water/dams
  - Crappie: Extreme water fluctuations in mainly USACOE reservoirs can negatively impact crappie populations, especially if fluctuations occur during spawning
  - Northern pike: Bulkhead seawall development reduces emergent vegetation used by northern pike for reproduction and cover during feeding

- Successional change

- Point and nonpoint source pollution
  - Point source: 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
  - Any practices that create more erosion/sediment deposition and eliminates instream cover are serious threats
  - Water quality degradation that leads to cloudy water

    - Resulting from increasing human population in Southern Indiana and development of area
    - Caused by agricultural practices

- Competition, invasive species
    - Competition with non-native species for habitat. Need quality habitat so fish is not in competition with round goby
    - Round goby
    - Emergent bulrush

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

- nonpoint source pollution is a major threat, siltation is affecting the fisheries of Ohio River tributaries

Additional research and survey efforts

Current body of research

Species research

Thirty-eight percent of respondents stated that the current body of science is adequate for all fish in all habitats in Indiana; fifty-seven percent find the current body of science as inadequate or non-existent.

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

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 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 Shipman;
Date = 12/1997;
Publisher = DNR/Fisheries section

Title = Many in AFS journal of fish management and transactions of AFS

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.;

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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 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 = Impoundments Strategic Plan;
Author = IDNR - Fish and Wildlife;
Date = 1997;
Publisher = IDNR - Fish and Wildlife

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

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

Title = Lake Trout Restoration Plan;
Date = In progress

Title = Lake Trout Impediments Docuement;
Author = Numerous,;
Date = 2003;
Publisher = Lake Trout Task group/LMTC

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

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

Title = Distribution and status of the northern cavefish;
Author = Pearson, W. D. and C. Boston;
Date = 1995;
Publisher = Final report to IN Department of Nat. Res.Div. of F&W

Title = Age, growth and fin erosion of the northern cavefish, Amblyopsis spelaea, in KY and IN;
Author = Louis, M.;
Date = 1999;

Publisher = Unpubl. M.S. Thesis, University of Louisville

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

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 fish in all habitats. Their responses included:

- There seems to be limited data on fish communtiy health in large river tributaries cited. I know we have a good handle on the reserviors, what about the large creeks on the Ohio River like in the Cannelton Pool

Habitat research

Thirteen percent respondents stated that the current body of science is adequate; eighty-three percent found it inadequate or nonexistent for all fish habitats in Indiana.

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

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 = A survey of fish communties and aquatic habitats at Indiana's major streams with emphasis on smallmouth bass distribution and abundance.;
Author = Stuart T. Shipman;
Date = December 1997;
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Title = Surveys of the fish communities and aquatic habitats in 16 small streams in Indiana from 1996 through 1997.;
Author = Douglas C. Keller;
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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 = Cisco population status and management in Indiana;
Author = Jed Pearson;
Date = 2001;
Publisher = Division of 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 = 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 = Ohio River Mainstem Study;
Author = USACOE;
Date = 2000?;
Publisher = USACOE

Title = Ohio River Mainstem Study;
Author = USACOE;
Date = 2000?;
Publisher = USACOE

Title = Cave adaptation in Amblyopsid fishes;
Author = Poulson, T.;
Date = 1963;
Publisher = Amer. Midl. Nat. 70(2):257-290

Title = A faunal inventory of subterranean streams using a modified index of biotic integrity;
Author = Jones, T.G.;
Date = 1997;
Publisher = Unpubl. Ph.D. Disst. University of Louisville

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 fish habitats. Their responses included:

- Need more recent smallmouth info

Research needs

Species research

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

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

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

- How to produce more, larger crappie
- Limiting factors and impacts of competition and predation
- Continued research on movement and survival as part of rehabilitation strategy
- Determine population limiting factors in Ohio River
- Population persistent
- Impact of commercial harvests
- Metapopulation dynamics
- Extent of populations in subterranean systems which cannot be entered by humans

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

Habitat research

Respondents ranked research needs for all fish habitats in Indiana:

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

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

- Water quality variations and impacts of land use and shoreline alterations
- Water quality requirements
- Cavefishes
  - Assessment of the physical dimensions of the phreatic environment available to cavefishes, and the connections between known windows into the system.
  - Toxin concentrations in cave sediments and their recruitment rates into underground waters
- Effects of roads and stream crossings on some fish; 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 all fish habitats. Their responses included:

- I think land use changes are of high priority

Conservation actions necessary

Species actions

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

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

Respondents noted other current conservation practices for all fish in all 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 add to the spawning stock biomass

