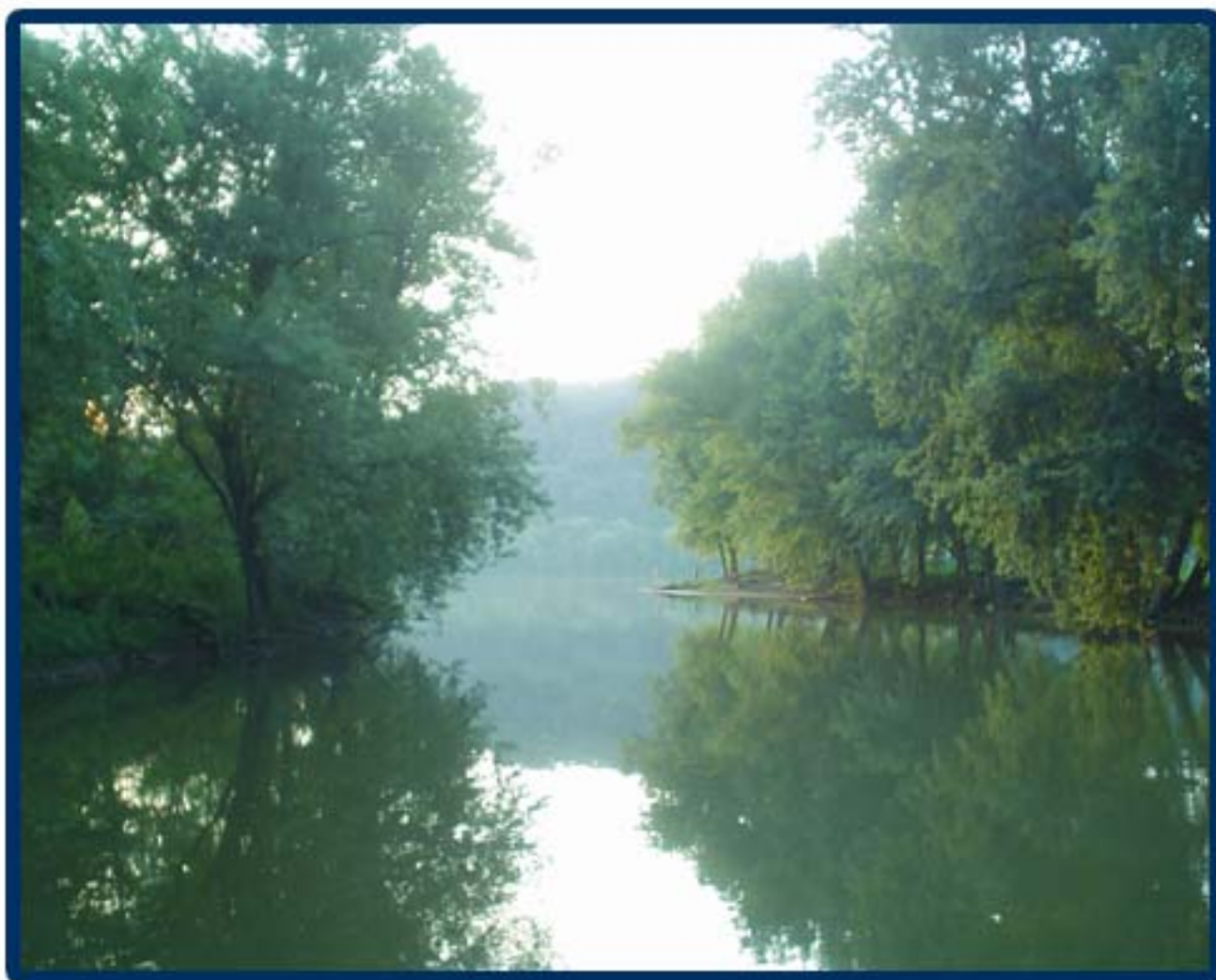




A Biological Study of the Ohio River

The Willow Island Pool



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 20 assessment units based primarily on the locations of navigational dams. Using a random design, each assessment unit was assigned 15 sampling locations.
- Once sampled, each site is graded as passing or failing. For an assessment unit to meet its aquatic life use designation, more than 75% of the sites assessed must be in passing condition.
- In 2006, the Willow Island pool met these criteria, with 100% of sites passing. Therefore, the Willow Island pool will be reported to EPA as meeting (supporting) its aquatic life use designation.
- Previous analyses have identified a relationship between flow and ORFIn (Ohio River Fish Index) scores and the need for sampling thresholds and/or flow calibration. Increased flows tend to cause lower ORFIn scores due to decreased sampling efficiency and changes in fish behavior.
- Flows were moderately elevated when sampling was conducted in the Willow Island pool, but ORFIn scores did not reflect the expected trend of lower scores.
- Recommendations include accepting the assessment of Willow Island pool as meeting 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.

