Chapter 4:
Methods for the Collection of Fish Assemblage Information based on Electrofishing and the Traveling Zone Study Design

TABLE OF CONTENTS

4.0 INTRODUCTION

4.0.1 Background

An accepted method of determining the effect of an outfall on a stream was to compare the impacted area to an upstream, unimpaired "reference" condition. This method can work well and can be very effective in determining the extent of an impairment, but it also has several drawbacks that researchers need to account. Primarily, the upstream site must reflect what the unimpaired study area conditions should be. Researchers should consider the importance of changes in microhabitat features (i.e., substrate type, depth, stream morphology) within the study area and the upstream reference area, carefully matching these conditions as closely as possible. We account for this variability by conducting a detailed examination of the microhabitats of the outfall zone. Based on the requirements of 316(a), it is not necessary to evaluate or match upstream locations since reference conditions have already been established for the mainstem rivers of the Wabash and White rivers, Ohio River, and inland lakes.

A limitation of the upstream/downstream comparison is that of multiple impairments. It is often difficult, particularly in large and great rivers, to find an upstream reference site that matches the habitat of a study area, yet is not impacted by another outfall (Dufour et al. 2003). It is common also for the study area itself to be impacted by multiple dischargers (Emery et al. 2003). Isolating the affect of one particular effluent in an area where several outfalls can sometimes be found within a 500 m segment of a great river can be very difficult using a typical upstream/downstream study. However, using the T-zone method it is possible to detect change in the biological community at the site of each impairment.

4.0.2 Scope

A technique for evaluating fish community response, applicable for situations where the zone of impairment is too small to be adequately represented by a standard sized boat-electrofishing zone was developed by Emery and Thomas (2003). This approach is known as the traveling zone (T-zone). By collecting data in 100 m increments along a continuous 1000 m, they were able to construct traveling zones, or T-zones, each 500 m in length and incrementally move them 100 m further from the point of impact. This technique has been modified for sampling heated effluent impacts from power generating facilities and requires the sampling effort equivalent of two standard sized boat-electrofishing zones, but provides results that are equivalent of six standard sized boat-electrofishing zones. This overlapping technique provides 100 m resolution, increasing the ability to assess community response usually overlooked by standard 500 m zones. This method is to be used for sampling outfalls in large and great river, lake, and Great Lake nearshore sites.

4.1 METHODS

4.1.1 Fish Collection Methods

I. PURPOSE

To describe methods for sampling fish assemblages in large and great river, lake, and Great Lake nearshore sites using DC electrofishing equipment for the purpose of developing biological criteria and assessing water quality. This method is based on Emery et al. (2003), Wang et al. (1998), Simon (1998), and Thoma (1999).

II SCOPE/LIMITATIONS

This procedure applies to all sites that will be sampled for fish communities for assessing thermal discharges in large and great river, lake, and Great Lake nearshore sites. Data for this analysis will include collecting data on fish community composition, species richness, CPUE, and DELT anomalies based on ten (10), 100-m reaches that are distributed along the discharge plume.

III GENERAL INFORMATION

The methods described in this assessment are to be applied to all large and great river, lake, and Great Lake nearshore sites sampled for assessing thermal discharges. In addition, this method can be applied to assessing any type of discharge, assuming that the plume characteristics of the stream can be determined by an instantaneous measure (see Chapter 2), or the stream width is not of sufficient size to warrant differences along different shores. If shoreline differences are suspected but immeasurable using an instantaneous measurement device, then both shores can be sampled and appropriate water chemistry samples taken and analyzed at a later time so that pattern correlates can be compared. Although the reasons for visiting a particular site may vary, the fish sampling procedures in this document applies to all site types unless otherwise noted. This procedure must be implemented simultaneously with an assessment of habitat (Chapter 3), and water temperature (Chapter 1 & 2) for an assessment of thermal discharges.

IV REQUIREMENTS

Personnel conducting this procedure must be capable of operating electrofishing equipment, be certified to operate boats, and be capable of identifying freshwater North American fish species. In addition, the personnel must have excellent map reading skills and demonstrate proficiency in the use of a GPS receiver and an orienteering compass. Because sites may be located miles from the nearest road, it is often necessary to wade

through wetlands, canoe or boat, or hike for long distances overland to reach a site. Personnel conducting this procedure must have the physical ability to accomplish this task. The station summary form (appendix A) must be used to record pertinent information for each site visit.

A. Qualifications of crew leaders: The crew leader must be a professional aquatic biologist with a minimum of a Bachelor of Science degree in biology with an aquatic entomology, invertebrate zoology, fisheries, or closely related specialization. Additionally, they must have at least six months experience working under a fish biologist in the areas of community sampling methodology and taxonomy.

B. Qualifications of field technicians - interns: A field technician must have at least one year of college education and coursework in environmental and/or biological sciences.

V. RESPONSIBILITIES

A. Field Crew leader: Ensures that data generated under this procedure meets the standards and objectives of the integrated condition monitoring program. Carry out the procedures outlined in the action steps.

B. Technical personnel: Carry out the procedures outlined in the action steps including equipment stocking, calibration of equipment, data collection, and recording. Personnel must be attentive to following instructions and be capable of expressing themselves when information is not understood.

VI. QUALITY ASSURANCE AND QUALITY CONTROL

Compliance with this procedure will be maintained through annual internal reviews. Technical personnel will conduct periodic self-checks by comparing their results with other trained personnel. Calibration of equipment will be conducted according to the guidelines specified in the manufacturers manuals.

In addition to adhering to the specific requirements of this sampling protocol and any site supplementary specific procedures, the minimum QA/QC requirements for this activity are the following:

A. Control of deviations: Deviation shall be sufficiently documented to allow repetition of the activity as actually performed.

B. QC samples: Ten percent of all sites sampled within any given year are resampled as a means of determining sampling error.

C. Verification: The field crew leader will conduct periodic reviews of field personnel to ensure that technical personnel are following the procedures according to this SOP.

VII TRAINING

A. All personnel will receive instruction annually from a trainer designated by the program manager. Major revisions in this procedure will require that all personnel be retrained in the revised procedure by an authorized trainer.

B. The responsibility of the field crew leader includes training activities that will include instruction in the field, as well as, a field test to ensure that personnel can successfully implement this procedure. The crew chief should be boat operator certified.

VIII. ACTION STEPS

A. Equipment list

Ensure that the following items are present before implementing this procedure.

Boat (and necessary equipment—e.g., throw cushions, personal floatation device [for each passenger], whistle, paddles, anchor, gasoline, tool box, and appropriately rated boat motor
DC electrofishing unit including miscellaneous parts and pieces (generator and VVP unit)
3/16 inch mesh dip nets
Appropriate sized scales and fish board (preferably in metric units for length and weight)
Two buckets and miscellaneous sorting chambers (capable of holding water)
Station Summary form, previously completed with attached copies of 1: 24,000 USGS topographic maps
Latitude and longitude and Geographic Positioning System device
County platt maps
State specific atlas and Gazateer (Delorme)
Aerial photographs
Pencils/Blunt-tipped Sharpies
Permanent/Alcohol proof markers
Labeling tape
Fish sample identification labels
10% formalin, enough to preserve one days worth of samples, ca. 4 L/site
Waterproof notebook incl. data sheets & permits (water temperature form, fish field sheets, collection permit)
Chest-high waders and Rain-gear
Habitat gear (meter tape or hip chain, densitometer, Philadelphia rod)
10-20 Jars or bottles, in which the sample is to be preserved; preferably non-breakable synthetic, minimum 1 L capacity (“A” and “B” jars) including labels (interior & exterior)

Box or crate to store sample bottles
Canoe or stream shocker (including gloves, ear protection)
GPS receiver, battery, and antenna
Flagging
Cellular telephone and first aid kit
35 mm camera and 35 mm slide film

B. Data collection method

The objective of assessing point source discharge plumes is to determine if impairments are occurring to the biological indicator that has been specifically designed to measure various large and great river, lake, and Great Lakes nearshore systems. The project will (1) document the current downstream discharge conditions, determine zones of recovery, and establish the instantaneous pattern of the outfall discharge plume.

Fish field sampling methods:

All fish collected will be identified to species, enumerated, examined for external anomalies, and either returned to the lake or preserved as voucher specimens and stored at the Indiana Biological Survey Aquatic Research Center Museum. Weights will be based on sorted species samples that are batch weighed. Each site will have a instantaneous measure of temperature taken prior to sampling (see Chapter 2) and habitat data sheet filled out for each 500 m reach (see Chapter 3).

