Biological Programs 2009
Intensive Survey Results
Series 6
Report 2

A Biological Study of the Markland 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 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 based on 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 2009, fish population data from Markland pool yielded 42 species and 2 hybrid taxa, representing 10 different families. One of these taxa was listed as endangered in OH [shortnose gar (*Lepisosteus platostomus*)] and one listed as endangered in IN [channel darter (*Percina copelandi*)]. Two of these taxa were listed in OH as threatened (channel darter) and [river darter (*Percina shumardi*)]. One is listed in KY as a species of concern [black buffalo (*Ictiobus niger*)].

- At the species level, freshwater drum (*Aplodinotus grunniens*) was the most abundant, comprising 18.4% of the catch.

- Previous analyses have identified a relationship between flow and MORFIn scores and the need for sampling thresholds and/or flow calibration. These analyses demonstrated that increased flows appeared to cause lower MORFIn scores due to decreased sampling efficiency and changes in fish behavior.

- Flows were relatively low in 2009 when sampling was conducted, and did not appear to affect electrofishing surveys.

- In 2009, all of the sites assessed in Markland pool had site quality scores $\geq$2.0 and the pool had an average quality score of 3.8 (out of 5.0). This score indicates the pool is in 'Good' biological condition. Therefore, Markland pool will be reported to EPA as meeting its aquatic life-use designation.

- As of 2009, all of the 19 pools (AUs) have been assessed which comprises 981 miles or 100% of the resource.

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A Biological Study of the Markland Pool of the Ohio River (2009)

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 fish populations of the Ohio River, ORSANCO developed the Ohio River Fish Index (ORFIn, Emery et al. 2003). The ORFIn 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 ORFIn 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 ORFIn (MORFIn).

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 2009, the Belleville, Markland, McAlpine pools and the Open Water section were sampled as part of ORSANCO's normal monitoring. This report presents the 2009 survey of the Markland 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

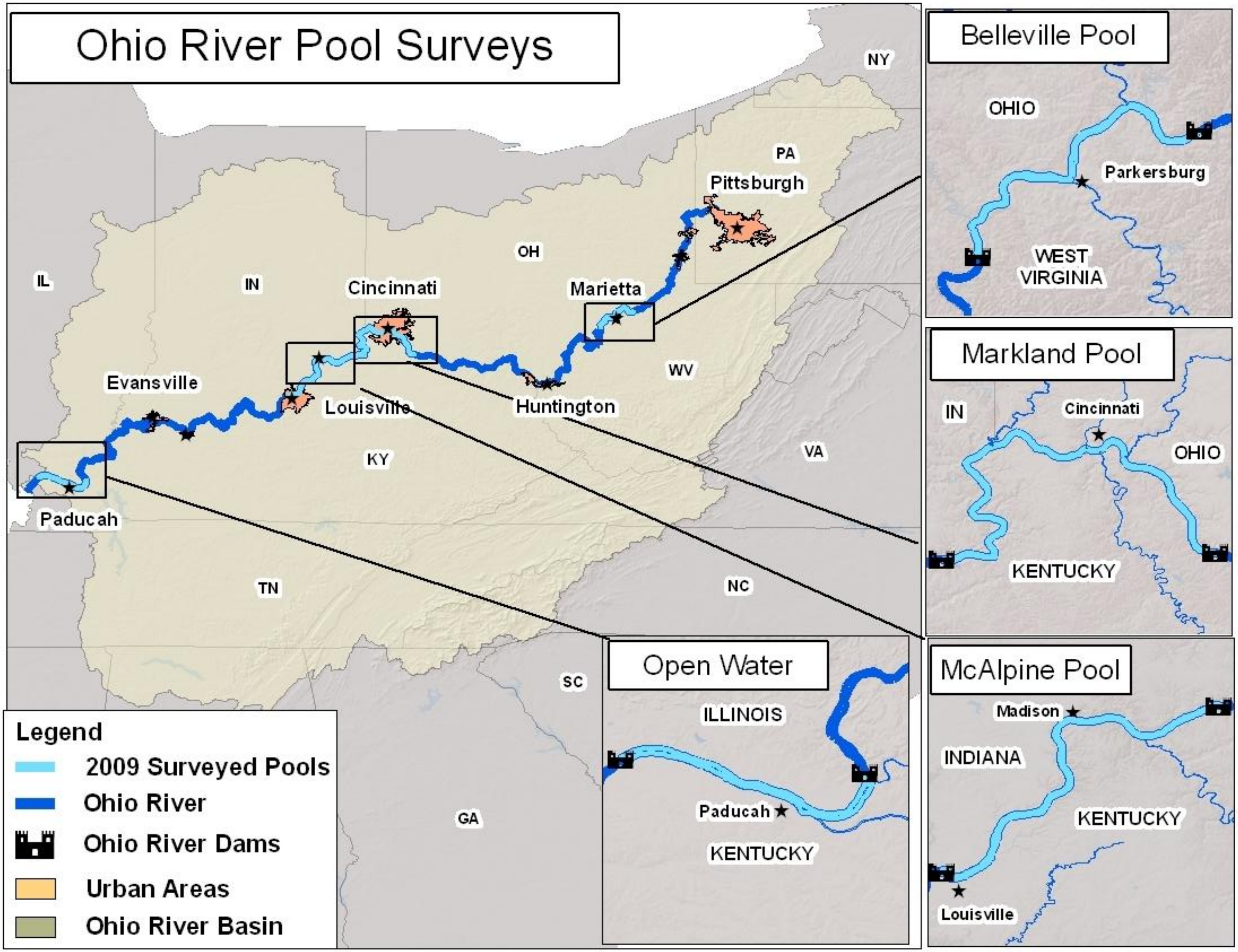

Figure 1. *The Ohio River basin and the four pools selected for 2009 sampling.*

are power-generating facilities. The Ohio River Basin contains nearly ten percent of the nation's 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 Markland Pool

The Markland pool is 95.3 miles long, extending from Captain Anthony Meldahl Locks and Dam (ORM 436.2) to Markland Locks and Dam (ORM 531.5). The pool has a gradient drop of 0.4 feet per mile and averages 1,594 feet wide and 31 feet deep (ORSANCO 1994). The pool is bordered by the states of Kentucky, Ohio, and Indiana.

2.3 Markland Pool Land Cover

This pool lies in a portion of the Ohio River heavily influenced by industry with a large amount of barge activity. The Markland pool receives water from the following major tributaries: Little Miami River in Ohio at mile point 463.5 with a drainage area of 1.750 square miles, Licking River in Kentucky at mile point 470.2 with a drainage area of 3,670 square miles, Mill Creek in Ohio at mile point 472.5 with a drainage area of 166 square miles, Great Miami River at mile point 491.1 with a drainage area of 5,400 square miles, Tanners Creek at mile point 494.8 with a drainage area of 136 square miles, Hogan Creek at mile point 496.7 draining 130 square miles and Laughery Creek at mile point 498.7 with a drainage area of 350 square miles. These watersheds are primarily forested (54.7%) but also have a considerable amount of row crops (14.0%) and pasture lands (13.2%; Figure 2).

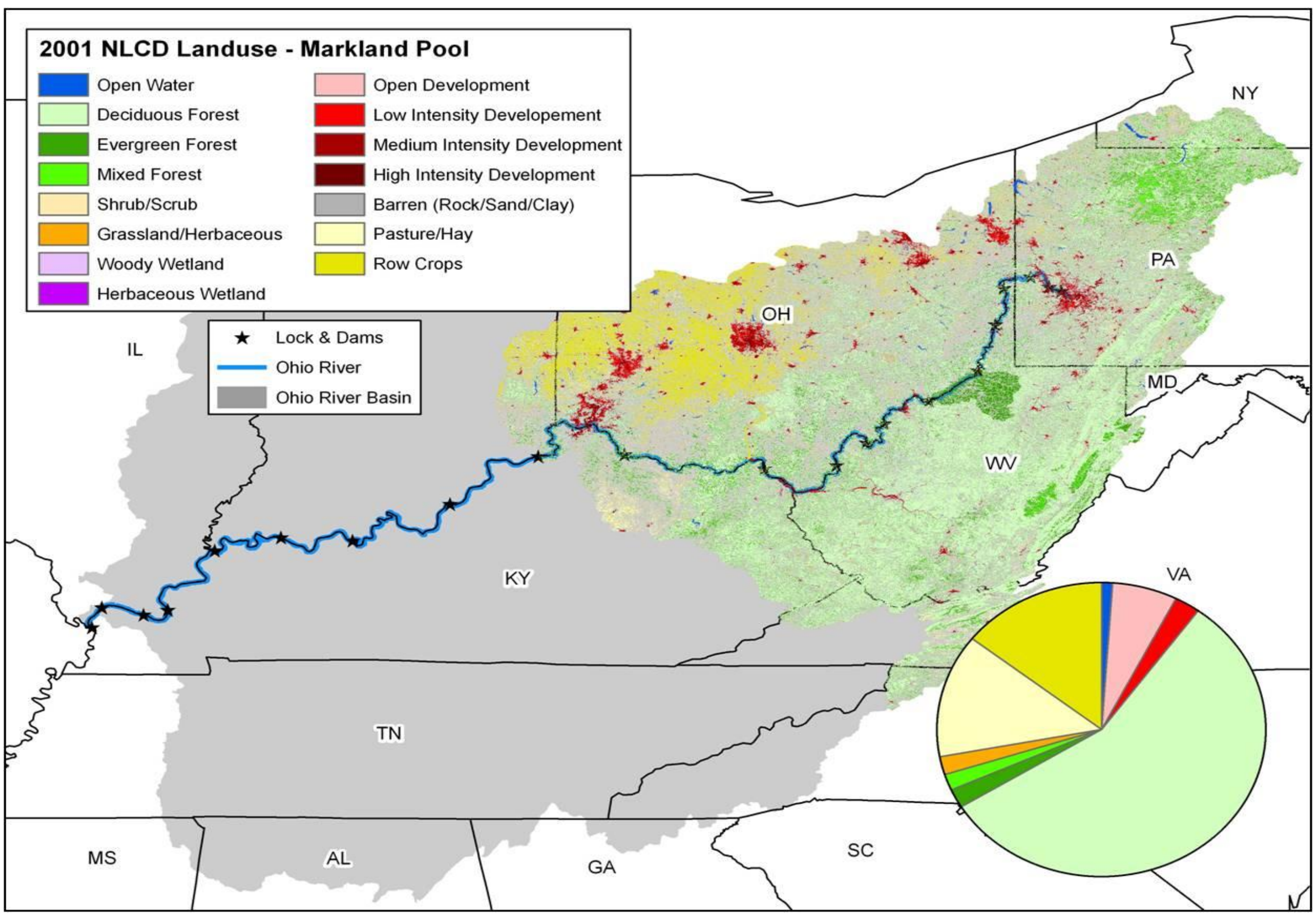

Figure 2. *Land cover within the Markland pool catchment area.*

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 Markland pool of the Ohio River from mile marker 436.2 (Meldahl Locks and Dam) to 531.5 (Markland Locks and Dam). The total linear extent of the target population was approximately 190.6 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 survey design for a linear network with reverse hierarchical randomization 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 June 29 and October 31 when water levels were within one meter of "normal flat pool" and Secchi depths were greater than 0.3m (12 in). 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 night sampling 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 5.0 GPP 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 are deeper (depths exceeding 20 feet).

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 and an optical dissolved oxygen (DO) meter: water temperature, pH, 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 4ºC until sent off for laboratory analyses. Water quality parameters analyzed included: ammonia (nitrogen), chloride, hardness, nitrate-nitrite, total Kjeldahl nitrogen (TKN), 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. Flow was also monitored and 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 2009, ORSANCO employed a probabilistic design to provide a thorough assessment of biological condition. Individual navigational pools served as the primary assessment units. Therefore, the Markland 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 (i.e. different fish assemblages are found at each habitat). To account for these variations in our assessment, the condition of each site was determined by comparing its performance (i.e. MORFIn score) to those of previously sampled sites within its particular habitat class. The distribution of historical MORFIn scores was determined by compiling reference fish data (i.e. data from least-disturbed sites) from the five distinct habitat classes over a fifteen year period. A fish quality score between 0 and 5 was given to each individual site based upon how each site scored relative to the statistical distribution (5th, 25th, 50th, 75th, and 95th percentiles) of historical MORFIn scores (see Appendix A for a detailed explanation). For example, a fish quality score of 3 is applied to a site whose score falls between the 50th and 75th percentiles of the historical MORFIn scores specific to that habitat class (Figure 3). To further aid in interpretation, condition ratings were applied to each site quality score as follows: 0='Very Poor', 1='Poor', 2='Fair', 3='Good', 4='Very Good' and 5='Excellent'. Essentially, a site is considered in 'Good' biological condition when its MORFIn score is equal to or slightly better than the historical average.

To obtain a final bio-assessment of each pool, an average fish quality score was calculated. The 25th percentile (average fish quality score of at least 2.0) was established as the criterion for determining whether a pool 'passes' (meets its aquatic life-use designation) or 'fails' (does not meet its aquatic life-use designation). The pool was assessed as 'passing' if its average fish quality score was above the 25th percentile (≥2.0). Any pool with an average fish quality score less than 2.0 (i.e. a rating of 'Poor' or ''Very Poor') was assessed as failing to meet its aquatic life-use designation.