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A Biological Study of the Willow Island Pool of the Ohio River

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 (fish and macroinvertebrate studies). Another priority, water quality impact 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_n) (Emery et al. 2003). The ORFI_n 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.

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 2006, the Montgomery, Willow Island, Greenup, and Cannelton pools were sampled as part of ORSANCO's normal monitoring. This report covers the 2006 survey of the Willow Island 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 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).

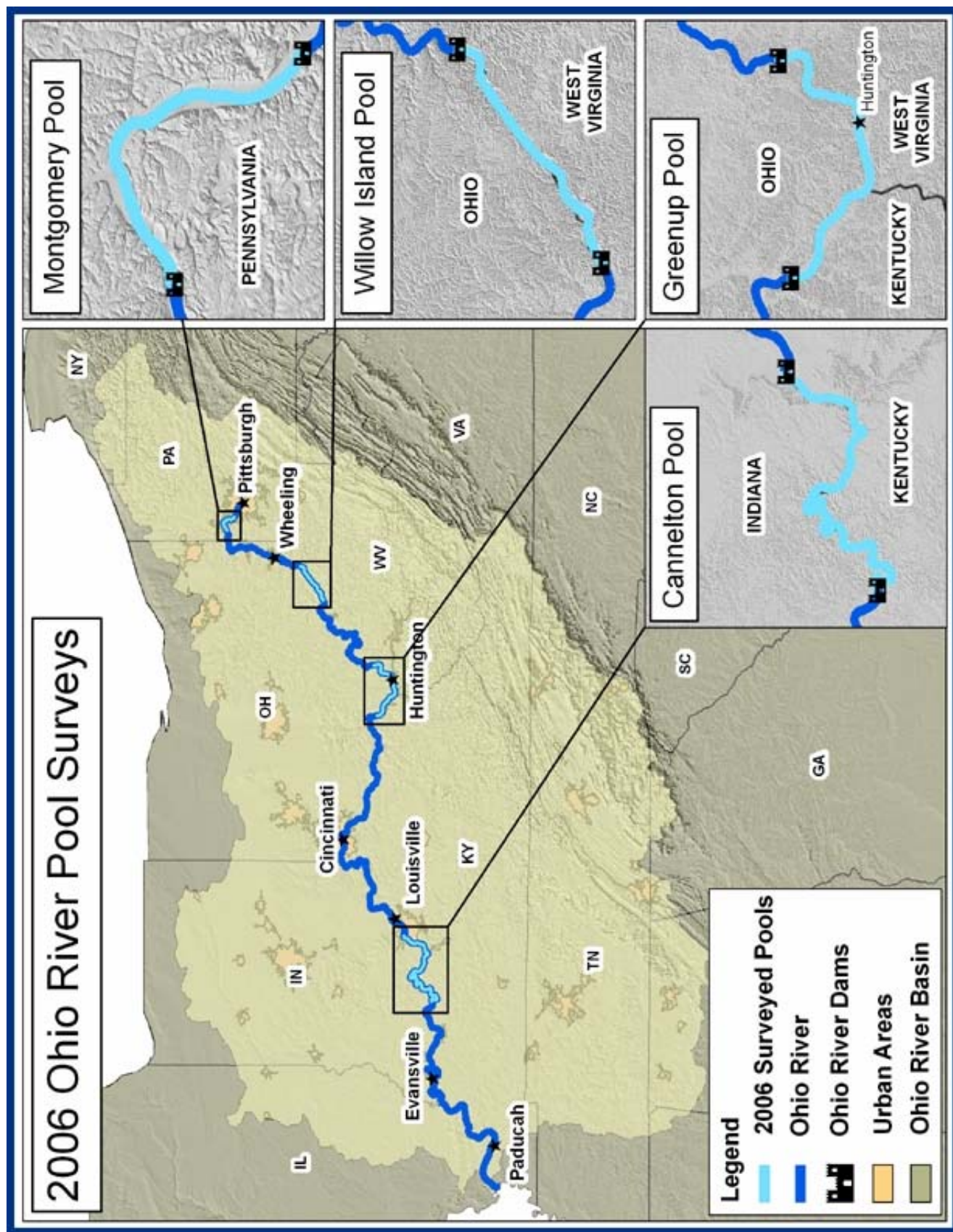


Figure 1. The Ohio River Basin and the four pools selected for 2006 sampling

2.2 Willow Island Pool

The Willow Island pool is 35.3 miles long, extending from Hannibal Locks and Dam (ORM 126.4) to Willow Island Locks and Dam (ORM 161.7). The pool has a gradient drop of 0.6 feet per mile, averages 1194 feet wide and 21 feet deep. The pool flows adjacent to the states of Ohio and West Virginia. The Willow Island pool receives water from two sub-basins: the Fishing and Middle Island creeks, both draining parts of West Virginia. This pool lies in a portion of the Ohio River where the land use consists primarily of forested and cropland activities, but is also impacted by the presence of animal farming and urban influences.