Electrofishing consistently catches more species and individuals in less time and effort than other sampling methods used. It is the only method that can be used under all habitat conditions thus yielding a database that was easily comparable (in terms of catch/effort) under the variable conditions encountered. Previous Ohio EPA (Thoma 1999) work indicated that night electrofishing would likely capture more species and individuals than day electrofishing. Both day and night collections have been made on Great Lake nearshore sites and results have been compared for Ohio River mainstem sampling (Simon and Emery 1995; Simon and Sanders 1999;). **NOTE: Sampling on the Ohio River is based on night electrofishing methods, while data for the Wabash and White rivers, inland lakes, and Great Lakes nearshore are based on day electrofishing methods. These procedures must be followed in order to use the established reference conditions.**

General electrofishing methodologies for Inland Lakes, Nearshore Great Lakes, Large- , and Great Rivers

A 3.5-5.8-meter modified V-hull john boat will be used for electrofishing in nonwadeable riverine, inland lakes, and Great Lake nearshore sites. For small wadeable riverine wetlands where a boat cannot navigate, a back pack Smith-Root electroshocker will be used. Electrical current will be provided by a 3,500-7,000 watt generator and Smith-Root pulsator. Controls will be set on DC current, 60 pulses per second, 240-340 volts, and run at 5 to 6 amps. In low conductivity conditions the voltage will be adjusted in order

to maintain 2 to 2.5 amps. Anodes will be either a single or two separately charged 1 m circumference electrospheres while in low conductivity conditions a 20 dropper array will be used.

Each sampling site will be 500 meters long and the method will be deployed in water depths less than 1 meter. A set sampling time will not be used and time may vary between 1,800-5,000 seconds and will be dependent on habitat complexity. The greater the number of fish to be captured in the zone and the greater the complexity of the shore line the longer it will take to complete the sample. A crew of two active individuals will be used in all electrofishing efforts. During sampling one individual will be positioned on the bow of the boat with a dip net with 3/16 inch bar mesh and serve as the principal collector of fish captured in the electrical field while the second person will operate the outboard motor, pulsator controls (and spot lights at night), and collect any fish that surface at the back of the boat. Additional people can be rotated as principal netter so that a fresh person can be available for each 100-m zone. All fish will be placed in livewells supplied with fresh water. Common carp will be placed in their own livewell to avoid excess oxygen consumption and the death of small fish that otherwise would frequently be trapped in common carp mouths and crushed.

General electrofishing methodologies for Great Lakes

The anode and cathode array deployments used in this study will be different from those used in previous sampling efforts. Anodes will be two separately charged electrospheres (Great Lakes nearshore), 1 m in circumference, and constructed with 2 stainless steel bowls bolted together. The anodes will be suspended 5 cm below the surface, 2.1 m in front of the boat on articulated booms, one to each side. Two sets of cathodes, each set to be used at different depths, will be used. All had electrified portions 1.6 m in length. The cathode sets were designed to be deployed with the electrified surface at a maximum of 1.8 m and 3 m. Cathodes, 1.8 m long, will be used under all conditions where bottom depths are 2.5 m or less and 3 m cathodes will be used in depths greater than 3 m. Cathodes will be deployed from the sides of the boat at mid-ship, four on each side.

Sampling will be conducted when winds are generally from off shore and wave action is 0.6 m or less. Winds resulting in waves greater than 0.6 m prevent effective sampling, especially at nearshore Great Lake sites. If winds are from the southwest, zones will be sampled from the west to the east. If winds are from the south east, zones will be sampled from the east to the west. This will allow the boat and stunned fish to move with the shoreline currents. After periods of sustained on-shore winds and heavy wave action, sampling will be avoided to allow for stabilization.

Day Sampling Methods for Inland Lakes, Large Rivers, Great Rivers (other than Ohio River), and Great Lake Nearshore Coastal wetlands

All habitat types will be sampled with day electrofishing in large and great rivers, and inland lakes. For the most part, the sampling techniques employed are the same as those used in Ohio EPA stream sampling efforts (Ohio EPA 1988) except for the following

differences; electrosphere anodes, cathode array and depth, two person sampling crew (as described above), and site selection based on habitat type.

Night Sampling Methods for the Ohio River

All night collections will be made at least 30 minutes after sunset and before 5:00 AM. Above surface lights will be used during night sampling. Six 12-volt tractor flood lights will be mounted on the bow 1 m above the water. Four 12-volt tractor flood lights mounted at the stern, 1 m above the surface, two on each side of the boat will illuminate the sides of the boat aft of the bow. One light will be directed forward and the other perpendicular to the side. A hand held spot light will be used to search for stunned fish outside these illuminated areas (especially behind the boat) and to scan the shoreline. When sampling is completed, four 12-volt tractor flood lights mounted on a transverse beam at the stern of the boat and directed at the sample processing area were used to process the sample. All lights will be powered by 12-volt, deep cycle marine batteries during sample processing and while sampling, powered by the electrofishing generator.

B.1 **General sampling procedures** - Mean wetland width (MWW) is used to define the length of the station in riverine sites, the distance from the station to unusual features or disturbances (e.g., bridges, etc.), and for inland lakes and Great Lake nearshore the standard length will be a 500 m zone. For most sites on large and great rivers a standard zone is the maximum distance of 500 m. Once the MWW for a station has been determined, this value is used for all future sampling, including future years when riparian land use or other factors may have changed the actual site width.

Great Lake Nearshore Sampling Procedures

If the water level appears to be substantially (> 0.15 m) above normal, sampling should not occur (see Station Summary). Fish Habitat Evaluation, for determination of water levels) and will require a revisit of the site when appropriate conditions exist.

Sampling Methods for Inland Lakes, Large Rivers, Great Rivers (other than Ohio River), and Great Lake Nearshore Coastal wetlands

Sampling stations distances for riverine wetlands are **35 times** the MWW in length. The **minimum sampling distance for riverine sites is 150 m while the maximum length is 500 m**. This length is based on the distance necessary to capture most species present and is based on a desire to sample >3 habitat cycles. In **inland lakes and Great Lake nearshore habitats, the sample distance is 500 m and the number of zones will be based on the open wetted surface area** of the waterbody.

Each station starts and ends at the prescribed distance from the X-point irrespective of placement. Thus, **stations can only be moved 26 m** to avoid the influence of a beaver dam, dry site condition, or an impoundment. Stations can be somewhat less than 35 times

the MWW in length. Based on US EPA protocols for EMAP methodology, a minimum of 50% of the stream width must be sampled for a site to be considered valid. Stations should not contain permanent tributaries or hydraulic controls within the middle of a sampling zone (e.g., dams, old bridges abutements). This generally will not be a concern for thermal discharge sampling, but may be important for other compliance sampling events on wadeable and small rivers.

General Procedures for Collection at all Sites

Habitat should be checked against the recorded QHEI field sheet each time fish are sampled. For each 1000 m, two QHEI data sheets should be completed. One for the first 500 m (0-500 m) and a second for the remaining distance (500-1000 m). Any changes in habitat quality should be noted on the datasheet based on the date observed. Since sampling is conducted repeatedly in the same year it would be infrequent that changes in the QHEI would occur between sampling events. Sampling of fish is done in the same site reach that is sampled for habitat. The first 100-m zone should be positioned immediately below the legal discharge point for the facility. This is usually at the mouth of a cement channel or constructed discharge point where it enters the main waterbody.

Fish community composition and species relative abundance are estimated over the entire length of each station (ten (10), 100-m segments) using catch-per-unit of effort (CPUE) sampling procedures. A single electrofishing run is made from the upstream to downstream end of the station in riverine sites starting at the discharge. In inland lakes or Great Lake nearshore habitats, fish sampling runs are started along the nearest shoreline where mixing occurs immediately downstream of the discharge and would usually be in a downstream direction following current or wind direction. No block nets are ever used. All fish (> 25 mm in total length) observed are collected. At the end of the pass, minimum and maximum length and batch weight are measured for all species encountered. Number and aggregate weight of adults and young-of-the-year are recorded separately for all fish species. Fish specimens less than 25 mm TL should not be counted in the number of specimens but listed separately, with the exception of species that as adults do not lengths greater than 25 mm (e.g., *Gambusia affinis, Etheostoma microperca*).

For fish species that are > 25 mm TL, but are too hard to identify accurately, place these specimens in the “B” or unknown jar for the site. Only fish that were batch weighed and counted are to be vouchered in the “A” jar. Inspect all fish for deformities, eroded fins, lesions, and tumors (DELT).

Fish should be handled carefully to minimize mortality. Sort fish into containers with cool water. After processing, fish are released alive other than vouchers upstream of the station reach or in an area where the same individual will not be collected in a downstream sample. For any species that cannot be identified with 100% certainty in the field, preserve the fish in the “B” jar and bring it back to the laboratory to be identified. Generally, 2-3 individuals of each species should be vouchered per zone. Photographs of large specimens are acceptable as long as the photograph shows key identification traits.

B.2. **Fish Community Evaluation** - Data sheets used in the Fish Community Evaluation include the **Station Summary** and **Catch Summary** data sheets. Both sheets apply to the whole station. There is a single **Station Summary** sheet per station and one or more of the catch summary sheets depending on the number and diversity of fish captured. Guidelines for filling out each sheet and examples of blank sheets are provided on the following pages.

