



# A Biological Study of the Smithland Pool of the Ohio River



## Executive Summary

- Since 2004, ORSANCO has been using a probabilistic (random) design for monitoring fish communities in the Ohio River and conducting biological assessments.
- The Ohio River was divided into 19 assessment units based primarily on the locations of high-lift navigational dams. Using the random design, each assessment unit was assigned 15 sampling locations.
- Once fish assemblages are sampled, each site is assessed using a site quality score (0- 5) which is generated from an Ohio River fish index (MORFIn). The expectations for the MORFIn are derived from each site's substrate composition. For an assessment unit (i.e. pool) to meet its aquatic life-use designation, the average of the quality scores for the pool must be greater than 2.0.
- In 2008, fish population data from Smithland pool yielded 44 species and 3 hybrid taxa, representing 12 different families. Two of these taxa were listed in KY as either threatened (inland silverside) or of special concern (black buffalo). None of the species collected were listed in Indiana or Illinois.
- The two most abundant species were freshwater drum and gizzard shad comprising 31.7% and 19.8% of the catch respectively
- Previous analyses have identified a relationship between flow and MORFIn scores and the need for sampling thresholds and/or flow calibration. Increased flows appeared to cause lower MORFIn scores due to decreased sampling efficiency and changes in fish behavior.
- Flows were variable in 2008 when sampling was conducted. Sampling was conducted at very low flows as well as at moderately elevated flows. Flows did not appear to affect electrofishing surveys.
- In 2008, 85.7% of the sites assessed in Smithland pool had site quality scores >2.0 and the pool had an average quality score of 3.1 out of 5.0. This score indicates the pool is in good biological condition. Therefore the Smithland pool will be reported to EPA as meeting (supporting) its aquatic life-use designation.
- Recommendations include characterizing Smithland pool as supporting its aquatic life-use designation and moving to the next pool to be sampled while continuing to monitor flow and its influence on assessment results.
- As of 2008, 16 of the 19 pools (AUs) have been assessed which comprises 801.0 miles or 81.7% of the resource. Only two pools or 4.2% of the assessed resource has failed to meet its aquatic life-use designation.

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# **A Biological Study of the Smithland Pool of the Ohio River (2008)**

## **1.0 Introduction**

The Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate water pollution control agency created in 1948 by an act of Congress to monitor and improve the water quality of the Ohio River. Until that time, water quality issues on the Ohio River had been charged to state water quality agencies. However, due to large-scale interstate implications and large pollution loads received by the Ohio River, these agencies were not sufficiently equipped to work with such a system. ORSANCO's role is to work in conjunction with state agencies to develop a set of pollution control standards exclusive to the Ohio River. The creation of these standards requires the establishment of monitoring programs that can efficiently be used on the Ohio River.

The routine ambient monitoring programs of ORSANCO are primarily directed at three monitoring and assessment priorities: spill detection (through an organics detection system), trend assessment (manual sampling system), and aquatic resource characterization (macroinvertebrate and fish studies). Another priority, water quality impacts assessment, is achieved through entire watershed intensive surveys.

In 1993, following direction from state and federal agencies, ORSANCO staff developed and implemented an intensive survey design that used electrofishing methods designed for the navigational pools of the Ohio River. This entailed extensive sampling of fish communities throughout the entire length of a particular pool. The surveys were intended to provide background information on fish populations and lay a foundation for establishing biological criteria (biocriteria) for the Ohio River. With appropriate biocriteria in place, information on the biological community provides insight into the health of the Ohio River.

After several years of collecting background data on the fish population of the Ohio River, ORSANCO developed the Ohio River Fish Index (ORFI<sub>n</sub>,

Emery et al. 2003). The ORFI<sub>n</sub> incorporates 13 attributes, or metrics, of the fish community that when compiled provide an accurate representation of the overall condition of the Ohio River fish community. These 13 metrics take into account several different aspects of the fish population, including diversity, abundance, feeding and reproductive guilds, pollution tolerance/intolerance, and fish health. In 2008, ORSANCO recalibrated the original ORFI<sub>n</sub> and adjusted for more-detailed habitat classifications and a contemporary means of scoring the fish metrics (i.e. continuous in lieu of discrete scoring). A new assessment approach was also adopted for the modified ORFI<sub>n</sub> (MORFI<sub>n</sub>).

An important aspect of biological monitoring is the reduction of human induced bias in the samples. The use of probability-based sample site selection was designed to reduce this bias. Within this design, sample sites are randomly selected by computer generation, eliminating the tendency to sample only in the best or worst locations. Many states already have programs in place that use this design for sampling on smaller streams, and it is also used by the U.S. Environmental Protection Agency's (USEPA) Environmental Monitoring and Assessment Program (EMAP). ORSANCO has now begun using this approach on the Ohio River for its biological monitoring. In 2008, the Dashields, Hannibal, Robert C. Byrd, and Smithland pools were sampled as part of ORSANCO's normal monitoring. This report presents the 2008 survey of the Smithland pool including the data collected and assessment results based on the fish population surveys.

## **2.0 Study Area**

### *2.1 Ohio River*

The Ohio River (Figure 1) begins at the confluence of the Monongahela and Allegheny rivers and flows 981 miles in a southwesterly direction to the confluence with the Mississippi River. Twenty navigational dams maintain a nine-foot minimum depth for commercial navigation throughout the entire length of the river. There are over 600 permitted discharges to the Ohio River, 49 of which are power-generating facilities. The Ohio River Basin contains nearly ten percent of the nation's



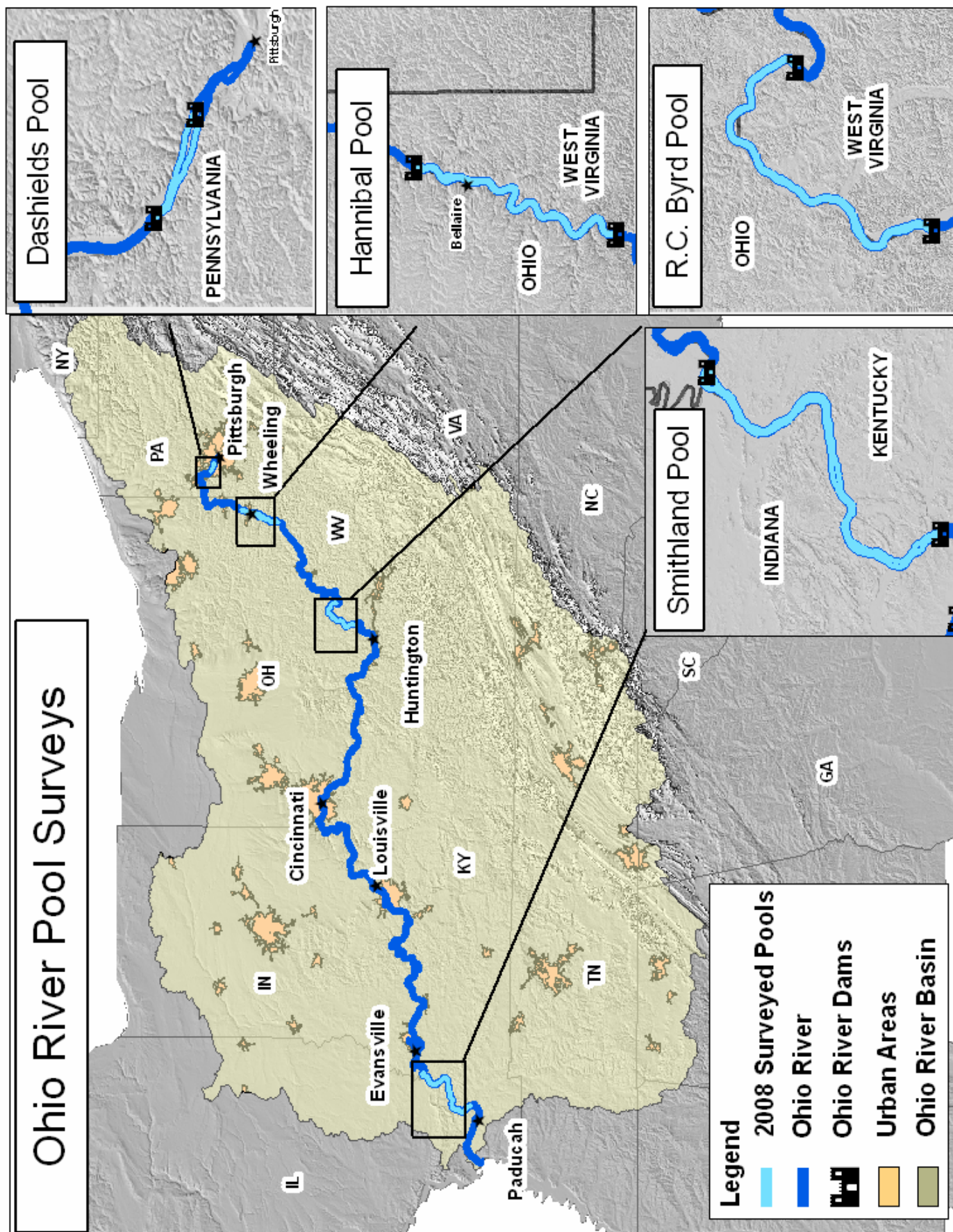


Figure 1. The Ohio River basin and the four pools selected for 2008 sampling.

population, more than 25 million people, and serves as an avenue for transportation of approximately 250 million tons of cargo each year (ORSANCO 1994). The Ohio River dissects four ecoregions: the Western Allegheny Plateau, the Interior Plateau, the Interior River Lowland, and the Mississippi Alluvial Plain (Omernik 1987).

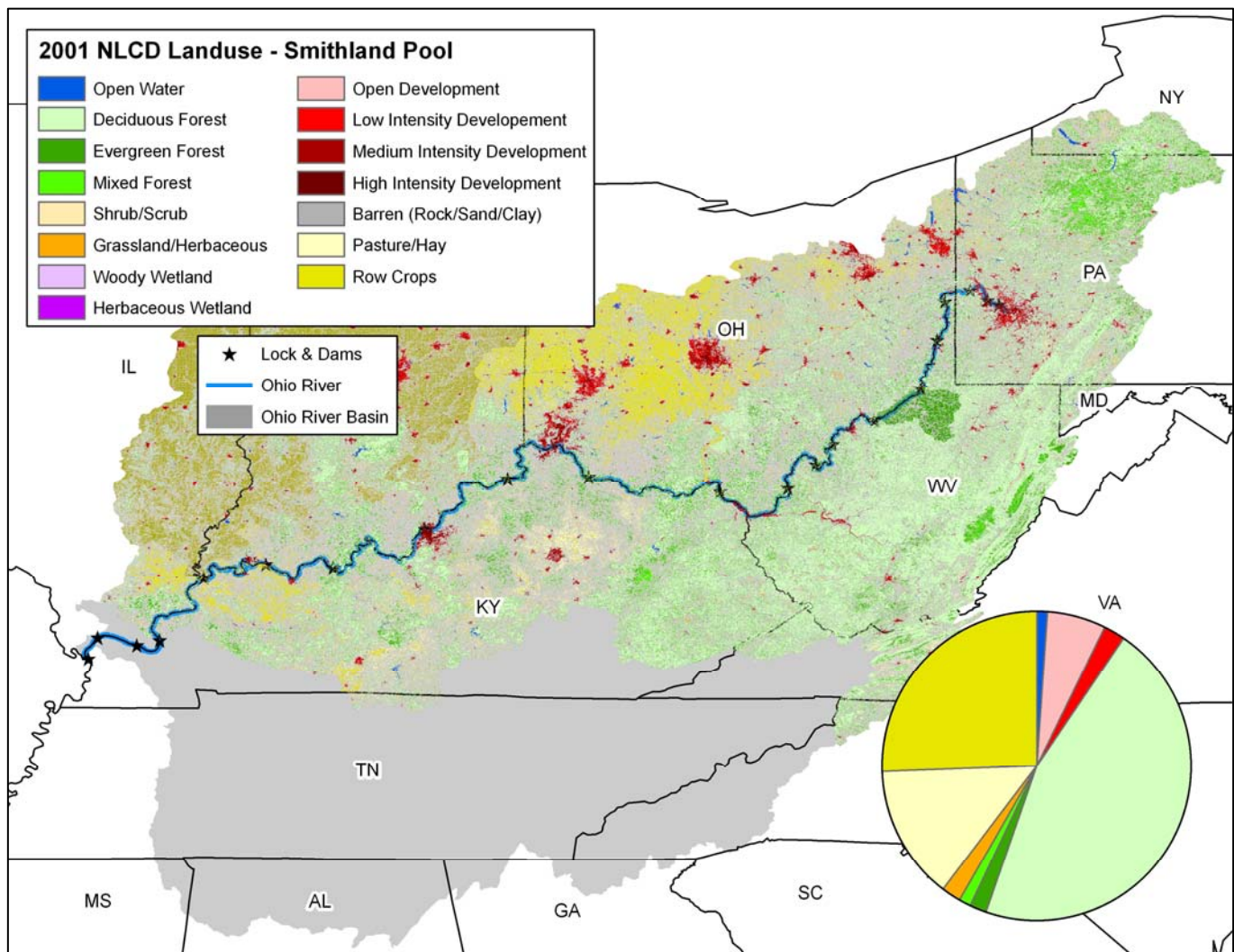
## 2.2 Smithland Pool

The Smithland pool is 72.5 miles long, extending from J.T. Meyers Locks and Dam (ORM 846.0) to Smithland Locks and Dam (ORM 918.5). The pool has a gradient drop of 0.3 feet per mile and averages 4,116 feet wide and 30 feet deep (ORSANCO

1994). The pool is bordered by the states of Kentucky, Illinois, and Indiana.

## 2.3 Smithland Pool Land Cover

Smithland pool lies in a portion of the Ohio River where the land cover consists primarily of deciduous forest (47.7%), but also has a considerable amount of row crops (25.0%) and pasture lands (13.7%: Figure 2). The Smithland pool receives water from the following tributaries: Wabash River at mile point 848.0 with a drainage area of 33,100 square miles, Saline River at mile point 867.3 with a drainage area of 1,170 square miles and Tradewater River at mile point 873.5 with a drainage area of 1,000 square miles.



**Figure 2.** Land-cover within the Smithland pool catchment area.



### 3.0 Methods

#### 3.1 Survey Design and Site Location

A random, probability-based survey design was used to select sampling site locations within each Ohio River survey pool. The USEPA National Health and Environmental Effects Laboratory, Western Ecology Division provided assistance by generating the survey design for this project. The target population was the linear shorelines of the Smithland pool of the Ohio River from mile marker 846.0 (J.T. Meyers Locks and Dam) to 918.5 (Smithland and Dam). The total linear extent of the target population was approximately 145.0 miles. The sample frame was generated using RF3 river double lines for the Ohio River and river mile coverage provided by ORSANCO. A generalized random tessellation stratified (GRTS) survey design for a linear network with reverse hierarchical randomization (RHR) was used to select all sampling locations. This survey design provided coordinates for 15 sampling sites in each of the selected pools. The data collected from these sites were used to make an assessment of the pool (see Section 3.6 and Appendix A).

Sites were sampled as closely as possible to the location generated from the design, but in cases of restricted access or unsafe sampling conditions (e.g. barge loading/mooring area), sampling zones were shifted if possible (up to a maximum of 500m up- or downstream). The survey design supplied additional sampling sites to be used if a site could not be placed within 500m of the original location.

#### 3.2 Index Period and Sampling Restrictions

All sampling was conducted under the required conditions as described by Emery et al. (2003). This included sampling between July 1 and October 31 when water levels were within one meter of “normal flat pool” and Secchi depths were greater than 0.3m (12”). These sampling restrictions were used to reduce community variability by increasing the likelihood that samples were collected during the stable, low-flow conditions usually present on the Ohio River during the summer and early fall months.

#### 3.3 Fish Collections

Standard collection techniques were employed throughout the surveys as described by Emery et al. (2003). Fish were collected using boat electrofishing techniques at night because nighttime electrofishing typically yields samples of increased diversity and richness (Sanders 1992).



*ORSANCO crew conducting night-time electrofishing*

A sampling crew consisted of a three-person team working from an 18-foot aluminum johnboat. Each boat was equipped with a 5000-watt generator and a Smith-Root Type VI-A electrofishing unit. Sampling was conducted over a 500m long section of near-shore habitat (shoreline out to a maximum distance of 100 ft or a depth of 20 ft.) and was sampled for a minimum of 1800 seconds (Gammon 1998). Time could vary depending upon the complexity of the habitat within a given zone. Stunned fish were captured with nets and placed into large, aerated tubs for processing. Each fish was measured, inspected for anomalies, and identified to lowest possible taxonomic level (species) before being returned to the water. Fish that could not be confidently identified in the field (e.g. minnows) were preserved in a ten percent formalin solution and identified in the laboratory.



*Typical 500 meter electrofishing reach*

### *3.4 Habitat Characterizations*

Large rivers have distinct habitat types, including unique microhabitats (Reash 1999). Therefore, extensive habitat surveys were conducted for each electrofishing zone, including thorough substrate and depth measurements. Descriptions of the riparian corridor adjacent to the sampling zone and the presence of woody material available as fish cover were also recorded. Depth and substrate composition were measured at 66 points throughout each 500m zone. Six points along the shoreline were selected throughout the length of the zone at 0, 100, 200, 300, 400 and 500m. From each of these points, depth was recorded at 10ft intervals beginning at the shore/water interface and moving away from the shore for 100ft. Woody cover, which included submerged brush, logs, and stumps, was estimated visually. Using these data, each site, or electrofishing zone, was assigned to one of five existing classes of habitat: 'A', 'B', 'C', 'D' or 'E' (Emery et al, in prep). By assigning each sampling site to one of five habitat categories, biologists can reduce the amount of assessment variability, or 'noise', because each habitat class has a slightly different expectation. Sites assigned to habitat class 'A' are characterized by a >81% presence of boulder, cobble, and gravel at depths <10 feet. Sites assigned to habitat class 'B' are characterized by a ≤81% and >50% presence of boulder, cobble, and gravel at depths <10 feet. Classes 'C', 'D', and 'E' each exhibit substrate compositions of boulder, cobble, and gravel that are ≤50%. Sites that fall in habitat class 'C' exhibit a lower percentage of smaller substrates (≤77%; sand, fine, and hardpan) at depths <10 feet. Class 'D' and 'E' sites similarly exhibit large amounts of sand and fine substrates (>77%), however these two classes differ with respect to depth. Habitat class 'D' sites are relatively shallow while class 'E' sites exhibit a larger percentage of >20' depths.