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 Willow Island pool of the Ohio River from mile marker 126.4 (Hannibal Locks and Dam) to 161.7 (Willow Island Locks and Dam). The total linear extent of the target population was approximately 70.6 miles. The sample frame was generated using RF3 river double lines for the Ohio River and river mile coverages 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).

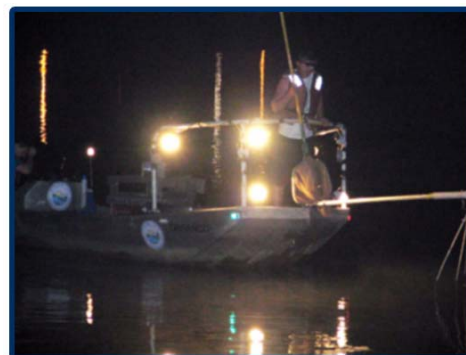
Sites were to be sampled as close as possible to the location generated from the design, but in cases of restricted access or unsafe sampling conditions (e.g. barge loading/mooring area), sampling zones could be shifted (up to a maximum of 500m up- or downstream). The survey design supplied additional 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 12 inches. 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 100ft or a depth of 20ft.) 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 weighed, 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 10 ft intervals beginning at the shore/water interface and moving away from the shore for 100 ft. 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 three existing classes of habitat: 'A', 'B', or 'C'. By assigning each sampling site to one of three 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 the presence of large substrates such as cobble and boulders. Sites that fall in habitat class 'C' are dominated by sand (small substrates), and habitat class 'B' describes sites that fall between 'A' and 'C' with a mix of large and small substrate materials.

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. Secchi depth was measured using a

standard Secchi disk. Flow data were obtained from the U.S. Army Corps of Engineers. These included daily average flow volumes and velocities from the sampling station within or nearest to the sampled pool. Harmonic mean flow (HMF) values were determined by ORSANCO using 30-year means for the flow data obtained from the U.S. Army Corps of Engineers (ORSANCO 2003).

3.6 Pool Assessment

In 2006, 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 Willow Island 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) and comparing observed ORFIn scores to habitat derived expectations for each site (Emery et al. 2003). The three distinct habitat classes ('A', 'B', and 'C') each exhibit different levels of ORFIn performance. Performance expectations for each habitat class were determined based on the statistical distribution of data (ORFIn scores) gathered from 'least impacted' (reference) sites within each habitat class. The 25th 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 2).

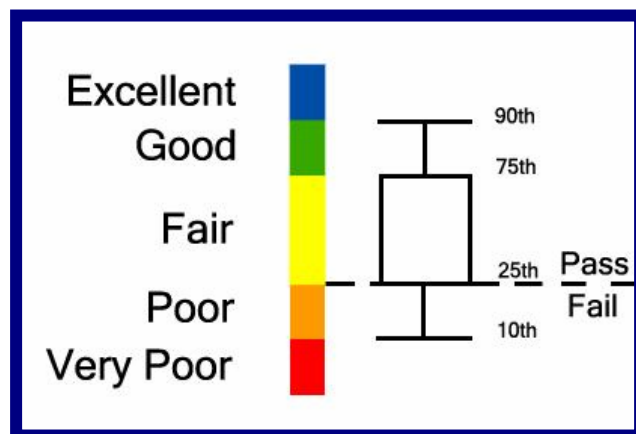


Figure 2. Approach used to assign site condition ratings.

Individual site scores were compared to expected values and the percentage of failing sites in the pool was then calculated. A precision estimate for the percentage of sites failing was also calculated (see Appendix A for a detailed explanation). The precision estimate was used to create a 90% confidence interval around the percentage of sites failing. The threshold for the pool assessment was set at 25% failure. The pool passed the assessment if the entire confidence interval fell below 25%. If the whole confidence interval was greater than 25%, the pool was assessed as failing. If the confidence

interval overlapped the 25% threshold, the assessment required additional sampling to determine the result. To further characterize the condition of each pool, sites were given individual condition ratings. These ratings were based on the same distribution of data from 'least impacted' sites used to determine expectations and consisted of Excellent, Good, Fair, Poor and Very Poor. The 90th, 75th, 25th, and 10th percentiles were used as cutoff points for the different ratings. Any sites that were classified as Poor or Very Poor were also sites that failed to meet expectations (Figures 2 and 3).