C. STATION SUMMARY (Appendix A)

This sheet summarizes the location, sampling characteristics, and gear used for the station. Some of the data on this form are derived from maps or from other data sheets. The location information should be identical to that collected during the Habitat Evaluation (see chapter 3). The variables on this sheet follows:

C.1. LOCATION ----------

1) Waterbody name: The name of the waterbody as shown on the most recent USGS 7.5" topographic map. The name used here should be identical to that used on the other data sheets and to that used for all other stations on the same waterbody. Make sure that the spelling of the name is accurate and include all parts of the waterbody name (e.g., West Branch, Middle Fork, River, Creek, Lake) to avoid confusion. Other commonly used names for the waterbody can be written here in parentheses (Herdendorf et al. 1981).

2) Station number - The station number must correspond to the station number assigned for the site by IDEM. This number may refer to NPDES permit number or may be a random number generated by AIMS.

3) Date - Fill in the date when the fish community data were collected for the station. To avoid confusion use the YYMMDD format (e.g. 000706 equals 6 July 2000).

4) Starting location - A precise verbal description of the point on the stream where the fish sampling began (i.e., the upstream edge of the first 100-m sampling zone). The description should include the exact distance and direction from the start to a "permanent" landmark such as a bridge (include road identification) or road marker. Avoid using landmarks that might be lost during future years (e.g., don't use tree or fence lines). Make the description as specific and precise as possible so that someone visiting the station for the first time can easily find the starting point. GPS measurement of transects should be recorded from pre-survey sampling of instantaneous temperature (see Chapter 2). Installation of a permanent stake to mark the downstream end of the station is desireable if conditions permit. Be sure to confer with the landowner if the stake could interfere with the normal use of that area. Be sure to provide accurate and complete site description information. **For example, a complete identification would include: West Branch Dunes Creek, 0.75 mi u/s SR 49 bridge, 2 mi N Chesterton, Nowhere Twp, Lat. 41.3334, Lon 86.2323.**

5) State – Indicate state where sampling is occurring. For example, if sampling on the lower Wabash River, indicate whether sampling is along the Indiana or Illinois shoreline.

6) County - The name of the county the station is located. Include county in other states if along a state boundary on the Wabash or Ohio rivers.

7) Township, Range, Section, 1/16 Section, 1/4 Section - Legal description for the station within the Public Lands System. These can be determined from recent USGS 7.5" topographic maps or a detailed county map. On a topographic map, a "land locator" template is useful for determining the 1/16 and 1/4 sections, indicate by a compass direction (NW, NE, SW, or SE). Note that for Indiana Townships can be either "N" (north) or "S" (south), as can Range be either "E" or "W" (east or west). Make sure that the appropriate letter is included for both Township and Range. For example, T 18N R 2W S 3, NE ¼, NE 1/4 .

C.2. SAMPLING DESCRIPTION ----------

1) Sampling type - The type of fish sampling done at a station. Circle the appropriate category. Generally, during this project a single pass catch-per-unit-of-effort (CPUE) sampling is done. In special cases, other types of sampling such could be added onto the sheet such as "depletion", "trawling" or "mark-recapture" may also be done at a station.

2) Station length - The length following the riverine wetland channel of the station. This length is based on 35 times the average stream width. For most discharge assessment surveys, this will be 1000 m of Large or Great River habitat. However, if MWW of small rivers or wadeable streams requires a distance of less than 500 m, then divide the total sample distance into ten equal segments so that the appropriate biological criteria can be applied. For example, if 350 m of sample distance is required because MWW is 10-m, then each t-zone should be 35-m in length. For inland lakes and Great Lake nearshore sites the station length should always be 1000 m. Measure stream width with a metric tape to the nearest 1 m. All transects also must be measured to the nearest 1 m so that 100 m are sampled within each transect.

3) Number of passes - The total number of times a shocker is passed through the station during fish sampling. Normally, for "CPUE" sampling there will only be one downstream pass, and for inland lake and Great Lake nearshore sites a total of 1800 seconds of sampling/ 500 m or 360 s / 100 m is required. This may result in multiple passes within each 100 m reach, especially when there is limited habitat heterogeneity.

4) Time - The time range during which the sampling was completed. "Start" refers to the time when the first shocking pass was started, and "finish" refers to the time when the last shocking pass was completed. Use military time to the nearest minute. In addition, the shock time collected in each 100 m zone should be recorded in seconds at the bottom of each sample zone.

5) Type of pass - A description of the direction of sampling through the station during a

pass. "Downstream only" refers to a pass that begins at the upstream end of the station, proceeds downstream, and then ends at the downstream end of the 100-m reach. This is the type of pass used for "CPUE" sampling. "Downstream, then Upstream" may occur in an inland lake or Great Lake sample and refers to a pass that begins in a downstream direction, then at the end of the station (usually because of a lack of sampling time in the zone), sampling stops and the boat proceeds upstream to the upstream end of the station, and then electrofishing continues again as the boat proceeds back downstream to the downstream end of the station.

C.3. GEAR DESCRIPTION ----------

1) Gear - A description of the number and type of electroshockers used in sampling. Specify the number of each type of gear that applies. Sampling will normally involve boat mounted electroshockers for most site conditions; however, this method can also be applied to smaller rivers and wadeable streams using a backpack electroshocker or tote-barge for smaller river sites.

2) Number of anodes per unit - The number of anodes per shocker. Normally there is one for backpacks and either one or two for boat electroshockers.

a) **For backpacks and stream shockers** -

3a) Anode size - The length of the long axis of the anode (the diamond-shaped or circular stainless steel tip on the hand-held probe), measured with a tape measure to the nearest 0.001 m. If multiple anodes are used on a shocker, they must all have the same anode size, shape, and material thickness. Anode size can be changed (by replacing the tip with a larger tip, or covering part of the tip with electrical tape or raising a ball out of the water) if necessary to maintain a relatively constant voltage and amperage. Also, please describe the shape of the anode, i.e., spherical, diamond, triangle.

4a) Anode material thickness - The thickness (diameter) of the metal used to form the tip of the anode. Measure with calipers or a ruler to the nearest 0.001 m.

b. For Boat-Mounted shockers

3b) Anode length: The length of the exposed metal portion of either the cylindrical dropper(s) that come off of the boom or the diameter of the metal ball that dangles into the water. Measure with a tape measure to the nearest 0.01 m.

4b) Anode diameter The outside diameter of the exposed metal portion of the droppers on the front boom. Measure with calipers or a ruler to the nearest 0.001 m. Please indicate shape, i.e., spherical with 12 droppers or single electrosphere.

5b) Number of front droppers - The number of individual droppers on the front boom.

C.4 METER READINGS ----------

1) Type of electrofishing current - The type of electrical current (AC, DC, or pulsed DC) that the shocker emits into the water (this will often be different from that emitted by the generator in the shocker). Check the appropriate category.

2) Electroshocker control box meter reading - The typical output readings (i.e., not the extreme high or low readings) observed during sampling. Note for boat mounted systems the units of amperage and voltage for the meters when recording the meter values. Effort should be made to keep readings fairly constant during shocking within a station, between stations, within a site, and among samples of the same waterbody type over time. Preliminary sampling just downstream of the station may be necessary to determine the output readings associated with the most effective shocking. As a rule, try to keep the voltage above 150 V and average amperage above 2 A. Voltage can be adjusted by changing the number and surface area of anodes (see below), and amperage can be adjusted by increasing generator output (adjusting generator throttle, using a boost switch if present, or using a generator with a different power rating). For AC or pulsed DC, some control box output ammeters read peak rather than average amperage; if this is the case, this should be noted on the sheet. Peak amperage approximates four times average amperage. If output meters are not present or are broken, note this on the sheet. Always try to use electroshockers with functioning output meters.

If Pulsed DC - This refers to two important variables, “pulse rate” and “duty cycle”, of pulsed DC current. Some shockers allow values for these variables to be varied, whereas others have a single fixed value for each parameter. If values can be changed, they should be set to the appropriate level at the beginning of sampling and not changed during sampling. This may require preliminary sampling just outside the station to determine the values where shocking is most effective. The same values should be used for all sampling within a station, between stations within a study reach, and among samples for the same reach over time. Sampling for many species is most effective and least harmful at pulse rates of 40-80 per second and at duty cycles of 10-20%. The frequency and wavelength of back-pack units should record the number and letter associated with the settings.

COMMENTS/NOTES: Any and all information that appear relevant to the fish community survey but is not recorded anywhere else on the data sheet should be noted. This information should include weather, water, habitat conditions (e.g., glare, wind, precipitation, water clarity, unusually deep or shallow areas) and gear performance (e.g., problems with generators or meters) that influenced sampling effectiveness. Any evidence of fish kills (i.e., dead fish in the water or on the bank) or angler use of the stream (e.g., hooks and lines caught in bushes; evidence of cleaned fish on the bank; footprints from waders) should also be noted. Don’t hesitate to make comments, if in doubt – write it down!

D. CATCH SUMMARY

This data sheet is for summarizing and recording the numbers and aggregate weights by species, of fish captured during each sampling pass. The parameters on this sheet are as follows:

1) Waterbody Name – Same as for **Station Summary** data sheet.

2) Site Number – Same as for **Station Summary** data sheet.