### *3.5 Water Quality and Flow Condition Data*

Basic measures of water quality were collected at each site prior to sampling. The following parameters were measured with a YSI meter: water temperature, pH, dissolved oxygen (DO), and conductivity. Water samples were also collected using a Kemmerer and consisted of a

single-point, mid-depth grab sample at the downstream end of each 500m zone. Samples were collected approximately 100ft from shore at each site on three separate occasions throughout the field season. Samples were kept at or below 4°C until sent off for laboratory analyses. Water quality parameters analyzed included: ammonia nitrogen, chloride, hardness, nitrate-nitrite, total Kjeldahl nitrogen (TKN), phenolics, sulfate, total suspended solids (TSS), total phosphorus, and total organic carbon (TOC).

Secchi depth was measured using a standard Secchi disc just prior to electrofishing. The potential effects of flow on fish assemblages are unclear therefore flow was also monitored. Flow data were obtained from the U.S. Army Corps of Engineers. These included daily average flow volumes and velocities from the nearest-upstream sampling station to any particular site. There are 234 flow stations on the mainstem of the Ohio River from which data is recorded or modeled. Harmonic mean flow (HMF), the 22-year average flow, was calculated for every Julian day and flow station by ORSANCO using raw flow data obtained from the U.S. Army Corps of Engineers (ORSANCO 2003)

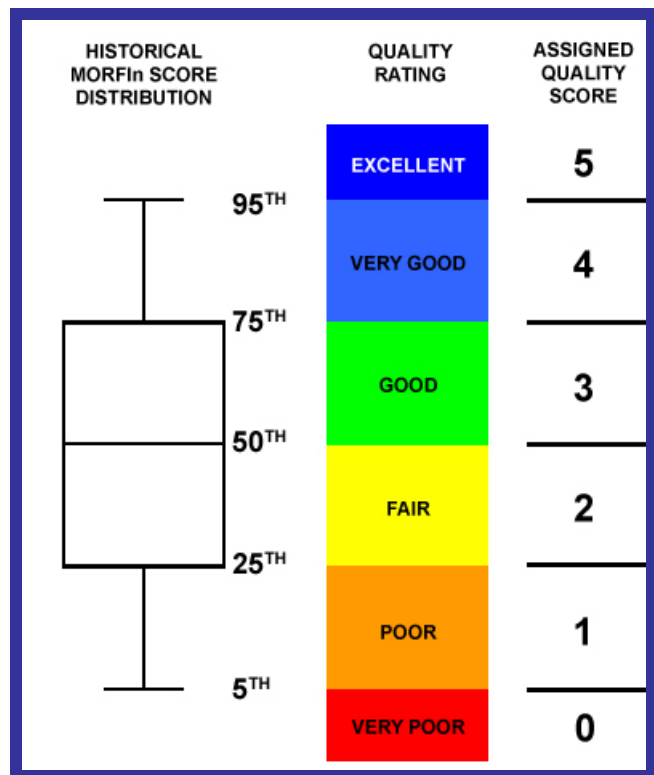
### *3.6 Pool Assessment*

In 2008, ORSANCO employed a probability-based sampling and assessment approach to provide a thorough assessment of biological condition. For the purpose of assessment, individual navigational pools served as the primary assessment units. Therefore, the Smithland pool served as one distinct assessment unit (AU) and will be reported on as such in the 305(b) report issued to EPA. The approach to assessing each AU involved sampling a statistically determined number of sites (15). Observed MORFIN scores were compared to habitat derived expectations for each site (Emery et al. 2003).

The five distinct habitat classes ('A', 'B', 'C', 'D', and 'E') each exhibit different levels of historical MORFIN performance. Performance expectations for each habitat class were determined based on the statistical distribution of data (MORFIN scores) gathered from 'least



impacted' (reference) sites within each habitat class. The 25<sup>th</sup> percentile value for each habitat class was established as the criterion for determining whether an individual site 'passes' (meets its aquatic life-use designation) or 'fails' (does not meet its aquatic life-use designation, Figure 3).

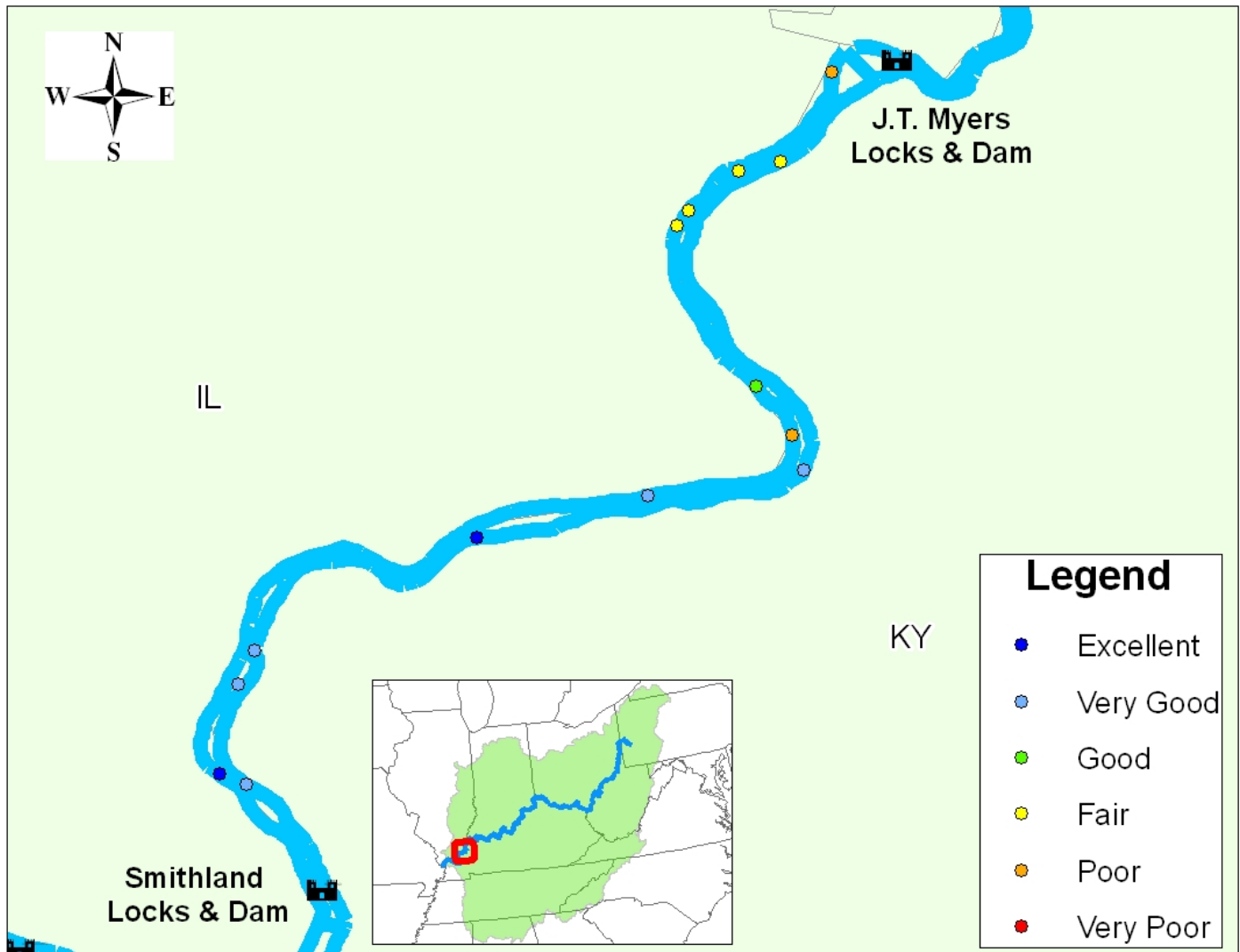


**Figure 3.** Approach used to assign fish quality scores for each habitat class.

Individual site scores were compared to historical MORFIn score values for a particular habitat

class. Historical MORFIn values were determined by compiling fish data from the five distinct habitat classes over a fifteen year period to determine the range of scores that exists within each habitat class. A fish quality score (between 0 and 5) was assigned based on how each site scored relative to the statistical distribution of historical MORFIn scores (see Appendix A for a detailed explanation). For example, a fish quality score of 0 corresponds to the 5<sup>th</sup> percentile of the range of historical MORFIn scores specific to that habitat class (Figure 3).

Quality scores were determined to obtain a final bio-assessment and the threshold for the pool assessment was set at 25% failure. The pool passed the assessment if the average fish quality score for the pool was above the 25<sup>th</sup> percentile ( $\geq 2.0$ ). If the average fish quality score for a pool was below the 25<sup>th</sup> percentile, the pool was assessed as failing. To further characterize the condition of each pool, sites were given individual condition ratings. The 95<sup>th</sup>, 75<sup>th</sup>, 50<sup>th</sup>, 25<sup>th</sup>, and 5<sup>th</sup> percentiles were used as cutoff points for the different ratings. These ratings were based on the same distribution of data from 'least impacted' sites used to determine expectations and consisted of Excellent, Very Good, Good, Fair, Poor, and Very Poor. Any sites that were classified as Poor or Very Poor were sites that failed to meet expectations (Figures 3 and 4).



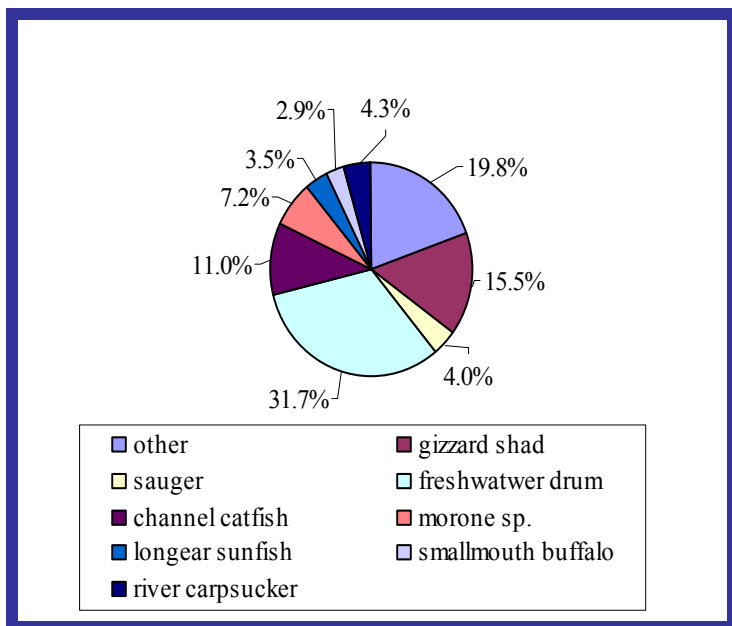
**Figure 4.** Locations and results of sampling at 14 sites within the Smithland pool.

## 4.0 Results

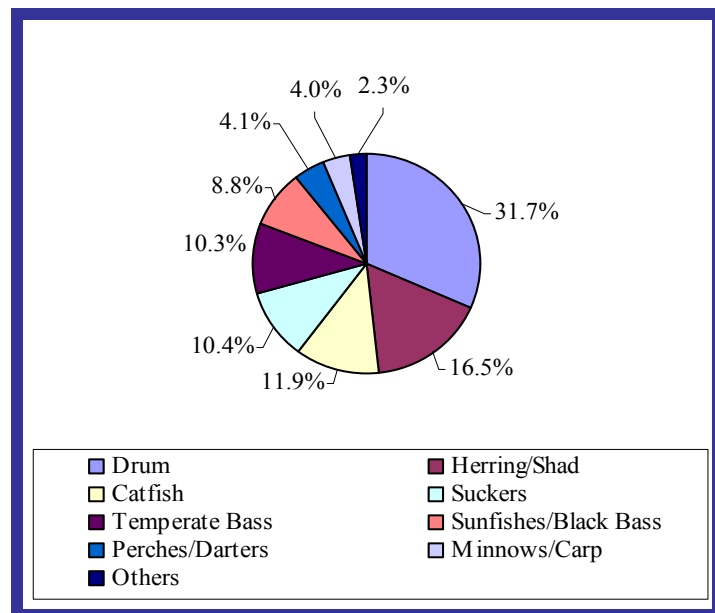
### 4.1 Fish Population

In 2008, fish population data (Appendix B) were collected from 14 randomly selected locations throughout the length of Smithland pool (Table 1). Time constraints and unfavorable weather events prevented the completion of all 15 sites. These collections produced 44 species and 3 hybrid taxa, representing 12 different families (Table 2). Two of these taxa were listed in KY as either threatened [inland silverside (*Menidia beryllina*)] or of special

concern [black buffalo (*Ictiobus niger*)]. None of the species collected were listed in Indiana or Illinois and no federally listed taxa were collected from Smithland pool. The two most abundant species were freshwater drum (*Aplodinotus grunniens*) and gizzard shad (*Dorosoma cepedianum*) comprising 31.7% and 19.8% of the catch respectively (Figure 5). Similarly, the two most abundant families were drum family (Sciaenidae) and the shad and herring family (Clupeidae) which made up 31.7% and 16.5% of the total catch (Figure 6).



**Figure 5.** Species composition of fish sampled in Smithland pool.



**Figure 6.** Sampled fish composition by family in the Smithland pool.

**Table 1.** Electrofishing site list for the Smithland pool, including habitat designation, MORFIN scores and status.

| Site # | River Mile | Bank | Date      | Latitude | Longitude | Habitat Class | MORFIN Expectation | MORFIN | Quality Values | Quality Score |
|--------|------------|------|-----------|----------|-----------|---------------|--------------------|--------|----------------|---------------|
| 1      | 849.5      | RDB  | 15-Oct-08 | 37.78407 | 88.04178  | E             | 37.69              | 38.48  | 1              | Poor          |
| 2      | 854.6      | LDB  | 29-Jul-08 | 37.71651 | 88.08043  | D             | 41.00              | 47.12  | 2              | Fair          |
| 3      | 856.3      | RDB  | 29-Jul-08 | 37.70956 | 88.11192  | D             | 41.00              | 44.18  | 2              | Fair          |
| 4      | 859.4      | RDB  | 29-Jul-08 | 37.67911 | 88.14978  | D             | 41.00              | 46.48  | 2              | Fair          |
| 5      | 860.4      | RDB  | 29-Jul-08 | 37.66772 | 88.15784  | E             | 37.69              | 47.93  | 2              | Fair          |
| 6      | 869.7      | RDB  | 14-Oct-08 | 37.54658 | 88.09836  | D             | 41.00              | 51.76  | 3              | Good          |
| 7      | 873.0      | RDB  | 14-Oct-08 | 37.50985 | 88.07167  | C             | 43.13              | 41.54  | 1              | Poor          |
| 8      | 874.9      | LDB  | 23-Aug-08 | 37.48331 | 88.06276  | D             | 41.00              | 62.51  | 4              | Very Good     |
| 9      | 881.7      | RDB  | 28-Jul-08 | 37.46464 | 88.18008  | C             | 43.13              | 63.80  | 4              | Very Good     |
| 10     | 889.4      | LDB  | 28-Jul-08 | 37.43298 | 88.30880  | E             | 37.69              | 68.85  | 5              | Excellent     |
| 11     | 903.7      | RDB  | 15-Oct-08 | 37.34803 | 88.47703  | D             | 41.00              | 63.64  | 4              | Very Good     |
| 12     | 905.7      | LDB  | 15-Oct-08 | 37.32255 | 88.48918  | D             | 41.00              | 61.09  | 4              | Very Good     |
| 13     | 910.7      | RDB  | 14-Oct-08 | 37.25491 | 88.50280  | D             | 41.00              | 68.89  | 5              | Excellent     |
| 14     | 912.0      | LDB  | 14-Oct-08 | 37.24709 | 88.48264  | D             | 41.00              | 64.41  | 4              | Very Good     |

LDB = Left Descending Bank

RDB = Right Descending Bank

**Table 2.** Species collected in the Smithland pool during the 2008 survey. Species information are determined by and relative to the individual states (T = 'Threatened,' and SC = 'Species of Concern').