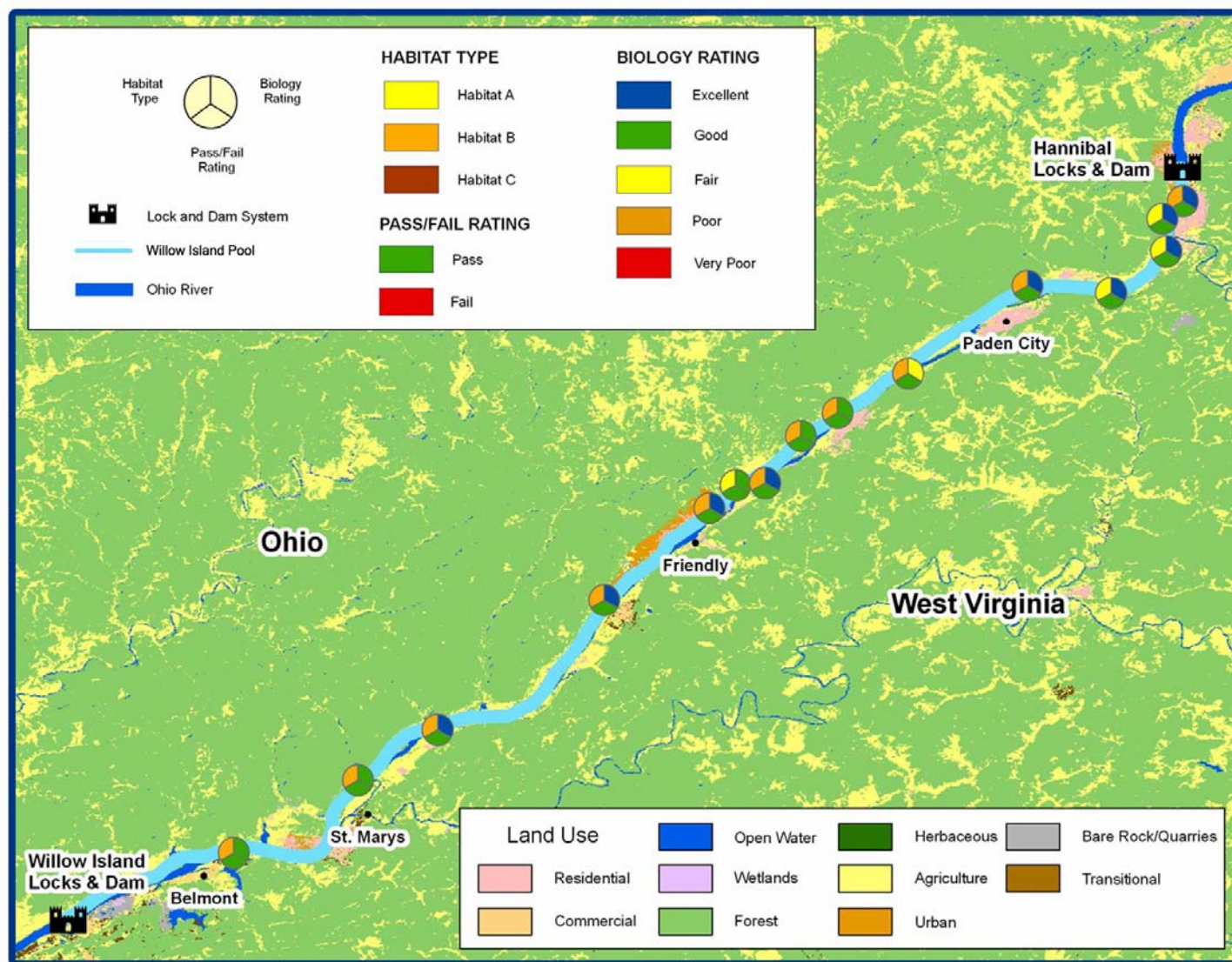


Figure 3. Locations and results of sampling at 15 sites within the Willow Island pool.

4.0 Results

4.1 Fish Population

In 2006, fish population data (Appendix B) were collected from 15 randomly selected locations throughout the length of the Willow Island pool (Table 1). These collections produced 47 species and 2 hybrid taxa, representing 10 different families (Table 2). Three of the 47 species are listed in OH as either threatened or of special concern. These include river redhorse (*Moxostoma carinatum*), river darter (*Percina shumardi*), and channel darter

(*Percina copelandi*). WV does not generate such state listings for species. At the species level, the most abundant species were emerald shiner (*Notropis atherinoides*) and sauger (*Sander canadensis*), which comprised 21.6% and 10.1% of the catch respectively (Figure 4). The number of gizzard shad was lower than expected. The two dominant families were the minnow family (Cyprinidae) and the sucker family (Catostomidae), which comprised 37.3% and 19.6% of the catch respectively (Figure 5).