3) Date – Same as for **Station Summary** data sheet.

4) Time - The starting and ending time of the actual fish shocking for the pass should be recorded. If the shocking time is interrupted (e.g., to work up fish when the holding tank is too full, or due to equipment failure, etc.) the time of the interruption should be noted as the End time; the actual shocking was resumed and finally ended should be recorded in the parentheses.

5) County – Indicate the name of the County the survey is being conducted.

6) Gear Type – Indicate the type of equipment being used.

7) Seconds Fished -- Elapsed shocking time (in seconds) should be recorded after Total.

D.1 CATCH SUMMARY ----------

This section of the data sheet is used to summarize the identity, total number, total weight, number of fish with deformities, eroded fins, lesions, and tumors (DELT), and the number of voucher specimens retained for each species captured based on each 100 m reach. For species that are individually measured, transcribe these individual totals from the Individual Fish data sheet.

1) Species - The identity of each species captured during the pass. Only accepted American Fisheries Society common names should be used (see Simon et al. 2002; "Revised checklist of the Vertebrates of Indiana. PIAS 111:182-214"). Use of abbreviations is prohibited. If a species cannot be identified with 100% certainty then preserve **all unknowns in the "B" jar** for later complete identifications; **do not count and weigh any individuals in the "B" jar.**

NOTE

"A" jars contain vouchered specimens (generally 2-3 individuals), while the "B" jar contain the unknowns. The "A" jar should be identified, batch weighed, and have minimum and maximum lengths recorded. The "B" jar does not require any data collection.

2) Species Code - The species code is provided in Appendix C. These three digit codes

must be entered into this field for data entry next to the species name.

3) Number caught (N) - The total number of individuals of each species captured during the pass.

4) Weight (Wt) - The total wet weight (g) of all individuals of the same fish species captured during the pass. Weigh to the nearest 0.1 g or to the nearest 1% of total weight, whichever is larger. For example, for a species with an aggregate weight of about 8 g, weigh to the nearest 0.1 g; for a species with an aggregate weight of about 60 g, weight to the nearest 1 g; for a species with an aggregate weight of about 250 g, weigh to the nearest 3 g; for a species with an aggregate weight of about 1450 g, weigh to the nearest 15 g; and so on. Weigh groups of fish in a calibrated net or plastic bag using an appropriately sized balance or scale (gross weight), and don't forget to subtract the weight of the net or bag (tare weight) to get the actual weight of the fish (FINAL weight).

NOTE

The Final Weight of each fish species is based on wet weight. Weigh to the nearest 0.1 or 1% of body weight, whichever is larger.

5) Number of DELT - The total number of fish of a species that have deformities, eroded fins or scales, lesions, or tumors ("DELT"). Only obvious deformities, eroded fins or scales, lesions, and tumors observed on live fish should be counted. These should be written into the appropriate t-zone and circled. For example, D1 would indicate that one individual of that species had a deformity. Electroshocking (usually AC current only) sometimes causes wounds or burns; do not count these as DELT. Record each type of DELT separately. Indicate if light <20% of body (L) or heavy > 20% of body (H) or if multiple types of DELT (M).

NOTE

Deformities (D), Eroded Fins (E), Lesions (L), and Tumors (T) need to be tallied separately. The magnitude of the DELT anomaly should be noted as light < 20% of body (L) or heavy > 20% of body (H), or if multiple types of DELT (M).

6) Number of vouchers – The total number of individuals of a species that were retained as vouchers. All fish species that can be identified to species with certainty should be preserved in 10% formalin and put in the "A" jar. The total number preserved should be written into this data field. Number of vouchers can be written in a colored red pencil. All jars should have a double label including an internal tag (fill out Fish Collection Tag Record) and then a strip of tape should be placed across the top of the jar with the REMAP site number.

NOTE

Double label all jars with an internal "wet" label printed on Rite-in-rain paper or index weight labels. Place a label tape across the top of the jar and label with the appropriate transect and site number.

Specimens that are too large to preserve, but are documented with a photograph should show important characters. For example, to differentiate between a walleye and a sauger the spinous dorsal fin should be spread to show the mottling in the spinous dorsal fin for sauger and two distal pigment spots in walleye. Multiple specimens can be photographed simultaneously; however, each frame should have the site number and t-zone number included on a 3" x 5" card written with a Sharpie and placed visibly in the frame. Specimens that are photographed should be noted in the comments section of the form indicating the frame number and roll number (e.g., Joe Exl roll 1, frame 24 could be documented as JE 1-24).

Effort should be made to minimize handling mortality by using live wells, coolers, or quickly sorting fish into wet containers. Keep hands wet or use wet surgical gloves to minimize disruption of mucous layer. Although every effort may be made to return all fish back to the site alive, some mortality is inevitable. Dead fish should be counted and either be preserved or disposed of by burying. DO NOT DISPOSE OF DEAD FISH BY DUMPING THEM BACK INTO THE WATERBODY SINCE OTHERS MAY THINK A FISH KILL HAS OCCURRED.

NOTE

Vouchers can be specimens or pictures of specimens. Note in the appropriate place how many specimens and in the picture ID field. On the Photo Record Form, note the location and a description of the location. Make sure a card is inserted into the picture frame that shows the site transect and IDEM sample number.

7) Laboratory check vouchers – When voucher specimens are preserved, verify the Number of Vouchers retained and record a check in the "number" column. If the number preserved (after a lab count) does not match the number vouchers, record the correct number under number vouchers. Verify the identification of vouchers and record a check in the "ID" column. If the field identification (under species) was incorrect, based on a lab examination, change species to the correct identification.

8) Minimum and maximum total length (TL) mm – The distance from the tip of the snout to the posterior tip of the longest caudal (tail) lobe of each individual fish. The caudal lobes should be pinched together slightly when measuring this distance. Measure to the nearest 0.1 mm, using a meter stick or measuring board.

9) Picture identification – In this field should be noted the size of the fish photographed

and the abbreviated frame reference for site vouchers that are recorded as pictures (e.g., JE1-24).

XI. REQUIRED RECORDS

Station Summary Form

A. The Station Summary Form will be completed during the actual field sampling process. This information will be placed in the biological database.

B. The Station Summary Form should be inserted into a file that was created for each site that includes on the outside of the file the station number, including a photocopy of the 7.5 minute U.S. Geological Survey topographic map (reduced to show perspective of the site), and a copy of the site location sheet.

Catch Summary Form

A. The completely filled out form should include the species name, number, minimum and maximum length, aggregated weight, and presence of DELT anomalies by date. Species code information must be listed on the form for processing. Number of specimens vouchered by species should be written in red on the datasheet.

B. The Photograph Record Form must be included for the groups of samples and identified using the appropriate labeling designation.

All specimen data must be entered electronically into the fish structure format for AIMS. This structure can be downloaded from the Indiana Biological Survey Aquatic Research Center website (http://www.indiana.edu/~inbsarc/) from the "Collections" web page.

4.1.2 Zone Design

At the completion of 10 (ten) 100-m sampling t-zones, providing a cumulative total of 1000 m, data is analyzed based on 500 m reaches (this requires the addition of 5 (five) 100-m reaches. The fish data is arranged so that the first T-zone (T1) consisted of the first five 100 meter zones starting at the outfall. The second traveling zone (T2) is the compilation of the data from the second to the sixth 100 meter zones, and so on downstream to T6, which was the last five 100 m zones (Fig. 4.1).

4.1.3 Data Analysis

The six T-zones are created after the data were entered into a database based on 100-m reaches and could be reconfigured. Fish metrics were calculated from the data from these new 500 m zones (Dufour 2002; Emery et al., 2003; Simon 2003; Simon and Dufour

"Calculation of IBI metrics chapter this document). These metrics are graphed and appropriate statistical methods are applied to reveal trends observed from T1 to T6.

4.1.4 Defining zones of recovery

The traveling zone technique has been successfully shown to reveal gradients at the outfalls that were not stressed at two normal concurrent 500 m zones (Emery and Thomas 2003). Emery and Thomas (2003) has shown that the percent of individuals as piscivores increased from the upper 500 m zone to the lower 500 m zone. However, the T-zone approach better defined this increase. While looking at these data with only the two 500 m zones, it can only be determined that after 500 m the outfall no longer affects the piscivores. However, by using the T-zone approach, it can be determined that the effect may be diminished by T5, indicating that the effluent was diluted enough for the piscivore numbers to return to normal after 800 m. This conclusion can be drawn by observing that the last effluent effect on the percent of individuals as piscivores was seen at T4, which was the compilation of data from the 500 m between 300 m to 800 m. When evaluating the data from the last two 100 m zones, the percent piscivores returned to expected conditions, suggesting an end of the effluent effect on the piscivore populations.