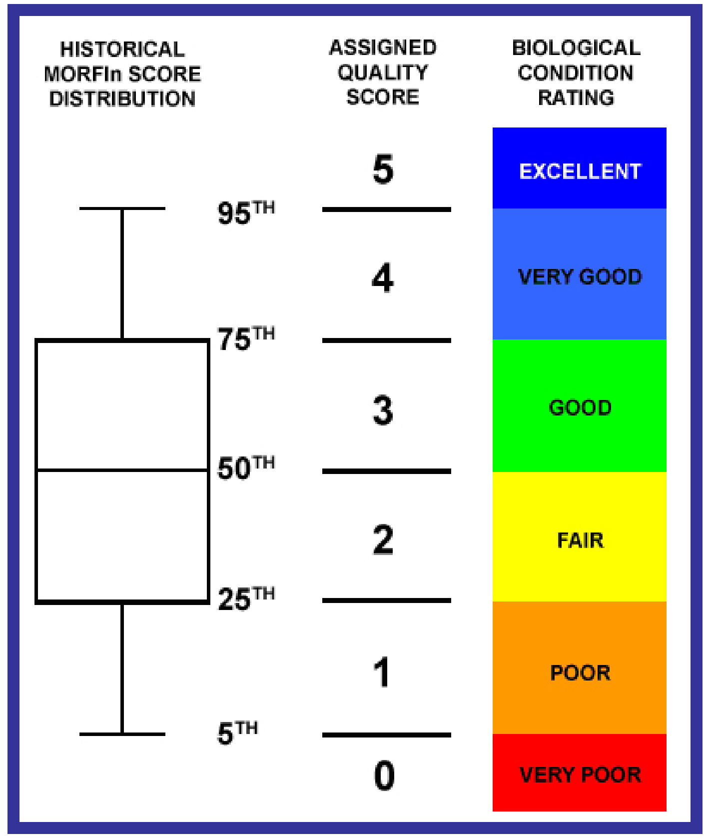

Figure 3. *Approach used to assign fish quality scores for each habitat class.*

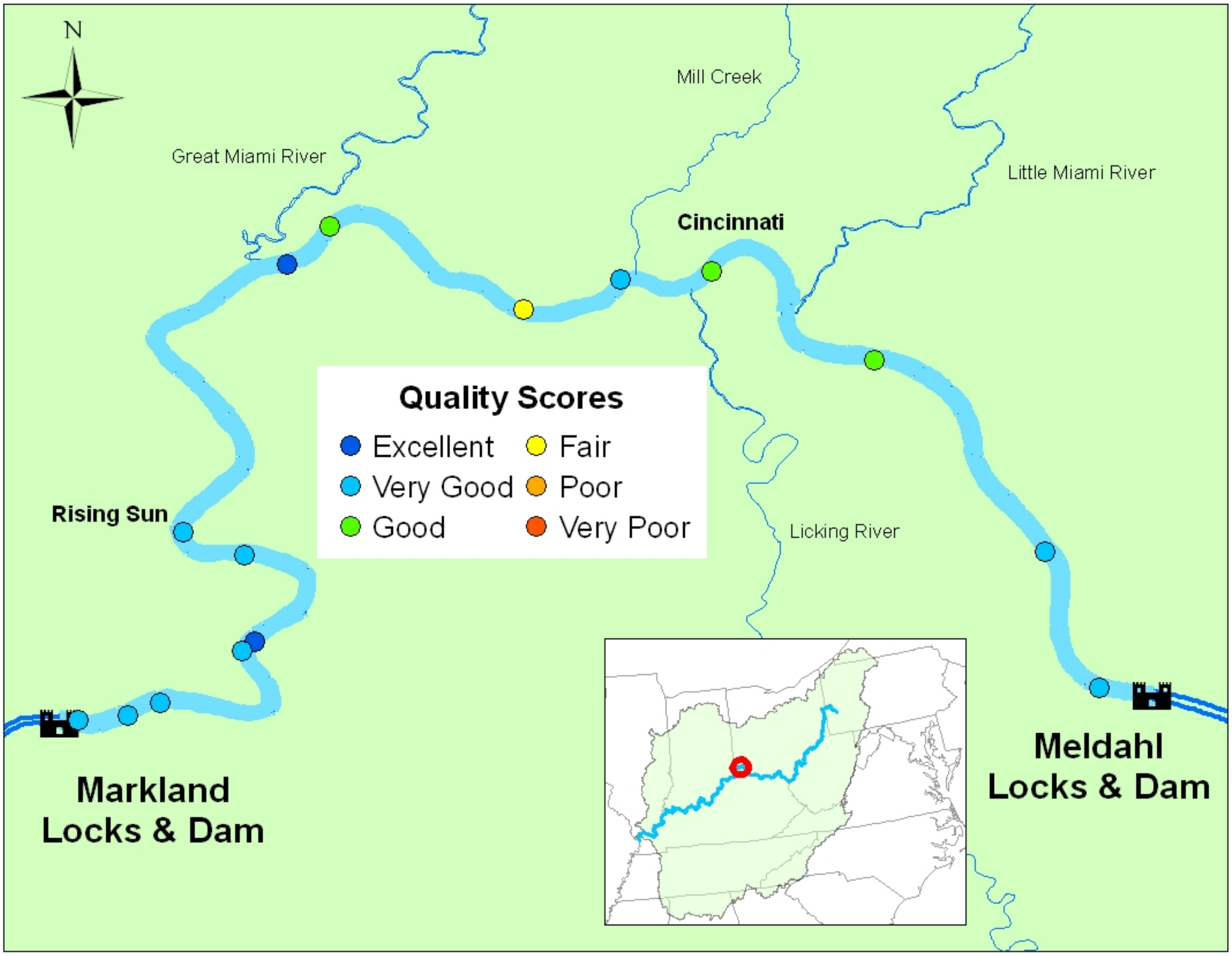

Figure 4. *Locations and results of sampling at 15 sites within Markland pool.*

4.0 Results

4.1 Fish Population

In 2009, fish population data (Appendix B) were collected from 15 randomly selected locations throughout the length of the Markland pool (Figure 4). These collections produced 42 species and 2 hybrid taxa, representing 10 different families (Table 2). One of these taxa was listed as endangered in OH [shortnose gar (*Lepisosteus platostomus*)] and one listed as endangered in IN [channel darter (*Percina copelandi*)]. Two of these taxa were listed in OH as threatened [channel darter (*Percina copelandi*)] and [river darter (*Percina shumardi*)]. One is listed in KY as a species of concern [black buffalo (*Ictiobus niger*)]. No federally listed taxa were collected from the Markland pool. At the species level, freshwater drum (*Aplodinotus grunniens*) was the most abundant, comprising 18.4% of the catch (Figure 5). The minnows and carp family (Cyprinidae), made up 21.6% of the total catch, followed by the drum family (Sciaenidae) which made up 18.4% of the catch (Figure 6).

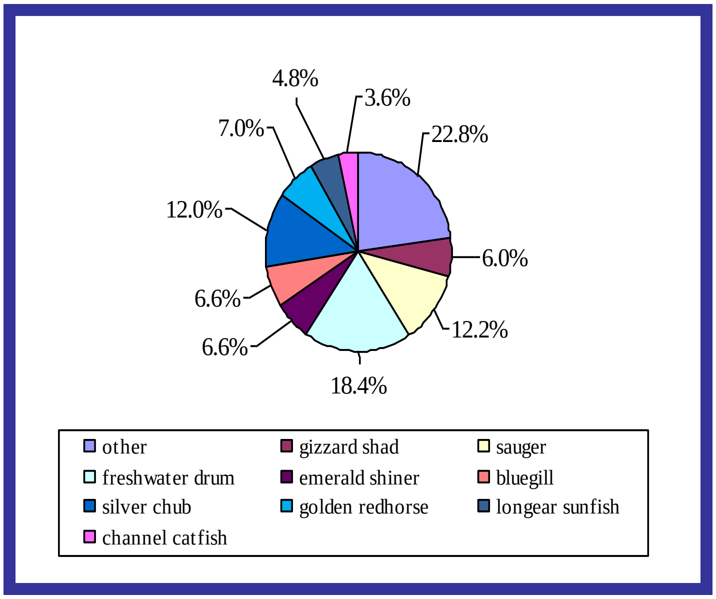

Figure 5. *Species composition of fish sampled in Markland pool.*

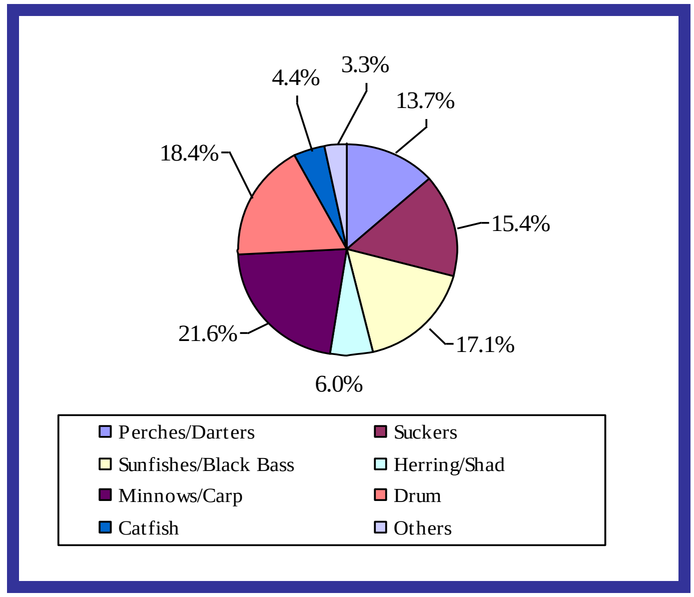

Figure 6. *Sampled fish composition by family in Markland pool.*

Table 1. *Electrofishing site list for the Markland pool including habitat designation, MORFIn scores, and quality scores.*

Site #	River Mile	Bank	Date	Latitude	Longitude	Habitat Class	MORFin Expectation	MORFin	Quality Values	Quality Score
1	438.3	LDB	09-Sep-09	38.79977	84.20667	A	50.03	68.53	4	Very Good
2	445.7	LDB	09-Sep-09	38.89902	84.24561	D	41.80	58.61	4	Very Good
3	458.2	LDB	15-Sep-09	39.03887	84.37050	D	41.80	50.75	3	Good
4	469.2	LDB	15-Sep-09	39.10342	84.48900	C	44.55	56.83	3	Good
5	473	RDB	21-Sep-09	39.09785	84.55570	A	50.03	70.27	4	Very Good
6	477.7	RDB	21-Sep-09	39.07595	84.62565	D	41.80	47.91	2	Fair
7	487.5	LDB	21-Sep-09	39.13644	84.76731	E	39.59	58.66	3	Good
8	490.1	LDB	21-Sep-09	39.10850	84.79853	B	46.71	81.19	5	Excellent
9	508.9	LDB	17-Sep-09	38.91375	84.87402	D	41.80	59.19	4	Very Good
10	511.9	RDB	17-Sep-09	38.89630	84.82990	D	41.80	68.29	4	Very Good
11	519	LDB	22-Sep-09	38.83330	84.82162	D	41.80	69.77	5	Excellent
12	520	RDB	22-Sep-09	38.82717	84.83123	C	44.55	71.20	4	Very Good
13	527	LDB	23-Sep-09	38.78897	84.89115	D	41.80	61.06	4	Very Good
14	529	LDB	23-Sep-09	38.77958	84.91462	D	41.80	65.51	4	Very Good
15	531	RDB	23-Sep-09	38.77667	84.95088	D	41.80	60.21	4	Very Good

LDB = Left Descending Bank
RDB = Right Descending Bank

Table 2. *Species collected in the Markland pool during the 2009 survey. Species information are determined by and relative to the states of Kentucky, Ohio, and Indiana (T = 'Threatened, E= 'Endangered', and SC = 'Species of Concern')*

Family	Species	Latin Name	KY	OH	IN
Lepisosteidae	Longnose Gar	*Lepisosteus osseus*			
Lepisosteidae	Shortnose Gar	*Lepisosteus platostomus*		E	
Hiodontidae	Mooneye	*Hiodon tergisus*			
Clupeidae	Skipjack Herring	*Alosa chrysochloris*			
Clupeidae	Gizzard Shad	*Dorosoma cepedianum*			
Cyprinidae	Spotfin Shiner	*Cyprinella spiloptera*			
Cyprinidae	Common Carp	*Cyprinus carpio*			
Cyprinidae	Silver Chub	*Macrhybopsis storeriana*			
Cyprinidae	Emerald Shiner	*Notropis atherinoides*			
Cyprinidae	River Shiner	*Notropis blennius*			
Cyprinidae	Mimic Shiner	*Notropis volucellus*			
Cyprinidae	Suckermouth Minnow	*Phenacobius mirabilis*			
Cyprinidae	Bullhead Minnow	*Pimephales vigilax*			
Catostomidae	River Carpsucker	*Carpiodes carpio*			
Catostomidae	Quillback	*Carpiodes cyprinus*			
Catostomidae	Northern Hog Sucker	*Hypentelium nigricans*			
Catostomidae	Smallmouth Buffalo	*Ictiobus bubalus*			
Catostomidae	Black Buffalo	*Ictiobus niger*	SC		
Catostomidae	Silver Redhorse	*Moxostoma anisurum*			
Catostomidae	Smallmouth Redhorse	*Moxostoma breviceps*			
Catostomidae	Golden Redhorse	*Moxostoma erythrurum*			
Ictaluridae	Channel Catfish	*Ictalurus punctatus*			
Ictaluridae	Flathead Catfish	*Pylodictis olivaris*			
Moronidae	Morone Sp	*Morone sp.*			
Moronidae	White Perch	*Morone americana*			
Moronidae	White Bass	*Morone chrysops*			
Moronidae	Hybrid Striper	*Morone saxatilis x M. chrysops*			
Centrarchidae	Rock Bass	*Ambloplites rupestris*			
Centrarchidae	Green Sunfish	*Lepomis cyanellus*			
Centrarchidae	Pumpkinseed	*Lepomis gibbosus*			
Centrarchidae	Warmouth	*Lepomis gulosus*			
Centrarchidae	Bluegill	*Lepomis macrochirus*			
Centrarchidae	Longear Sunfish	*Lepomis megalotis*			
Centrarchidae	Redear Sunfish	*Lepomis microlophus*			
Centrarchidae	Smallmouth Bass	*Micropterus dolomieu*			
Centrarchidae	Spotted Bass	*Micropterus punctulatus*			
Centrarchidae	Largemouth Bass	*Micropterus salmoides*			
Centrarchidae	White Crappie	*Pomoxis annularis*			
Percidae	Logperch	*Percina caprodes*			
Percidae	Channel Darter	*Percina copelandi*		T	E
Percidae	Slenderhead Darter	*Percina phoxocephala*			
Percidae	River Darter	*Percina shumardi*		T	
Percidae	Sauger	*Sander canadensis*			
Percidae	Saugeye	*Sander canandensis x S. vitreus*			
Sciaenidae	Freshwater Drum	*Aplodinotus grunniens*			

4.2 Metric Performance

Thirteen metrics were used to calculate MORFIn scores for each electrofishing site (See Emery et al. 2003). Each site's performance and scores for the MORFIn metrics are shown in Table 3. The number of native species collected at each site ranged from 11 to 24, with an average of 18.4 species per site. The number of sucker species found at each site ranged from 2 to 6 and the number of centrarchid species varied from 0 to 6. The number of great river species ranged from 1 to 5. The number of intolerant species ranged from 1 to 5 at the sampled sites. The percentage of tolerant individuals at each site did not exceed 5.5% and the percentage of simple lithophils ranged between 7.3% and 66.9%. All sites had below 11.5% non-native individuals and the percent detritivores ranged from 1.0% to 21.1%. The percent invertivores ranged between 12.3% to 63.2%, and the percent piscivores ranged from 7.6% to 57.8%. Five of the sites had one DELT (deformities, eroded fins, lesions and tumors) anomaly and two of the sites had two DELT anomalies. The CPUE (catch per unit effort) ranged from 71 to 351 individuals and averaged 203 individulas per site.