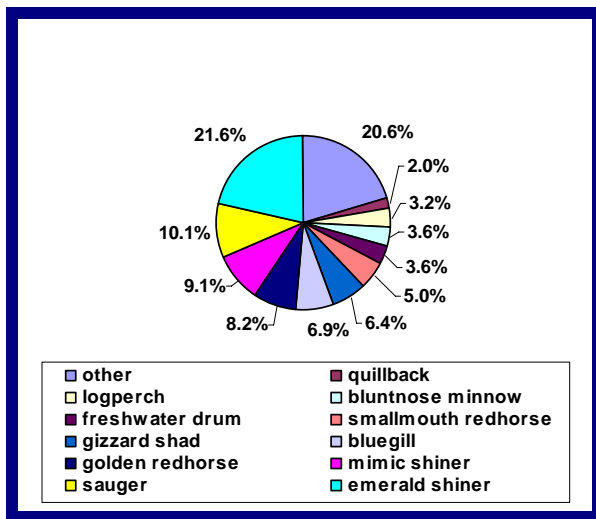


Figure 4. Species composition of fish sampled in the Willow Island pool.

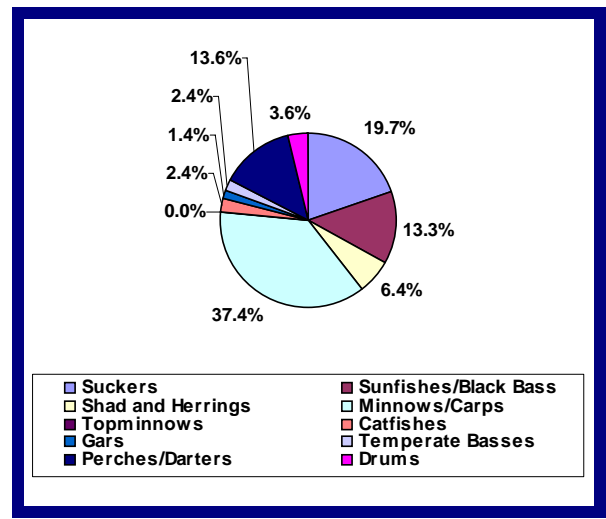


Figure 5. Sampled fish composition by family in the Willow Island pool.

Table 1. Electrofishing site list for the Willow Island pool, including habitat designation, ORFI scores and status.

Site #	River Mile	Bank	Date	Latitude	Longitude	Habitat Class	ORFI Expectation	Observed ORFI	Site Result	Rating
1	127.4	LDB	10-Jul-06	39.6520	80.8637	B	33	49	PASS	EXCELLENT
2	128.0	RDB	10-Jul-06	39.6448	80.8705	A	39	53	PASS	EXCELLENT
3	128.5	RDB	12-Jul-06	39.6375	80.8727	A	39	53	PASS	EXCELLENT
4	130.6	LDB	12-Jul-06	39.6147	80.8929	A	39	53	PASS	EXCELLENT
5	132.4	RDB	11-Jul-06	39.6176	80.9269	B	33	47	PASS	EXCELLENT
6	135.9	LDB	11-Jul-06	39.5817	80.9756	B	33	41	PASS	FAIR
7	137.8	RDB	5-Sep-06	39.5657	81.0043	B	33	45	PASS	GOOD
8	138.9	RDB	5-Sep-06	39.5563	81.0193	B	33	45	PASS	GOOD
9	140.9	RDB	5-Sep-06	39.5364	81.0458	A	39	49	PASS	GOOD
10	141.1	LDB	6-Sep-06	39.5344	81.0412	B	33	53	PASS	EXCELLENT
11	141.7	RDB	6-Sep-06	39.5270	81.0565	B	33	51	PASS	EXCELLENT
12	145.2	RDB	6-Sep-06	39.4898	81.0993	B	33	47	PASS	EXCELLENT
13	150.8	LDB	7-Sep-06	39.4369	81.1672	B	33	47	PASS	EXCELLENT
14	153.2	RDB	7-Sep-06	39.4164	81.1997	B	33	43	PASS	GOOD
15	157.4	LDB	7-Sep-06	39.3869	81.2502	B	33	45	PASS	GOOD

LDB = Left Descending Bank
RDB = Right Descending Bank

Table 2. Species collected in the Willow Island pool during the 2006 survey.