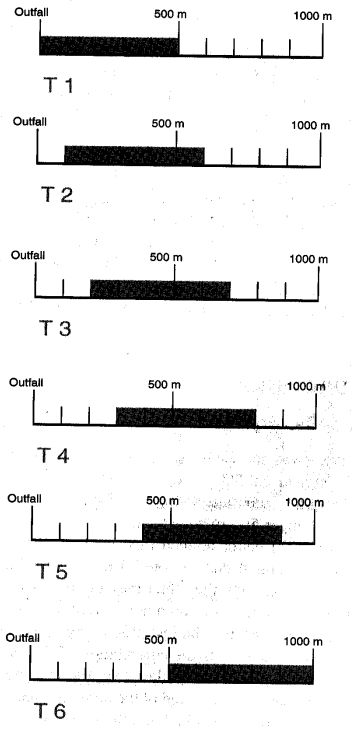

Fig. 4.1. Traveling zone analysis procedure for calculating T1 to T6, which corresponds to the downstream subtraction of an upstream 100-m reach fish assemblage catch and the addition of the downstream 100-m fish assemblage catch.

While an effluent that can have an effect on the fish community for approximately 800 m, often the effect of an outfall on Ohio River fish did not extend that far downstream. Using 500 m zones it is difficult, therefore, to determine the distance that an outfall effect may last. Emery and Thomas (2003) showed an example of an effluent that affected the centrarchid population within the first 500 m of the outfall. The effect appears to be diminished by the second 500 m zone, but it is impossible to determine precisely where the effect weakened. However, by examining the T-Zones at the same outfall, they were able to show that the effect was only observed in the first 100 m of the outfall, since the number of centrarchids appears to have recovered by T2.

4.3 LITERATURE CITED

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Appendix A
Station Summary Forms

FISH COMMUNITY EVALUATION STATION SUMMARY

LOCATION _____

Waterbody Name _____

Station No. _____ Date: _____ _____ _____ Starting Location: _____

State: _____ County: _____ Township: _____

SAMPLING DESCRIPTION _____

Sampling Type (Circle one): CPUE Mark/Recapture Depletion

Total Station Length (m): _____ Number Passes: _____ Time (military): Start _____ End _____

Type of Pass (Check one): _____Downstream only _____Downstream then Upstream_____ Other

GEAR DESCRIPTION _____

Gear (indicate number of each type) __ Backpack __ Tote Barge __ 12-14 Jon Boat __16+ ft Jon Boat

Number of Anodes per unit _____ Shape _____

For Backpacks and Tote Barges

Anode size (long axis or diameter, m) _____ Anode material thickness (diameter, m): _____

Anode shape: _____

Boat Mounted Electrofishing Units

Number of front droppers (circle one) 1 2 Type (circle one): Electrosphere Wisconsin ring Other ____

Anode Length (m) _____ Anode diameter _____

METER READINGS _____

Type of Electrofishing current (check one): _____ AC _____DC _____ Pulse DC

Electroshocker Control Box Readings: Voltage (V) _____ Amps (A) _____

For Backpack shockers

If Pulsed DC Pulse Rate _____ Duty Cycle (%) _____ Wave Length (indicate letter) _____

For Jon Boat Shockers

Frequency _____ Wave Length _____

COMMENTS/NOTES (Continue on back of sheet if necessary):

Appendix B
Summary Catch Field Sheets

CATCH SUMMARY **Station #**:

Date:_____ Time:_____ County:_____Collectors:

Waterbody:_____ Gear Type: BP BT SC Seconds Fished: _____

Shore: RDB LDB RDB LDB RDB LDB RDB LDB

	100 m				200 m				300 m				400 m			
Species/Code	Min	Max	Wt	N	Min	Max	Wt	N	Min	Max	Wt	N	Min	Max	Wt	N
Dorosoma cepedianum																
Dorosoma petenense																
Lepisosteus osseus																
Cyprinus carpio																
Notropis atherinoides																
Notropis blennius																
Notropis ludibundus																
Notropis																
Pimephales notatus																
Catostomus commersonii																
Carpiodes carpio																
Carpiodes cyprinus																
Ictiobus bubalus																
Cycleptus elongatus																
Hypentelium nigricans																
Moxostoma anisurum																
Moxostoma duquesnei																
Moxostoma erythrurum																
Moxostoma macrolepidotum																
Ameiurus natalis																
Ictalurus punctatus																
Pylodictis olivaris																
Fundulus notatus																
Ambloplites rupestris																
Lepomis cyanellus																
Lepomis gulosus																
Lepomis macrochirus																
Lepomis megalotis																
Micropterus dolomieu																
Micropterus punctulatus																
Etheostoma nigrum																
Percina caprodes																
Percina sciera																

CATCH SUMMARY **Station #**:

Date:_____ Time:_____ County:_____Collectors:

Waterbody:_____ Gear Type: BP BT SC Seconds Fished: _____

Shore: RDB LDB RDB LDB RDB LDB RDB LDB

	500 m				600 m				700 m				800 m			
Species/Code	Min	Max	Wt	N	Min	Max	Wt	N	Min	Max	Wt	N	Min	Max	Wt	N
Dorosoma cepedianum																
Dorosoma petenense																
Lepisosteus osseus																
Cyprinus carpio																
Notropis atherinoides																
Notropis blennius																
Notropis ludibundus																
Notropis																
Pimephales notatus																
Catostomus commersonii																
Carpiodes carpio																
Carpiodes cyprinus																
Ictiobus bubalus																
Cycleptus elongatus																
Hypentelium nigricans																
Moxostoma anisurum																
Moxostoma duquesnei																
Moxostoma erythrurum																
Moxostoma macrolepidotum																
Ameiurus natalis																
Ictalurus punctatus																
Pylodictis olivaris																
Fundulus notatus																
Ambloplites rupestris																
Lepomis cyanellus																
Lepomis gulosus																
Lepomis macrochirus																
Lepomis megalotis																
Micropterus dolomieu																
Micropterus punctulatus																
Etheostoma nigrum																
Percina caprodes																
Percina sciera																

CATCH SUMMARY **Station #**:

Date:_____ Time:_____ County:_____Collectors:

Waterbody:_____ Gear Type: BP BT SC Seconds Fished: _____

Shore

	900 m				1000 m				TOTAL							
Species/Code	Min	Max	Wt	N	Min	Max	Wt	N	Min	Max	Wt	N				
Dorosoma cepedianum																
Dorosoma petenense																
Lepisosteus osseus																
Cyprinus carpio																
Notropis atherinoides																
Notropis blennius																
Notropis ludibundus																
Notropis																
Pimephales notatus																
Catostomus commersonii																
Carpiodes carpio																
Carpiodes cyprinus																
Ictiobus bubalus																
Cycleptus elongatus																
Hypentelium nigricans																
Moxostoma anisurum																
Moxostoma duquesnei																
Moxostoma erythrurum																
Moxostoma macrolepidotum																
Ameiurus natalis																
Ictalurus punctatus																
Pylodictis olivaris																
Fundulus notatus																
Ambloplites rupestris																
Lepomis cyanellus																
Lepomis gulosus																
Lepomis macrochirus																
Lepomis megalotis																
Micropterus dolomieu																
Micropterus punctulatus																
Etheostoma nigrum																
Percina caprodes																
Percina sciera																

Appendix C
Fish species codes for use in studies of Indiana (from IDEM Assessment Information Management System (AIMS).

Indiana Department of Environmental Managment/Office of Water Quality/Biological Studies Section
Species List of Indiana Fish

(Indexed by Phylogenetic Code)

				Author	IDEM Taxon ID		Range/	Abundance/	Status/
05			**CLASS:** Cephalaspidomorphi						
	01		**ORDER:** Petromyzontiformes						
			FAMILY:						
	002	006	*Lampetra*	*appendix*	DeKay	2	American brook lamprey	NW	O	
			FAMILY: N/A						
	002	003	*Lampetra*	*aepyptera*		1	least brook lamprey	SW	R	
			FAMILY: Petromyzontidae						
	004	001	*Ichthyomyzon*	*bdellium*	Jordan	4	Ohio lamprey	W,S	R	
	004	002	*Ichthyomyzon*	*castaneus*	Girard	5	chestnut lamprey	SW	O	
	004	003	*Ichthyomyzon*	*fossor*	Reighard & Cummins	6	northern brook lamprey	NE	R	ST
	004	006	*Ichthyomyzon*	*unicuspis*	Hubbs & Trautman	7	silver lamprey	W,S	O	
	000	000	*N/A*	*N/A*		221	Ammocoetes			
	003	001	*Petromyzon*	*marinus*	Linnaeus	3	sea lamprey	NW,X	O	
07			**CLASS:** Osteichthyes						
	05		**ORDER:** Acipenseriformes						
			FAMILY: Acipenseridae						
	001	006	*Acipenser*	*fulvescens*	Rafinesque	8	lake sturgeon	W,S	R	SE

Range Distribution Code, I=Statewide, N=North, S=South, W=West, E= East, NW=Northwest, NE= Northeast,SW=Southwest, SE=Southeast, C=Central, X=Exotic, Ex=Extirpated
Abundance Code, A=Abundant, C=Common, H=State Hypothetical, O=Occasional, R=Rare
Federal Status, FE=Endangered, FT=Threatened, FC=Candidate State Status, SE=Endangered, ST=Threatened, SC=Special Concern