| Family          | Species                    | Latin Name                                | IN | IL | KY |
|-----------------|----------------------------|---|----|----|----|
| Atherinopsidae  | Brook Silverside           | <i>Labidesthes sicculus</i>               |    |    |    |
| Atherinopsidae  | Inland Silverside          | <i>Menidia beryllina</i>                  |    |    | T  |
| Catostomidae    | River Carpsucker           | <i>Carpiodes carpio</i>                   |    |    |    |
| Catostomidae    | Quillback                  | <i>Carpiodes cyprinus</i>                 |    |    |    |
| Catostomidae    | Highfin Carpsucker         | <i>Carpiodes velifer</i>                  |    |    |    |
| Catostomidae    | Smallmouth Buffalo         | <i>Ictiobus bubalus</i>                   |    |    |    |
| Catostomidae    | Bigmouth Buffalo           | <i>Ictiobus cyprinellus</i>               |    |    |    |
| Catostomidae    | Black Buffalo              | <i>Ictiobus niger</i>                     |    |    | SC |
| Catostomidae    | Spotted Sucker             | <i>Minytrema melanops</i>                 |    |    |    |
| Catostomidae    | Silver Redhorse            | <i>Moxostoma anisurum</i>                 |    |    |    |
| Catostomidae    | Golden Redhorse            | <i>Moxostoma erythrurum</i>               |    |    |    |
| Catostomidae    | Shorthead Redhorse         | <i>Moxostoma macrolepidotum</i>           |    |    |    |
| Centrarchidae   | Green Sunfish              | <i>Lepomis cyanellus</i>                  |    |    |    |
| Centrarchidae   | Bluegill                   | <i>Lepomis macrochirus</i>                |    |    |    |
| Centrarchidae   | Bluegill X Longear Sunfish | <i>Lepomis macrochirus x L. megalotis</i> |    |    |    |
| Centrarchidae   | Longear Sunfish            | <i>Lepomis megalotis</i>                  |    |    |    |
| Centrarchidae   | Redear Sunfish             | <i>Lepomis microlophus</i>                |    |    |    |
| Centrarchidae   | Spotted Bass               | <i>Micropterus punctulatus</i>            |    |    |    |
| Centrarchidae   | Largemouth Bass            | <i>Micropterus salmoides</i>              |    |    |    |
| Centrarchidae   | Micropterus Sp             | <i>Micropterus sp</i>                     |    |    |    |
| Clupeidae       | Skipjack Herring           | <i>Alosa chrysochloris</i>                |    |    |    |
| Clupeidae       | Gizzard Shad               | <i>Dorosoma cepedianum</i>                |    |    |    |
| Clupeidae       | Threadfin Shad             | <i>Dorosoma petenense</i>                 |    |    |    |
| Cyprinidae      | Spotfin Shiner             | <i>Cyprinella spiloptera</i>              |    |    |    |
| Cyprinidae      | Common Carp                | <i>Cyprinus carpio</i>                    |    |    |    |
| Cyprinidae      | Silver Carp                | <i>Hypophthalmichthys molitrix</i>        |    |    |    |
| Cyprinidae      | Silver Chub                | <i>Macrhybopsis storeriana</i>            |    |    |    |
| Cyprinidae      | Emerald Shiner             | <i>Notropis atherinoides</i>              |    |    |    |
| Cyprinidae      | River Shiner               | <i>Notropis blenniuss</i>                 |    |    |    |
| Cyprinidae      | Notropis Sp                | <i>Notropis sp</i>                        |    |    |    |
| Cyprinidae      | Bluntnose Minnow           | <i>Pimephales notatus</i>                 |    |    |    |
| Cyprinidae      | Bullhead Minnow            | <i>Pimephales vigilax</i>                 |    |    |    |
| Hiodontidae     | Goldeye                    | <i>Hiodon alosoides</i>                   |    |    |    |
| Ictaluridae     | Blue Catfish               | <i>Ictalurus furcatus</i>                 |    |    |    |
| Ictaluridae     | Channel Catfish            | <i>Ictalurus punctatus</i>                |    |    |    |
| Ictaluridae     | Flathead Catfish           | <i>Pylodictis olivaris</i>                |    |    |    |
| Lepisosteidae   | Spotted Gar                | <i>Lepisosteus oculatus</i>               |    |    |    |
| Lepisosteidae   | Longnose Gar               | <i>Lepisosteus osseus</i>                 |    |    |    |
| Lepisosteidae   | Shortnose Gar              | <i>Lepisosteus platostomus</i>            |    |    |    |
| Moronidae       | White Bass                 | <i>Morone chrysops</i>                    |    |    |    |
| Moronidae       | Yellow Bass                | <i>Morone mississippiensis</i>            |    |    |    |
| Moronidae       | Striped Bass               | <i>Morone saxatilis</i>                   |    |    |    |
| Moronidae       | Hybrid Striper             | <i>Morone saxatilis x M. chrysops</i>     |    |    |    |
| Moronidae       | Morone Sp                  | <i>Morone sp</i>                          |    |    |    |
| Percidae        | Logperch                   | <i>Percina caprodes</i>                   |    |    |    |
| Percidae        | Dusky Darter               | <i>Percina sciera</i>                     |    |    |    |
| Percidae        | Sauger                     | <i>Sander canadensis</i>                  |    |    |    |
| Percidae        | Saugeye                    | <i>Sander canadensis x S. vitreus</i>     |    |    |    |
| Petromyzontidae | Silver Lamprey             | <i>Ichthyomyzon unicuspis</i>             |    |    |    |
| Sciaenidae      | Freshwater Drum            | <i>Aplodinotus grunniens</i>              |    |    |    |





#### 4.2 Metric Performance

Thirteen metrics were used to calculate MORFI scores for each electrofishing site (See Emery et al. 2003). Each site's performance and scores for the MORFI metrics are shown in Table 3. The number of native species collected at each site ranged from 8 to 24, with an average of 16.5 species per site. The number of sucker species found at each site ranged from 0 to 7 and the number of centrarchid species varied from 0 to 6. The number of great river species ranged from 1 to 3 and the number of intolerant species were less than 2 at the sampled sites. The percentage of tolerant individuals at each site did not exceed 8.0% and the percentage of simple lithophils ranged between 0% and 28.8%. All sites had less than 10.4% non-native individuals and the percent detritivores ranged from 0% to 39.6%. The percent invertivores ranged between 0% to 32.7%, and the percent piscivores ranged from 7.8% to 67.3%. Two of the sites had individuals with single DELT (deformities, eroded fins, lesions, and tumors) anomalies. The CPUE (catch per unit effort) ranged from 58 to 599 individuals and averaged 185 individuals per site.

#### 4.3 Habitat Surveys

Intensive habitat surveys at each of the 14 sampling locations revealed that the bottom substrate in the Smithland pool was largely sand and fines with a smaller percentage of hardpan and cobble (Figure 7). There was some variation among the individual sites (Figure 8) within the pool. The percentages of substrate variables were used to give each site a habitat classification of 'A', 'B', 'C', 'D', or 'E'. Two sites in Smithland pool were classified as class 'C' habitats, 9 sites were class 'D' habitats, and 3 sites were class 'E' habitats. There were zero 'A' and 'B' habitat classes sampled in the pool (Table 1).

Woody cover was present at 13 of the sites sampled and overhanging vegetation was present at 6 of the sites. Riparian land cover was primarily natural forest with some agricultural uses present. Barge activity was moderate throughout the pool; however mooring structures were not present at any of the sites sampled (see Appendix C).

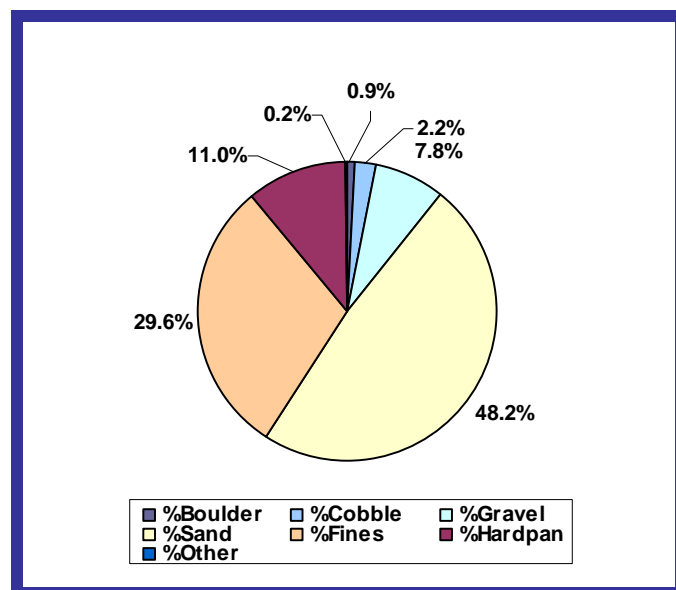


Figure 7. Substrate composition of the Smithland pool.

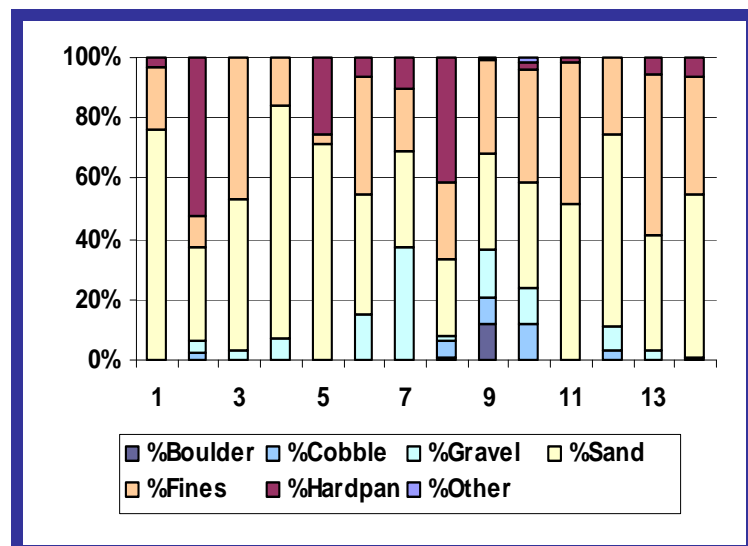


Figure 8. Substrate composition at each site sampled in the Smithland pool.

#### 4.4 Water Quality and Flow Conditions

Rain events were relatively common throughout the sampling period in 2008; therefore river levels and flows were variable. However, sampling was only conducted in Smithland pool when flows were near or below the harmonic mean flow (HMF) for the sites. Flow conditions during sampling varied from 34% and 115% of the HMF (Figure 9).

Measurements of water quality parameters did not reveal any unusual or poor water conditions present at the time of fish sampling (Appendix D). Secchi depths at the time of sampling ranged from 18 to 48 inches.

Table 3. MORFI metrics and scores from the 2008 survey of Smithland pool.

| Site # | Rmi   | Bank | # Individuals | # Individuals w/o G & E | # Individuals w/o GETHEX | # Species | # Species Score | # Suckers | Suckers Score | # Centrarchid Species | Centrarchid Species Score | # Great River Species | Great River Species Score | # Intolerant Species | Intolerant Species Score | % Tolerant Individuals | Tolerant Individuals Score | % Simple Lithophils | Simple Lithophils Score | % Non-native Individuals | Non-native Individuals Score | % Detritivores | % Detritivores Score | % Invertivores | Invertivores Score | % Piscivores | % Piscivores Score | # DELTs | DEL T score | CPUE | CPUE score | Expected MORFI | Observed MORFI |
|--------|-------|------|---------------|-------------------------|--------------------------|-----------|-----------------|-----------|---------------|-----------------------|---------------------------|-----------------------|---------------------------|----------------------|--------------------------|------------------------|----------------------------|---------------------|-------------------------|--------------------------|------------------------------|----------------|----------------------|----------------|--------------------|--------------|--------------------|---------|-------------|------|------------|----------------|----------------|
| 1      | 849.5 | R    | 99            | 69                      | 64                       | 8         | 4.1             | 0         | 5.5           | 0                     | 0.0                       | 1                     | 33.3                      | 0                    | 26.1                     | 0.0                    | 100.0                      | 4.3                 | 11.9                    | 5.8                      | 46.3                         | 0.0            | 100.0                | 0.0            | 16.1               | 29.0         | 35.0               | 0       | 100         | 94   | 21.9       | 37.7           | 38.5           |
| 2      | 854.6 | L    | 72            | 61                      | 61                       | 14        | 47.9            | 3         | 63.8          | 3                     | 50.0                      | 1                     | 33.3                      | 0                    | 26.5                     | 0.0                    | 100.0                      | 0.0                 | 4.1                     | 0.0                      | 100.0                        | 27.9           | 3.4                  | 6.6            | 26.3               | 31.1         | 38.7               | 0       | 100         | 72   | 18.4       | 41.0           | 47.1           |
| 3      | 856.3 | R    | 103           | 55                      | 53                       | 12        | 33.4            | 2         | 44.6          | 1                     | 16.7                      | 1                     | 33.3                      | 0                    | 26.6                     | 3.6                    | 61.5                       | 21.8                | 43.4                    | 3.6                      | 66.3                         | 20.0           | 31.2                 | 1.8            | 19.2               | 67.3         | 100.0              | 1       | 75          | 101  | 23.1       | 41.0           | 44.2           |
| 4      | 859.4 | R    | 128           | 106                     | 104                      | 16        | 62.6            | 5         | 100.0         | 0                     | 0.0                       | 1                     | 33.3                      | 1                    | 45.4                     | 1.9                    | 80.0                       | 13.2                | 28.0                    | 1.9                      | 82.5                         | 39.6           | 0.0                  | 1.9            | 19.5               | 23.6         | 25.6               | 0       | 100         | 126  | 27.3       | 41.0           | 46.5           |
| 5      | 860.4 | R    | 105           | 30                      | 30                       | 9         | 11.8            | 1         | 25.5          | 0                     | 0.0                       | 1                     | 33.3                      | 1                    | 45.5                     | 0.0                    | 100.0                      | 13.3                | 28.2                    | 0.0                      | 100.0                        | 3.3            | 90.0                 | 0.0            | 16.7               | 36.7         | 48.2               | 0       | 100         | 105  | 23.9       | 37.7           | 47.9           |
| 6      | 869.7 | R    | 164           | 113                     | 103                      | 20        | 92.1            | 3         | 64.7          | 6                     | 100.0                     | 2                     | 66.7                      | 2                    | 64.7                     | 8.0                    | 15.6                       | 13.3                | 28.3                    | 7.1                      | 34.4                         | 21.2           | 26.8                 | 32.7           | 66.4               | 12.4         | 6.2                | 1       | 75          | 154  | 32.1       | 41.0           | 51.8           |
| 7      | 873.0 | R    | 63            | 48                      | 43                       | 14        | 48.6            | 2         | 45.5          | 4                     | 66.7                      | 1                     | 33.3                      | 0                    | 27.7                     | 4.2                    | 55.8                       | 8.3                 | 19.4                    | 10.4                     | 3.5                          | 10.4           | 65.0                 | 8.3            | 29.8               | 25.0         | 28.0               | 0       | 100         | 58   | 16.6       | 43.1           | 41.5           |
| 8      | 874.9 | L    | 602           | 600                     | 597                      | 19        | 85.0            | 6         | 100.0         | 3                     | 50.0                      | 1                     | 33.3                      | 1                    | 46.5                     | 0.5                    | 94.7                       | 1.7                 | 7.5                     | 0.5                      | 95.4                         | 6.3            | 79.4                 | 2.3            | 20.9               | 7.8          | 0.0                | 0       | 100         | 599  | 100.0      | 41.0           | 62.5           |
| 9      | 881.7 | R    | 243           | 225                     | 222                      | 24        | 100.0           | 7         | 100.0         | 5                     | 83.3                      | 3                     | 100.0                     | 1                    | 46.9                     | 0.9                    | 90.6                       | 3.6                 | 11.0                    | 1.3                      | 87.6                         | 29.3           | 0.0                  | 25.3           | 55.8               | 13.3         | 7.7                | 0       | 100         | 240  | 46.3       | 43.1           | 63.8           |
| 10     | 889.4 | L    | 81            | 78                      | 77                       | 22        | 100.0           | 7         | 100.0         | 4                     | 66.7                      | 2                     | 66.7                      | 2                    | 66.1                     | 0.0                    | 100.0                      | 17.9                | 37.0                    | 1.3                      | 88.1                         | 16.7           | 43.0                 | 19.2           | 47.0               | 43.6         | 60.0               | 0       | 100         | 80   | 20.5       | 37.7           | 68.8           |
| 11     | 903.7 | R    | 168           | 131                     | 131                      | 16        | 64.2            | 3         | 66.7          | 4                     | 66.7                      | 2                     | 66.7                      | 0                    | 29.9                     | 0.0                    | 100.0                      | 21.4                | 43.4                    | 0.0                      | 100.0                        | 7.6            | 74.8                 | 17.6           | 45.2               | 29.0         | 34.7               | 0       | 100         | 168  | 35.2       | 41.0           | 63.6           |
| 12     | 905.7 | L    | 320           | 254                     | 254                      | 17        | 71.5            | 4         | 86.1          | 2                     | 33.3                      | 1                     | 33.3                      | 1                    | 48.6                     | 0.0                    | 100.0                      | 16.1                | 34.0                    | 0.0                      | 100.0                        | 4.3            | 86.5                 | 8.7            | 31.9               | 14.2         | 9.0                | 0       | 100         | 320  | 59.9       | 41.0           | 61.1           |
| 13     | 910.7 | R    | 225           | 201                     | 187                      | 21        | 100.0           | 6         | 100.0         | 5                     | 83.3                      | 3                     | 100.0                     | 1                    | 48.9                     | 0.0                    | 100.0                      | 8.5                 | 20.3                    | 7.0                      | 35.5                         | 6.5            | 78.9                 | 18.4           | 46.8               | 31.8         | 39.5               | 0       | 100         | 211  | 42.3       | 41.0           | 68.9           |
| 14     | 912.0 | L    | 264           | 229                     | 223                      | 19        | 86.3            | 5         | 100.0         | 5                     | 83.3                      | 1                     | 33.3                      | 1                    | 49.0                     | 1.3                    | 86.1                       | 4.8                 | 13.7                    | 2.6                      | 75.7                         | 8.3            | 72.5                 | 10.9           | 35.6               | 38.9         | 51.6               | 0       | 100         | 258  | 50.0       | 41.0           | 64.4           |

R = Right Descending Bank

L = Left Descending Bank

w/o G & E = Individuals minus gizzard shad and emerald shiners

w/o GETHEX = Individuals minus gizzard shad, emerald shiners, tolerants, hybrids, and exotics

Centrarchid Species = black bass, sunfishes, crappie

Great River Species = fish expected to be predominant in great rivers

Intolerant Species = species with low pollution/disturbance tolerance

Tolerant Individuals = individuals with high pollution/disturbance tolerance

Simple Lithophils = fish that are sensitive to substrate disturbance based on reproductive needs

Detritivore = fish that feed primarily on detritus

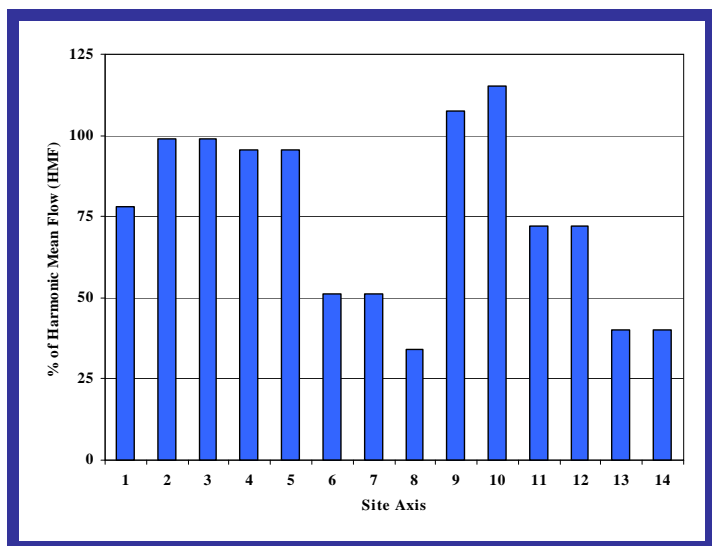
Invertivore = fish that feed primarily on invertebrates

Piscivore = fish that feed primarily on other fish

DELT = individuals with Deformities, Eroded fins, Lesions, and/or Tumors

CPUE = Catch Per Unit Effort

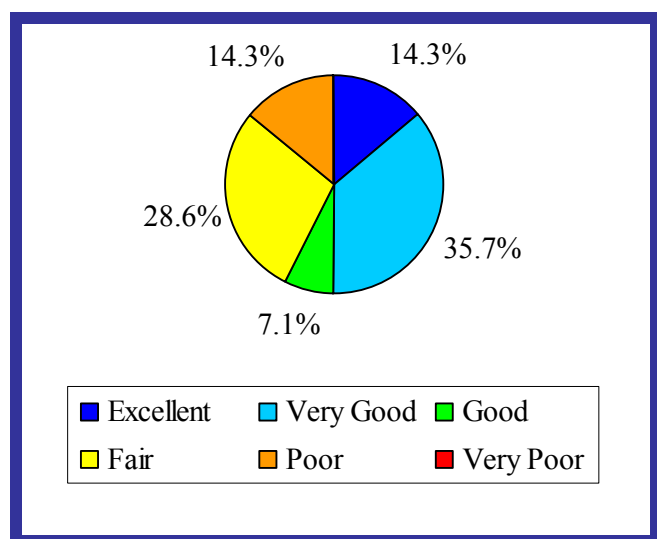
The water quality parameters measured from water samples, collected three times with Kemmerers, did not reveal any parameters exceeding water quality criteria (Appendix E).