Family	Species	Latin Name	OH	WV
Lepisosteidae	longnose gar	<i>Lepisosteus osseus</i>		
Clupeidae	gizzard shad	<i>Dorosoma cepedianum</i>		
Cyprinidae	central stoneroller	<i>Camptostoma anomalum</i>		
Cyprinidae	spotfin shiner	<i>Cyprinella spiloptera</i>		
Cyprinidae	common carp	<i>Cyprinus carpio</i>		
Cyprinidae	silver chub	<i>Macrhybopsis storeriana</i>		S3S4
Cyprinidae	emerald shiner	<i>Notropis atherinoides</i>		
Cyprinidae	mimic shiner	<i>Notropis volucellus</i>		
Cyprinidae	bluntnose minnow	<i>Pimephales notatus</i>		
Cyprinidae	bullhead minnow	<i>Pimephales vigilax</i>		S2
Catostomidae	river carpsucker	<i>Carpoides carpio</i>		S2S3
Catostomidae	quillback	<i>Carpoides cyprinus</i>		
Catostomidae	highfin carpsucker	<i>Carpoides velifer</i>		S1
Catostomidae	northern hog sucker	<i>Hypentelium nigricans</i>		
Catostomidae	smallmouth buffalo	<i>Ictiobus bubalus</i>		
Catostomidae	black buffalo	<i>Ictiobus niger</i>		S2
Catostomidae	spotted sucker	<i>Minytrema melanops</i>		
Catostomidae	silver redhorse	<i>Moxostoma anisurum</i>		
Catostomidae	smallmouth redhorse	<i>Moxostoma breviceps</i>		
Catostomidae	river redhorse	<i>Moxostoma carinatum</i>	SC	S3
Catostomidae	black redhorse	<i>Moxostoma duquesnei</i>		
Catostomidae	golden redhorse	<i>Moxostoma erythrurum</i>		
Ictaluridae	channel catfish	<i>Ictalurus punctatus</i>		
Ictaluridae	flathead catfish	<i>Pylodictis olivaris</i>		
Fundulidae	banded killifish	<i>Fundulus diaphanus</i>		S2
Moronidae	morone sp	<i>Morone sp</i>		
Moronidae	white perch	<i>Morone americana</i>		
Moronidae	white bass	<i>Morone chrysops</i>		
Moronidae	striped bass	<i>Morone saxatilis</i>		
Moronidae	hybrid striper	<i>Morone saxatilis x chrysops</i>		
Centrarchidae	rock bass	<i>Ambloplites rupestris</i>		
Centrarchidae	lepomis hybrid	<i>Lepomis hybrid</i>		
Centrarchidae	lepomis sp	<i>Lepomis sp</i>		
Centrarchidae	green sunfish	<i>Lepomis cyanellus</i>		
Centrarchidae	pumpkinseed	<i>Lepomis gibbosus</i>		
Centrarchidae	warmouth	<i>Lepomis gulosus</i>		S2
Centrarchidae	orangespotted sunfish	<i>Lepomis humilis</i>		S2
Centrarchidae	bluegill	<i>Lepomis macrochirus</i>		
Centrarchidae	longear sunfish	<i>Lepomis megalotis</i>		
Centrarchidae	redeer sunfish	<i>Lepomis microlophus</i>		
Centrarchidae	smallmouth bass	<i>Micropterus dolomieu</i>		
Centrarchidae	spotted bass	<i>Micropterus punctulatus</i>		
Centrarchidae	largemouth bass	<i>Micropterus salmoides</i>		
Percidae	rainbow darter	<i>Etheostoma caeruleum</i>		
Percidae	johnny darter	<i>Etheostoma nigrum</i>		
Percidae	logperch	<i>Percina caprodes</i>		
Percidae	channel darter	<i>Percina copelandi</i>	T	S2S3
Percidae	river darter	<i>Percina shumardi</i>	T	
Percidae	sauger	<i>Sander canadensis</i>		
Percidae	walleye	<i>Sander vitreus</i>		
Sciaenidae	freshwater drum	<i>Aplodinotus grunniens</i>		

SC = Special Concern

T = Threatened

4.2 Metric Performance

Thirteen metrics were used to calculate ORFIn scores for each electrofishing site (Emery et al. 2003). Each site's performance and scores for the ORFIn metrics are shown in Table 3. The number of native species collected at each site ranged from 16 to 29, with an average of 22.7 species per site. Twelve of the fifteen sites scored a 5 for the number of native species metric. The number of sucker species found at each site ranged from 3 to 9 and all of the sites scored either 3 or 5 for this metric. The number of centrarchid species varied from 3 to 8 and metric scores were either 3 or 5. The number of great river species varied between 0 and 2 species per site, with all but one of the sites scoring 1 for this metric. The number of intolerant species ranged from 2 to 7 at the sampled sites. The percent of tolerant individuals ranged from 0% to 22.5%, and the majority of sites scored either a 3 or 5 for this metric. The percentage of simple lithophils was between 17.8% and 77.7%, and the majority of site scores for this metric were either 3 or 5. All sites had below 2.7% non-native individuals, and all of the sites scored a 5 for this metric. The percent detritivores ranged from 2.0% to 27.5%, and the majority of sites scored either 3 or 5. The percent invertivores ranged from 28.2% to 80.9%, with most sites scoring a 3 for this metric. The percent piscivores ranged from 13.8% to 52.6% and metric scores ranged from 1 to 5. All of the sites had a single DELT (deformities, eroded fins, lesions and tumors) anomaly or less, except for two sites that had 3 DELTs. Those two sites received a score of 3, while the others scored 5 for the DELT metric. The CPUE (catch per unit effort) ranged from 115 to 427 individuals per site, and scores ranged from 1 to 5 for the CPUE metric.