Indiana Department of Environmental Managment/Office of Water Quality/Biological Studies Section
Species List of Indiana Fish

(Indexed by Phylogenetic Code)

				Author	IDEM Taxon ID		Range/	Abundance/	Status/
002	002	*Scaphirhynchus*	*platorynchus*	Rafinesque	9	shovelnose sturgeon	W,SE	O	
002		**FAMILY:** Polyodontidae							
001	001	*Polyodon*	*spathula*	Walbaum	10	paddlefish	W,SE	O	
06		**ORDER:** Lepisosteiformes							
001		**FAMILY:** Lepisosteidae							
002	001	*Atractosteus*	*spatula*	Lacepede	14	alligator gar	Ex1976		
001	002	*Lepisosteus*	*oculatus*	Winchell	12	spotted gar	NE,SW	O	
001	001	*Lepisosteus*	*osseus*	Linnaeus	11	longnose gar	I	C	
001	003	*Lepisosteus*	*platostomus*	Rafinesque	13	shortnose gar	W,S	O	
07		**ORDER:** Amiiformes							
001		**FAMILY:** Amiidae							
001	001	*Amia*	*calva*	Linnaeus	15	bowfin	N,S	O	
09		**ORDER:** Anguilliformes							
001		**FAMILY:** Anguillidae							
001	001	*Anguilla*	*rostrata*	LeSueur	16	American eel	W,S	R	
11		**ORDER:** Clupeiformes							

Range Distribution Code, I=Statewide, N=North, S=South, W=West, E= East, NW=Northwest, NE= Northeast,SW=Southwest, SE=Southeast, C=Central, X=Exotic, Ex=Extirpated
Abundance Code, A=Abundant, C=Common, H=State Hypothetical, O=Occasional, R=Rare
Federal Status, FE=Endangered, FT=Threatened, FC=Candidate State Status, SE=Endangered, ST=Threatened, SC=Special Concern

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				Author	IDEM Taxon ID		Range/	Abundance/	Status/
002		**FAMILY:** Clupeidae							
001	004	*Alosa*	*alabamae*	Jordan & Evermann	17	Alabama shad	Ex1902		
001	006	*Alosa*	*chrysochloris*	Rafinesque	20	skipjack herring	W,S	C	
001	005	*Alosa*	*pseudoharengus*	Wilson	18	alewife	NW	A	X
005	001	*Dorosoma*	*cepedianum*	LeSueur	19	gizzard shad	I	A	
005	002	*Dorosoma*	*petenense*	Gunther	21	threadfin shad	S	C	X
12		**ORDER:** Osteoglossiformes							
003		**FAMILY:** Hiodontidae							
001	001	*Hiodon*	*alosoides*	Rafinesque	22	goldeye	S	O	
001	002	*Hiodon*	*tergisus*	LeSueur	23	mooneye	W,S	O	
14		**ORDER:** Salmoniformes							
001		**FAMILY:** Salmonidae							
001	008	*Coregonus*	*artedi*	LeSueur	25	cisco or lake herring	NW	R	SC
001	006	*Coregonus*	*clupeaformis*	Mitchill	24	lake whitefish	NW	C	SC
001	009	*Coregonus*	*hoyi*	Milner	26	bloater	NW	R	
001	800	*Coregonus*	*kiyi*	Koelz	223	kiyi	NW	R	

Range Distribution Code, I=Statewide, N=North, S=South, W=West, E= East, NW=Northwest, NE= Northeast,SW=Southwest, SE=Southeast, C=Central, X=Exotic, Ex=Extirpated
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Federal Status, FE=Endangered, FT=Threatened, FC=Candidate State Status, SE=Endangered, ST=Threatened, SC=Special Concern

Indiana Department of Environmental Managment/Office of Water Quality/Biological Studies Section
Species List of Indiana Fish

(Indexed by Phylogenetic Code)

				Author	IDEM Taxon ID		Range/	Abundance/	Status/
001	012	*Coregonus*	*nigripinnis*	Gill	27	blackfin cisco	Ex		
001	013	*Coregonus*	*reighardi*	Koelz	28	shortnose cisco	Ex1972		
001	014	*Coregonus*	*zenithicus*	Jordan & Evermann	29	shortjaw cisco	NW	R	
002	003	*Oncorhynchus*	*kisutch*	Walbaum	30	coho salmon	NW	C	X
002	011	*Oncorhynchus*	*mykiss*	Walbaum	32	rainbow trout	N	C	X
002	011	*Oncorhynchus*	*mykiss*	Walbaum	227	Steelhead	N,X	C	
002	006	*Oncorhynchus*	*tshawytscha*	Walbaum	31	chinook salmon	NW	C	X
003	005	*Salmo*	*salar*	Linnaeus	33	Atlantic salmon	NW	O	X
003	006	*Salmo*	*trutta*	Linnaeus	34	brown trout	N	C	X
004	004	*Salvelinus*	*fontinalis*	Mitchill	36	brook trout	NW	R	
004	003	*Salvelinus*	*namaycush*	Walbaum	35	lake trout	NW	O	
003		**FAMILY:** Osmeridae							
003	002	*Osmerus*	*mordax*	Mitchill	37	rainbow smelt	NW	C	X
011		**FAMILY:** Esocidae							
001	002	*Esox*	*americanus*	Gmelin	39	grass pickerel	I	C	

Range Distribution Code, I=Statewide, N=North, S=South, W=West, E= East, NW=Northwest, NE= Northeast,SW=Southwest, SE=Southeast, C=Central, X=Exotic, Ex=Extirpated
Abundance Code, A=Abundant, C=Common, H=State Hypothetical, O=Occasional, R=Rare
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Indiana Department of Environmental Managment/Office of Water Quality/Biological Studies Section
Species List of Indiana Fish

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				Author	IDEM Taxon ID		Range/	Abundance/	Status/	
001	001	*Esox*	*lucius*	Linnaeus	38	northern pike	N	O		
001	900	*Esox*	*lucius x masquinongy*		208	tiger muskie	NC			
001	004	*Esox*	*masquinongy*	Mitchill	41	Great Lakes muskellunge	Ex1910			
001	004	*Esox*	*ohioensis*	Mitchill	40	Ohio River muskellunge	S	R	SC	
012		**FAMILY:** Umbridae								
001	002	*Umbra*	*limi*	Kirtland	42	central mudminnow	N	A		
18		**ORDER:** Cypriniformes								
021		**FAMILY:** Cyprinidae								
014	001	*Campostoma*	*anomalum*	Rafinesque	77	central stoneroller	I	A		
014	002	*Campostoma*	*oligolepis*	Hubbs & Greene	78	largescale stoneroller	N	A		
003	001	*Carassius*	*auratus*	Linnaeus	44	goldfish	I	C	X	
003	900	*Carassius*	*auratusxcarpio*	Linnaeus	224	goldfish x carp	I,X			
007	002	*Clinostomus*	*elongatus*	Kirtland	50	redside dace	E	R	SE	
022	001	*Couesius*	*plumbeus*	Agassiz	82	lake chub	NW	R		
023	001	*Ctenopharyngodon*	*idella*	Valenciennes	83	grass carp	NW,C	O	X	

Range Distribution Code, I=Statewide, N=North, S=South, W=West, E= East, NW=Northwest, NE= Northeast,SW=Southwest, SE=Southeast, C=Central, X=Exotic, Ex=Extirpated
Abundance Code, A=Abundant, C=Common, H=State Hypothetical, O=Occasional, R=Rare
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Indiana Department of Environmental Managment/Office of Water Quality/Biological Studies Section
Species List of Indiana Fish

(Indexed by Phylogenetic Code)

				Author	IDEM Taxon ID		Range/	Abundance/	Status/
076	014	*Cyprinella*	*lutrensis*	Baird & Girard	87	red shiner	NW	C	X
076	019	*Cyprinella*	*spiloptera*	Cope	88	spotfin shiner	I	A	
076	022	*Cyprinella*	*whipplei*	Girard	89	steelcolor shiner	C,S	C	
001	001	*Cyprinus*	*carpio*	Linnaeus	43	carp	I	A	X
011	111	*Ericymba*	*buccata*	Cope	73	silverjaw minnow	I	C	
077	002	*Erimystax*	*dissimilis*	Kirtland	90	streamline chub	NW	R	
077	005	*Erimystax*	*x-punctatus*	Hubbs & Crowe	91	gravel chub	W	R	
005	005	*Hybognathus*	*hankinsoni*	Hubbs	47	brassy minnow	NW	H	
005	006	*Hybognathus*	*hayi*	Jordan	48	cypress minnow	SW	R	
005	002	*Hybognathus*	*nuchalis*	Agassiz	46	Mississippi silvery minnow	SC,SW	C	
012	001	*Hybopsis*	*amblops*	Rafinesque	74	bigeye chub	NW	C	
012	011	*Hybopsis*	*amnis*	Hubbs & Greene	75	pallid shiner	W	R	SE
056	001	*Hypophthalmichthys*	*molitrix*	Valenciennes	86	silver carp	SE,SW	R	X
056	800	*Hypophthalmichthys*	*nobilis*	Richardson	214	bighead carp	SW	O	X
078	004	*Luxilus*	*chrysocephalus*	Rafinesque	92	striped shiner	I	A	