4.3 Habitat Surveys

Intensive habitat surveys at each of the 15 sampling locations revealed that the benthic substrate in Markland pool was in nearly equal proportions of fines and sand (Figure 7). There was some variation among the individual sites and the percentage of fines generally increased as river miles increased (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 the Markland pool were classified as 'A' habitats, 1 site was a class 'B' habitat, 2 sites were class 'C' habitats, and 9 sites were class 'D' habitats. There was only 1 site classified as an 'E' habitat sampled in the pool (Table 1).

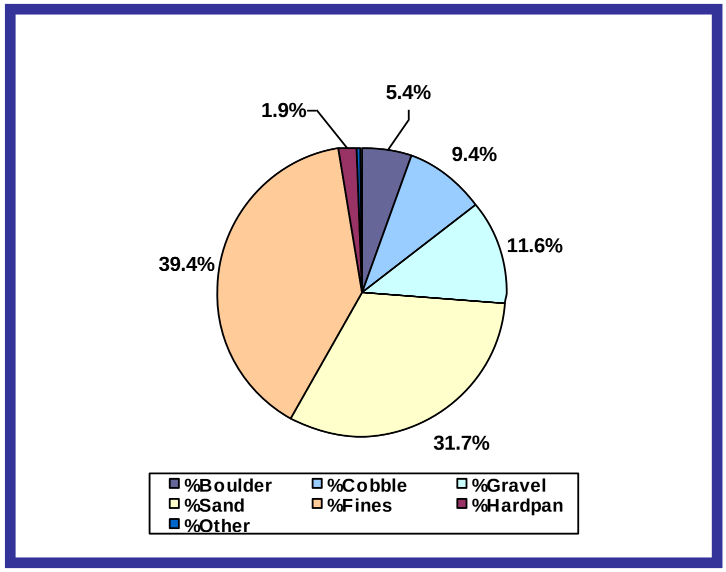

Figure 7. *Substrate composition of the Markland pool.*

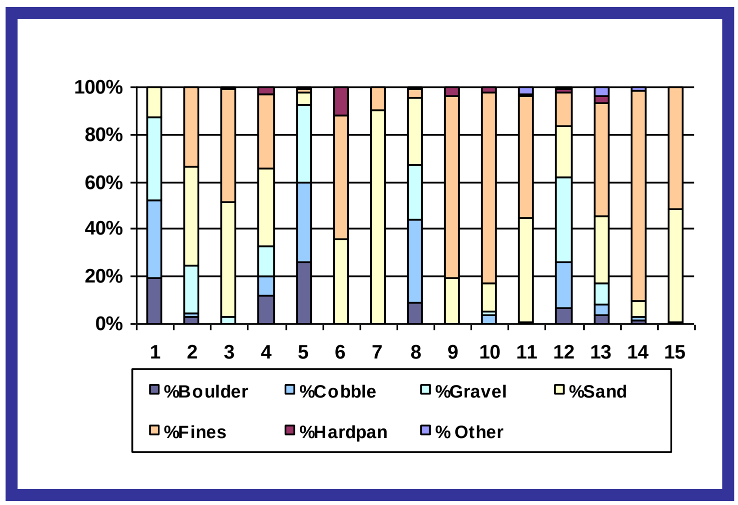

Figure 8. *Substrate composition at each site sampled in the Markland pool.*

Woody cover was present at all 15 sites sampled, as was overhanging vegetation. Riparian land cover was primarily natural forest with some residential and industrial uses present. Barge activity was moderate throughout the pool, and mooring structures were present at only one of the sites (see Appendix C).

Table 3. *MORFIn metrics and scores from the 2009 survey of Markland 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	DELT score	CPUE	CPUE score	Expected MORFIn	Observed MORFIn
1	438.3	L	139	132	128	19	69.8	4	59.0	3	50.0	3	100.0	6	100.0	3.0	67.9	43.9	76.0	0.0	100.0	12.1	59.0	47.0	67.0	20.5	23.4	0	100.0	135	18.8	50.03	68.5
2	445.7	L	71	57	57	17	55.5	5	78.8	1	16.7	3	100.0	2	35.5	0.0	100.0	38.6	66.6	0.0	100.0	21.1	27.5	12.3	15.1	40.4	57.8	0	100.0	71	8.6	41.80	58.6
3	458.2	L	133	49	48	12	19.5	3	40.8	0	0.0	1	33.3	1	17.8	0.0	100.0	53.1	92.8	2.0	81.1	6.1	80.2	36.7	52.5	34.7	47.9	1	75.0	132	18.8	41.80	50.7
4	469.2	L	152	135	130	18	63.6	4	60.8	6	100.0	2	66.7	2	37.1	2.2	76.4	35.6	61.5	3.0	72.6	11.1	62.6	34.8	50.2	16.3	16.0	2	50.0	147	21.5	44.55	56.8
5	473	R	180	165	154	24	100.0	5	80.3	5	83.3	5	100.0	5	93.2	5.5	42.2	57.0	100.0	6.1	43.9	10.3	65.4	38.2	55.4	35.8	49.6	1	75.0	169	25.1	50.03	70.3
6	477.7	R	138	96	85	11	12.9	2	22.6	2	33.3	1	33.3	1	19.1	0.0	100.0	57.3	100.0	11.5	0.0	1.0	98.1	40.6	59.3	21.9	25.6	0	100.0	127	18.4	41.80	47.9
7	487.5	L	178	139	138	16	49.6	2	23.2	2	33.3	2	66.7	2	38.4	0.0	100.0	37.4	65.1	0.7	93.3	0.7	99.2	40.3	59.3	11.5	7.6	0	100.0	177	26.8	39.59	58.7
8	490.1	L	283	239	234	23	100.0	4	62.0	6	100.0	3	100.0	5	94.4	0.8	91.1	66.9	100.0	2.1	80.6	2.9	91.4	63.2	93.9	20.9	23.8	1	75.0	278	43.2	46.71	81.2
9	508.9	L	185	176	171	19	72.2	4	63.1	5	83.3	1	33.3	1	21.3	1.7	81.9	44.3	77.9	2.8	73.7	14.2	51.7	27.3	40.7	31.8	42.5	0	100.0	180	27.8	41.80	59.2
10	511.9	R	220	214	214	20	79.6	4	63.3	5	83.3	2	66.7	2	40.1	0.0	100.0	36.9	64.7	0.0	100.0	9.8	67.1	38.3	57.5	25.2	31.1	0	100.0	220	34.3	41.80	68.3
11	519	L	353	341	339	21	87.1	5	83.0	6	100.0	1	33.3	3	59.2	0.3	96.9	37.8	66.4	0.6	94.6	8.8	70.7	38.1	57.6	23.2	27.5	1	75.0	351	55.8	41.80	69.8
12	520	R	277	247	241	19	72.6	5	83.1	6	100.0	2	66.7	2	40.6	0.0	100.0	37.7	66.1	2.4	77.5	5.7	81.8	42.1	63.6	25.1	30.8	0	100.0	271	42.8	44.55	71.2
13	527	L	189	187	183	18	65.6	6	100.0	4	66.7	1	33.3	3	59.7	2.1	77.3	41.7	73.5	2.1	80.2	13.4	54.6	32.1	48.9	24.6	29.9	1	75.0	185	29.0	41.80	61.1
14	529	L	285	240	235	20	80.2	5	83.6	5	83.3	2	66.7	2	41.3	1.7	82.3	35.8	63.0	2.1	80.7	12.1	59.1	23.8	36.4	25.0	30.6	0	100.0	280	44.5	41.80	65.5
15	531	R	324	301	294	19	73.0	3	45.0	6	100.0	2	66.7	2	41.4	2.3	75.3	7.3	11.7	1.3	87.7	9.6	67.8	52.8	80.3	26.6	33.3	2	50.0	317	50.5	41.80	60.2

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

4.4 Water Quality and Flow Conditions

Rain events were relatively common throughout the sampling period in 2009, though river levels and flow remained relatively stable. Sampling was conducted in Markland pool when flows were below the harmonic mean flow (HMF). Flow conditions during sampling varied from 19% and 67% 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 36 inches.

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

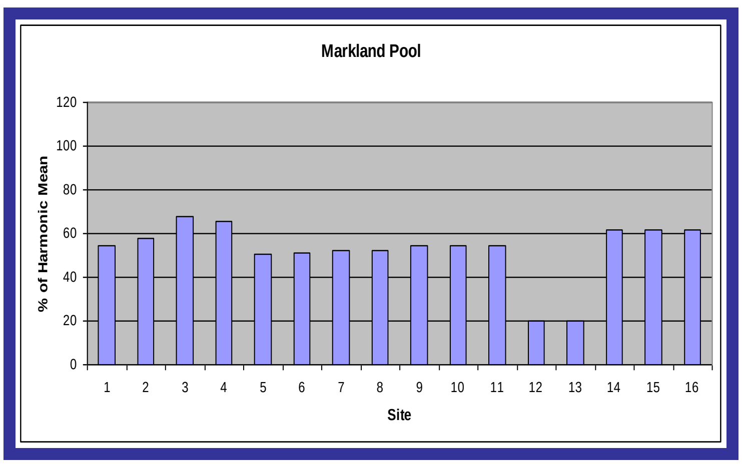

Figure 9. *Relative flows (%HMF) at the time of sampling.*

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 81.2 and the minimum was 47.9. By comparing observed and expected MORFIn scores, ORSANCO determined if a site met its expectations (based on habitat class) or not (Table 3). None of the 15 sites assessed in 2009 scored less than the minimum expected scores (i.e. were assessed as either poor or very poor) (Table 1; Figure 10). The remaining 15 sites received a fair (6.7%), good (20.0%), very good (60.0%), or excellent (13.3%) quality rating (Figure 4).

5.0 Discussion

5.1 Fish Population

In 2009, the fish population of Markland pool was in 'Good' condition. This was supported by the diversity and types of species collected. Multiple pollution intolerant species such as northern hogsucker (*Hypentelium nigricans*), mimic shiner (*Notropis volucellus*), smallmouth bass (*Micropterus dolomieu*), channel darter (*Percina copelandi*), logperch (*Percina caprodes*), smallmouth redhorse (*Moxostoma breviceps),* slenderhead darter (*Percina phoxocephala*), and mooneye (*Hiodon tergisus*) were collected from Markland pool. This suggests that pollution may not be a problem in the area as indicated by fish populations. Common carp (*Cyprinus carpio*) was the only non-native species collected during the survey.

The three most abundant species in the survey were freshwater drum (*Aplodinotus grunniens*; 572 individuals), sauger (*Sander canadensis*; 378 individuals), and silver chub (*Macrhybopsis storeriana*; 372 individuals).

5.2 Metric Performance

Most of the metric scores in Markland pool were relatively high with the exception of four metrics: CPUE, % pisciviores, and % intolerant individuals. There was no explanation for these low scores.

Three metrics stood out as the highest performing in Markland pool; DELTs, centrarchid species score, and the # of non-native individuals metrics. Though DELT anomalies were found at seven sites (46.7%), there were no sites with incidences >2, suggesting the majority of fishes in Markland pool are not experiencing environmental stressors severe enough to decrease their health. Low proportions of pollution-tolerant individuals and non-native species were collected. These metrics indicate that Markland pool is in 'Good' condition. Other metrics that performed relatively well include: # sucker species, % simple lithophilic spawners, % detritivores, and % piscivores.

5.3 Habitat Surveys
The habitat assessments showed that in Markland pool there was a relatively balanced number of sites classified as class 'A', 'B', 'C', and 'E' habitats. The majority of the sites fell into class 'D' which indicated that the majority of the benthic substrate was comprised of sand, fines, and the depth is shallow. The heterogeneous 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
There were no indications that fluctuations in river level could potentially have affected the survey of Markland pool. Flows remained below HMF values, and Secchi depths indicated sufficient visibility for sampling. No water quality measurements exceeded their respective criteria or provided any major insight into the assessment results for Markland pool.