4.3 Habitat Surveys

Intensive habitat surveys at each of the 15 sampling locations revealed that the bottom substrate in the Willow Island pool was almost equally composed of sand, gravel, and fines with a smaller percentage of cobble and boulders (Figure 6). However, there was some variation among the individual sites (Figure 7). The Willow Island pool was dominated by class 'B' habitats, which account for three-

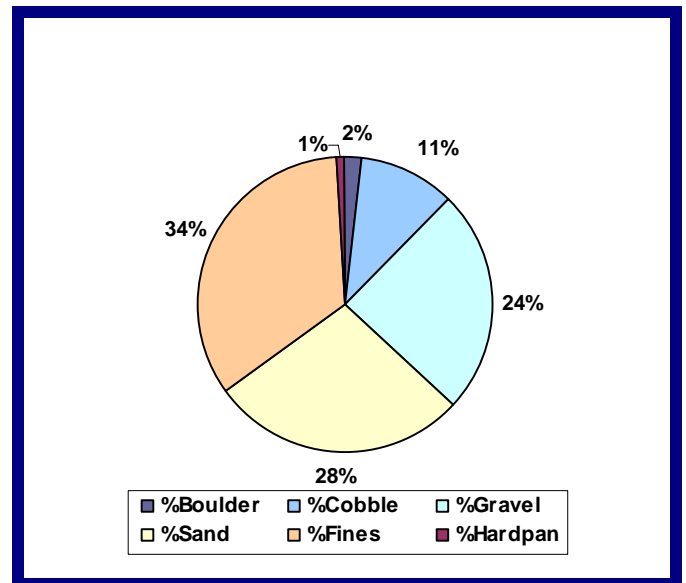


Figure 6. Substrate composition of the Willow Island Pool.

fourths of the samples. The remaining samples were classified as class 'A' habitats. There were no class 'C' habitats sampled in the pool (Table 1).

Submerged aquatic vegetation was present at 10 sites and large patches were frequently seen. Woody cover was present in all of the 15 sites sampled. Boat docks were common throughout the pool and present in 8 sites. The riparian land use was primarily residential lawns followed by forest. (Additional data in Appendix C).

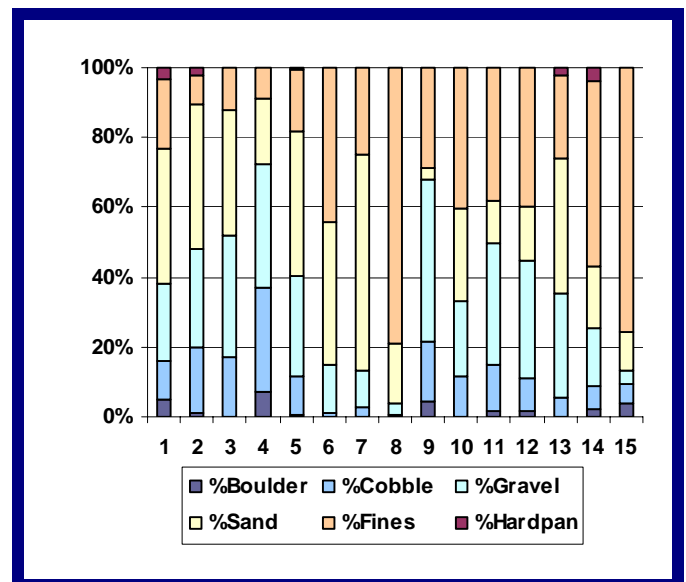


Figure 7. Substrate composition at each site sampled in the Willow Island Pool.

Table 3. ORFIN metrics and scores from the 2006 Willow Island pool survey.