**Figure 9.** Relative flows (%HMF) at the time of sampling.

#### 4.5 Assessment of Condition

MORFIn scores were calculated for each of the sites sampled. The maximum score achieved by any site in this pool out of a possible 100 was 68.9 and the minimum was 38.5. By comparing observed and expected MORFIn scores, ORSANCO determined if a site met its expectations (based on habitat class) or not (Table 3).



**Figure 10.** Condition of the Smithland pool based on MORFIn scores at 14 sites (Pass=Excellent-Fair, Fail=Poor-Very Poor).

Two of the 14 sites (14.3%) assessed in 2008 scored less than the minimum expected scores and were assessed as in poor condition (Table 1; Figure 10). The remaining 12 sites received a fair (28.6%), good (7.1%), very good (35.7%), or excellent condition (14.3%; Figure 10).

## 5.0 Discussion

### 5.1 Fish Population

In 2008, the fish population of Smithland pool was in good condition. This was supported by the diversity and types of species collected from the pool. Multiple pollution intolerant species such as shorthead redhorse (*Moxostoma macrolepidotum*), brook silverside (*Labidesthes sicculus*), logperch (*Percina caprodes*), dusky darter (*Percina sciera*) and goldeye (*Hiodon alosoides*) were collected from Smithland pool, indicating that pollution was not a problem in the area. Four non-native species were collected from Smithland pool during the survey including common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), striped bass (*Morone saxatilis*), and redear sunfish (*Lepomis microlophus*).

The most abundant species in the survey were gizzard shad (*Dorosoma cepedianum*; 837 individuals), freshwater drum (*Aplodinotus grunniens*; 409 ind.), channel catfish (*Ictalurus punctatus*; 291 ind.), and temperate bass species (*Morone sp.*; 190 ind.).

### 5.2 Metric Performance

Most of the metric scores in Smithland pool were relatively high with the exception of 3 metrics: % simple lithophils, % invertivores, and CPUE metrics. There was no known reason or explanation for the lower percentages of invertivores or simple lithophils. Gizzard shad was the dominant species collected (by abundance) and the CPUE metric does not include that species (or emerald shiners) in calculating the metric's score, a potential reason for the lower CPUE metric scores.

Five metrics stood out as the highest performing in Smithland pool; DELTs, the % tolerant individuals, # of non-native individuals, # of sucker species, and # of native species metrics. DELT anomalies were



only found at two sites suggesting the majority of fishes in Smithland pool are not experiencing environmental stressors severe enough to decrease their health. Low proportions of pollution-tolerant individuals and non-native species were collected. Relatively high numbers of sucker species were encountered on average at each site. Furthermore, on average, a relatively diverse fish assemblage was collected at each site based on the number of native species metric. These metrics indicate that Smithland pool is in good condition.

### *5.3 Habitat Surveys*

The habitat assessments show that in Smithland pool there was a relatively balanced number of sites classified as class 'C', class 'D', and class 'E' habitats. This indicates that the majority of the benthic substrate is comprised of sand and fines. The relatively homogenous, small substrate compositions, supplemented with the presence of woody cover, provided adequate habitat to support the diverse populations of fishes in the pool.

### *5.4 Water Quality and Flow Conditions*

The fluctuations in river levels are not likely to have affected the survey of Smithland pool. Rain events were relatively frequent throughout the field season however sampling was conducted during stable flows. Secchi depths indicated sufficient visibility for sampling at all sites. There were no water quality measurements that exceeded their respective criteria or provided any major insight into the assessment results for Smithland pool.

During the spring, a large flood event occurred creating a new channel in the Wabash River near its mouth. The river now bypasses a large horseshoe-bend and cuts through large agricultural fields. A massive sediment load was deposited into the Ohio River requiring the

navigational channel to be dredged. New sandbars and habitats were created in the upper portion of Smithland pool as a result of the new channel. During the 2008 field season, small rain events triggering even minute rises in the Wabash River caused increases in turbidity as the new channel was still expanding, scouring, eroding, etc. It is unsure to what extent the events occurring in the lower Wabash River are affecting the fish behaviors, populations, and the efficiency of our surveys.

### *5.5 Conclusions and Assessments of Condition*

The overall average quality score in Smithland pool was 3.1, indicating the pool is in good biological condition. Despite two of the sites being in poor condition, the assessment of Smithland pool met the criteria established by ORSANCO's Biological Water Quality Subcommittee (Appendix A). The data collected in 2008 indicated that Smithland pool met its aquatic life-use designation.

## **6.0 Interpool Comparisons**

### *6.1 Purpose*

As of 2008, 16 of 19 pools have been surveyed and assessed. This section was developed to compare Smithland pool to other previously surveyed pools in the Ohio River.

### *6.2 Land Cover*

Smithland pool lies in the downstream third of the Ohio River and the primary land cover within the catchment is deciduous forest (Figure 11). However, the many areas immediately surrounding the pool is heavily influenced by agriculture.

### *6.3 Substrate Composition*

The substrate composition in this pool was dominated by sand and fines. The relatively high proportion of agricultural land cover, which was quite similar to other pools near this portion of the river, can probably account for the large percentages of smaller substrates (Figure 12).

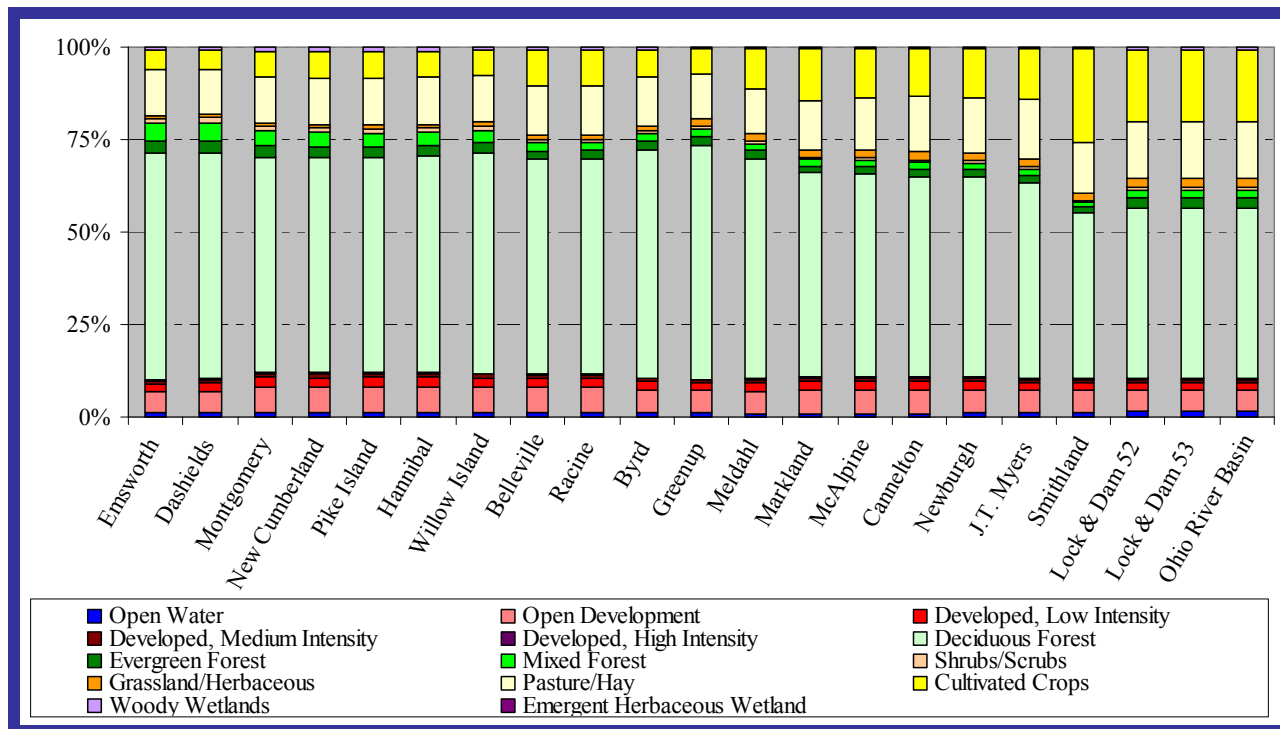


Figure 11. Cumulative land-cover within the catchment area of each pool of the Ohio River.

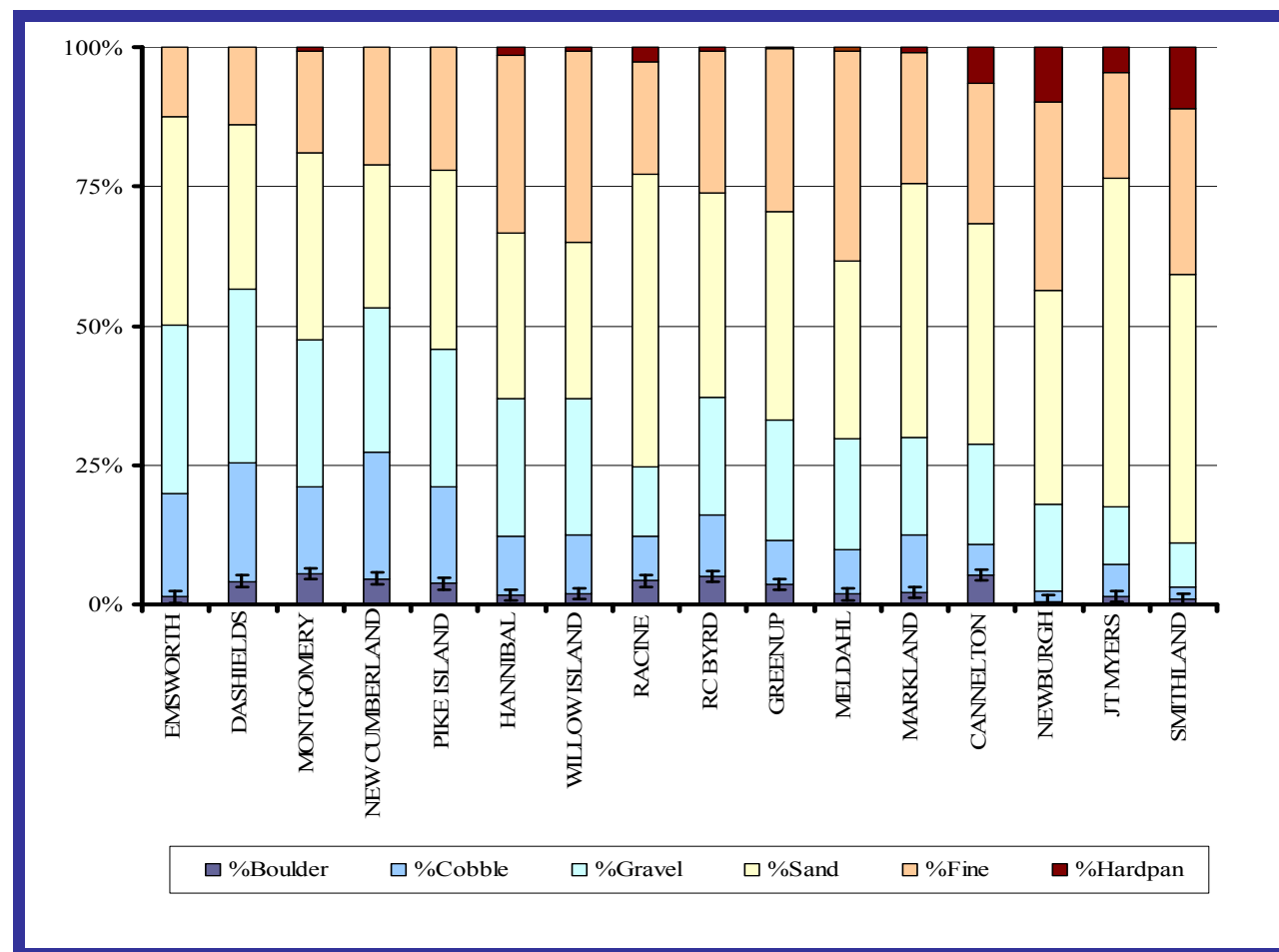
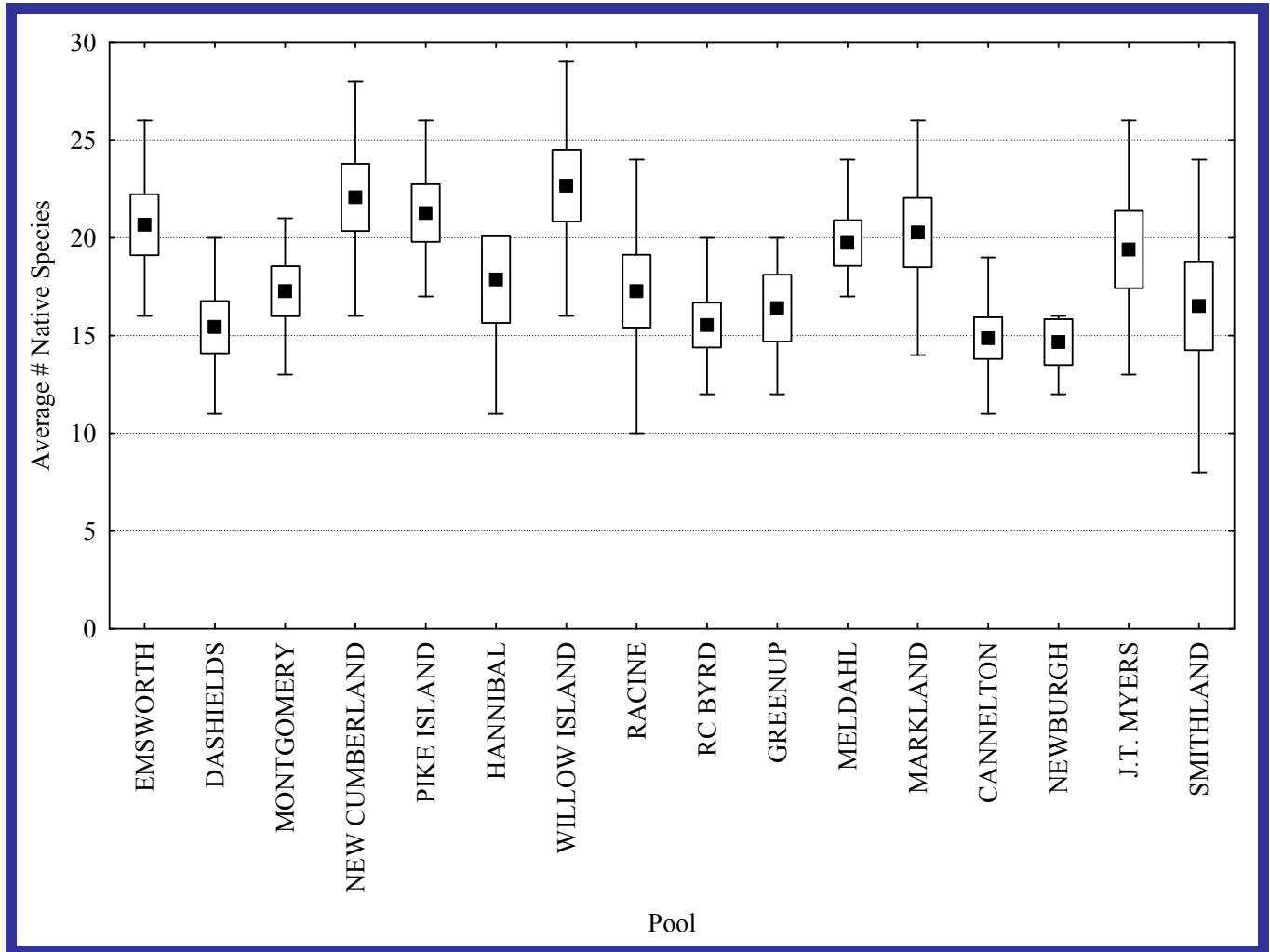


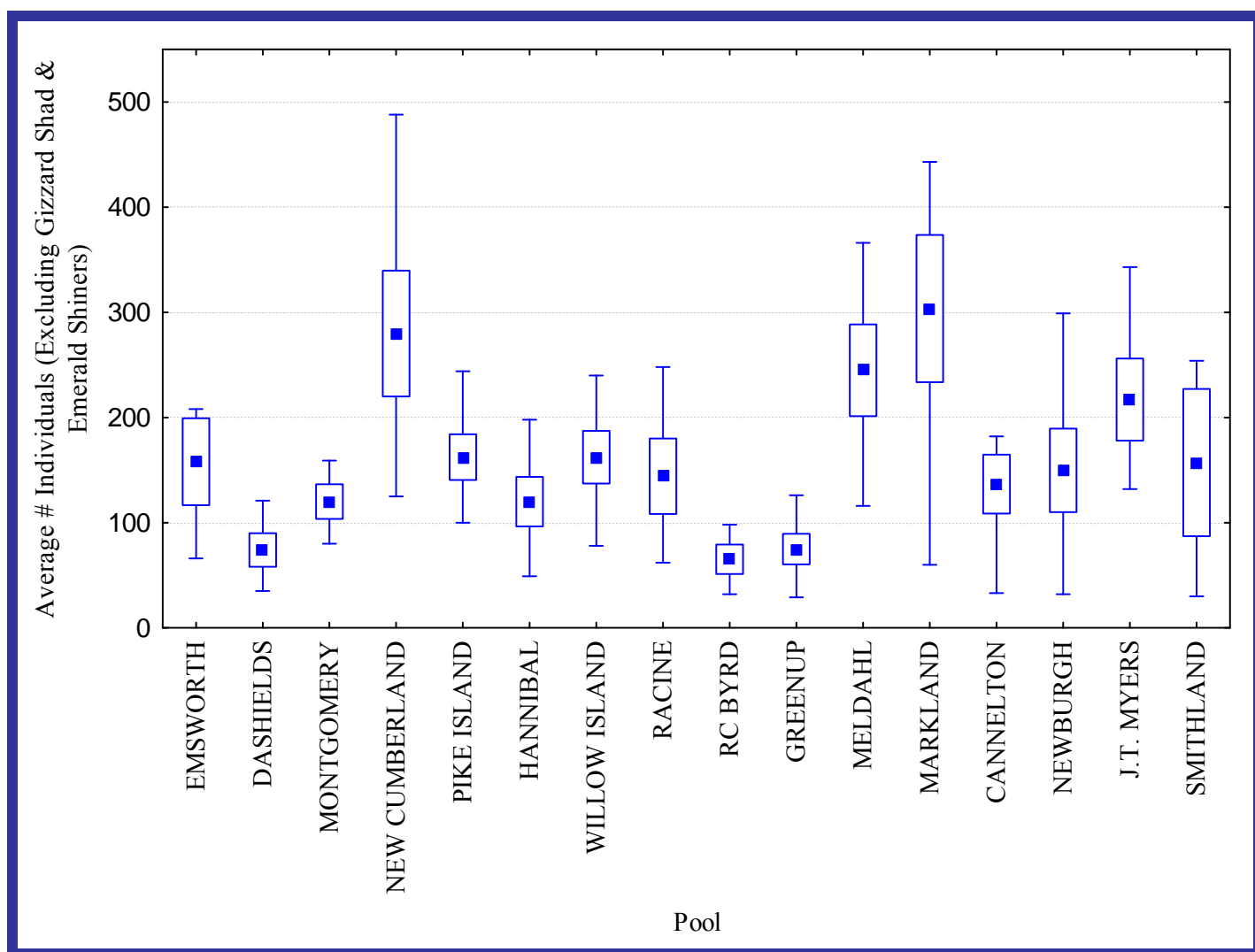
Figure 12. Substrate composition for each pool surveyed as of 2008.