- Hornyhead chub
  - To greatly reduce turbidity in streams for hornyhead chub feeding and breeding behaviors
  - Exotic/invasive species control
  - Limiting contact with pollutants/contaminants
  - Control regulation of collecting since hornyhead chub is a popular bait fish

- Orangethroat darter
  - 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 all fish in all habitats in Indiana (not ranked):

- Pollution/contaminants control and reduction
  - Includes activities of wastewater treatment plants and confined feeding operations
  - See “Habitat protection” (below)

- Habitat protection, restoration, enhancement and management
  - Add more woody cover to old impoundments where former woody cover has decomposed
  - Continue stocking for rehabilitation efforts
  - Cisco: Greatly limit/mitigate new development on cisco lakes, particularly addressing runoff from lawns and other lawn quality issues
  - Cisco: Work with farmlands adjacent to cisco lakes to use no-till practices
  - Protect habitat through land use regulation
  - Protect migration routes
  - Implement ecozones in undeveloped areas to conserve vegetation present
  - Acquire and protect a reserve at Blue Spring Caverns
  - Erosion controls
  - Declare moratorium on channel/drainage “improvement” projects that do not mitigate losses
  - Eastern sand darter: Reduce sedimentation covering sand substrate
  - Restore stream channels so that riffle habitats are protected and enhanced
  - Restore riparian vegetation to protect stream channels from runoff or impacts
  - Maintain road and stream crossing so that stream channel function and aquatic passage are maintained

- Create/maintain aquatic passage for fish and other species

  - Northern pike: Restore connection between streams and wetlands that were formerly associated with them to allow pike access to spawning areas. Current water regimes often rely on pumping to fill restored wetlands, thus fish passage is still restricted

- Harvest/collecting management and regulation; limit human disturbance
  - Completely eliminate commercial fishing. This appears to have reduced the spawning stock to a level that could not maintain a fishery
  - Implement a catch-and-release only regulation in lakes with low densities
  - Limit public access to population concentrations already under agency control at Spring Mill State Park and Harrison-Crawford State Forest

- Public education
  - To reduce habitat disturbance
  - To reduce agricultural runoff
  - To teach land use planning

- Continue stocking for rehabilitation efforts
  - Change genetic suite of strains to be stocked; utilize at least one deep water strain

- Control predators/invasive species
  - Cisco: Assure there is no stocking of predators in cisco lakes
  - Make possession of exotic species illegal (must dispose of fish properly and not release back into stream)

- 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 of all fish in all habitats. Their responses included:

- We always support increasing habitat and reducing non point source pollution.

  From a stocking standpoint, our members would like to have more opportunities to catch smallmouth and spotted bass out of our reserviors....there seem to be plenty of wipers and hybrids...lets stock bass

Habitat actions

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

Rank	Conservation efforts for all fish habitats
1	Pollution reduction
2	Protection of adjacent buffer zone
3	Corridor development/protection
4	Habitat restoration incentives (financial)
5	Habitat protection incentives (financial)

6 (tie)	Cooperative land management agreements (conservation easements)
6 (tie)	Habitat restoration through regulation
7	Managing water regimes
8 (tie)	Restrict public access and disturbance
8 (tie)	Habitat protection through regulation
9 (tie)	Habitat restoration on public lands
9 (tie)	Land use planning
10	Habitat protection on public lands
11 (tie)	Technical assistance
11 (tie)	Artificial habitat creation (artificial reefs, nesting platforms)
11 (tie)	Succession control (fire, mowing)

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

- Closing and/or year around gating of caves with large populations of hibernating or reproducing bats will ensure normal trophic cascades for those systems
    - Restricting recreational caving in some caves might reduce periodic disturbances, increases in turbidity, and remobilization of toxins in sediments.
- Eastern sand darter, hornyhead chub (and other species)
    - Habitat protection
    - Restore flood plain to reduce sedimentation reaching stream beds
    - Manage water regimes to reduce settling of sediments in stream (thus dam removal may be appropriate)
    - Protect adjacent buffer zone to stop deleterious effects of erosion and sedimentation in the stream
    - Land use planning and conservation easements to minimize runoff

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

- Habitat protection, restoration and management
    - Create and protect buffer strips and adjacent buffer/riparian zones
    - Stabilize banks
    - Protect corridors
    - Create woody debris/instream cover
    - Through regulation
    - Reduce point and nonpoint pollution
    - Determine and create critical habitat
    - Minimize fragmentation
    - Create artificial structures during lake construction projects
    - Protect and restore riffles
    - Implement ecozones in undeveloped areas to conserve vegetation
    - Reduce inlet and upstream degradation