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078	006	*Luxilus*	*cornutus*	Mitchill	93	common shiner	N	O		
079	001	*Lythrurus*	*fasciolaris*	Gilbert	94	scarletfin shiner	SE	C		
079	004	*Lythrurus*	*fumeus*	Evermann	95	ribbon shiner	SW	R		
079	008	*Lythrurus*	*umbratilis*	Girard	96	redfin shiner	W,C	C		
080	001	*Macrhybopsis*	*hyostoma*	Girard	99	shoal chub	W,S	O		
080	004	*Macrhybopsis*	*storeriana*	Kirtland	97	silver chub	W	C		
800	800	*Mylopharyngodon*	*piceus*		213	black carp	S	H		X
000	000	*N/A*	*N / A*		226	Cyprinidae hybrid				
010	004	*Nocomis*	*biguttatus*	Kirtland	55	hornyhead chub	N	C		
010	001	*Nocomis*	*micropogon*	Cope	54	river chub	NE,C	C		
006	001	*Notemigonus*	*crysoleucus*	Mitchill	49	golden shiner	I	C		
011	032	*Notropis*	*anogenus*	Forbes	65	pugnose shiner	Ex1945			
011	034	*Notropis*	*ariommus*	Cope	66	popeye shiner	Ex1894			
011	012	*Notropis*	*atherinoides*	Rafinesque	59	emerald shiner	I	A		
011	040	*Notropis*	*blennius*	Girard	67	river shiner	W,S	C		

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011	041	*Notropis*	*boops*	Gilbert	68	bigeye shiner	C	C	
011	014	*Notropis*	*buchanani*	Meek	60	ghost shiner	NW,S	O	
011	004	*Notropis*	*chalybaeus*	Cope	56	ironcolor shiner	NW	O	
011	058	*Notropis*	*dorsalis*	Agassiz	69	bigmouth shiner	NW	R	SC
011	067	*Notropis*	*heterodon*	Cope	70	blackchin shiner	N	R	
011	068	*Notropis*	*heterolepis*	Eigenmann & Eigenm	71	blacknose shiner	N	R	
011	006	*Notropis*	*hudsonius*	Clinton	57	spottail shiner	NW	A	
011	086	*Notropis*	*photogenis*	Cope	72	silver shiner	C,SE	O	
011	008	*Notropis*	*rubellus*	Agassiz	58	rosyface shiner	N,C	C	
011	021	*Notropis*	*shumardi*	Girard	61	silverband shiner	SW	C	
011	023	*Notropis*	*stramineus*	Girard	62	sand shiner	I	A	
011	024	*Notropis*	*texanus*	Girard	63	weed shiner	NW	R	
011	027	*Notropis*	*volucellus*	Cope	64	mimic shiner	E,C,S	O	
011	119	*Notropis*	*wickliffi*	Trautman	207	channel shiner	S	C	
013	900	*Notropis Sp.*	*N / A*		225	Lythrurus X Notropis hybrid	C	R	

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082	001	*Opsopoeodus*	*emiliae*	Hay	98	pugnose minnow	N,SW	R	SC
013	001	*Phenacobius*	*mirabilis*	Girard	76	suckermouth minnow	C,S	C	
037	003	*Phoxinus*	*erythrogaster*	Rafinesque	84	southern redbelly dace	NW,C	O	
016	001	*Pimephales*	*notatus*	Rafinesque	79	bluntnose minnow	I	A	
016	002	*Pimephales*	*promelas*	Rafinesque	80	fathead minnow	N,SE	C	
016	003	*Pimephales*	*vigilax*	Baird & Girard	81	bullhead minnow	W,S	O	
009	001	*Rhinichthys*	*atratulus*	Hermann	52	blacknose dace	NW,C,SE	C	
009	002	*Rhinichthys*	*cataractae*	Valenciennes	53	longnose dace	N	O	SC
042	001	*Scardinius*	*erythrophthalmus*	Linnaeus	85	rudd	NW	R	X
008	002	*Semotilus*	*atromaculatus*	Mitchill	51	creek chub	I	A	
024		**FAMILY:** Catostomidae							
002	002	*Carpiodes*	*carpio*	Rafinesque	103	river carpsucker	W,S	C	
002	001	*Carpiodes*	*cyprinus*	LeSueur	102	quillback	I	C	
002	003	*Carpiodes*	*velifer*	Rafinesque	104	highfin carpsucker	W,S	O	
001	001	*Catostomus*	*catostomus*	Forster	100	longnose sucker	NW	R	SC

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001	002	*Catostomus*	*commersoni*	Lacepede	101	white sucker	I	A	
006	001	*Cycleptus*	*elongatus*	Lesueur	114	blue sucker	C,S	O	FC
003	002	*Erimyzon*	*oblongus*	Mitchill	106	creek chubsucker	NW,C,SW	O	
003	001	*Erimyzon*	*sucetta*	Lacepede	105	lake chubsucker	N	O	
005	001	*Hypentelium*	*nigricans*	LeSueur	113	northern hogsucker	N,C	C	
007	001	*Ictiobus*	*bubalus*	Rafinesque	115	smallmouth buffalo	W,S	C	
007	002	*Ictiobus*	*cyprinellus*	Valenciennes	116	bigmouth buffalo	W,S	O	
007	003	*Ictiobus*	*niger*	Rafinesque	117	black buffalo	NW,S	R	
010	001	*Lagochila*	*lacera*	Jordan & Brayton	119	harelip sucker	Ex1893		
008	001	*Minytrema*	*melanops*	Rafinesque	118	spotted sucker	NE,C	C	
004	004	*Moxostoma*	*anisurum*	Rafinesque	108	silver redhorse	N,C	C	
004	007	*Moxostoma*	*carinatum*	Cope	109	river redhorse	C	O	
004	009	*Moxostoma*	*duquesnei*	LeSueur	110	black redhorse	C	C	
004	010	*Moxostoma*	*erythrurum*	Rafinesque	111	golden redhorse	I	A	
004	001	*Moxostoma*	*m. breviceps*		218	Ohio redhorse	S	O	

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004	001	*Moxostoma*	*macrolepidotum*	LeSueur	107	shorthead redhorse	I	A	
004	018	*Moxostoma*	*valenciennesi*	Jordan	112	greater redhorse	N	R	SE
19	**ORDER:** Siluriformes								
002	**FAMILY:** Ictaluridae								
006	002	*Ameiurus*	*catus*	Linnaeus	130	white catfish	S	O	X
006	003	*Ameiurus*	*melas*	Rafinesque	131	black bullhead	I	A	
006	004	*Ameiurus*	*natalis*	LeSueur	132	yellow bullhead	I	A	
006	005	*Ameiurus*	*nebulosus*	LeSueur	133	brown bullhead	S	C	
001	002	*Ictalurus*	*furcatus*	LeSueur	120	blue catfish	S	O	
001	005	*Ictalurus*	*punctatus*	Rafinesque	121	channel catfish	I	C	
002	007	*Noturus*	*eleutherus*	Jordan	124	mountain madtom	W,C	O	
002	008	*Noturus*	*exilis*	Nelson	125	slender madtom	C	H	
002	011	*Noturus*	*flavus*	Rafinesque	126	stonecat	I	C	
002	001	*Noturus*	*gyrinus*	Mitchill	122	tadpole madtom	I	C	
002	018	*Noturus*	*miurus*	Jordan	127	brindled madtom	C	O	

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002	003	*Noturus*	*nocturnus*	Jordan & Gilbert	123	freckled madtom	W	O	
002	023	*Noturus*	*stigmosus*	Taylor	128	northern madtom	W,C	R	SC
003	001	*Pylodictus*	*olivaris*	Rafinesque	129	flathead catfish	I	C	
20		**ORDER:** Percopsiformes							
003		**FAMILY:** Percopsidae							
001	001	*Percopsis*	*omiscomaycus*	Walbaum	137	trout-perch	NW,S	R	SC
24		**ORDER:** Gadiformes							
013		**FAMILY:** Lotidae							
007	001	*Lota*	*lota*	Linnaeus	138	burbot	NW,WE	O	
25		**ORDER:** Atheriniformes							
013		**FAMILY:** Atherinidae							
008	001	*Labidesthes*	*sicculus*	Cope	145	brook silverside	I	C	
003	001	*Menidia*	*beryllina*	Cope	219	inland silverside	S	R	X
30		**ORDER:** Gasterosteiformes							
001		**FAMILY:** Gasterosteidae							
004	001	*Culaea*	*inconstans*	Kirtland	147	brook stickleback	N,SE	C	
001	001	*Gasterosteus*	*aculeatus*	Linnaeus	220	threespine stickleback	NW	O	X