#### 6.4 Species Richness

Smithland pool had a decreased average number of native species per site (16.5) and ranked 11<sup>th</sup> in comparison (Figure 13).



**Figure 13.** The average number of native species collected at each site within each pool surveyed as of 2008 (■=Average, □= 90% Confidence Interval, I=Non-Outlier Range).



**Figure 14.** The average number of individuals (excluding gizzard shad & emerald shiner) collected at each site within each pool surveyed as of 2008 (■=Average, □= 90% Confidence Interval, I=Non-Outlier Range).

### 6.5 Number of Individuals

An average of 157.1 individuals (excluding gizzard shad and emerald shiner) was collected at each site in Smithland pool which ranked 11<sup>th</sup> in comparison (Figure 14) to all pools sampled as of 2008.

### 6.6 Noteworthy Fish Observations

Three of the species collected in Smithland were unique to the pool (based on probabilistic surveys): inland silverside (*Menidia beryllina*), shorthead redhorse (*Moxostoma macro-*

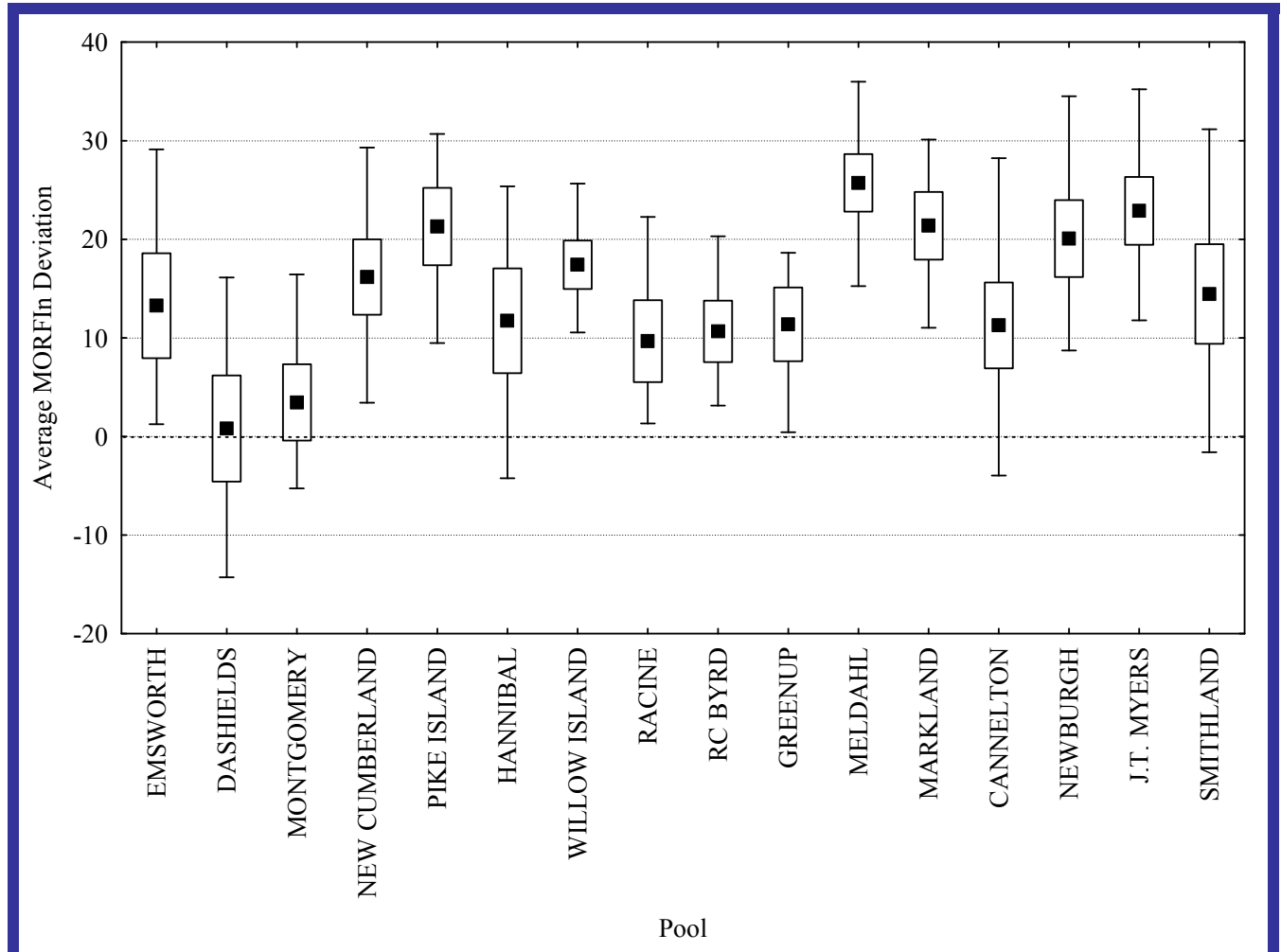
*lepidotum*), and yellow bass (*Morone mississippiensis*; Table 4). Several other species were collected in this pool that were uncommon to the rest of the pools such as: blue catfish (*Ictalurus furcatus*), dusky darter (*Percina sciera*), goldeye (*Hiodon alosoides*), shortnose gar (*Lepisosteus platostomus*), spotted gar (*Lepisosteus oculatus*), and silver carp (*Hypophthalmichthys molitrix*). All of the aforementioned species are more common in (and some are limited to) the downstream portions of the Ohio River.



### 6.7 MORFIn Deviation

The MORFIn deviation is a measure of how well the pool performed with regard to expected MORFIn values. Positive values indicate that

scores were greater than expected. Smithland pool had an average deviation of 14.5 and was ranked 8<sup>th</sup> in comparison to other pools surveyed as of 2008 (Figure 15).

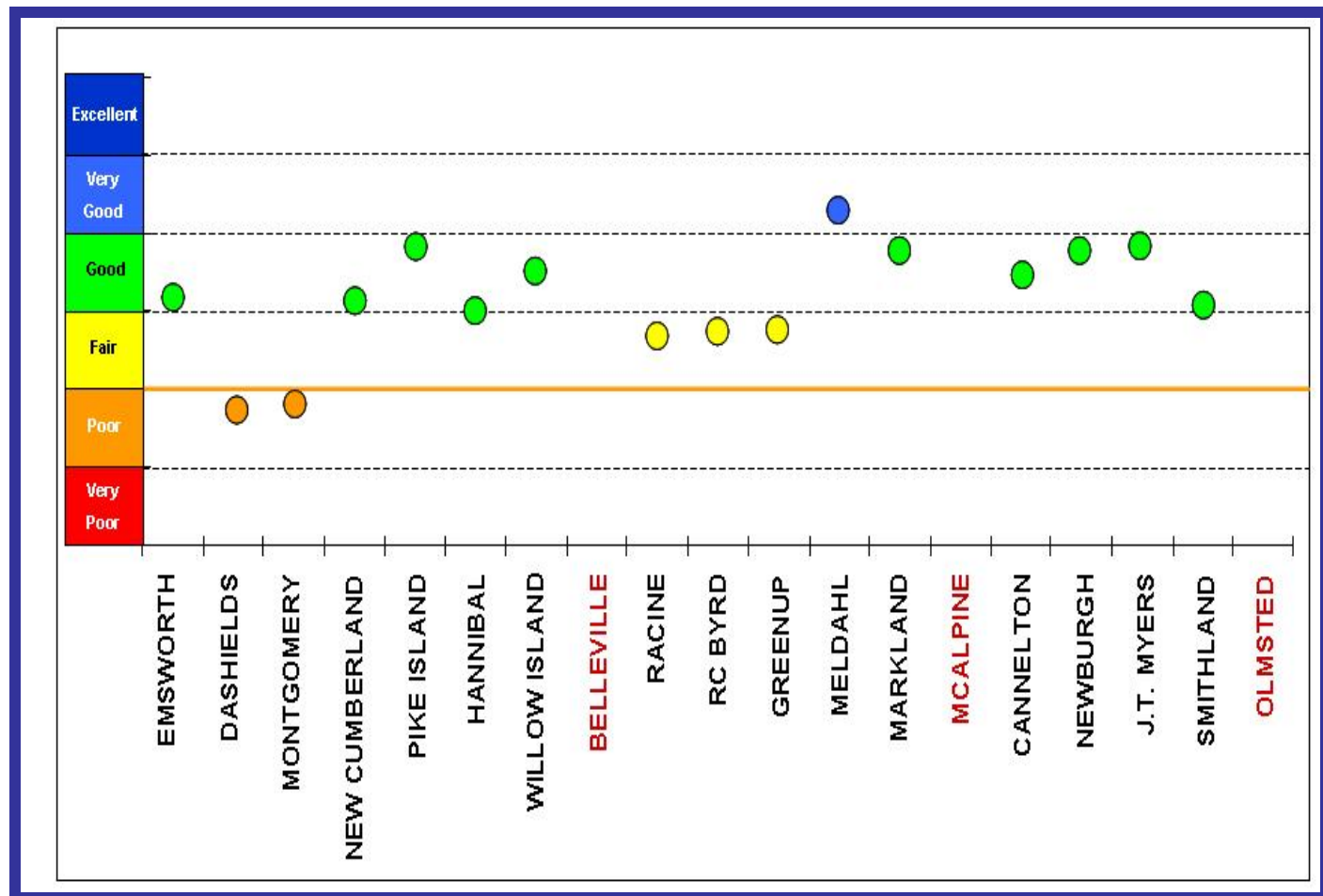


**Figure 15.** The average MORFIn deviation of each site within pools surveyed as of 2008 (■=Average, □= 90% Confidence Interval, I=Non-Outlier Range).

### 6.8 Assessment of Condition

The average quality score in Smithland pool was 3.1 and it was assessed as being in good condition. The 3 nearest surveyed pools

upstream (Cannelton, Newburgh, and J. T. Myers) of Smithland pool were also considered to be in good condition (Figure 16).



**Figure 16.** The average quality score for each pool surveyed as of 2008 (black text, red text = pools to be surveyed in 2009). Data points are color-coded to indicate the biological condition of a pool.

**Table 4.** A compiled species list containing the number of individuals collected per pool as of 2008.

| #  | Species              | Emsworth 07 | Dashields 08 | Montgomery 06 | New Cumberland 05 | Pike Island 07 | Hannibal 08 | Willow Island 06 | Racine 05 | RC Byrd 08 | Greenup 06 | Meldahl 07 | Markland 05 | Cannelton (30) 06-07 | Newburgh 07 | Myers 05 | Smithland 08 |
|----|----------------------|-------------|--------------|---------------|-------------------|----------------|-------------|------------------|-----------|------------|------------|------------|-------------|----------------------|-------------|----------|--------------|
| 1  | Silver Lamprey       |             |              |               |                   |                |             |                  |           |            | 1          |            |             |                      |             |          | <b>1</b>     |
| 2  | Paddlefish           |             |              |               |                   |                |             |                  |           |            |            |            |             |                      | 1           |          |              |
| 3  | Longnose Gar         | 13          | 11           | 10            | 11                | 43             | 49          | 46               | 24        | 27         | 23         | 22         | 15          | 48                   | 20          |          | <b>16</b>    |
| 4  | Spotted Gar          |             |              |               |                   |                |             |                  |           |            |            |            |             |                      | 1           |          | <b>1</b>     |
| 5  | Shortnose Gar        |             |              |               |                   |                |             |                  |           |            |            |            |             |                      | 9           | 2        | <b>13</b>    |
| 6  | Skipjack Herring     | 8           |              |               | 3                 | 6              |             |                  | 1         | 2          |            | 64         | 145         | 174                  | 70          | 249      | <b>1</b>     |
| 7  | Gizzard Shad         | 167         | 123          | 266           | 1202              | 7326           | 1461        | 216              | 8048      | 301        | 267        | 2408       | 1743        | 3527                 | 600         | 444      | <b>409</b>   |
| 8  | Threadfin Shad       |             |              |               |                   |                |             |                  |           |            |            |            |             | 1                    | 9           | 112      | <b>25</b>    |
| 9  | Goldeye              |             |              |               |                   |                |             |                  |           |            |            |            |             |                      | 12          |          | <b>2</b>     |
| 10 | Mooneye              | 20          | 11           | 6             | 22                | 37             | 10          |                  | 1         | 7          |            | 48         | 12          | 8                    | 10          | 4        |              |
| 11 | Muskellunge          | 1           |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          |              |
| 12 | Common Carp          | 63          | 36           | 44            | 25                | 15             | 15          | 22               | 9         | 12         | 9          | 8          | 20          | 5                    | 4           | 10       | <b>17</b>    |
| 13 | Grass Carp           |             |              |               | 1                 |                |             |                  |           |            |            |            |             |                      | 1           |          |              |
| 14 | Silver Carp          |             |              |               |                   |                |             |                  |           |            |            |            |             |                      | 2           |          | <b>4</b>     |
| 15 | Bighead Carp         |             |              |               |                   |                |             |                  |           |            |            |            |             |                      | 2           |          |              |
| 16 | Goldfish             |             |              |               | 1                 |                |             |                  |           |            |            |            |             |                      |             |          |              |
| 17 | Golden Shiner        | 1           |              |               | 1                 |                |             |                  |           |            |            |            |             |                      |             |          |              |
| 18 | Miss. Silvery Minnow |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             | 1        |              |
| 19 | Notropis Sp          |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          | <b>1</b>     |
| 20 | Striped Shiner       |             |              |               |                   |                | 2           |                  | 2         |            |            |            |             |                      |             |          |              |
| 21 | Spottail Shiner      |             |              |               | 6                 | 2              | 1           |                  |           |            |            |            |             |                      |             |          |              |
| 22 | Spotfin Shiner       |             |              | 1             | 21                | 14             |             | 24               | 63        | 1          | 2          | 32         | 2           | 63                   | 8           | 12       | <b>4</b>     |
| 23 | Emerald Shiner       | 82          | 5            | 8             | 342               | 197            | 21          | 728              | 795       | 16         | 50         | 637        | 303         | 1331                 | 166         | 801      | <b>28</b>    |
| 24 | Mimic Shiner         | 35          | 1            | 13            | 76                | 162            | 16          | 306              | 402       | 1          | 61         | 7          | 5           | 195                  | 6           | 43       |              |
| 25 | River Shiner         | 1           |              |               |                   |                |             |                  |           |            |            | 54         | 8           | 276                  | 3           | 91       | <b>2</b>     |
| 26 | Silver Chub          | 26          | 26           | 12            | 20                | 11             | 19          | 57               | 44        | 11         | 33         | 90         | 171         | 130                  | 126         | 206      | <b>46</b>    |
| 27 | River Chub           |             |              |               | 1                 | 1              |             |                  |           |            |            |            |             |                      |             |          |              |

**Table 4.** A compiled species list containing the number of individuals collected per pool as of 2008.

| #  | Species             | Emsworth 07 | Dashields 08 | Montgomery 06 | New Cumberland 05 | Pike Island 07 | Hannibal 08 | Willow Island 06 | Racine 05 | RC Byrd 08 | Greenup 06 | Meldahl 07 | Markland 05 | Cannelton (30) 06-07 | Newburgh 07 | Myers 05 | Smithland 08 |
|----|---------------------|-------------|--------------|---------------|-------------------|----------------|-------------|------------------|-----------|------------|------------|------------|-------------|----------------------|-------------|----------|--------------|
| 28 | Central Stoneroller |             |              |               | 4                 |                | 3           | 1                |           |            |            |            | 1           |                      |             |          |              |
| 29 | Bluntnose Minnow    |             |              |               | 2                 | 2              | 4           | 120              | 3         |            | 1          | 1          |             | 2                    |             |          | 1            |
| 30 | Fathead Minnow      |             |              |               |                   |                |             |                  | 6         |            |            |            |             |                      |             |          |              |
| 31 | Bullhead Minnow     |             |              |               |                   |                |             | 4                | 5         |            |            | 23         | 2           |                      |             | 8        | 2            |
| 32 | Silverjaw Minnow    |             |              |               |                   |                | 1           |                  |           |            |            |            |             |                      |             |          |              |
| 33 | Gravel Chub         |             |              |               |                   |                |             |                  |           |            |            | 1          |             |                      |             |          |              |
| 34 | Creek Chub          |             |              |               | 1                 |                |             |                  |           |            |            | 3          |             |                      |             |          |              |
| 35 | Carpiodes Sp        |             | 1            |               |                   | 14             |             |                  | 2         |            |            | 1          |             | 2                    |             |          |              |
| 36 | Ictiobinae Sp       |             |              |               | 20                |                |             |                  |           |            |            |            |             |                      |             |          |              |
| 37 | Quillback           | 17          | 12           | 30            | 80                | 27             | 28          | 66               | 16        | 8          | 17         | 31         | 137         | 21                   | 34          | 57       | 28           |
| 38 | River Carpsucker    | 18          | 18           | 13            | 46                | 36             | 64          | 18               | 50        | 25         | 49         | 87         | 47          | 122                  | 179         | 86       | 114          |
| 39 | Highfin Carpsucker  |             |              | 37            | 3                 | 10             | 13          | 1                | 7         |            | 4          |            | 2           | 1                    | 12          | 3        | 24           |
| 40 | Shorthead Redhorse  |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          | 10           |
| 41 | Smallmouth Redhorse | 61          | 16           | 110           | 110               | 28             | 41          | 168              | 5         | 27         | 30         | 62         | 31          | 12                   | 3           | 11       |              |
| 42 | Moxostoma Sp        |             |              |               | 58                |                |             |                  |           |            |            |            |             |                      |             |          |              |
| 43 | Silver Redhorse     | 221         | 93           | 157           | 63                | 78             | 105         | 51               | 11        | 11         | 12         | 25         | 19          | 3                    |             |          | 1            |
| 44 | River Redhorse      | 39          | 13           | 3             | 5                 | 27             | 35          | 2                |           | 2          | 6          | 1          | 1           |                      | 1           |          |              |
| 45 | Black Redhorse      | 18          |              |               | 11                |                |             | 4                |           |            |            |            | 1           | 1                    |             |          |              |
| 46 | Golden Redhorse     | 7           | 33           | 227           | 90                | 66             | 204         | 277              | 11        | 33         | 39         | 120        | 105         | 4                    | 14          |          | 3            |
| 47 | Northern Hog Sucker | 3           | 1            | 3             | 132               | 4              | 2           | 15               |           | 1          |            |            | 14          | 1                    | 1           |          |              |
| 48 | Ictiobus Sp         |             |              |               |                   |                | 19          |                  |           |            |            |            |             |                      |             |          |              |
| 49 | Smallmouth Buffalo  | 97          | 99           | 217           | 283               | 94             | 45          | 60               | 96        | 40         | 49         | 123        | 150         | 147                  | 72          | 314      | 77           |
| 50 | Bigmouth Buffalo    |             |              |               |                   |                |             |                  | 1         |            |            |            |             |                      | 3           | 7        | 5            |
| 51 | Black Buffalo       | 1           | 13           |               |                   | 5              | 1           | 2                |           |            | 1          |            | 2           | 1                    | 7           | 3        | 4            |
| 52 | Spotted Sucker      |             |              |               |                   |                |             | 1                | 1         |            | 5          | 1          |             | 1                    |             |          | 7            |
| 53 | Blue Catfish        |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             | 1        | 7            |
| 54 | Brown Bullhead      |             |              |               |                   |                |             |                  |           |            | 1          |            |             |                      |             |          |              |