  - Establish a reserve at Blue Spring Cavern
  - Restrict dredging
  - Restrict removal of debris
  - Restore and stabilize streambanks and streams (reconstruct channels to reconnect to its natural floodplain elevation)
  - Restore riparian vegetative communities through tree planting, etc.
  - Improve culverts or stream crossing structures (replace non-functioning culverts or other crossing structures and replace wit ones that function and are at the right elevation/location within the streams longitudinal profile

- Create financial incentives/conservation easements
  - To protect habitat
  - For land use planning
  - Riparian conservation easements
  - Obtain conservation easement/agreements with selected cave owners in Orange, Washington, Lawrence and Harrison counties

- Improve land use practices/education
  - To reduce sedimentation in impoundments and reduce nutrient inputs
  - To maintain riparian buffer strips since most headwater areas run through agricultural areas
  - Reduce nutrient inputs: This would allow a deeper thermocline important for crappie growth
  - Land use rezoning
  - Increase awareness and cooperation of landowners to create better shoreline and tributary habitat

- Manage water regimes
  - In USACOE impoundments, alterations in water level control would likely benefit crappie
  - Need to move toward natural regulation of water levels instead of artificial means

- Manage/create aquatic passage/reduce habitat fragmentation
  - Restore wetlands with connectivity to stream or corridors, allowing passage to wetlands

- Reduce human disturbance
  - Restrict entry to selected caves at Harrison-Crawford State Forest

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

- yes, the idea of creating financial incentives for all types of habitat improvement or conservation is important

Proposed plans for monitoring

Current monitoring

<u>Species monitoring</u>

Appendix F-75: Fish

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

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

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

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

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

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

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

Rank	Monitoring efforts by other organizations for conservation of all fish in all habitats
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

4 Statewide year-round monitoring

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

6 Statewide once-a-year monitoring

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

8 Regional or local year-round monitoring

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

- General locations listed for a variety of species monitoring
  - Wabash River
  - West Fork - White River
  - East Fork - White River
  - Ohio River
  - Patoka River watershed
  - Blue River (Harrison County)
  - Sugar Creek (Shelby County)
  - Indian Creek (Greene County)
  - Patoka Lake
  - Hovey Lake
  - Dogwood Lake
  - Lake Sullivan
  - Wabash River, Lafayette area, annual spring monitoring; occasional stream surveys
  - Newburgh and McApline Tailwater fall/winter annual monitoring
  - Stream surveys

- IDNR Division of Fish and Wildlife monitoring efforts
  - Spring assessment out of Michigan City
  - Fall spawning assessment, Indiana waters of Lake Michigan
  - Nine-month creel survey for harvest information
  - DNR fishery surveys are occasionally conducted on the Iroquois River, the Yellow River, and the Kankakee River
  - IDNR periodically conducts fish stream surveys
  - Headwater streams surveys were conducted in 2001 through 2004 by Lake Michigan Fisheries Office

- 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 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 of the eastern sand darter
- Tracking study conducted in two Indiana natural lakes in the late 1990s IDNR to better understand reproductive habitat of northern pike
- Northeast Indiana studies (Jed Pearson)
- IDEM/DNR Nongame program also conduct fish monitoring during the field season. These above fish surveys are not specific to the orangethroat darter, but would include the darter
- IDEM and IDNR collect fish community samples in this area; thus, they may have data on the distribution of least darters
- Northern Pike are monitored via general fish surveys conducted to update lake status. There is now monitoring of northern pike on a general schedule
- Monitoring cisco at cisco lakes
- Largemouth bass
  - Division of Fish and Wildlife standardized largemouth bass sampling protocols
  - Tournament fishing monitoring by the Division of Fish and Wildlife
- Smallmouth bass
  - 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. The goal was to determine smallmouth bass population changes due to the imposition of a 12-inch black bass size limit in 1998
- Crappie: Many impoundments throughout the state have general fisheries survey conducted on them; crappie are caught during these
- See IDNR Fisheries Section work plans