5.5 Conclusions and Assessments of Condition
The overall average quality score in Markland pool was 3.8, indicating the pool is in 'Good' biological condition. This assessment demonstrated that the Markland pool met the criteria established by ORSANCO's Biological Water Quality Subcommittee (Appendix A), and therefore met its aquatic life-use designation.

6.0 Interpool Comparison

6.1 Purpose
As of 2009, all 19 pools have been surveyed and assessed. This section was developed to compare Markland pool to other previously surveyed pools in the Ohio River.

6.2 Land Cover
Markland pool lies in the middle portion of the Ohio River and has a relatively large catchment area. Despite many industrial facilities immediately surrounding the pool, the primary land cover within the watershed is deciduous forest. Agricultural practices are secondary land uses but in lower proportions than pools in the lower third of the Ohio River (Figure 10).

6.3 Substrate Composition
This pool had a relatively large percentage of fines and sand substrates. The heterogeneous substrate composition was most similar to its closest downstream pool (McAlpine). These percentages were relatively similar to pools assessed in the lower third of the river (Figure 11).

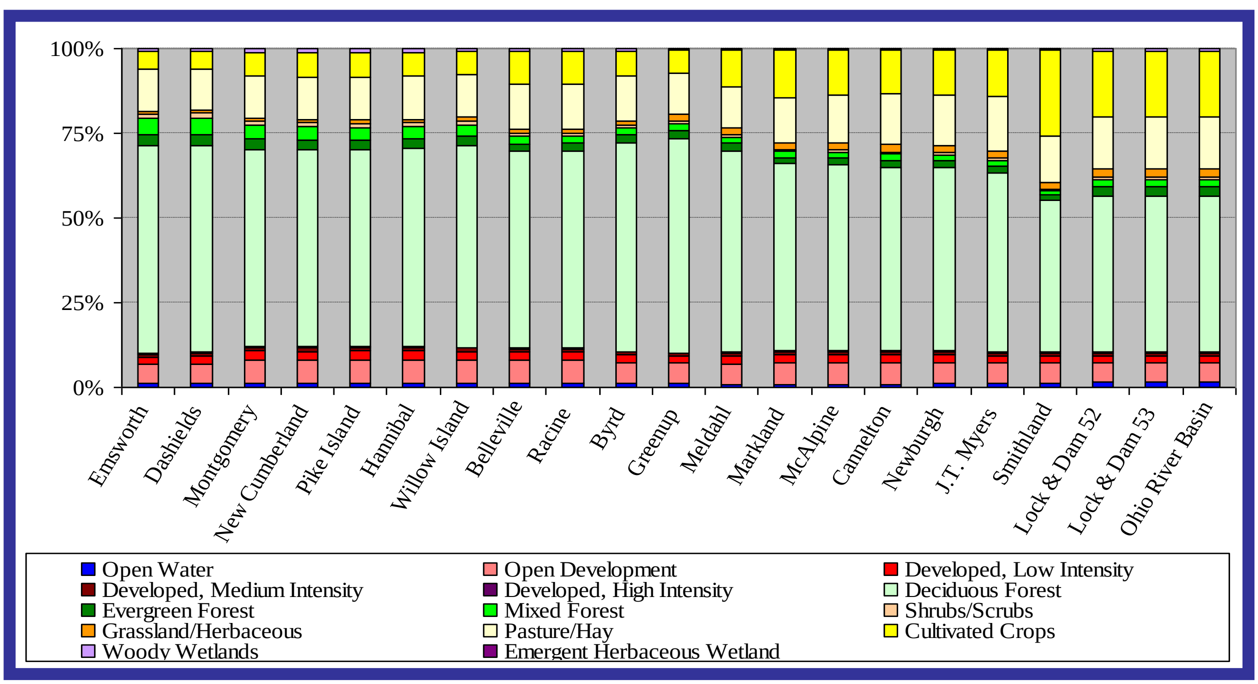

Figure 10. *Cumulative land-cover within the catchment area of each pool of the Ohio River.*

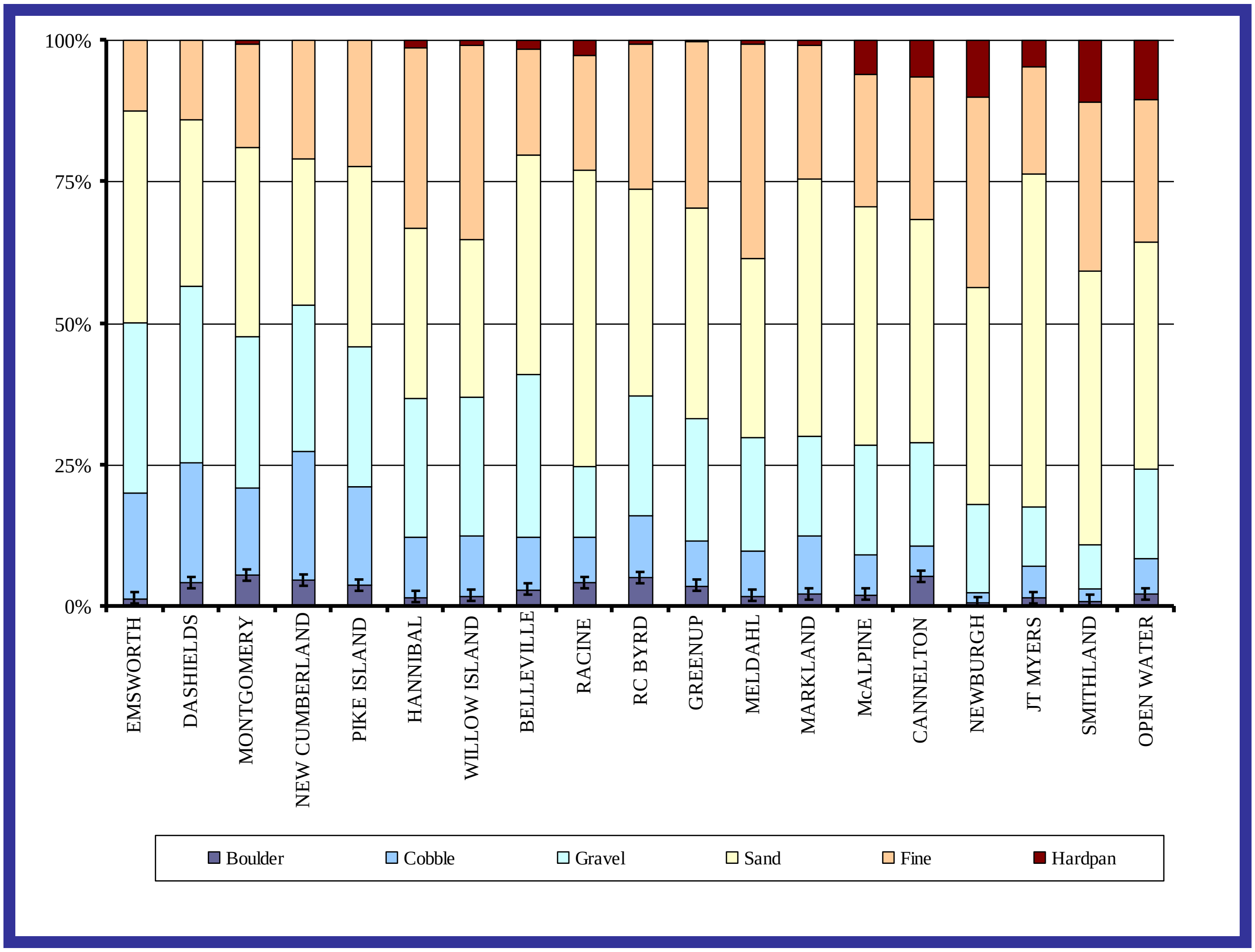

Figure11. *Substrate composition for each pool surveyed as of 2009.*

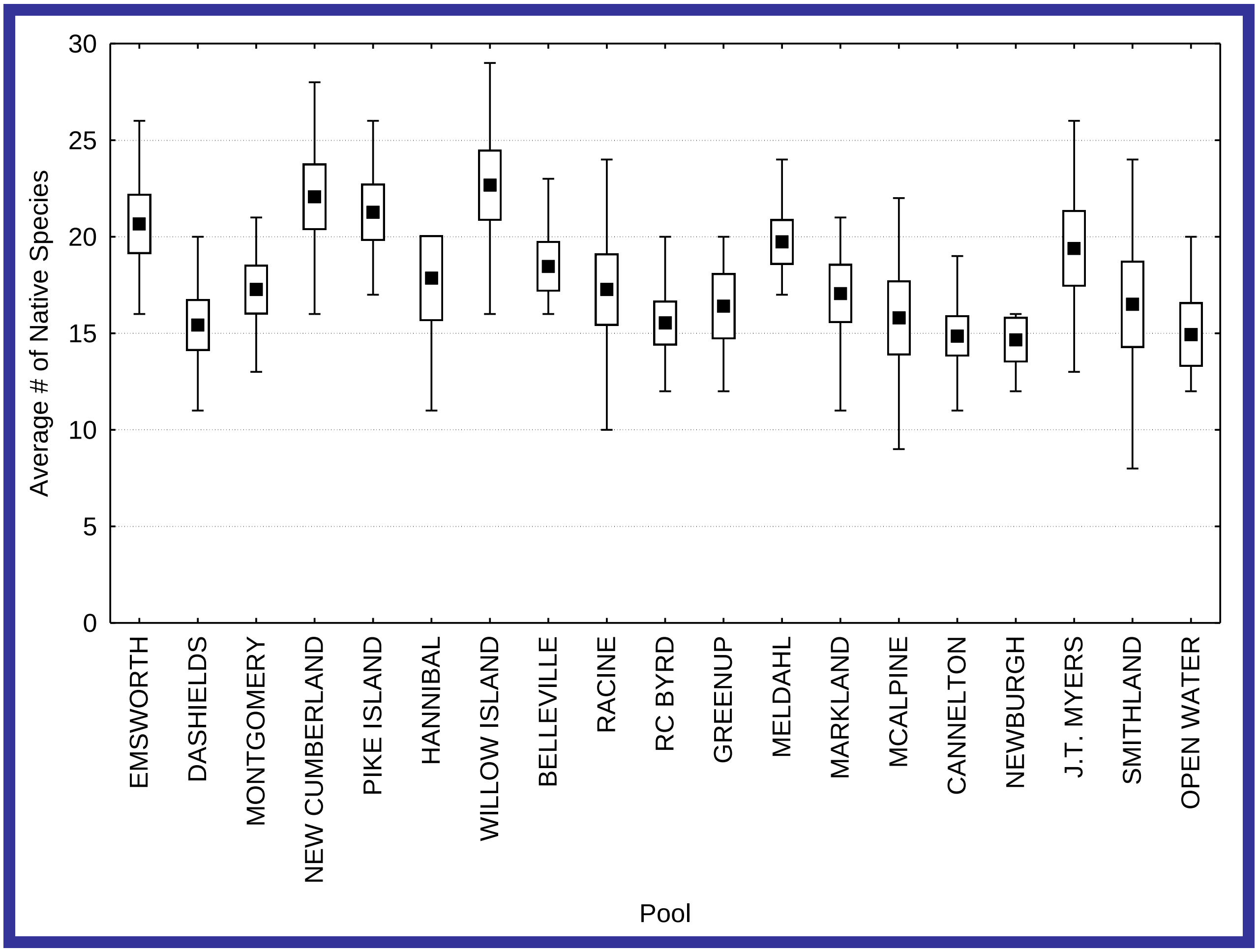

Figure 12. *The average number of native species collected at each site within each pool surveyed as of 2009 (■=Average, □= 90% Confidence Interval, I=Non-Outlier Range).*