**Table 4.** A compiled species list containing the number of individuals collected per pool as of 2008.

| #  | Species                    | Emsworth 07 | Dashields 08 | Montgomery 06 | New Cumberland 05 | Pike Island 07 | Hannibal 08 | Willow Island 06 | Racine 05 | RC Byrd 08 | Greenup 06 | Meldahl 07 | Markland 05 | Cannelton (30) 06-07 | Newburgh 07 | Myers 05 | Smithland 08 |
|----|----------------------------|-------------|--------------|---------------|-------------------|----------------|-------------|------------------|-----------|------------|------------|------------|-------------|----------------------|-------------|----------|--------------|
| 55 | Channel Catfish            | 32          | 17           | 34            | 123               | 40             | 62          | 61               | 70        | 53         | 58         | 89         | 247         | 48                   | 11          | 330      | <b>291</b>   |
| 56 | Flathead Catfish           | 14          | 11           | 11            | 15                | 35             | 38          | 21               | 32        | 42         | 32         | 49         | 38          | 63                   | 11          | 43       | <b>16</b>    |
| 57 | Trout-Perch                |             |              |               |                   |                |             |                  | 3         |            |            |            |             |                      |             |          |              |
| 58 | Banded Killifish           |             |              |               |                   |                |             | 1                |           |            |            |            |             |                      |             |          |              |
| 59 | Inland Silverside          |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          | <b>26</b>    |
| 60 | Brook Silverside           |             |              |               |                   |                |             |                  | 1         |            |            |            | 1           | 1                    | 1           | 1        | <b>1</b>     |
| 61 | Morone Sp                  | 27          |              | 6             | 568               | 419            | 91          | 17               | 561       | 73         | 2          | 152        | 250         | 625                  | 403         | 253      | <b>190</b>   |
| 62 | Striped Bass               |             |              |               |                   |                | 14          | 1                |           |            |            |            |             | 6                    |             | 12       | <b>2</b>     |
| 63 | Hybrid Striper             |             |              | 4             | 17                |                |             | 1                | 46        | 1          |            |            | 40          | 6                    |             | 11       | <b>2</b>     |
| 64 | White Perch                | 5           |              |               | 4                 |                | 1           | 3                |           |            |            |            | 5           |                      |             |          |              |
| 65 | White Bass                 | 9           | 16           | 36            | 6                 | 2              | 3           | 58               | 3         | 29         | 64         | 18         | 22          | 66                   | 4           | 17       | <b>76</b>    |
| 66 | Yellow Bass                |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          | <b>2</b>     |
| 67 | Rock Bass                  | 16          | 9            | 8             | 5                 | 1              | 2           | 3                |           |            |            |            |             |                      |             | 1        |              |
| 68 | Lepomis Hybrid             |             |              | 1             |                   |                |             | 9                |           |            |            |            |             |                      |             |          |              |
| 69 | Lepomis Sp                 |             |              |               |                   |                |             | 16               | 1         |            |            |            |             | 1                    |             | 1        |              |
| 70 | Green Sunfish              | 12          | 3            | 2             | 4                 | 2              | 2           | 4                | 6         | 6          | 4          | 3          | 10          | 2                    | 4           | 10       | <b>1</b>     |
| 71 | Warmouth                   |             |              |               |                   |                |             | 1                |           |            |            | 1          | 1           |                      |             | 1        |              |
| 72 | Bluegill                   | 379         | 32           | 216           | 53                | 46             | 36          | 232              | 58        | 52         | 112        | 207        | 245         | 103                  | 11          | 31       | <b>64</b>    |
| 73 | Bluegill X Longear Sunfish |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          | <b>1</b>     |
| 74 | Bluegill X Green Sunfish   |             |              |               |                   | 1              |             |                  |           |            |            |            |             | 1                    |             |          |              |
| 75 | Pumpkinseed                |             |              | 2             |                   |                | 2           | 18               |           |            |            |            |             |                      |             |          |              |
| 76 | Orangespotted Sunfish      |             |              |               | 1                 |                |             | 2                | 1         | 1          |            | 1          | 1           |                      |             | 2        |              |
| 77 | Longear Sunfish            |             |              |               |                   |                | 9           | 23               | 3         | 9          | 14         | 35         | 53          | 39                   | 3           | 11       | <b>92</b>    |
| 78 | Longear X Green Sunfish    |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             | 1        |              |
| 79 | Redear Sunfish             |             |              | 4             |                   | 1              |             | 1                | 1         |            | 1          |            | 2           | 16                   |             | 1        | <b>20</b>    |
| 80 | Micropterus Sp             |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          | <b>1</b>     |
| 81 | Smallmouth Bass            | 339         | 163          | 185           | 262               | 208            | 92          | 61               | 6         | 32         | 7          | 4          | 28          | 7                    | 1           | 4        |              |

**Table 4.** A compiled species list containing the number of individuals collected per pool as of 2008.

| #   | Species                | Emsworth 07 | Dashields 08 | Montgomery 06 | New Cumberland 05 | Pike Island 07 | Hannibal 08 | Willow Island 06 | Racine 05 | RC Byrd 08 | Greenup 06 | Meldahl 07 | Markland 05 | Cannelton (30) 06-07 | Newburgh 07 | Myers 05 | Smithland 08 |
|-----|------------------------|-------------|--------------|---------------|-------------------|----------------|-------------|------------------|-----------|------------|------------|------------|-------------|----------------------|-------------|----------|--------------|
| 82  | Largemouth Bass        | 4           | 2            | 8             | 8                 | 16             |             | 16               | 22        | 25         | 65         | 16         | 56          | 37                   | 2           | 70       | <b>21</b>    |
| 83  | Spotted Bass           | 125         | 34           | 15            | 79                | 74             | 38          | 62               | 22        | 30         | 43         | 90         | 123         | 53                   | 49          | 104      | <b>31</b>    |
| 84  | White Crappie          | 5           | 1            |               |                   |                |             |                  |           | 1          | 4          |            | 1           | 1                    | 1           |          |              |
| 85  | Black Crappie          | 3           | 1            | 6             | 2                 | 2              |             |                  | 3         | 1          |            |            | 2           | 3                    |             |          |              |
| 86  | Johnny Darter          | 1           |              |               |                   |                |             | 2                |           |            |            |            |             |                      |             |          |              |
| 87  | Greenside Darter       | 5           |              | 2             | 11                | 5              |             |                  |           |            |            |            | 1           |                      |             |          |              |
| 88  | Rainbow Darter         |             |              | 4             | 1                 |                |             | 2                |           |            |            |            | 8           |                      |             | 12       |              |
| 89  | Fantail Darter         | 3           |              | 1             |                   |                |             |                  |           |            |            | 1          |             |                      |             |          |              |
| 90  | Banded Darter          |             |              | 1             | 4                 |                |             |                  |           |            |            |            | 1           |                      |             | 1        |              |
| 91  | Yellow Perch           |             |              | 4             | 2                 |                | 3           |                  |           |            |            |            |             |                      |             |          |              |
| 92  | Logperch               | 141         | 166          | 67            | 244               | 85             | 105         | 108              | 6         | 72         | 12         | 20         | 60          | 39                   | 4           | 3        | <b>1</b>     |
| 93  | Dusky Darter           |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             | 3        | <b>1</b>     |
| 94  | Channel Darter         | 16          |              | 1             | 9                 |                | 1           | 3                |           |            | 20         |            |             |                      |             | 1        |              |
| 95  | Slenderhead Darter     |             |              |               |                   |                |             |                  |           |            |            |            | 5           |                      |             | 5        |              |
| 96  | River Darter           |             |              |               |                   | 2              |             | 1                | 2         |            | 1          | 6          | 4           | 11                   |             | 4        |              |
| 97  | Walleye                | 44          | 7            | 11            | 31                | 70             | 11          | 1                | 4         | 1          | 1          | 3          | 1           |                      | 7           |          |              |
| 98  | Saugeye                | 2           | 8            |               | 5                 | 4              | 1           |                  | 4         | 1          |            |            | 17          |                      |             | 7        | <b>2</b>     |
| 99  | Sauger                 | 283         | 192          | 243           | 180               | 244            | 317         | 341              | 173       | 259        | 220        | 1174       | 664         | 1314                 | 747         | 484      | <b>105</b>   |
| 100 | Freshwater Drum        | 254         | 58           | 47            | 1468              | 496            | 211         | 120              | 375       | 83         | 121        | 1000       | 1778        | 435                  | 378         | 612      | <b>837</b>   |
|     |                        |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          |              |
|     |                        |             |              |               |                   |                |             |                  |           |            |            |            |             |                      |             |          |              |
|     | Total # of Taxa        | 43          | 33           | 42            | 53                | 43             | 43          | 51               | 46        | 36         | 38         | 41         | 51          | 46                   | 44          | 50       | <b>50</b>    |
|     | Total # of Individuals | 2618        | 1232         | 2076          | 5742              | 9958           | 3198        | 3378             | 11006     | 1296       | 1441       | 6718       | 6600        | 8953                 | 3013        | 4501     | <b>2636</b>  |

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## Appendix A

### Assessment Unit Criteria Details

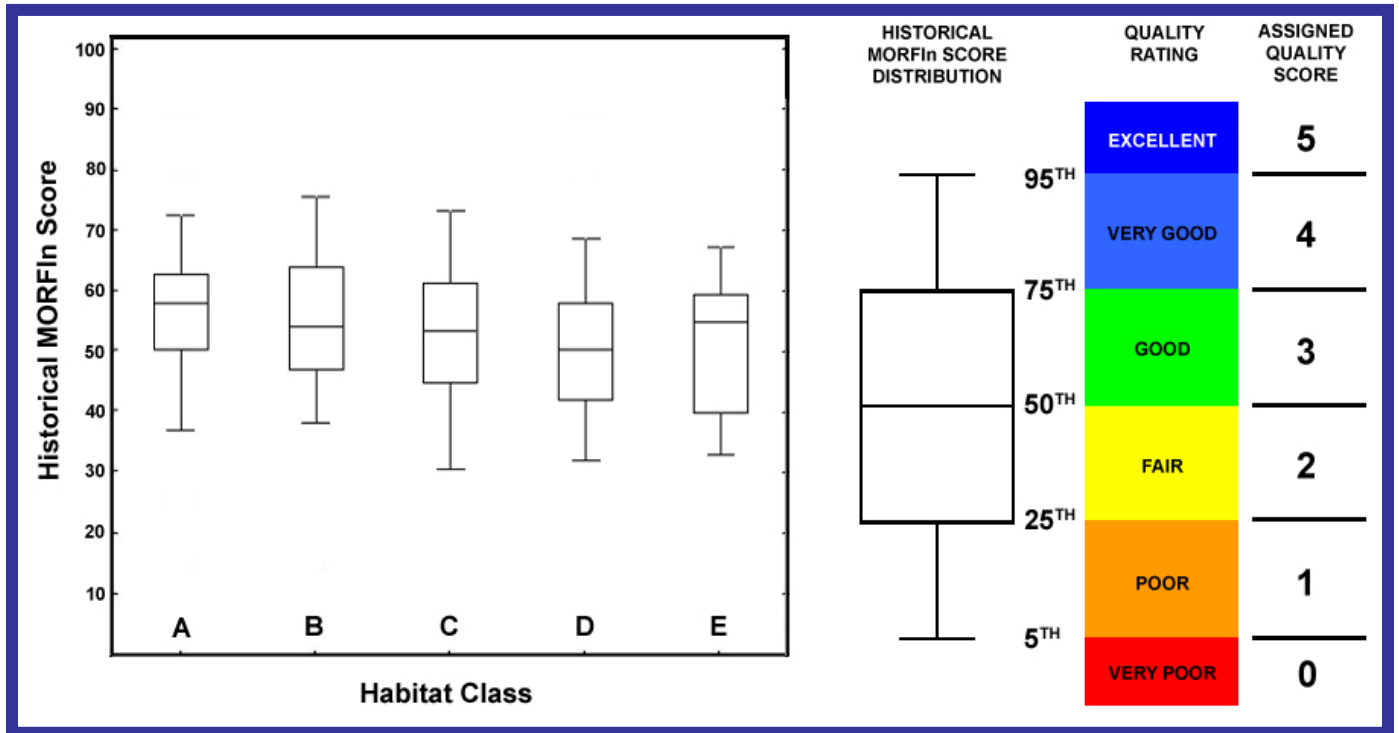
- Each individual navigational pool will serve as a separate and distinct Assessment Unit (AU), with the exception of the area below Smithland dam will also be considered one distinct AU.
  - This is based on the observation that biologically, each pool more closely resembles a lake, and not a free-flowing river. Therefore, biological condition becomes more homogeneous throughout, exhibiting little longitudinal change.
  - The dams are seen as the only real barriers that isolate individual populations. This observation is supported by research at the University of Louisville indicating little or no synchrony between pools. Each pool behaves independent of even its nearest neighbor, indicating isolated and independent populations among pools.
  - Isolated pockets, or areas, with poorly performing biotic communities have not been observed over the last ten years of sampling.
  - The BWQSC believes that a subset of randomly selected sites within each pool can accurately describe the condition of the target population (the fish population of that pool).
- All AUs will be sampled and assessed on a 5-year rotating basis. This is consistent with state schedules, and it will allow ORSANCO (after one full rotation) in each 305(b) report, to incorporate 5 years worth of data and report on 100% of the resource.
  - It is acceptable to EPA to include the most recent 5 years of data in each 305(b) report.

|      | Ernsworth | Deshields | Montgomery | New Cumberland | Pike Island | Hannibal | Willow Island | Belleville | Racine | R. C. Byrd | Greenup | Meldahl | Markland | McAlpine | Cannelton | Newburgh | Uniontown | Smithland | Olmsted | Sites |
|------|-----------|-----------|------------|----------------|-------------|----------|---------------|------------|--------|------------|---------|---------|----------|----------|-----------|----------|-----------|-----------|---------|-------|
| 2005 |           |           |            | 15             |             |          |               | 15         |        |            |         | 15      |          |          | 11        | 15       |           |           |         | 60    |
| 2006 |           |           | 15         |                |             |          |               |            | 15     |            |         |         |          |          | 19        |          |           |           |         | 56    |
| 2007 | 15        |           |            |                | 15          |          |               |            |        | 15         |         |         |          |          |           |          |           |           |         | 79    |
| 2008 |           | 15        |            |                |             | 15       |               |            | 15     |            |         |         |          |          |           |          | 15        |           |         | 60    |
| 2009 |           |           |            |                |             |          | 15            |            |        |            |         | 15      | 15       |          |           |          |           |           | 15      | 60    |
| SUM  | 15        | 15        | 15         | 15             | 15          | 15       | 15            | 15         | 15     | 15         | 15      | 30      | 15       | 30       | 15        | 15       | 15        | 15        | 15      | 315   |

- Assessment Units that yield an average quality score that is less than 2.0 will be listed as failing to meet (support) its aquatic life-use designation. The process of conducting a bioassessment and determining an AU's biological condition is outlined below:
  - Individual sites were assigned to a habitat class ('A', 'B', 'C', 'D' and 'E') based on its substrate composition. Each of these 5 habitat classes exhibits a different range of historical MORFIN scores and expectations. Therefore, the expected MORFIN score changes for each of the habitat classes. For example, if a site is characterized as habitat class 'A', then the MORFIN expectation is 50.03 whereas a habitat class 'E' site is 39.59. These MORFIN expectations for each habitat are the 25<sup>th</sup> percentiles of historical MORFIN scores for each habitat.
  - A quality score (between 0 and 5) was assigned to a site based on its score relative to the statistical distribution of historical MORFIN scores. Each quality score corresponds to the ranges between

the 5<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, or 95<sup>th</sup> percentiles of historical MORFIn scores. For example, the range less than the 25<sup>th</sup> percentile receives a quality score <2.0 (see figure below).

- Those sites with MORFIn scores less than the 25<sup>th</sup> percentile are considered to be in poor or very poor condition and fail to meet its expected MORFIn score. The quality scores for individual sites are averaged within an AU (pool) to determine the AU's biological condition.