- Indiana Department of Environmental Management monitoring
  - Cisco: Department of Environmental Management water quality monitoring
  - Eastern sand darters: IDEM occasionally collected eastern sand darters as part of their Surface Water Quality Monitoring Strategy evaluating fish community structure in certain watersheds every five
  - IDEM conducts stream health surveys using fish and invertebrates
  - IDEM occasionally samples fish for contaminants analysis for the annual Fish Consumption Advisory
  - IDEM annual ecoregion sampling
  - IDEM probabilistic sampling
  - Horneyhead chub: 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 and IDNR collect fish community samples in this area; thus, they may have data on the distribution of least darters
- Tadpole madtoms: 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
- IDEM Office of Water Quality's Surface Water Quality Monitoring Strategy and project work plans and IDNR Fisheries Section Work Plans
- Southern redbelly dace: 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 any one state or other organization
- Orangethroat darter: IDEM and the DNR Nongame program conduct fish monitoring during the field season. These above fish surveys are not specific to the Orangethroat Darter, but would include the orangethroat darter

Respondents listed regional or local monitoring <u>by other organizations</u> for all <u>fish</u> in all habitats in Indiana (not ranked):

- West Fork – White River and tributaries (Muncie area)
- 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
- In some cities, stream health also is assessed by fish and invertebrate surveys
- Ohio, White and Wabash rivers
- Wabash River
- Ball State University fish sampling near Michigan City and Gary
- University of Louisville has been monitoring the Northern Cavefish at irregular intervals and locations in Southern Indiana since 1994
- City of Elkhart and St. Joseph counties
  - Elkhart Public Works and Utilities has a fisheries biologist on staff to actively collect fish community samples from the Great Lakes Basin (one to two times per summer). He may have data on hornyhead chub as well
- 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. (Please 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
- Consulting firms
- 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 all fish in all habitats in Indiana (not ranked):

- IDNR – Division of Fish and Wildlife
- Bass fishing clubs that hold tournaments on Lake Wawasee and Syracuse Lake
- Muncie Bureau of Water Quality
- Illinois Natural History Survey
- U.S. Fish and Wildlife Service
- IDEM
- Purdue University
- Ball State University
- Southern Illinois University
- University of Louisville, Biology Department
- University of Michigan through a coastal program grant
- City of Elkhart (Elkhart and St. Joseph counties)
- Cinergy and other electric utilities
- USDA Forest Service
- U.S. Environmental Protection Agency
- USGS Water Resources Division
- Ohio River Valley Water Sanitation Commission
- Midwest Biodiversity Institute
- U.S. Army Corps of Engineers
- Soil and Water Conservation Districts
- Wildcat Creek Watershed Alliance

Appendix F-75: Fish

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

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

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

- Larval sampling to check for reproduction
- Long term monitoring through gillnets and trawling has been conducted at three sites along the Lake Michigan lakefront since the mid 197's by Ball State University during the summer season.
- Creel census conducted by IDNR-Fish and Wildlife division for approximately 20 years
- Commercial monitoring was conducted until the halt of the commercial fishing industry in 1996
- Delury or survey/removal techniques have been used at Donaldson Cave in the 1990s
- 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 lumping them into the generic class of "round bodied suckers"
- 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 techniques for all fish in all habitats. Their responses included:

- Seems thorough…how easily can the public obtain this info

Habitat inventory and assessment

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

Rank	Inventory and assessment by state agencies for conservation of all fish habitats in Indiana
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	Regional or local once-a-year inventory and assessment
5	Periodic statewide (less than once a year but still regularly scheduled) 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

Rank	Inventory and assessment by other organizations for conservation of
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	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
5	Regional or local year-round 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 fish habitats in Indiana (not ranked):

- West Fork - White River; East Fork - White River; Wabash River

- Blue River (Harrison County), Sugar Creek (Shelby County), Indian Creek (Greene County)
- Blue River (Harrison County)
- By IDNR Division of Fish and Wildlife, Indiana Department of Environmental Management, City of Elkhart, statewide QHEI
    - For sand darter
    - For least darter
- 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
- Northeast Indiana, IDNR – Division of Fish and Wildlife, Jed Pearson
- Habitat mapping and shoreline aerial imagery.
- Lake Michigan
    - In all major tributaries
    - Along the shoreline in nearshore area less than 30 feet in depth
- IDNR Division of Fish and wildlife in this drainage habitat in Indiana
- Habitat evaluations are conducted as part of general stream surveys by DNR biologists. Such surveys have been conducted on the Iroquois, Yellow and Kankakee rivers
- Trail Creek, East Branch of Little Calumet River, Reynolds Creek, Salt Creek, West Branch of Little Calumet River Deep River
- IDEM ecoregion surveys
- ORSANCO