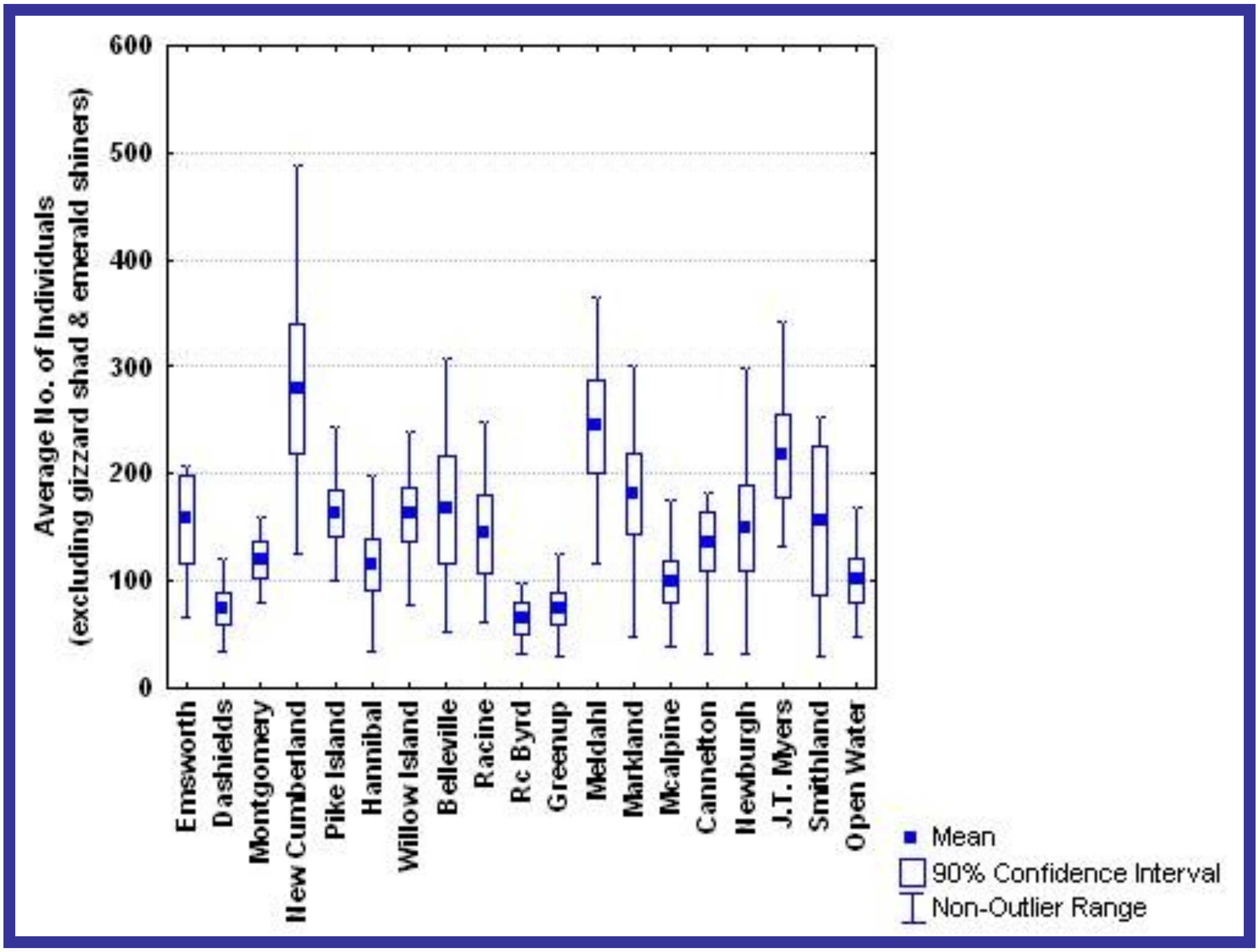

Figure 13. *The average number of individuals (excluding gizzard shad & emerald shiner) collected at each site within each pool surveyed as of 2009.*

6.4 Species Richness

Markland pool was similar to other surveyed pools in the average number of native species per site (18.4) and ranked 11th in comparison (Figure 12).

6.5 Number of Individuals

An average of 177.0 individuals (excluding gizzard shad and emerald shiner) was collected at each site in Markland pool which ranked 4th in comparison (Figure 13).

6.6 Noteworthy Fish Observations

One of the species collected in Markland pool was unique to the pool [suckermouth minnow (*Phenacobius mirabilis*)] during our random 2009 survey design. However, this species is commonly found in tributaries of the Ohio River. Several species were collected from this pool that are more commonly found in the lower portions of the Ohio River including shortnose gar and black buffalo.

In addition to our random sampling protocol, targeted sites were sampled within the pool during the field season. Several other species were found from these collections including river darters (*Percina shumardi*), and channel darters (*Percina copelandi)*; both of which were listed in Ohio as threatened. One other notable catch was a shortnose gar (*Lepisosteus platostomus*) collected from the mainstem of the Ohio which is considered to be endangered in Ohio.

6.7 Assessment of Condition

The average quality score in Markland pool was 3.8 and it was assessed as being in 'Good' condition. The nearest surveyed pool upstream (Meldahl) and downstream (McAlpine) of Markland pool were considerd to be in 'Very Good' and 'Good' condition respectively (Figure 14).

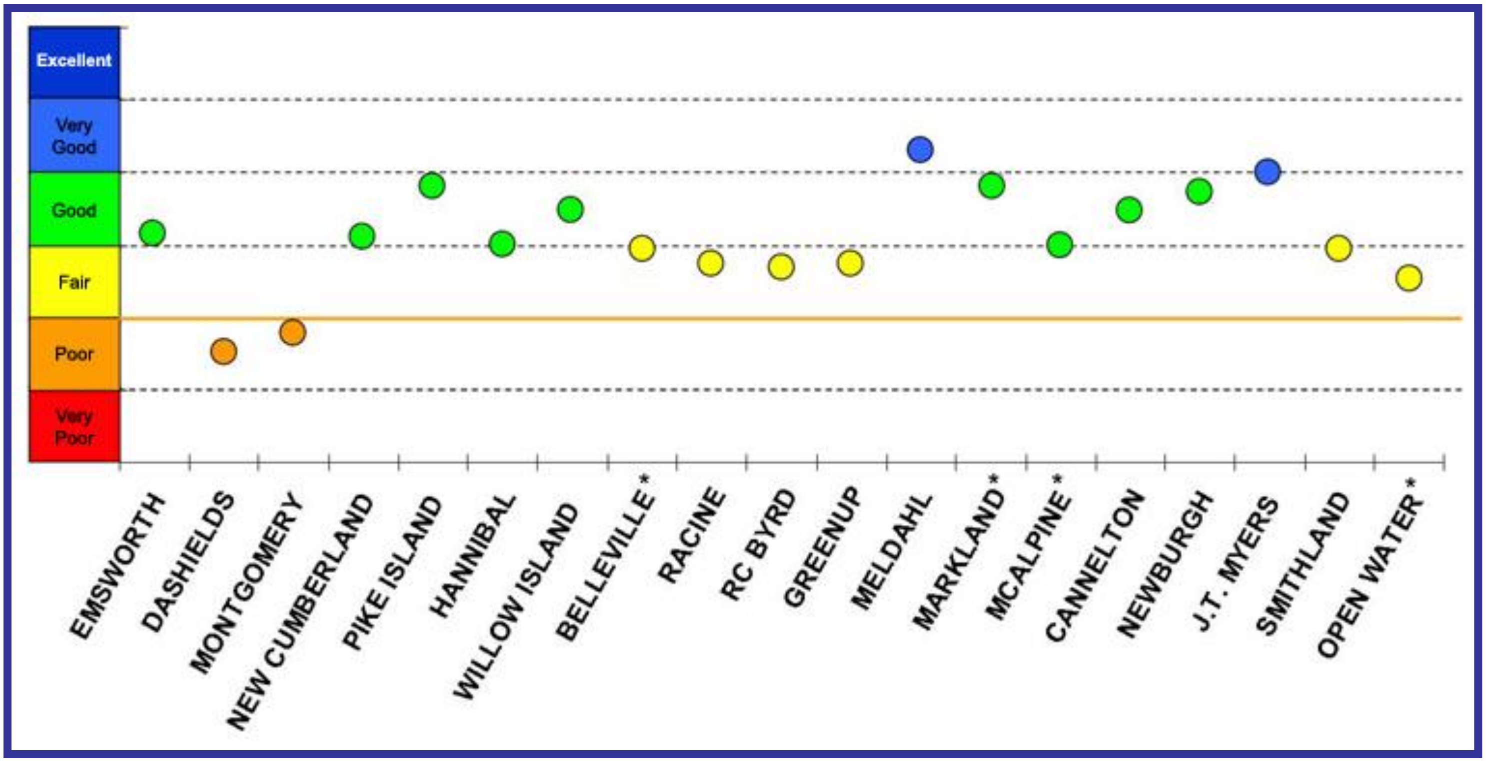

Figure 14*. The average quality score for each pool surveyed as of 2009 (* = pools surveyed in 2009). Data points are color-coded to indicate the biological condition of a pool.*

***Table 4**. A compiled species list containing the number of individuals collected per pool as of 2009*

#	Species	Emsworth 07	Dashields 08	Montgomery 06	New Cumberland 05	Pike Island 07	Hannibal 08	Willow Island 06	**Belleville 09**	Racine 05	R.C. Byrd 08	Greenup 06	Meldahl 07	**Markland 09**	**McAlpine 09**	Cannelton (30) 06-07	Newburgh 07	Myers 05	Smithland 08	**Open Water 09**
1	Ohio Lamprey								**1**											
2	Silver Lamprey											1							1	
3	Paddlefish																1			**1**
4	Spotted Gar																1		1	
5	Longnose Gar	13	11	10	11	43	49	46	**49**	24	27	23	22	**15**	**40**	48	20		16	**40**
6	Shortnose Gar													**1**	**1**		9	2	13	**75**
7	Goldeye																12		2	**4**
8	Mooneye	20	11	6	22	37	10		**4**	1	7		48	**9**	**10**	8	10	4		**1**
9	Skipjack Herring	8			3	6			**2**	1	2		64	**2**	**6**	174	70	249	1	**8**
10	Gizzard Shad	167	123	266	1202	7326	1461	216	**439**	8048	301	267	2408	**185**	**490**	3527	600	444	409	**325**
11	Threadfin Shad														**1**	1	9	112	25	**3**
12	Central Stoneroller				4		3	1												
13	Goldfish				1															
14	Grass Carp				1												1			**3**
15	Spotfin Shiner			1	21	14		24	**159**	63	1	2	32	**1**	**6**	63	8	12	4	**12**
16	Common Carp	63	36	44	25	15	15	22	**36**	9	12	9	8	**28**	**12**	5	4	10	17	**51**
17	Gravel Chub												1							
18	Miss. Silvery Minnow																	1		**1**
19	Silver Carp																2		4	**6**
20	Bighead Carp																2			**2**
21	Striped Shiner						2			2										
22	Silver Chub	26	26	12	20	11	19	57	**32**	44	11	33	90	**372**	**39**	130	126	206	47	**25**
23	River Chub				1	1														
24	Golden Shiner	1			1															
25	Emerald Shiner	82	5	8	342	197	21	728	**637**	795	16	50	637	**204**	**67**	1331	166	801	28	**25**
26	River Shiner	1											54	**12**	**10**	276	3	91	2	**9**

***Table 4**. A compiled species list containing the number of individuals collected per pool as of 2009*

#	Species	Emsworth 07	Dashields 08	Montgomery 06	New Cumberland 05	Pike Island 07	Hannibal 08	Willow Island 06	**Belleville 09**	Racine 05	R.C. Byrd 08	Greenup 06	Meldahl 07	**Markland 09**	**McAlpine 09**	Cannelton (30) 06-07	Newburgh 07	Myers 05	Smithland 08	**Open Water 09**
27	Silverjaw Minnow						1													
28	Spottail Shiner				6	2	1													
29	Silverband Shiner																			**6**
30	Sand Shiner								**1**											
31	Mimic Shiner	35	1	13	76	162	16	306	**795**	402	1	61	7	**45**	**30**	195	6	43		**8**
32	Suckerrmouth Minnow													**1**						
33	Bluntnose Minnow				2	2	4	120	**11**	3		1	1		**1**	2			1	
34	Fathead Minnow									6										
35	Bullhead Minnow							4	**1**	5			23	**9**	**1**			8	2	**19**
36	Creek Chub				1								3							
37	Ictiobinae Sp				20															
38	Carpiodes Sp		1			14			**3**	2			1			2				**1**
39	River Carpsucker	18	18	13	46	36	64	18	**12**	50	25	49	87	**85**	**88**	122	179	86	114	**218**
40	Quillback	17	12	30	80	27	28	66	**6**	16	8	17	31	**21**	**12**	21	34	57	28	**15**
41	Highfin Carpsucker			37	3	10	13	1	**1**	7		4			**18**	1	12	3	24	
42	Northern Hog Sucker	3	1	3	132	4	2	15	**3**		1			**1**	**2**	1	1			
43	Ictiobus Sp.						19													
44	Smallmouth Buffalo	97	99	217	283	94	45	60	**75**	96	40	49	123	**110**	**102**	147	72	314	77	**76**
45	Bigmouth Buffalo									1							3	7	5	**5**
46	Black Buffalo	1	13			5	1	2	**1**			1		**1**	**1**	1	7	3	4	**7**
47	Spotted Sucker							1		1		5	1			1			7	
48	Moxostoma Sp				58															
49	Silver Redhorse	221	93	157	63	78	105	51	**55**	11	11	12	25	**3**	**41**	3			1	

***Table 4**. A compiled species list containing the number of individuals collected per pool as of 2009*

#	Species	Emsworth 07	Dashields 08	Montgomery 06	New Cumberland 05	Pike Island 07	Hannibal 08	Willow Island 06	**Belleville 09**	Racine 05	R.C. Byrd 08	Greenup 06	Meldahl 07	**Markland 09**	**McAlpine 09**	Cannelton (30) 06-07	Newburgh 07	Myers 05	Smithland 08	**Open Water 09**
50	Smallmouth Redhorse	61	16	110	110	28	41	168	**97**	5	27	30	62	**38**	**66**	12	3	11		
51	Shorthead Redhorse																		10	
52	River Redhorse	39	13	3	5	27	35	2	**1**		2	6	1		**2**		1			
53	Black Redhorse	18			11			4	**2**							1				
54	Golden Redhorse	7	33	227	90	66	204	277	**115**	11	33	39	120	**219**	**194**	4	14		3	**1**
55	Brown Bullhead											1								
56	Blue Catfish																	1	7	**4**
57	Channel Catfish	32	17	34	123	40	62	61	**89**	70	53	58	89	**113**	**84**	48	11	330	291	**165**
58	Flathead Catfish	14	11	11	15	35	38	21	**27**	32	42	32	49	**24**	**11**	63	11	43	16	**15**
59	Muskellunge	1																		
60	Trout-Perch								**7**	3										
61	Banded Killifish							1												
62	Western Mosquitofish																			**1**
63	Brook Silverside									1						1	1	1	1	
64	Inland Silverside																		26	
65	Atlantic Needlefish																			**5**
66	Morone Sp	27		6	568	419	91	17	**35**	561	73	2	152	**44**	**63**	625	403	253	190	**31**
67	White Perch	5			4		1	3						**1**	**1**					**7**
68	White Bass	9	16	36	6	2	3	58	**41**	3	29	64	18	**19**	**26**	66	4	17	76	**54**
69	Yellow Bass																		2	**104**
70	Striped Bass						14	1								6		12	2	
71	Hybrid Striper			4	17			1	**3**	46	1			**15**	**6**	6		11	2	**45**
72	Rock Bass	16	9	8	5	1	2	3	**9**					**2**				1		
73	Lepomis Hybrid			1				9												
74	Lepomis Sp					1		16		1						2		2	1	