**Appendix B.** Fish survey data from the Smithland pool.

| Site # | River Mile | Bank | Date      | Common Name      | Latin Name                            | Count |
|--------|------------|------|-----------|------------------|---------------------------------------|-------|
| 1      | 849.5      | RDB  | 15-Oct-08 | Gizzard Shad     | <i>Dorosoma cepedianum</i>            | 26    |
| 1      | 849.5      | RDB  | 15-Oct-08 | Notropis Sp      | <i>Notropis sp</i>                    | 1     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Emerald Shiner   | <i>Notropis atherinoides</i>          | 4     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Blue Catfish     | <i>Ictalurus furcatus</i>             | 2     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Channel Catfish  | <i>Ictalurus punctatus</i>            | 23    |
| 1      | 849.5      | RDB  | 15-Oct-08 | Flathead Catfish | <i>Pylodictis olivaris</i>            | 1     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Striped Bass     | <i>Morone saxatilis</i>               | 1     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Hybrid Striper   | <i>Morone saxatilis x M. chrysops</i> | 2     |
| 1      | 849.5      | RDB  | 15-Oct-08 | White Bass       | <i>Morone chrysops</i>                | 13    |
| 1      | 849.5      | RDB  | 15-Oct-08 | Saugeye          | <i>Sander canadensis x S. vitreus</i> | 1     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Sauger           | <i>Sander canadensis</i>              | 2     |
| 1      | 849.5      | RDB  | 15-Oct-08 | Freshwater Drum  | <i>Aplodinotus grunniens</i>          | 23    |
| 2      | 854.6      | LDB  | 29-Jul-08 | Longnose Gar     | <i>Lepisosteus osseus</i>             | 2     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Shortnose Gar    | <i>Lepisosteus platostomus</i>        | 1     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Gizzard Shad     | <i>Dorosoma cepedianum</i>            | 11    |
| 2      | 854.6      | LDB  | 29-Jul-08 | Quillback        | <i>Carpionodes cyprinus</i>           | 2     |
| 2      | 854.6      | LDB  | 29-Jul-08 | River Carpsucker | <i>Carpionodes carpio</i>             | 13    |
| 2      | 854.6      | LDB  | 29-Jul-08 | Bigmouth Buffalo | <i>Ictiobus cyprinellus</i>           | 2     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Channel Catfish  | <i>Ictalurus punctatus</i>            | 1     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Flathead Catfish | <i>Pylodictis olivaris</i>            | 2     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Morone Sp        | <i>Morone sp</i>                      | 3     |
| 2      | 854.6      | LDB  | 29-Jul-08 | White Bass       | <i>Morone chrysops</i>                | 9     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Bluegill         | <i>Lepomis macrochirus</i>            | 4     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Micropterus Sp   | <i>Micropterus sp</i>                 | 1     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Largemouth Bass  | <i>Micropterus salmoides</i>          | 1     |
| 2      | 854.6      | LDB  | 29-Jul-08 | Freshwater Drum  | <i>Aplodinotus grunniens</i>          | 20    |
| 3      | 856.3      | RDB  | 29-Jul-08 | Longnose Gar     | <i>Lepisosteus osseus</i>             | 2     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Shortnose Gar    | <i>Lepisosteus platostomus</i>        | 7     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Gizzard Shad     | <i>Dorosoma cepedianum</i>            | 48    |
| 3      | 856.3      | RDB  | 29-Jul-08 | Silver Carp      | <i>Hypophthalmichthys molitrix</i>    | 2     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Quillback        | <i>Carpionodes cyprinus</i>           | 1     |
| 3      | 856.3      | RDB  | 29-Jul-08 | River Carpsucker | <i>Carpionodes carpio</i>             | 10    |
| 3      | 856.3      | RDB  | 29-Jul-08 | Channel Catfish  | <i>Ictalurus punctatus</i>            | 1     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Flathead Catfish | <i>Pylodictis olivaris</i>            | 2     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Morone Sp        | <i>Morone sp</i>                      | 5     |
| 3      | 856.3      | RDB  | 29-Jul-08 | White Bass       | <i>Morone chrysops</i>                | 9     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Bluegill         | <i>Lepomis macrochirus</i>            | 1     |
| 3      | 856.3      | RDB  | 29-Jul-08 | Sauger           | <i>Sander canadensis</i>              | 12    |
| 3      | 856.3      | RDB  | 29-Jul-08 | Freshwater Drum  | <i>Aplodinotus grunniens</i>          | 3     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Longnose Gar     | <i>Lepisosteus osseus</i>             | 4     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Spotted Gar      | <i>Lepisosteus oculatus</i>           | 1     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Gizzard Shad     | <i>Dorosoma cepedianum</i>            | 21    |
| 4      | 859.4      | RDB  | 29-Jul-08 | Common Carp      | <i>Cyprinus carpio</i>                | 2     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Emerald Shiner   | <i>Notropis atherinoides</i>          | 1     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Quillback        | <i>Carpionodes cyprinus</i>           | 10    |



| Site # | River Mile | Bank | Date      | Common Name        | Latin Name                      | Count |
|--------|------------|------|-----------|--------------------|---------------------------------|-------|
| 4      | 859.4      | RDB  | 29-Jul-08 | River Carpsucker   | <i>Carpiodes carpio</i>         | 13    |
| 4      | 859.4      | RDB  | 29-Jul-08 | Highfin Carpsucker | <i>Carpiodes velifer</i>        | 12    |
| 4      | 859.4      | RDB  | 29-Jul-08 | Shorthead Redhorse | <i>Moxostoma macrolepidotum</i> | 2     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>         | 5     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Blue Catfish       | <i>Ictalurus furcatus</i>       | 1     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Channel Catfish    | <i>Ictalurus punctatus</i>      | 9     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Flathead Catfish   | <i>Pylodictis olivaris</i>      | 2     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Morone Sp          | <i>Morone sp</i>                | 4     |
| 4      | 859.4      | RDB  | 29-Jul-08 | White Bass         | <i>Morone chrysops</i>          | 2     |
| 4      | 859.4      | RDB  | 29-Jul-08 | Sauger             | <i>Sander canadensis</i>        | 12    |
| 4      | 859.4      | RDB  | 29-Jul-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>    | 27    |
| 5      | 860.4      | RDB  | 29-Jul-08 | Longnose Gar       | <i>Lepisosteus osseus</i>       | 2     |
| 5      | 860.4      | RDB  | 29-Jul-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>      | 75    |
| 5      | 860.4      | RDB  | 29-Jul-08 | Goldeye            | <i>Hiodon alosoides</i>         | 1     |
| 5      | 860.4      | RDB  | 29-Jul-08 | Quillback          | <i>Carpiodes cyprinus</i>       | 1     |
| 5      | 860.4      | RDB  | 29-Jul-08 | Channel Catfish    | <i>Ictalurus punctatus</i>      | 4     |
| 5      | 860.4      | RDB  | 29-Jul-08 | Morone Sp          | <i>Morone sp</i>                | 3     |
| 5      | 860.4      | RDB  | 29-Jul-08 | White Bass         | <i>Morone chrysops</i>          | 3     |
| 5      | 860.4      | RDB  | 29-Jul-08 | Sauger             | <i>Sander canadensis</i>        | 3     |
| 5      | 860.4      | RDB  | 29-Jul-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>    | 13    |
| 6      | 869.7      | RDB  | 14-Oct-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>      | 46    |
| 6      | 869.7      | RDB  | 14-Oct-08 | Threadfin Shad     | <i>Dorosoma petenense</i>       | 16    |
| 6      | 869.7      | RDB  | 14-Oct-08 | Common Carp        | <i>Cyprinus carpio</i>          | 7     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Emerald Shiner     | <i>Notropis atherinoides</i>    | 5     |
| 6      | 869.7      | RDB  | 14-Oct-08 | River Shiner       | <i>Notropis blennius</i>        | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Silver Chub        | <i>Macrhybopsis storeriana</i>  | 8     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Bluntnose Minnow   | <i>Pimephales notatus</i>       | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | River Carpsucker   | <i>Carpiodes carpio</i>         | 4     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Shorthead Redhorse | <i>Moxostoma macrolepidotum</i> | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>         | 12    |
| 6      | 869.7      | RDB  | 14-Oct-08 | Channel Catfish    | <i>Ictalurus punctatus</i>      | 14    |
| 6      | 869.7      | RDB  | 14-Oct-08 | Flathead Catfish   | <i>Pylodictis olivaris</i>      | 2     |
| 6      | 869.7      | RDB  | 14-Oct-08 | White Bass         | <i>Morone chrysops</i>          | 3     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Green Sunfish      | <i>Lepomis cyanellus</i>        | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Bluegill           | <i>Lepomis macrochirus</i>      | 5     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Longear Sunfish    | <i>Lepomis megalotis</i>        | 20    |
| 6      | 869.7      | RDB  | 14-Oct-08 | Redear Sunfish     | <i>Lepomis microlophus</i>      | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Largemouth Bass    | <i>Micropterus salmoides</i>    | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Spotted Bass       | <i>Micropterus punctulatus</i>  | 4     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Dusky Darter       | <i>Percina sciera</i>           | 1     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Sauger             | <i>Sander canadensis</i>        | 4     |
| 6      | 869.7      | RDB  | 14-Oct-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>    | 7     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>      | 14    |
| 7      | 873.0      | RDB  | 14-Oct-08 | Threadfin Shad     | <i>Dorosoma petenense</i>       | 5     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Common Carp        | <i>Cyprinus carpio</i>          | 2     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Emerald Shiner     | <i>Notropis atherinoides</i>    | 1     |

| Site # | River Mile | Bank | Date      | Common Name        | Latin Name                                   | Count |
|--------|------------|------|-----------|--------------------|--|-------|
| 7      | 873.0      | RDB  | 14-Oct-08 | Silver Chub        | <i>Macrhybopsis storeriana</i>               | 2     |
| 7      | 873.0      | RDB  | 14-Oct-08 | River Carpsucker   | <i>Carpodes carpio</i>                       | 2     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>                      | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Channel Catfish    | <i>Ictalurus punctatus</i>                   | 9     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Morone Sp          | <i>Morone sp</i>                             | 7     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Striped Bass       | <i>Morone saxatilis</i>                      | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Yellow Bass        | <i>Morone mississippiensis</i>               | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Bluegill           | <i>Lepomis macrochirus</i>                   | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Redear Sunfish     | <i>Lepomis microlophus</i>                   | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Largemouth Bass    | <i>Micropterus salmoides</i>                 | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Spotted Bass       | <i>Micropterus punctulatus</i>               | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Saugeye            | <i>Sander canadensis</i> x <i>S. vitreus</i> | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Sauger             | <i>Sander canadensis</i>                     | 1     |
| 7      | 873.0      | RDB  | 14-Oct-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>                 | 12    |
| 8      | 874.9      | LDB  | 23-Aug-08 | Longnose Gar       | <i>Lepisosteus osseus</i>                    | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Shortnose Gar      | <i>Lepisosteus platostomus</i>               | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>                   | 2     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Threadfin Shad     | <i>Dorosoma petenense</i>                    | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Common Carp        | <i>Cyprinus carpio</i>                       | 2     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Silver Carp        | <i>Hypophthalmichthys molitrix</i>           | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Quillback          | <i>Carpodes cyprinus</i>                     | 2     |
| 8      | 874.9      | LDB  | 23-Aug-08 | River Carpsucker   | <i>Carpodes carpio</i>                       | 23    |
| 8      | 874.9      | LDB  | 23-Aug-08 | Highfin Carpsucker | <i>Carpodes velifer</i>                      | 5     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Shorthead Redhorse | <i>Moxostoma macrolepidotum</i>              | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>                      | 5     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Black Buffalo      | <i>Ictiobus niger</i>                        | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Channel Catfish    | <i>Ictalurus punctatus</i>                   | 25    |
| 8      | 874.9      | LDB  | 23-Aug-08 | Flathead Catfish   | <i>Pylodictis olivaris</i>                   | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Morone Sp          | <i>Morone sp</i>                             | 5     |
| 8      | 874.9      | LDB  | 23-Aug-08 | White Bass         | <i>Morone chrysops</i>                       | 21    |
| 8      | 874.9      | LDB  | 23-Aug-08 | Bluegill           | <i>Lepomis macrochirus</i>                   | 13    |
| 8      | 874.9      | LDB  | 23-Aug-08 | Largemouth Bass    | <i>Micropterus salmoides</i>                 | 1     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Spotted Bass       | <i>Micropterus punctulatus</i>               | 8     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Sauger             | <i>Sander canadensis</i>                     | 9     |
| 8      | 874.9      | LDB  | 23-Aug-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>                 | 474   |
| 9      | 881.7      | RDB  | 28-Jul-08 | Shortnose Gar      | <i>Lepisosteus platostomus</i>               | 3     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>                   | 18    |
| 9      | 881.7      | RDB  | 28-Jul-08 | Common Carp        | <i>Cyprinus carpio</i>                       | 2     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Spotfin Shiner     | <i>Cyprinella spiloptera</i>                 | 3     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Silver Chub        | <i>Macrhybopsis storeriana</i>               | 2     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Quillback          | <i>Carpodes cyprinus</i>                     | 3     |
| 9      | 881.7      | RDB  | 28-Jul-08 | River Carpsucker   | <i>Carpodes carpio</i>                       | 37    |
| 9      | 881.7      | RDB  | 28-Jul-08 | Highfin Carpsucker | <i>Carpodes velifer</i>                      | 6     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Silver Redhorse    | <i>Moxostoma anisurum</i>                    | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Golden Redhorse    | <i>Moxostoma erythrurum</i>                  | 2     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>                      | 17    |

| Site # | River Mile | Bank | Date      | Common Name                | Latin Name                                | Count |
|--------|------------|------|-----------|----------------------------|---|-------|
| 9      | 881.7      | RDB  | 28-Jul-08 | Bigmouth Buffalo           | <i>Ictiobus cyprinellus</i>               | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Blue Catfish               | <i>Ictalurus furcatus</i>                 | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Channel Catfish            | <i>Ictalurus punctatus</i>                | 46    |
| 9      | 881.7      | RDB  | 28-Jul-08 | Flathead Catfish           | <i>Pylodictis olivaris</i>                | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Brook Silverside           | <i>Labidesthes sicculus</i>               | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Morone Sp                  | <i>Morone sp</i>                          | 7     |
| 9      | 881.7      | RDB  | 28-Jul-08 | White Bass                 | <i>Morone chrysops</i>                    | 10    |
| 9      | 881.7      | RDB  | 28-Jul-08 | Yellow Bass                | <i>Morone mississippiensis</i>            | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Bluegill                   | <i>Lepomis macrochirus</i>                | 10    |
| 9      | 881.7      | RDB  | 28-Jul-08 | Longear Sunfish            | <i>Lepomis megalotis</i>                  | 41    |
| 9      | 881.7      | RDB  | 28-Jul-08 | Redear Sunfish             | <i>Lepomis microlophus</i>                | 1     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Largemouth Bass            | <i>Micropterus salmoides</i>              | 4     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Spotted Bass               | <i>Micropterus punctulatus</i>            | 2     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Sauger                     | <i>Sander canadensis</i>                  | 3     |
| 9      | 881.7      | RDB  | 28-Jul-08 | Freshwater Drum            | <i>Aplodinotus grunniens</i>              | 20    |
| 10     | 889.4      | LDB  | 28-Jul-08 | Longnose Gar               | <i>Lepisosteus osseus</i>                 | 3     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Gizzard Shad               | <i>Dorosoma cepedianum</i>                | 2     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Goldeye                    | <i>Hiodon alosoides</i>                   | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Spotfin Shiner             | <i>Cyprinella spiloptera</i>              | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Emerald Shiner             | <i>Notropis atherinoides</i>              | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | River Shiner               | <i>Notropis blennioides</i>               | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Quillback                  | <i>Carpionodes cyprinus</i>               | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | River Carpsucker           | <i>Carpionodes carpio</i>                 | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Highfin Carpsucker         | <i>Carpionodes velifer</i>                | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Shorthead Redhorse         | <i>Moxostoma macrolepidotum</i>           | 4     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Smallmouth Buffalo         | <i>Ictiobus bubalus</i>                   | 8     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Bigmouth Buffalo           | <i>Ictiobus cyprinellus</i>               | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Black Buffalo              | <i>Ictiobus niger</i>                     | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Channel Catfish            | <i>Ictalurus punctatus</i>                | 8     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Morone Sp                  | <i>Morone sp</i>                          | 16    |
| 10     | 889.4      | LDB  | 28-Jul-08 | White Bass                 | <i>Morone chrysops</i>                    | 3     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Bluegill                   | <i>Lepomis macrochirus</i>                | 2     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Bluegill X Longear Sunfish | <i>Lepomis macrochirus x L. megalotis</i> | 1     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Longear Sunfish            | <i>Lepomis megalotis</i>                  | 8     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Largemouth Bass            | <i>Micropterus salmoides</i>              | 2     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Spotted Bass               | <i>Micropterus punctulatus</i>            | 2     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Sauger                     | <i>Sander canadensis</i>                  | 8     |
| 10     | 889.4      | LDB  | 28-Jul-08 | Freshwater Drum            | <i>Aplodinotus grunniens</i>              | 5     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Silver Lamprey             | <i>Ichthyomyzon unicuspis</i>             | 1     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Gizzard Shad               | <i>Dorosoma cepedianum</i>                | 37    |
| 11     | 903.7      | RDB  | 15-Oct-08 | Silver Chub                | <i>Macrhybopsis storeriana</i>            | 11    |
| 11     | 903.7      | RDB  | 15-Oct-08 | Quillback                  | <i>Carpionodes cyprinus</i>               | 3     |
| 11     | 903.7      | RDB  | 15-Oct-08 | River Carpsucker           | <i>Carpionodes carpio</i>                 | 3     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Smallmouth Buffalo         | <i>Ictiobus bubalus</i>                   | 4     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Blue Catfish               | <i>Ictalurus furcatus</i>                 | 2     |