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002	001	*Pungitius*	*pungitius*	Linnaeus	146	ninespine stickleback	NW	O		
33	**ORDER:** Scorpaeniformes									
014	**FAMILY:** Cottidae									
008	007	*Cottus*	*bairdi*	Girard	149	mottled sculpin	I	C		
008	009	*Cottus*	*carolinae*	Gill	150	banded sculpin	SC	O		
008	002	*Cottus*	*cognatus*	Richardson	148	slimy sculpin	NW	R		
008	023	*Cottus*	*ricei*	Nelson	151	spoonhead sculpin	N	H		
019	012	*Myoxocephalus*	*thompsoni*	Girard	152	deepwater sculpin	NW	R		
36	**ORDER:** Perciformes									
002	**FAMILY:** Moronidae									
001	001	*Morone*	*americana*	Gmelin	217	white perch	NW	R		X
001	004	*Morone*	*chrysops*	Rafinesque	154	white bass	W	C		
001	900	*Morone*	*chrysopsxsaxatilis*		209	wiper	S			
001	005	*Morone*	*mississippiensis*	Jordan & Eigenmann	155	yellow bass	W,S	O		
001	002	*Morone*	*saxatilis*	Walbaum	153	striped bass	S	O		X

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016		**FAMILY:** Centrarchidae							
002	001	*Ambloplites*	*rupestris*	Rafinesque	156	rock bass	I	C	
003	001	*Centrarchus*	*macropterus*	Lacepede	157	flier	SW	O	
005	002	*Lepomis*	*cyanellus*	Rafinesque	158	green sunfish	I	A	
005	005	*Lepomis*	*gibbosus*	Linnaeus	161	pumpkinseed	I	C	
005	003	*Lepomis*	*gulosus*	Cuvier	159	warmouth	N	C	
005	006	*Lepomis*	*humilis*	Girard	162	orangespotted sunfish	N	O	
005	004	*Lepomis*	*macrochirus*	Rafinesque	160	bluegill	I	A	
005	008	*Lepomis*	*megalotis*	Rafinesque	163	longear sunfish	I	A	
005	009	*Lepomis*	*microlophus*	Gunther	164	redear sunfish	N,S	C	
005	010	*Lepomis*	*miniatus*	Jordan	165	redspotted sunfish	SW	R	
005	011	*Lepomis*	*symmetricus*	Forbes	166	bantam sunfish	W	R	SE
005	900	*Lepomis*	*x-hybrid*		211	hybrid sunfish			
006	001	*Micropterus*	*dolomieu*	Lacepede	167	smallmouth bass	I	A	
006	003	*Micropterus*	*punctulatus*	Rafinesque	169	spotted bass	S	A	

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006	002	*Micropterus*	*salmoides*	Lacepede	168	largemouth bass	I	A	
007	001	*Pomoxis*	*annularis*	Rafinesque	170	white crappie	I	C	
007	002	*Pomoxis*	*nigromaculatus*	LeSueur	171	black crappie	I	C	
020		**FAMILY:** Percidae							
005	004	*Ammocrypta*	*clara*	Jordan & Meek	202	western sand darter	NW,S	O	
005	006	*Ammocrypta*	*pellucida*	Agassiz	203	eastern sand darter	C,SW	O	FC
007	001	*Crystallaria*	*asprella*	Jordan	204	crystal darter	Ex1895		
001	013	*Etheostoma*	*asprigene*	Forbes	176	mud darter	S	C	
001	017	*Etheostoma*	*blennioides*	Rafinesque	177	greenside darter	C,E	C	
001	020	*Etheostoma*	*caeruleum*	Storer	178	rainbow darter	N,C	C	
001	021	*Etheostoma*	*camurum*	Cope	179	bluebreast darter	C	R	
001	006	*Etheostoma*	*chlorosoma*	Hay	172	bluntnose darter	W	R	
001	034	*Etheostoma*	*exile*	Girard	180	Iowa darter	N	O	
001	035	*Etheostoma*	*flabellare*	Rafinesque	181	fantail darter	E,C	C	
001	007	*Etheostoma*	*gracile*	Girard	173	slough darter	SW	O	

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001	039	*Etheostoma*	*histrio*	Jordan & Gilbert	182	harlequin darter	S	R	
001	049	*Etheostoma*	*maculatum*	Kirtland	184	spotted darter	C	R	SC
001	052	*Etheostoma*	*microperca*	Jordan & Gilbert	185	least darter	N	C	
001	010	*Etheostoma*	*nigrum*	Rafinesque	175	johnny darter	I	A	
001	065	*Etheostoma*	*proeliare*	Hay	228	cypress darter	SW	R	SC
001	009	*Etheostoma*	*spectabile*	Agassiz	174	orangethroat darter	C	A	
001	900	*Etheostoma*	*spectabilexcaeruleum*		222	orangethroat rainbow hybrid			
001	075	*Etheostoma*	*squamiceps*	Jordan	186	spottail darter	SW	R	
001	082	*Etheostoma*	*tippecanoe*	Jordan & Evermann	187	Tippecanoe darter	C	R	SC
001	085	*Etheostoma*	*variatum*	Kirtland	188	variegate darter	SE	R	SE
001	088	*Etheostoma*	*zonale*	Cope	189	banded darter	NW,SE	C	
006	001	*Gymnocephalus*	*cernuus*	Linnaeus	212	ruffe		H	
002	001	*Perca*	*flavescens*	Mitchill	190	yellow perch	N	C	
003	001	*Percina*	*caprodes*	Rafinesque	191	logperch	I	C	
003	009	*Percina*	*copelandi*	Jordan	201	channel darter	C	R	SE

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003	012	*Percina*	*evides*	Jordan & Copeland	193	gilt darter	C	O	SE
003	017	*Percina*	*maculata*	Girard	194	blackside darter	I	C	
003	024	*Percina*	*phoxocephala*	Nelson	195	slenderhead darter	C	C	
003	004	*Percina*	*sciera*	Swain	192	dusky darter	C	C	
003	027	*Percina*	*shumardi*	Girard	196	river darter	C,S	O	
003	030	*Percina*	*uranidea*	Jordan & Gilbert	197	stargazing darter	Ex1920		
003	033	*Percina*	*vigil*	Hay	198	saddleback darter	SW	R	
004	002	*Sander*	*canadense*	Griffith & Smith	200	sauger	W,S	C	
004	900	*Sander*	*canadense x vitreus*		210	saugeye	S		
004	001	*Sander*	*vitreus*	Mitchill	199	walleye	I	C	
044		**FAMILY:** Sciaenidae							
026	001	*Aplodinotus*	*grunniens*	Rafinesque	205	freshwater drum	I	C	
118		**FAMILY:** Gobiidae							
003	001	*Neogobius*	*melanostomus*	Pallas	215	round goby	NW	A	X
001	005	*Proterorhinus*	*marmoratus*		216	tube nose goby	N	H	

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146		**FAMILY:** Elassomatidae								
001	001	*Elassoma*	*zonatum*	Jordan	206	banded pygmy sunfish	SW	R		SC
39		**ORDER:** Aphredoderiformes								
001		**FAMILY:** Amblyopsidae								
002	002	*Amblyopsis*	*spelaea*	DeKay	134	northern cavefish	S	R	FC	SE
004	001	*Typhilchthys*	*subterraneus*	Girard	135	southern cavefish	S	R		SE
002		**FAMILY:** Apherododeridae								
001	001	*Aphredoderus*	*sayanus*	Gilliams	136	pirate perch	N,SW	C		
40		**ORDER:** Cyprinodoniformes								
007		**FAMILY:** Fundulidae								
002	016	*Fundulus*	*catenatus*	Storer	141	northern studfish	C	C		
002	002	*Fundulus*	*diaphanus*	LeSueur	139	banded killifish	N	C		
002	028	*Fundulus*	*dispar*	Agassiz	143	northern starhead topminnow	NW	C		
002	019	*Fundulus*	*notatus*	Rafinesque	142	blackstripe topminnow	I	A		
002	011	*Fundulus*	*olivaceus*	Storer	140	blackspotted topminnow	W,NE	R		

Range Distribution Code, I=Statewide, N=North, S=South, W=West, E= East, NW=Northwest, NE= Northeast,SW=Southwest, SE=Southeast, C=Central, X=Exotic, Ex=Extirpated
Abundance Code, A=Abundant, C=Common, H=State Hypothetical, O=Occasional, R=Rare
Federal Status, FE=Endangered, FT=Threatened, FC=Candidate State Status, SE=Endangered, ST=Threatened, SC=Special Concern

Indiana Department of Environmental Managment/Office of Water Quality/Biological Studies Section
Species List of Indiana Fish

(Indexed by Phylogenetic Code)

				Author	IDEM Taxon ID		Range/	Abundance/	Status/
011		**FAMILY:** Poeciliidae							
001	001	*Gambusia*	*affinis*	Baird & Girard	144	western mosquitofish	W	O	
41		**ORDER:** Mugiliformes							
072		**FAMILY:** Mugilidae							
001	001	*Mugil*	*cephalus*	Linnaeus	229	striped mullet	S	R	X

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