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75	Green Sunfish	12	3	2	4	2	2	4	**8**	6	6	4	3	**9**	**3**	2	4	10	1	**2**
76	Pumpkinseed			2			2	18	**1**					**1**						**1**
77	Warmouth							1					1	**2**	**1**			1		
78	Orangespotted Sunfish				1			2	**1**	1	1		1					2		**5**
79	Bluegill	379	32	216	53	46	36	232	**413**	58	52	112	207	**206**	**105**	103	11	31	64	**98**
80	Longear Sunfish						9	23	**18**	3	9	14	35	**149**	**91**	39	3	11	92	**110**
81	Redear Sunfish			4		1		1	**4**	1		1		**1**	**1**	16		1	20	
82	Micropterus Sp																		1	
83	Smallmouth Bass	339	163	185	262	208	92	61	**45**	6	32	7	4	**32**	**7**	7	1	4		**10**
84	Spotted Bass	125	34	15	79	74	38	62	**43**	22	30	43	90	**102**	**23**	53	49	104	31	**36**
85	Largemouth Bass	4	2	8	8	16		16	**72**	22	25	65	16	**25**	**11**	37	2	70	21	**23**
86	White Crappie	5	1						**3**		1	4		**2**		1	1			**13**
87	Black Crappie	3	1	6	2	2			**2**	3	1				**4**	3				**3**
88	Greenside Darter	5		2	11	5														
89	Rainbow Darter			4	1			2	**1**									12		
90	Fantail Darter	3		1									1							
91	Johnny Darter	1						2												
92	Banded Darter			1	4													1		
93	Yellow Perch			4	2		3		**2**											
94	Logperch	141	166	67	244	85	105	108	**48**	6	72	12	20	**24**	**7**	39	4	3	1	**1**
95	Channel Darter	16		1	9		1	3				20		**3**				1		
96	Slenderhead Darter													**1**				5		
97	Dusky Darter																	3	1	
98	River Darter					2		1	**2**	2		1	6	**7**	**1**	11		4		
99	Sauger	283	192	243	180	244	317	341	**133**	173	259	220	1174	**378**	**184**	1314	747	484	105	**127**
100	Walleye	44	7	11	31	70	11	1	**4**	4	1	1	3		**5**		7			**1**

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101	Saugeye	2	8		5	4	1		**1**	4	1			**13**				7	2	**16**
102	Freshwater Drum	254	58	47	1468	496	211	120	**33**	375	83	121	1000	**572**	**177**	435	378	612	837	**236**
	Total # of Individuals	2618	1232	2076	5742	9958	3198	3378	**3582**	11006	1296	1441	6718	**3107**	**2051**	8953	3013	4501	**2636**	**2060**
	Total # of Taxa	43	33	42	53	43	43	51	**50**	46	36	38	41	**45**	**44**	45	44	49	**49**	**52**

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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.

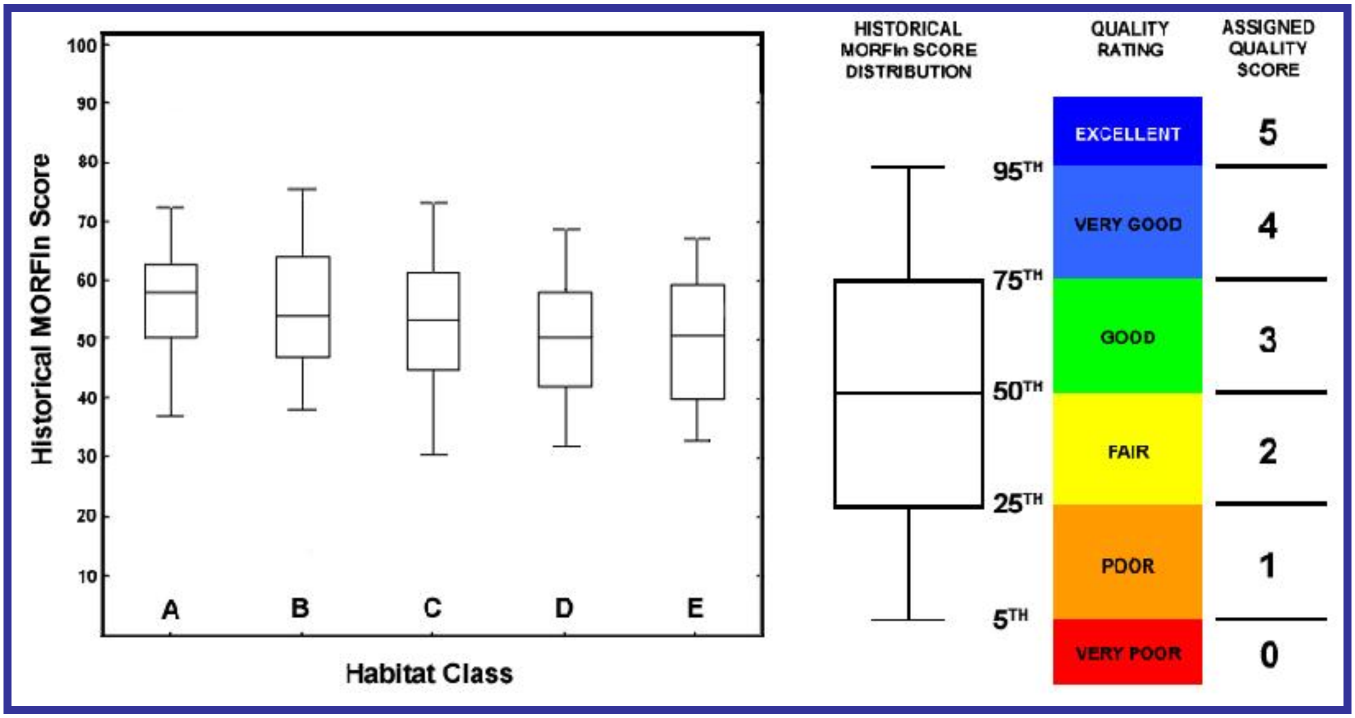
	Emsworth	Dashields	Montgomery	New Cumberland	Pike Island	Hannibal	Willow Island	Belleville	Racine	R. C. Byrd	Greenup	Meldahl	Markland	McAlpine	Cannelton	Newburgh	Uniontown	Smithland	Olmsted	Sites
2005				15					15				15				15			60
2006			15				15				15				11					56
2007	15				15							15			19	15				79
2008		15				15				15								15		60
2009								15					15	15					15	60
SUM	15	15	15	15	15	15	15	15	15	15	15	15	30	15	30	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 (see table below). These MORFIn expectations for each habitat are the 25th percentiles of historical MORFIn scores for each habitat.

Quality Score Constants	Class A	Class B	Class C	Class D	Class E
95th Percentile	72.53610	75.70669	73.19395	68.57603	67.26375
75th Percentile	62.59448	63.77092	61.13696	57.90023	59.17819
50th Percentile	55.97259	55.05460	52.23313	49.71604	50.53237
25th Percentile	50.03279	46.71055	44.54931	41.80374	39.59005
5th Percentile	36.62273	37.89377	30.12705	31.55379	32.57287

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

- Those sites with MORFIn scores less than the 25th 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 Markland pool.

Site #	Rmi	Bank	Date	Common Name	Latin Name	Count
1	438.3	LDB	09-Sep-09	Bluegill	*Lepomis macrochirus*	4
1	438.3	LDB	09-Sep-09	Channel Catfish	*Ictalurus punctatus*	12
1	438.3	LDB	09-Sep-09	Channel Darter	*Percina copelandi*	3
1	438.3	LDB	09-Sep-09	Emerald Shiner	*Notropis atherinoides*	7
1	438.3	LDB	09-Sep-09	Flathead Catfish	*Pylodictis olivaris*	1
1	438.3	LDB	09-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	11
1	438.3	LDB	09-Sep-09	Green Sunfish	*Lepomis cyanellus*	4
1	438.3	LDB	09-Sep-09	Logperch	*Percina caprodes*	5
1	438.3	LDB	09-Sep-09	Mimic Shiner	*Notropis volucellus*	24
1	438.3	LDB	09-Sep-09	Quillback	*Carpiodes cyprinus*	1
1	438.3	LDB	09-Sep-09	River Carpsucker	*Carpiodes carpio*	2
1	438.3	LDB	09-Sep-09	River Darter	*Percina shumardi*	2
1	438.3	LDB	09-Sep-09	Sauger	*Sander canadensis*	24
1	438.3	LDB	09-Sep-09	Silver Chub	*Macrhybopsis storeriana*	10
1	438.3	LDB	09-Sep-09	Slenderhead Darter	*Percina phoxocephala*	1
1	438.3	LDB	09-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	1
1	438.3	LDB	09-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	13
1	438.3	LDB	09-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	13
1	438.3	LDB	09-Sep-09	White Bass	*Morone chrysops*	1
2	445.7	LDB	09-Sep-09	Channel Catfish	*Ictalurus punctatus*	2
2	445.7	LDB	09-Sep-09	Emerald Shiner	*Notropis atherinoides*	6
2	445.7	LDB	09-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	10
2	445.7	LDB	09-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	8
2	445.7	LDB	09-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	1
2	445.7	LDB	09-Sep-09	Longnose Gar	*Lepisosteus osseus*	6
2	445.7	LDB	09-Sep-09	Mimic Shiner	*Notropis volucellus*	1
2	445.7	LDB	09-Sep-09	Mooneye	*Hiodon tergisus*	3
2	445.7	LDB	09-Sep-09	Morone Sp	*Morone sp*	2
2	445.7	LDB	09-Sep-09	Quillback	*Carpiodes cyprinus*	7
2	445.7	LDB	09-Sep-09	River Carpsucker	*Carpiodes carpio*	4
2	445.7	LDB	09-Sep-09	River Shiner	*Notropis blennius*	2
2	445.7	LDB	09-Sep-09	Sauger	*Sander canadensis*	13
2	445.7	LDB	09-Sep-09	Silver Chub	*Macrhybopsis storeriana*	1
2	445.7	LDB	09-Sep-09	Silver Redhorse	*Moxostoma anisurum*	2
2	445.7	LDB	09-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	1
2	445.7	LDB	09-Sep-09	Spotted Bass	*Micropterus punctulatus*	2
3	458.2	LDB	15-Sep-09	Channel Catfish	*Ictalurus punctatus*	3
3	458.2	LDB	15-Sep-09	Emerald Shiner	*Notropis atherinoides*	70
3	458.2	LDB	15-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	8
3	458.2	LDB	15-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	14
3	458.2	LDB	15-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	2
3	458.2	LDB	15-Sep-09	Longnose Gar	*Lepisosteus osseus*	3
3	458.2	LDB	15-Sep-09	Mimic Shiner	*Notropis volucellus*	3
3	458.2	LDB	15-Sep-09	Morone Sp	*Morone sp*	2
3	458.2	LDB	15-Sep-09	Quillback	*Carpiodes cyprinus*	2
3	458.2	LDB	15-Sep-09	Sauger	*Sander canadensis*	10
3	458.2	LDB	15-Sep-09	Saugeye	*Sander canandensis x S. vitreus*	1

3	458.2	LDB	15-Sep-09	Silver Chub	*Macrhybopsis storeriana*	13
3	458.2	LDB	15-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	1
3	458.2	LDB	15-Sep-09	White Bass	*Morone chrysops*	1
4	469.2	LDB	15-Sep-09	Bluegill	*Lepomis macrochirus*	3
4	469.2	LDB	15-Sep-09	Channel Catfish	*Ictalurus punctatus*	11
4	469.2	LDB	15-Sep-09	Common Carp	*Cyprinus carpio*	2
4	469.2	LDB	15-Sep-09	Emerald Shiner	*Notropis atherinoides*	11
4	469.2	LDB	15-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	38
4	469.2	LDB	15-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	6
4	469.2	LDB	15-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	10
4	469.2	LDB	15-Sep-09	Green Sunfish	*Lepomis cyanellus*	1
4	469.2	LDB	15-Sep-09	Hybrid Striper	*Morone saxatilis x M. chrysops*	2
4	469.2	LDB	15-Sep-09	Largemouth Bass	*Micropterus salmoides*	1
4	469.2	LDB	15-Sep-09	Longear Sunfish	*Lepomis megalotis*	5
4	469.2	LDB	15-Sep-09	Morone Sp	*Morone sp*	1
4	469.2	LDB	15-Sep-09	River Carpsucker	*Carpiodes carpio*	3
4	469.2	LDB	15-Sep-09	Sauger	*Sander canadensis*	9
4	469.2	LDB	15-Sep-09	Silver Chub	*Macrhybopsis storeriana*	28
4	469.2	LDB	15-Sep-09	Skipjack Herring	*Alosa chrysochloris*	1
4	469.2	LDB	15-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	6
4	469.2	LDB	15-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	10
4	469.2	LDB	15-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	1
4	469.2	LDB	15-Sep-09	Spotted Bass	*Micropterus punctulatus*	1
4	469.2	LDB	15-Sep-09	White Bass	*Morone chrysops*	2
5	473	RDB	21-Sep-09	Bluegill	*Lepomis macrochirus*	1
5	473	RDB	21-Sep-09	Channel Catfish	*Ictalurus punctatus*	5
5	473	RDB	21-Sep-09	Common Carp	*Cyprinus carpio*	8
5	473	RDB	21-Sep-09	Emerald Shiner	*Notropis atherinoides*	4
5	473	RDB	21-Sep-09	Flathead Catfish	*Pylodictis olivaris*	4
5	473	RDB	21-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	18
5	473	RDB	21-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	11
5	473	RDB	21-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	21
5	473	RDB	21-Sep-09	Green Sunfish	*Lepomis cyanellus*	1
5	473	RDB	21-Sep-09	Hybrid Striper	*Morone saxatilis x M. chrysops*	1
5	473	RDB	21-Sep-09	Logperch	*Percina caprodes*	10
5	473	RDB	21-Sep-09	Longear Sunfish	*Lepomis megalotis*	1
5	473	RDB	21-Sep-09	Longnose Gar	*Lepisosteus osseus*	2
5	473	RDB	21-Sep-09	Mooneye	*Hiodon tergisus*	2
5	473	RDB	21-Sep-09	Morone Sp	*Morone sp*	2
5	473	RDB	21-Sep-09	Northern Hog Sucker	*Hypentelium nigricans*	1
5	473	RDB	21-Sep-09	River Carpsucker	*Carpiodes carpio*	4
5	473	RDB	21-Sep-09	River Darter	*Percina shumardi*	5
5	473	RDB	21-Sep-09	River Shiner	*Notropis blennius*	3
5	473	RDB	21-Sep-09	Sauger	*Sander canadensis*	30
5	473	RDB	21-Sep-09	Saugeye	*Sander canandensis x S. vitreus*	1
5	473	RDB	21-Sep-09	Shortnose Gar	*Lepisosteus platostomus*	1
5	473	RDB	21-Sep-09	Silver Chub	*Macrhybopsis storeriana*	9
5	473	RDB	21-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	8
5	473	RDB	21-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	5
5	473	RDB	21-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	12