| Site # | River Mile | Bank | Date      | Common Name        | Latin Name                      | Count |
|--------|------------|------|-----------|--------------------|---------------------------------|-------|
| 11     | 903.7      | RDB  | 15-Oct-08 | Channel Catfish    | <i>Ictalurus punctatus</i>      | 15    |
| 11     | 903.7      | RDB  | 15-Oct-08 | Inland Silverside  | <i>Menidia beryllina</i>        | 14    |
| 11     | 903.7      | RDB  | 15-Oct-08 | Morone Sp          | <i>Morone sp</i>                | 10    |
| 11     | 903.7      | RDB  | 15-Oct-08 | Bluegill           | <i>Lepomis macrochirus</i>      | 8     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Longear Sunfish    | <i>Lepomis megalotis</i>        | 4     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Largemouth Bass    | <i>Micropterus salmoides</i>    | 4     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Spotted Bass       | <i>Micropterus punctulatus</i>  | 7     |
| 11     | 903.7      | RDB  | 15-Oct-08 | Sauger             | <i>Sander canadensis</i>        | 17    |
| 11     | 903.7      | RDB  | 15-Oct-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>    | 28    |
| 12     | 905.7      | LDB  | 15-Oct-08 | Longnose Gar       | <i>Lepisosteus osseus</i>       | 2     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>      | 50    |
| 12     | 905.7      | LDB  | 15-Oct-08 | Emerald Shiner     | <i>Notropis atherinoides</i>    | 16    |
| 12     | 905.7      | LDB  | 15-Oct-08 | Silver Chub        | <i>Macrhybopsis storeriana</i>  | 19    |
| 12     | 905.7      | LDB  | 15-Oct-08 | Bullhead Minnow    | <i>Pimephales vigilax</i>       | 2     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Quillback          | <i>Carpionodes cyprinus</i>     | 1     |
| 12     | 905.7      | LDB  | 15-Oct-08 | River Carpsucker   | <i>Carpionodes carpio</i>       | 5     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Shorthead Redhorse | <i>Moxostoma macrolepidotum</i> | 1     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>         | 5     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Channel Catfish    | <i>Ictalurus punctatus</i>      | 53    |
| 12     | 905.7      | LDB  | 15-Oct-08 | Inland Silverside  | <i>Menidia beryllina</i>        | 3     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Morone Sp          | <i>Morone sp</i>                | 10    |
| 12     | 905.7      | LDB  | 15-Oct-08 | White Bass         | <i>Morone chrysops</i>          | 2     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Bluegill           | <i>Lepomis macrochirus</i>      | 2     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Spotted Bass       | <i>Micropterus punctulatus</i>  | 1     |
| 12     | 905.7      | LDB  | 15-Oct-08 | Sauger             | <i>Sander canadensis</i>        | 21    |
| 12     | 905.7      | LDB  | 15-Oct-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>    | 127   |
| 13     | 910.7      | RDB  | 14-Oct-08 | Shortnose Gar      | <i>Lepisosteus platostomus</i>  | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Skipjack Herring   | <i>Alosa chrysochloris</i>      | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>      | 24    |
| 13     | 910.7      | RDB  | 14-Oct-08 | Threadfin Shad     | <i>Dorosoma petenense</i>       | 2     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Quillback          | <i>Carpionodes cyprinus</i>     | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Golden Redhorse    | <i>Moxostoma erythrurum</i>     | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>         | 10    |
| 13     | 910.7      | RDB  | 14-Oct-08 | Bigmouth Buffalo   | <i>Ictiobus cyprinellus</i>     | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Black Buffalo      | <i>Ictiobus niger</i>           | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Spotted Sucker     | <i>Minytrema melanops</i>       | 7     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Blue Catfish       | <i>Ictalurus furcatus</i>       | 1     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Channel Catfish    | <i>Ictalurus punctatus</i>      | 51    |
| 13     | 910.7      | RDB  | 14-Oct-08 | Flathead Catfish   | <i>Pylodictis olivaris</i>      | 2     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Morone Sp          | <i>Morone sp</i>                | 48    |
| 13     | 910.7      | RDB  | 14-Oct-08 | Bluegill           | <i>Lepomis macrochirus</i>      | 9     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Longear Sunfish    | <i>Lepomis megalotis</i>        | 12    |
| 13     | 910.7      | RDB  | 14-Oct-08 | Redear Sunfish     | <i>Lepomis microlophus</i>      | 14    |
| 13     | 910.7      | RDB  | 14-Oct-08 | Largemouth Bass    | <i>Micropterus salmoides</i>    | 2     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Spotted Bass       | <i>Micropterus punctulatus</i>  | 3     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Logperch           | <i>Percina caprodes</i>         | 1     |

| Site # | River Mile | Bank | Date      | Common Name        | Latin Name                         | Count |
|--------|------------|------|-----------|--------------------|------------------------------------|-------|
| 13     | 910.7      | RDB  | 14-Oct-08 | Sauger             | <i>Sander canadensis</i>           | 8     |
| 13     | 910.7      | RDB  | 14-Oct-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>       | 25    |
| 14     | 912.0      | LDB  | 14-Oct-08 | Gizzard Shad       | <i>Dorosoma cepedianum</i>         | 35    |
| 14     | 912.0      | LDB  | 14-Oct-08 | Threadfin Shad     | <i>Dorosoma petenense</i>          | 1     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Common Carp        | <i>Cyprinus carpio</i>             | 2     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Silver Carp        | <i>Hypophthalmichthys molitrix</i> | 1     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Silver Chub        | <i>Macrhybopsis storeriana</i>     | 4     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Quillback          | <i>Carpoides cyprinus</i>          | 3     |
| 14     | 912.0      | LDB  | 14-Oct-08 | River Carpsucker   | <i>Carpoides carpio</i>            | 3     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Shorthead Redhorse | <i>Moxostoma macrolepidotum</i>    | 1     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Smallmouth Buffalo | <i>Ictiobus bubalus</i>            | 10    |
| 14     | 912.0      | LDB  | 14-Oct-08 | Black Buffalo      | <i>Ictiobus niger</i>              | 1     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Channel Catfish    | <i>Ictalurus punctatus</i>         | 32    |
| 14     | 912.0      | LDB  | 14-Oct-08 | Flathead Catfish   | <i>Pylodictis olivaris</i>         | 3     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Inland Silverside  | <i>Menidia beryllina</i>           | 9     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Morone Sp          | <i>Morone sp</i>                   | 72    |
| 14     | 912.0      | LDB  | 14-Oct-08 | White Bass         | <i>Morone chrysops</i>             | 1     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Bluegill           | <i>Lepomis macrochirus</i>         | 9     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Longear Sunfish    | <i>Lepomis megalotis</i>           | 7     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Redear Sunfish     | <i>Lepomis microlophus</i>         | 3     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Largemouth Bass    | <i>Micropterus salmoides</i>       | 5     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Spotted Bass       | <i>Micropterus punctulatus</i>     | 3     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Sauger             | <i>Sander canadensis</i>           | 5     |
| 14     | 912.0      | LDB  | 14-Oct-08 | Freshwater Drum    | <i>Aplodinotus grunniens</i>       | 53    |

**Appendix C.** Habitat survey data from the Smithland pool.

| Site # | River Mile | Bank | % Boulder | % Cobble | % Gravel | % Sand | % Fine | % Hardpan | % Other | Depth | % Submerged Vegetation | % Woody Cover | % Overhanging Vegetation | Land Use | Human Influence | Bank Profile |
|--------|------------|------|-----------|----------|----------|--------|--------|-----------|---------|-------|------------------------|---------------|--------------------------|----------|-----------------|--------------|
| 1      | 849.5      | RDB  | 0.0       | 0.0      | 0.0      | 75.9   | 20.7   | 3.4       | 0.0     | 16.7  | 0.0                    | 0.0           | 0.0                      | A,NF     | none            | sloped       |
| 2      | 854.6      | LDB  | 0.0       | 2.2      | 4.3      | 30.4   | 10.9   | 52.2      | 0.0     | 16.2  | 0.0                    | 4.6           | 0.0                      | NF,A     | none            | cliff        |
| 3      | 856.3      | RDB  | 0.0       | 0.0      | 2.8      | 50.5   | 46.7   | 0.0       | 0.0     | 5.6   | 0.0                    | 1.2           | 0.0                      | NF       | none            | gradual      |
| 4      | 859.4      | RDB  | 0.0       | 0.0      | 7.3      | 76.8   | 15.9   | 0.0       | 0.0     | 10.9  | 0.0                    | 0.6           | 0.0                      | A        | none            | steep        |
| 5      | 860.4      | RDB  | 0.0       | 0.0      | 0.0      | 71.4   | 2.9    | 25.7      | 0.0     | 16.6  | 0.0                    | 0.2           | 0.0                      | A        | none            | cliff        |
| 6      | 869.7      | RDB  | 0.0       | 0.0      | 15.5     | 39.2   | 39.2   | 6.2       | 0.0     | 12.0  | 0.0                    | 7.0           | 0.0                      | NF       | none            | cliff        |
| 7      | 873.0      | RDB  | 0.0       | 0.0      | 37.3     | 31.8   | 20.9   | 10.0      | 0.0     | 5.2   | 0.0                    | 3.8           | 0.0                      | NF       | none            | cliff        |
| 8      | 874.9      | LDB  | 0.9       | 5.4      | 1.8      | 25.2   | 25.2   | 41.4      | 0.0     | 5.7   | 0.0                    | 8.2           | 0.0                      | NF       | none            | steep        |
| 9      | 881.7      | RDB  | 12.1      | 8.6      | 15.5     | 31.9   | 31.0   | 0.0       | 0.9     | 8.6   | 0.0                    | 2.4           | 5.0                      | NF       | barges          | sloped       |
| 10     | 889.4      | LDB  | 0.0       | 11.8     | 11.8     | 35.3   | 37.3   | 2.0       | 2.0     | 17.9  | 0.0                    | 3.4           | 7.5                      | NF       | ramp            | steep        |
| 11     | 903.7      | RDB  | 0.0       | 0.0      | 0.0      | 51.5   | 47.1   | 1.5       | 0.0     | 9.0   | 0.0                    | 22.2          | 6.7                      | NF       | none            | sloped       |
| 12     | 905.7      | LDB  | 0.0       | 3.4      | 8.0      | 63.6   | 25.0   | 0.0       | 0.0     | 9.9   | 0.0                    | 12.0          | 6.7                      | NF       | none            | gradual      |
| 13     | 910.7      | RDB  | 0.0       | 0.0      | 3.5      | 37.7   | 53.5   | 5.3       | 0.0     | 5.1   | 0.0                    | 13.8          | 10.0                     | NF       | none            | steep        |
| 14     | 912.0      | LDB  | 0.0       | 0.0      | 0.9      | 53.7   | 38.9   | 6.5       | 0.0     | 5.8   | 0.0                    | 12.8          | 10.0                     | A,NF     | none            | steep        |

**Appendix D.** Water quality parameters measured prior to fish sampling in Smithland pool.

| Site # | River Mile | Bank | pH   | Temp (C) | Dissolved Oxygen (mg/L) | Conductivity | Secchi (in) |
|--------|------------|------|------|----------|-------------------------|--------------|-------------|
| 1      | 849.5      | RDB  | 5.74 | 21.90    | 7.38                    | 605          | 24          |
| 2      | 854.6      | LDB  | 7.40 | 28.92    | 7.38                    | 479          | 22          |
| 3      | 856.3      | RDB  | 8.40 | 29.00    | 11.30                   | 517          | 22          |
| 4      | 859.4      | RDB  | 9.20 | 28.86    | 9.60                    | 495          | 22          |
| 5      | 860.4      | RDB  | 8.10 | 28.70    | 9.32                    | 497          | 22          |
| 6      | 869.7      | RDB  | 7.75 | 25.12    | 8.41                    | n/a          | 36          |
| 7      | 873.0      | RDB  | 8.78 | 21.87    | 8.78                    | 567          | 36          |
| 8      | 874.9      | LDB  | 7.40 | 29.34    | 8.34                    | 492          | 18          |
| 9      | 881.7      | RDB  | 7.72 | 28.50    | 8.61                    | 493          | 26          |
| 10     | 889.4      | LDB  | 9.05 | 28.70    | 8.88                    | 488          | 26          |
| 11     | 903.7      | RDB  | 7.90 | 22.15    | 6.71                    | 555          | n/a         |
| 12     | 905.7      | LDB  | 7.80 | 21.96    | 6.84                    | 555          | 48          |
| 13     | 910.7      | RDB  | 7.90 | 21.68    | 5.95                    | 542          | 48          |
| 14     | 912.0      | LDB  | 7.67 | 21.80    | 6.01                    | 542          | 36          |



**Appendix E.** Water quality parameters analyzed from Smithland pool in 2008. Values in bold exceed water quality criteria for respective analyte.

| Site # | River Mile | Round | Ammonia | Chloride | Hardness | Nitrate-Nitrite | Phenolics | Sulfate | TKN  | TOC | Phosphorus | TSS |
|--------|------------|-------|---------|----------|----------|-----------------|-----------|---------|------|-----|------------|-----|
| 1      | 849.5      | 1     | 0.08    | 17       | 206      | 2.70            | 9.0       | 33      | 0.40 | 4.8 | 0.7        | 190 |
|        |            | 2     | 0.08    | 26       | 196      | 0.58            | 9.0       | 46      | 0.82 | 3.7 | 0.7        | 33  |
|        |            | 3     | 0.08    | 29       | 183      | 0.94            | 9.0       | 54      | 0.61 | 3.3 | 0.7        | 52  |
| 2      | 854.6      | 1     | 0.08    | 27       | 171      | 1.20            | 9.0       | 68      | 0.54 | 2.8 | 0.7        | 18  |
|        |            | 2     | 0.08    | 32       | 209      | 0.46            | 9.0       | 51      | 0.85 | 3.5 | 0.7        | 28  |
|        |            | 3     | 0.08    | 30       | 177      | 0.80            | 9.0       | 67      | 0.42 | 2.8 | 0.7        | 40  |
| 3      | 856.3      | 1     | 0.08    | 17       | 187      | 2.60            | 9.0       | 33      | 0.56 | 3.9 | 0.7        | 51  |
|        |            | 2     | 0.08    | 30       | 200      | 0.29            | 9.0       | 56      | 0.86 | 3.5 | 0.7        | 35  |
|        |            | 3     | 0.08    | 29       | 177      | 0.79            | 9.0       | 64      | 0.39 | 3.3 | 0.7        | 42  |
| 4      | 859.4      | 1     | 0.08    | 19       | 194      | 2.30            | 9.0       | 42      | 0.31 | 3.6 | 0.7        | 54  |
|        |            | 2     | 0.08    | 31       | 202      | 0.52            | 9.0       | 56      | 0.81 | 3.6 | 0.7        | 24  |
|        |            | 3     | 0.08    | 30       | 174      | 0.82            | 9.0       | 65      | 0.62 | 3.0 | 0.7        | 31  |
| 5      | 860.4      | 1     | 0.08    | 21       | 183      | 2.10            | 9.0       | 48      | 0.29 | 3.5 | 0.7        | 54  |
|        |            | 2     | 0.08    | 31       | 211      | 0.49            | 9.0       | 56      | 0.66 | 3.8 | 0.7        | 22  |
|        |            | 3     | 0.08    | 30       | 172      | 0.83            | 9.0       | 65      | 0.37 | 3.0 | 0.7        | 36  |
| 6      | 869.7      | 1     | 0.08    | 21       | 192      | 2.00            | 9.0       | 50      | 0.34 | 3.7 | 0.7        | 60  |
|        |            | 2     | 0.08    | 27       | 182      | 0.35            | 9.0       | 59      | 0.68 | 3.7 | 0.7        | 18  |
|        |            | 3     | 0.08    | 33       | 195      | 0.92            | 9.0       | 65      | 0.36 | 2.9 | 0.7        | 27  |
| 7      | 873.0      | 1     | 0.08    | 21       | 185      | 2.10            | 9.0       | 49      | 0.42 | 3.5 | 0.7        | 58  |
|        |            | 2     | 0.08    | 26       | 191      | 0.42            | 9.0       | 60      | 0.86 | 4.7 | 0.7        | 33  |
|        |            | 3     | 0.08    | 37       | 211      | 0.82            | 9.0       | 71      | 0.36 | 3.4 | 0.7        | 23  |
| 8      | 874.9      | 1     | 0.08    | 25       | 183      | 1.30            | 9.0       | 65      | 0.47 | 3.1 | 0.7        | 88  |
|        |            | 2     | 0.08    | 26       | 197      | 0.42            | 9.0       | 64      | 0.77 | 4.6 | 0.7        | 30  |
|        |            | 3     | 0.08    | 35       | 202      | 0.80            | 9.0       | 71      | 0.47 | 2.6 | 0.7        | 30  |
| 9      | 881.7      | 1     | 0.08    | 21       | 173      | 2.00            | 9.0       | 46      | 0.41 | 3.3 | 0.7        | 46  |
|        |            | 2     | 0.08    | 24       | 188      | 0.42            | 9.0       | 52      | 1.10 | 4.2 | 0.7        | 20  |
|        |            | 3     | 0.08    | 34       | 183      | 0.74            | 9.0       | 75      | 0.59 | 3.0 | 0.7        | 18  |
| 10     | 889.4      | 1     | 0.08    | 23       | 164      | 1.50            | 9.0       | 61      | 0.33 | 3.7 | 0.7        | 62  |
|        |            | 2     | 0.08    | 25       | 186      | 0.42            | 9.0       | 57      | 1.10 | 4.2 | 0.7        | 27  |
|        |            | 3     | 0.08    | 32       | 174      | 0.77            | 9.0       | 69      | 0.46 | 3.1 | 0.7        | 20  |
| 11     | 903.7      | 1     | n/a     | 23       | 164      | 1.50            | 9.0       | 62      | 0.22 | 3.1 | 0.7        | 45  |
|        |            | 2     | 0.08    | 26       | 177      | 0.42            | 9.0       | 63      | 0.73 | 3.2 | 0.7        | 18  |
|        |            | 3     | 0.08    | 31       | 177      | 0.77            | 9.0       | 67      | 0.27 | 3.5 | 0.7        | 12  |
| 12     | 905.7      | 1     | 0.08    | 23       | 176      | 1.40            | 9.0       | 62      | 0.20 | 3.2 | 0.7        | 44  |
|        |            | 2     | 0.08    | 25       | 179      | 0.42            | 9.0       | 63      | 0.63 | 3.2 | 0.7        | 22  |
|        |            | 3     | 0.08    | 32       | 177      | 0.76            | 9.0       | 69      | 0.14 | 3.4 | 0.7        | 12  |
| 13     | 910.7      | 1     | 0.08    | 23       | 162      | 1.40            | 9.0       | 63      | 0.37 | 3.2 | 0.7        | 19  |
|        |            | 2     | 0.08    | 25       | 182      | 0.25            | 9.0       | 65      | 0.58 | 3.4 | 0.7        | 11  |
|        |            | 3     | 0.08    | 34       | 177      | 0.76            | 9.0       | 74      | 0.17 | 2.6 | 0.7        | 9.4 |
| 14     | 912.0      | 1     | 0.08    | 23       | 173      | 1.40            | 9.0       | 64      | 0.41 | 3.1 | 0.7        | 21  |
|        |            | 2     | 0.08    | 25       | 179      | 0.42            | 9.0       | 65      | 0.52 | 3.4 | 0.7        | 11  |
|        |            | 3     | 0.08    | 34       | 177      | 0.78            | 9.0       | 74      | 0.13 | 2.8 | 0.7        | 10  |