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

- West Fork - White River; East Fork - White River; Wabash River
- Muncie BWQ - WFWR and tributaries in the Muncie area
- St. Joseph River
- Lake Michigan proper along the shoreline in nearshore area less than 30 feet in depth
- City of Elkhart
- USACOE on Ohio River
- Hoosier National Forest; Harrison-Crawford State Forest; Spring Mill State Park; caves of south-central Indiana
- USGS/WRD
- 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 all fish habitats in Indiana (not ranked):

- IDNR – Division of Fish and Wildlife
- USFWS/GLFC
- IDEM

- City of Elkhart and South Bend
- Ball State University
- University of Michigan
- USACOE Ohio River
- USDA Forest Service
- University of Louisville

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

Inventory and assessment techniques for all fish habitats	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	--	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 fish habitats in Indiana (not ranked):

- QHEI
- Bottom mapping of habitat
- IBI for representative sites
- REMAP protocols for northern forested streams
- Stream channel cross-sections and longitudinal profiles
- Substrate analysis
- Descriptions of riparian vegetation
- Water quality parameters 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 all fish habitats. Their responses included:

- yes, but again I feel data availability and format is important

Recommended monitoring

Species monitoring

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

- Electrofishing
  - Catch rate data
  - In swift water habitats
  - Periodic electrofishing surveys and mark recapture techniques probably provide the best information about the pike populations
  - Get results from probabilistic and representative sites
- Stream sampling using electrofishing techniques and seining. This should be done every 5 years to get a clear picture of changes that occur to habitat, water quality and invasive species introductions and distribution
- Mark and recapture/radio telemetry
- Hoop nets (by scientists and professional fishermen)
  - To verify presence followed by intensive netting to confirm low levels or absence
- Trap netting surveys
- Gill netting surveys
- Kick netting
- Seining
- Population estimates
- Angler creel surveys
- Professional survey (fish management surveys) will show size structure, relative abundance, and provide age and growth information
- Tournament monitoring by the Indiana Division of Fish and Wildlife and bass clubs
- I would like to see all 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
- Monitor commercial catch (Quist, M.C., C.S. Guy, P.J. Braaten, C.L. Pierce, and V.H. Travnichek. 2002. Potential influence of harvest on shovelnose sturgeon populations in the Missouri River system. North American Journal of Fisheries Management 22:537-549)
- Fall trawl sampling for young of the year production. Possible incorporation of hydracoustic models for the nearshore area
- 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
- Fall/winter Ohio River tailwater sampling and occasional stream surveys
- Periodic stream surveys
- 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

- Cavefishes
  - Development of an index of biotic integrity (IBI) for vertebrate cave communities in southern Indiana
  - Select five to 10 locations for survey/counts every two to five years. A similar survey schedule has been established for cavefish populations in Mammoth Cave National Park and could be used as a model (both IBI and survey)
- Eastern sand darter: See where populations of the darter have been captured in the past. With seines or electrofishing equipment, mark and recapture darters to document habitat characteristics, water quality information and land use characterization. You will need to target 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
- 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
- Orangethroat darter
  - Electrofishing streams to 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 an appropriate method for sampling, especially in the riffle habitats
- Least darter: Survey representative sites or look for sites where the habitat is suitable for the least darter and seine in the vegetation over rocky substrate

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

- yes

Habitat inventory and assessment

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

- GIS
- 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
- 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
- Digital satellite imagery to conduct bottom contour mapping in nearshore spawning areas.

- Record habitat when fish are collected during a survey
- Systematic sampling of the habitat along the length of the stream to provide baseline data for comparison across time
- Telemetry Surveys
- Lidar mapping would help identify spawning areas within the nearshore zone along Indiana's coastline
- Sampling using electrofishing and seining in headwater areas. Completing IBI and QHEI and water quality analysis for these sites.
- 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
- Population surveys every five years and development of an IBI to be applied at five to 10 locations, including Blue Spring Caverns, Spring Mill State Park and Harrison-Crawford State Forest
- Orangethroat darter: Protocols that I recommend for reference:
    - 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 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)

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 fish habitats. Their responses included:

- we need a simple on-line system for bass tournament directors to submit catch information...easy data to acquire bass info

Technical experts and conservation organizations offered the following additional comments:

- Smallmouth and spotted bass seem to get little attention in our resevior system, and many anglers would enjoy the opportunities these fish provide

  We also see Asian carp as a serious threat to the Ohio River fishery and the fishermen themselves. These carp are dangerous to the native fish and to boaters. Is there anything that can be done?