5	473	RDB	21-Sep-09	Spotted Bass	*Micropterus punctulatus*	7
5	473	RDB	21-Sep-09	White Bass	*Morone chrysops*	3
6	477.7	RDB	21-Sep-09	Channel Catfish	*Ictalurus punctatus*	1
6	477.7	RDB	21-Sep-09	Emerald Shiner	*Notropis atherinoides*	17
6	477.7	RDB	21-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	33
6	477.7	RDB	21-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	25
6	477.7	RDB	21-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	5
6	477.7	RDB	21-Sep-09	Mimic Shiner	*Notropis volucellus*	1
6	477.7	RDB	21-Sep-09	Rock Bass	*Ambloplites rupestris*	1
6	477.7	RDB	21-Sep-09	Sauger	*Sander canadensis*	7
6	477.7	RDB	21-Sep-09	Saugeye	*Sander canandensis x S. vitreus*	10
6	477.7	RDB	21-Sep-09	Silver Chub	*Macrhybopsis storeriana*	33
6	477.7	RDB	21-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	1
6	477.7	RDB	21-Sep-09	Spotted Bass	*Micropterus punctulatus*	3
6	477.7	RDB	21-Sep-09	White Perch	*Morone americana*	1
7	487.3	LDB	21-Sep-09	Bluegill	*Lepomis macrochirus*	1
7	487.3	LDB	21-Sep-09	Bullhead Minnow	*Pimephales vigilax*	1
7	487.3	LDB	21-Sep-09	Channel Catfish	*Ictalurus punctatus*	2
7	487.3	LDB	21-Sep-09	Emerald Shiner	*Notropis atherinoides*	39
7	487.3	LDB	21-Sep-09	Flathead Catfish	*Pylodictis olivaris*	1
7	487.3	LDB	21-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	63
7	487.3	LDB	21-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	6
7	487.3	LDB	21-Sep-09	Hybrid Striper	*Morone saxatilis x M. chrysops*	1
7	487.3	LDB	21-Sep-09	Logperch	*Percina caprodes*	1
7	487.3	LDB	21-Sep-09	Longear Sunfish	*Lepomis megalotis*	1
7	487.3	LDB	21-Sep-09	Longnose Gar	*Lepisosteus osseus*	1
7	487.3	LDB	21-Sep-09	Mimic Shiner	*Notropis volucellus*	12
7	487.3	LDB	21-Sep-09	Morone Sp	*Morone sp*	2
7	487.3	LDB	21-Sep-09	River Shiner	*Notropis blennius*	1
7	487.3	LDB	21-Sep-09	Sauger	*Sander canadensis*	10
7	487.3	LDB	21-Sep-09	Silver Chub	*Macrhybopsis storeriana*	34
7	487.3	LDB	21-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	1
7	487.3	LDB	21-Sep-09	White Bass	*Morone chrysops*	1
8	490.1	LDB	21-Sep-09	Bluegill	*Lepomis macrochirus*	3
8	490.1	LDB	21-Sep-09	Bullhead Minnow	*Pimephales vigilax*	4
8	490.1	LDB	21-Sep-09	Channel Catfish	*Ictalurus punctatus*	4
8	490.1	LDB	21-Sep-09	Common Carp	*Cyprinus carpio*	2
8	490.1	LDB	21-Sep-09	Emerald Shiner	*Notropis atherinoides*	16
8	490.1	LDB	21-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	22
8	490.1	LDB	21-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	28
8	490.1	LDB	21-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	87
8	490.1	LDB	21-Sep-09	Hybrid Striper	*Morone saxatilis x M. chrysops*	3
8	490.1	LDB	21-Sep-09	Largemouth Bass	*Micropterus salmoides*	1
8	490.1	LDB	21-Sep-09	Logperch	*Percina caprodes*	4
8	490.1	LDB	21-Sep-09	Longear Sunfish	*Lepomis megalotis*	12
8	490.1	LDB	21-Sep-09	Mimic Shiner	*Notropis volucellus*	3
8	490.1	LDB	21-Sep-09	Mooneye	*Hiodon tergisus*	1
8	490.1	LDB	21-Sep-09	Morone Sp	*Morone sp*	6
8	490.1	LDB	21-Sep-09	Pumpkinseed	*Lepomis gibbosus*	1
8	490.1	LDB	21-Sep-09	River Carpsucker	*Carpiodes carpio*	2

8	490.1	LDB	21-Sep-09	River Shiner	*Notropis blennius*	5
8	490.1	LDB	21-Sep-09	Sauger	*Sander canadensis*	28
8	490.1	LDB	21-Sep-09	Silver Chub	*Macrhybopsis storeriana*	32
8	490.1	LDB	21-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	8
8	490.1	LDB	21-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	3
8	490.1	LDB	21-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	3
8	490.1	LDB	21-Sep-09	Spotted Bass	*Micropterus punctulatus*	4
8	490.1	LDB	21-Sep-09	Suckermouth Minnow	*Phenacobius mirabilis*	1
9	508.9	LDB	17-Sep-09	Bluegill	*Lepomis macrochirus*	6
9	508.9	LDB	17-Sep-09	Bullhead Minnow	*Pimephales vigilax*	2
9	508.9	LDB	17-Sep-09	Channel Catfish	*Ictalurus punctatus*	6
9	508.9	LDB	17-Sep-09	Common Carp	*Cyprinus carpio*	3
9	508.9	LDB	17-Sep-09	Emerald Shiner	*Notropis atherinoides*	8
9	508.9	LDB	17-Sep-09	Flathead Catfish	*Pylodictis olivaris*	2
9	508.9	LDB	17-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	39
9	508.9	LDB	17-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	1
9	508.9	LDB	17-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	11
9	508.9	LDB	17-Sep-09	Hybrid Striper	*Morone saxatilis x M. chrysops*	2
9	508.9	LDB	17-Sep-09	Largemouth Bass	*Micropterus salmoides*	3
9	508.9	LDB	17-Sep-09	Longear Sunfish	*Lepomis megalotis*	2
9	508.9	LDB	17-Sep-09	Longnose Gar	*Lepisosteus osseus*	1
9	508.9	LDB	17-Sep-09	Morone Sp	*Morone sp*	5
9	508.9	LDB	17-Sep-09	Quillback	*Carpiodes cyprinus*	2
9	508.9	LDB	17-Sep-09	River Carpsucker	*Carpiodes carpio*	17
9	508.9	LDB	17-Sep-09	Sauger	*Sander canadensis*	38
9	508.9	LDB	17-Sep-09	Silver Chub	*Macrhybopsis storeriana*	29
9	508.9	LDB	17-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	1
9	508.9	LDB	17-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	3
9	508.9	LDB	17-Sep-09	Spotted Bass	*Micropterus punctulatus*	1
9	508.9	LDB	17-Sep-09	White Bass	*Morone chrysops*	3
10	511.9	RDB	17-Sep-09	Bluegill	*Lepomis macrochirus*	28
10	511.9	RDB	17-Sep-09	Bullhead Minnow	*Pimephales vigilax*	1
10	511.9	RDB	17-Sep-09	Channel Catfish	*Ictalurus punctatus*	6
10	511.9	RDB	17-Sep-09	Emerald Shiner	*Notropis atherinoides*	5
10	511.9	RDB	17-Sep-09	Flathead Catfish	*Pylodictis olivaris*	1
10	511.9	RDB	17-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	48
10	511.9	RDB	17-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	1
10	511.9	RDB	17-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	13
10	511.9	RDB	17-Sep-09	Largemouth Bass	*Micropterus salmoides*	5
10	511.9	RDB	17-Sep-09	Longear Sunfish	*Lepomis megalotis*	11
10	511.9	RDB	17-Sep-09	Longnose Gar	*Lepisosteus osseus*	1
10	511.9	RDB	17-Sep-09	Mooneye	*Hiodon tergisus*	2
10	511.9	RDB	17-Sep-09	Morone Sp	*Morone sp*	2
10	511.9	RDB	17-Sep-09	River Carpsucker	*Carpiodes carpio*	15
10	511.9	RDB	17-Sep-09	Sauger	*Sander canadensis*	34
10	511.9	RDB	17-Sep-09	Silver Chub	*Macrhybopsis storeriana*	29
10	511.9	RDB	17-Sep-09	Silver Redhorse	*Moxostoma anisurum*	1
10	511.9	RDB	17-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	2
10	511.9	RDB	17-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	6
10	511.9	RDB	17-Sep-09	Spotted Bass	*Micropterus punctulatus*	8

10	511.9	RDB	17-Sep-09	White Bass	*Morone chrysops*	1
11	519	LDB	22-Sep-09	Bluegill	*Lepomis macrochirus*	37
11	519	LDB	22-Sep-09	Channel Catfish	*Ictalurus punctatus*	10
11	519	LDB	22-Sep-09	Common Carp	*Cyprinus carpio*	1
11	519	LDB	22-Sep-09	Emerald Shiner	*Notropis atherinoides*	12
11	519	LDB	22-Sep-09	Flathead Catfish	*Pylodictis olivaris*	3
11	519	LDB	22-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	91
11	519	LDB	22-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	20
11	519	LDB	22-Sep-09	Largemouth Bass	*Micropterus salmoides*	10
11	519	LDB	22-Sep-09	Logperch	*Percina caprodes*	1
11	519	LDB	22-Sep-09	Longear Sunfish	*Lepomis megalotis*	8
11	519	LDB	22-Sep-09	Longnose Gar	*Lepisosteus osseus*	1
11	519	LDB	22-Sep-09	Mimic Shiner	*Notropis volucellus*	1
11	519	LDB	22-Sep-09	Morone Sp	*Morone sp*	6
11	519	LDB	22-Sep-09	Quillback	*Carpiodes cyprinus*	1
11	519	LDB	22-Sep-09	Redear Sunfish	*Lepomis microlophus*	1
11	519	LDB	22-Sep-09	River Carpsucker	*Carpiodes carpio*	13
11	519	LDB	22-Sep-09	Sauger	*Sander canadensis*	46
11	519	LDB	22-Sep-09	Silver Chub	*Macrhybopsis storeriana*	60
11	519	LDB	22-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	15
11	519	LDB	22-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	2
11	519	LDB	22-Sep-09	Spotted Bass	*Micropterus punctulatus*	10
11	519	LDB	22-Sep-09	Warmouth	*Lepomis gulosus*	1
11	519	LDB	22-Sep-09	White Bass	*Morone chrysops*	2
11	519	LDB	22-Sep-09	White Crappie	*Pomoxis annularis*	1
12	520	RDB	22-Sep-09	Bluegill	*Lepomis macrochirus*	32
12	520	RDB	22-Sep-09	Channel Catfish	*Ictalurus punctatus*	31
12	520	RDB	22-Sep-09	Emerald Shiner	*Notropis atherinoides*	1
12	520	RDB	22-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	36
12	520	RDB	22-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	29
12	520	RDB	22-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	31
12	520	RDB	22-Sep-09	Hybrid Striper	*Morone saxatilis x M. chrysops*	6
12	520	RDB	22-Sep-09	Largemouth Bass	*Micropterus salmoides*	4
12	520	RDB	22-Sep-09	Longear Sunfish	*Lepomis megalotis*	12
12	520	RDB	22-Sep-09	Morone Sp	*Morone sp*	5
12	520	RDB	22-Sep-09	Quillback	*Carpiodes cyprinus*	2
12	520	RDB	22-Sep-09	River Carpsucker	*Carpiodes carpio*	2
12	520	RDB	22-Sep-09	River Shiner	*Notropis blennius*	1
12	520	RDB	22-Sep-09	Rock Bass	*Ambloplites rupestris*	1
12	520	RDB	22-Sep-09	Sauger	*Sander canadensis*	33
12	520	RDB	22-Sep-09	Silver Chub	*Macrhybopsis storeriana*	24
12	520	RDB	22-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	4
12	520	RDB	22-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	10
12	520	RDB	22-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	4
12	520	RDB	22-Sep-09	Spotted Bass	*Micropterus punctulatus*	5
12	520	RDB	22-Sep-09	White Bass	*Morone chrysops*	4
13	527	LDB	23-Sep-09	Black Buffalo	*Ictiobus niger*	1
13	527	LDB	23-Sep-09	Bluegill	*Lepomis macrochirus*	10
13	527	LDB	23-Sep-09	Channel Catfish	*Ictalurus punctatus*	3
13	527	LDB	23-Sep-09	Common Carp	*Cyprinus carpio*	4

13	527	LDB	23-Sep-09	Flathead Catfish	*Pylodictis olivaris*	4
13	527	LDB	23-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	52
13	527	LDB	23-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	2
13	527	LDB	23-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	6
13	527	LDB	23-Sep-09	Logperch	*Percina caprodes*	2
13	527	LDB	23-Sep-09	Longear Sunfish	*Lepomis megalotis*	11
13	527	LDB	23-Sep-09	Quillback	*Carpiodes cyprinus*	2
13	527	LDB	23-Sep-09	River Carpsucker	*Carpiodes carpio*	11
13	527	LDB	23-Sep-09	Sauger	*Sander canadensis*	39
13	527	LDB	23-Sep-09	Silver Chub	*Macrhybopsis storeriana*	29
13	527	LDB	23-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	1
13	527	LDB	23-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	7
13	527	LDB	23-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	2
13	527	LDB	23-Sep-09	Spotfin Shiner	*Cyprinella spiloptera*	1
13	527	LDB	23-Sep-09	Spotted Bass	*Micropterus punctulatus*	2
14	529	LDB	23-Sep-09	Bluegill	*Lepomis macrochirus*	13
14	529	LDB	23-Sep-09	Bullhead Minnow	*Pimephales vigilax*	1
14	529	LDB	23-Sep-09	Channel Catfish	*Ictalurus punctatus*	10
14	529	LDB	23-Sep-09	Common Carp	*Cyprinus carpio*	4
14	529	LDB	23-Sep-09	Emerald Shiner	*Notropis atherinoides*	3
14	529	LDB	23-Sep-09	Flathead Catfish	*Pylodictis olivaris*	3
14	529	LDB	23-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	82
14	529	LDB	23-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	42
14	529	LDB	23-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	1
14	529	LDB	23-Sep-09	Largemouth Bass	*Micropterus salmoides*	1
14	529	LDB	23-Sep-09	Longear Sunfish	*Lepomis megalotis*	4
14	529	LDB	23-Sep-09	Mooneye	*Hiodon tergisus*	1
14	529	LDB	23-Sep-09	Morone Sp	*Morone sp*	7
14	529	LDB	23-Sep-09	Quillback	*Carpiodes cyprinus*	4
14	529	LDB	23-Sep-09	River Carpsucker	*Carpiodes carpio*	8
14	529	LDB	23-Sep-09	Sauger	*Sander canadensis*	44
14	529	LDB	23-Sep-09	Saugeye	*Sander canandensis x S. vitreus*	1
14	529	LDB	23-Sep-09	Silver Chub	*Macrhybopsis storeriana*	38
14	529	LDB	23-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	13
14	529	LDB	23-Sep-09	Smallmouth Redhorse	*Moxostoma breviceps*	1
14	529	LDB	23-Sep-09	Spotted Bass	*Micropterus punctulatus*	2
14	529	LDB	23-Sep-09	White Bass	*Morone chrysops*	1
14	529	LDB	23-Sep-09	White Crappie	*Pomoxis annularis*	1
15	531	RDB	23-Sep-09	Bluegill	*Lepomis macrochirus*	68
15	531	RDB	23-Sep-09	Channel Catfish	*Ictalurus punctatus*	7
15	531	RDB	23-Sep-09	Common Carp	*Cyprinus carpio*	4
15	531	RDB	23-Sep-09	Emerald Shiner	*Notropis atherinoides*	5
15	531	RDB	23-Sep-09	Flathead Catfish	*Pylodictis olivaris*	5
15	531	RDB	23-Sep-09	Freshwater Drum	*Aplodinotus grunniens*	21
15	531	RDB	23-Sep-09	Gizzard Shad	*Dorosoma cepedianum*	18
15	531	RDB	23-Sep-09	Golden Redhorse	*Moxostoma erythrurum*	5
15	531	RDB	23-Sep-09	Green Sunfish	*Lepomis cyanellus*	3
15	531	RDB	23-Sep-09	Logperch	*Percina caprodes*	1
15	531	RDB	23-Sep-09	Longear Sunfish	*Lepomis megalotis*	82
15	531	RDB	23-Sep-09	Morone Sp	*Morone sp*	4

15	531	RDB	23-Sep-09	River Carpsucker	*Carpiodes carpio*	4
15	531	RDB	23-Sep-09	Sauger	*Sander canadensis*	13
15	531	RDB	23-Sep-09	Silver Chub	*Macrhybopsis storeriana*	3
15	531	RDB	23-Sep-09	Skipjack Herring	*Alosa chrysochloris*	1
15	531	RDB	23-Sep-09	Smallmouth Bass	*Micropterus dolomieu*	1
15	531	RDB	23-Sep-09	Smallmouth Buffalo	*Ictiobus bubalus*	21
15	531	RDB	23-Sep-09	Spotted Bass	*Micropterus punctulatus*	57
15	531	RDB	23-Sep-09	Warmouth	*Lepomis gulosus*	1
15	531	RDB	23-Sep-09	Warmouth	*Lepomis gulosus*	1

Appendix C. Habitat survey data from the Markland pool.

Site #	River Mile	Bank	% Boulder	% Cobble	% Gravel	% Sand	% Fine	% Hardpan	% Other	Depth	% Submerged Vegetation	% Woody Cover	% Overhanging Vegetation	Landuse	Human Influence	Bank Profile
1	438.3	LDB	19.3	33.0	34.9	12.8	0.0	0.0	0.0	12.1	0.0	0.0	0.0	NF, R, A	ramps, mooring cells	Slope
2	445.7	LDB	2.9	1.5	20.6	41.2	33.8	0.0	0.0	6.3	0.0	0.2	0.0	NF, R, A	ramps	Slope
3	458.2	LDB	0.0	0.0	3.0	48.9	47.4	0.7	0.0	7.7	0.0	0.2	2.0	NF, R, A	barges, mooring cells. boats/docks, ramps	Slope
4	469.2	LDB	12.2	8.1	12.2	33.3	30.9	3.3	0.0	10.1	0.0	0.6	0.0	U, NF, R	boats/docks, ramps	Slope
5	473	RDB	26.4	33.0	33.0	5.7	0.9	0.0	0.9	9.5	0.0	1.3	0.0	U, NF, R	ramps, barges, mooring cells, boats/docks	Slope
6	477.7	RDB	0.0	0.0	0.0	35.5	52.7	11.8	0.0	10.3	0.0	1.8	0.0	NF, R, I	barges, boats/docks, mooring cells, ramps	Slope
7	487.5	LDB	0.0	0.0	0.0	90.2	9.8	0.0	0.0		0.0	1.2	4.3	NF, R	boats/docks	Steep
8	490.1	LDB	8.8	35.2	23.1	28.6	3.3	1.1	0.0	12.7	0.0	2.0	2.0	NF, A, I	barges, mooring cells	Slope
9	508.9	LDB	0.0	0.0	0.0	19.6	76.8	3.6	0.0	11.6	0.0	5.4	5.0	NF, A, R	ramps	Slope
10	511.9	RDB	0.0	3.9	1.3	11.7	80.5	2.6	0.0	7.1	0.0	9.4	2.4	NF, A, I	barges, mooring cells	Slope
11	519	LDB	0.0	0.0	0.8	43.7	51.6	0.8	3.2	5.9	0.0	21.8	0.0	NF, A, R	boats/docks, ramps	Steep
12	520	RDB	6.6	19.8	35.5	21.5	14.0	1.7	0.8	10.0	0.0	4.7	5.0	NF, A, R	boats/docks, ramps	Steep
13	527	LDB	3.8	4.7	8.5	28.3	48.1	2.8	3.8	7.5	0.0	5.2	0.0	NF, R, A	boats/docks	Slope
14	529	LDB	1.4	1.4	0.0	6.8	89.0	0.0	1.4	3.4	0.0	10.8	0.0	NF, R, A	boats/docks, ramps	Steep
15	531	RDB	0.0	0.0	0.8	47.5	51.6	0.0	0.0	8.5	0.0	21.0	0.0	NF, R	boats/docks, ramps	Flat

A = Agriculture, I = Industry, NF = Natural Forest, P = Pasture, R = Residential, U = Urban (Listed in order of prevalence.)

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

Site #	Rmi	Bank	pH	Temp(C)	Dissolved Oxygen(mg/L)	Conductivity	Secchi(in)
1	438.3	LDB	7.69	26.1	8.01	460	24
2	445.7	LDB	7.08	24.4	7.42	456	24
3	458.2	LDB	7.64	26.2	8.82	460	36
4	469.2	LDB	9.2	26.2	8.32	475	36
5	473	RDB	–	25.2	7.53	420	30
6	477.7	RDB	–	25.1	7.18	465	30
7	487.3	LDB	–	24.9	7.04	475	24
8	490.1	LDB	8.24	24.9	6.77	460	24
9	508.9	LDB	7.3	25.3	6.57	420	30
10	511.9	RDB	7.54	25.5	6.95	476	30
11	519	LDB	8.48	25.7	6.33	497	30
12	520	RDB	8.48	25.7	6.33	497	30
13	527	LDB	6.3	24.9	5.72	504	24
14	529	LDB	7.6	25.2	4.81	493	18
15	531	RDB	6.72	24.9	4.95	500	18

Appendix E. Water quality parameters analyzed from Markland in 2009.

Site #	River Mile	Round	Ammonia	Chloride	Hardness	Nitrate-Nitrite	Sulfate	TKN	TOC	Phosphorus	TSS
1	438.3	1	0.05	28.0	128	0.805	78	0.490	3.90	0.030	8.54
		2	0.07	20.0	180	0.690	64	0.926	7.02	0.167	108
		3	0.03	29	144	0.926	82	0.693	4.06	0.073	23.0
2	445.7	1	0.05	28.0	140	0.770	100	0.489	3.66	0.024	6.54
		2	0.07	22.0	128	0.709	74	0.841	7.64	0.212	109
		3	<0.03	30	136	0.928	84	0.659	3.95	0.060	12.2
3	458.2	1	0.05	26.0	128	0.704	82	0.464	3.09	0.026	8.54
		2	0.08	22.0	192	0.691	70	0.937	6.97	0.216	148
		3	<0.03	30	136	0.904	80	0.633	4.15	0.057	10.8
4	469.2	1	0.05	24.0	160	0.726	96	0.497	3.20	0.044	13.3
		2	0.07	24.0	164	0.712	72	0.908	6.95	0.211	157
		3	<0.03	31	136	0.947	76	0.641	4.24	0.074	17.0
5	473	1	0.08	28.0	132	0.717	62	0.462	3.32	0.042	9.82
		2	0.08	20.0	124	0.790	66	0.862	7.24	0.231	146
		3	0.08	30	132	0.879	76	0.754	4.20	0.080	11.5
6	477.7	1	0.11	30.0	144	0.734	86	0.494	3.59	0.058	14.2
		2	0.07	24.0	148	0.715	62	0.873	7.80	0.252	144
		3	0.07	29	136	0.911	78	0.641	4.36	0.089	32.2
7	487.5	1	0.07	24.0	160	1.03	82	0.494	3.45	0.063	11.1
		2	0.08	22.0	136	0.751	64	1.23	7.86	0.329	346
		3	0.06	30	132	0.903	74	0.740	4.41	0.103	27.2
8	490.1	1	0.11	28.0	144	0.829	88	0.534	3.12	0.054	10.4
		2	0.07	26.0	156	0.750	48	0.840	7.20	0.212	127
		3	0.05	20	132	0.922	70	0.775	4.49	0.079	21.4
9	508.9	1	0.16	34.0	164	0.877	84	0.780	4.49	0.072	12.4
		2	0.07	22.0	192	0.769	54	1.76	8.86	0.580	460
		3	0.07	32	144	1.01	70	0.707	4.72	0.153	31.0
10	511.9	1	0.16	32.0	176	0.869	54	0.545	4.25	0.057	6.36
		2	0.09	24.0	172	0.756	58	1.19	7.69	0.435	259
		3	0.08	34	136	1.02	74	0.705	4.37	0.116	17.0
11	519	1	0.13	18.0	160	0.953	84	0.516	3.84	0.061	7.82
		2	0.09	20.0	156	0.746	60	1.44	9.13	0.519	242
		3	0.04	32	136	1.07	80	0.584	4.57	0.135	33.3
12	520	1	0.14	34.0	164	0.927	42	0.571	3.84	0.067	7.64
		2	0.08	28.0	132	0.736	60	0.927	8.25	0.284	138
		3	0.07	34	140	0.973	78	0.715	5.85	0.100	13.0
13	527	1	0.10	26.0	156	1.02	64	0.570	4.13	0.084	12.0
		2	0.08	28.0	184	0.702	68	1.01	7.90	0.284	246
		3	0.05	30	140	1.01	78	0.577	4.25	0.127	31.7
14	529	1	0.07	28.0	156	1.01	92	0.589	3.92	0.081	8.91
		2	0.07	24.0	144	0.719	78	1.12	7.71	0.364	206
		3	0.04	36	140	0.966	48	0.637	4.61	0.120	20.3
15	531	1	0.12	30.0	140	0.819	98	0.489	4.06	0.064	14.7
		2	0.08	24.0	176	0.726	68	0.889	7.82	0.265	139
		3	0.04	28	132	0.885	76	0.680	4.90	0.105	14.6