Site #	River Mile	Bank	# Individuals	# Individuals w/o G & E	# Individuals w/o GETHEX	# Species	# Species Score	# Suckers	Suckers Species Score	# Centrarchid Species	Centrarchid Species Score	# Great River Species	Great River Species Scores	# 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	ORfin Expectation	Observed ORfin	Site Result
1	127.4	L	206	188	187	20	5	6	5	4	3	0	1	4	3	0.5	5	38.8	3	0.5	5	3.7	5	80.9	5	13.8	1	1	5	205	3	33	49	PASS
2	128.0	R	215	191	189	22	5	8	5	5	3	0	1	7	5	1.0	5	44.5	5	1.0	5	7.9	5	69.6	5	19.9	3	3	3	213	3	39	53	PASS
3	128.5	R	174	166	165	21	5	6	5	5	3	0	1	5	5	0.6	5	71.7	5	0.6	5	10.8	3	60.8	5	23.5	3	1	5	173	3	39	53	PASS
4	130.6	L	153	148	147	18	3	6	5	4	3	1	1	6	5	0.7	5	77.7	5	0.0	5	2.0	5	64.2	5	30.4	3	1	5	152	3	39	53	PASS
5	132.4	R	116	97	96	20	5	5	3	4	3	0	1	4	3	1.0	5	42.3	5	0.0	5	18.6	3	35.1	3	40.2	5	0	5	115	1	33	47	PASS
6	135.9	L	121	107	105	19	3	5	3	3	3	1	1	2	1	0.9	5	36.4	3	1.9	5	17.8	3	38.3	3	40.2	5	1	5	119	1	33	41	PASS
7	137.8	R	143	78	78	16	3	4	3	3	3	1	1	2	1	0.0	5	44.9	5	0.0	5	7.7	5	28.2	3	52.6	5	0	5	143	1	33	45	PASS
8	138.9	R	170	96	91	22	5	6	5	3	3	1	1	3	3	4.2	3	24.0	3	2.1	5	17.7	3	39.6	3	20.8	3	0	5	165	3	33	45	PASS
9	140.9	R	220	195	180	22	5	4	3	6	5	1	1	5	5	7.7	1	51.3	5	2.1	5	9.2	5	43.6	3	29.7	3	0	5	205	3	39	49	PASS
10	141.1	L	171	128	125	23	5	7	5	5	3	0	1	5	5	2.3	5	53.1	5	1.6	5	7.8	5	49.2	3	38.3	3	0	5	168	3	33	53	PASS
11	141.7	R	294	183	174	28	5	9	5	5	3	1	1	7	5	3.8	3	50.3	5	2.2	5	8.2	5	50.8	3	26.2	3	0	5	285	3	33	51	PASS
12	145.2	R	250	187	177	24	5	3	3	6	5	1	1	3	3	3.7	3	29.4	3	2.7	5	8.6	5	46.5	3	31.6	3	0	5	240	3	33	47	PASS
13	150.8	L	476	273	229	29	5	8	5	4	3	2	3	6	5	15.0	1	37.0	3	1.8	5	16.8	3	48.4	3	19.0	1	1	5	432	5	33	47	PASS
14	153.2	R	482	240	185	29	5	8	5	8	5	1	1	4	3	22.5	1	23.8	3	1.3	5	27.5	1	47.9	3	14.2	1	0	5	427	5	33	43	PASS
15	157.4	L	187	157	147	27	5	6	5	6	5	1	1	4	3	5.1	3	17.8	1	2.5	5	9.6	5	52.2	3	23.6	3	3	3	177	3	33	45	PASS

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 of fish 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

Flow conditions were somewhat unstable throughout the 2006 sampling period and river levels were at or above normal. There were several rain events that caused increases in river flow and water levels throughout the Ohio River valley. Much of the sampling was conducted when flows were above the harmonic mean flow (HMF) for the pool, but still within one meter of “normal flat pool”. The HMF for this part of the river is 20.5 kcfs and sampling was conducted between 102% and 221% of the HMF (Figure 8). Measurements of water quality parameters did not reveal any unusual or poor water conditions present at the time of sampling (Appendix D). Secchi depths at the time of sampling ranged from 32 to 60 inches.

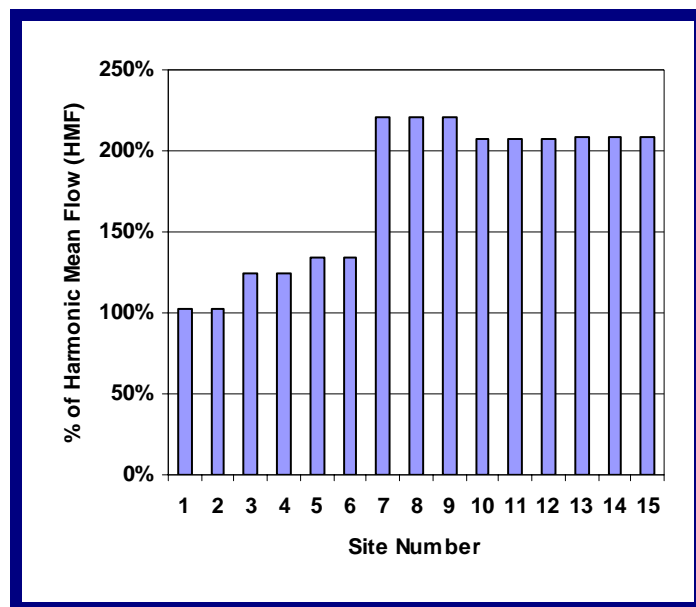


Figure 8. Relative flows (%HMF) at the time of sampling

4.5 Assessment of Condition

ORFIn scores were calculated for each of the sites sampled. Out of a possible 65 the maximum score achieved by any site in this pool was 53 and the minimum was 41. By comparing observed and expected ORFIn scores, ORSANCO assessed each site as either passing or failing (Table 3). All 15 sites sampled in 2006 scored higher than the minimum expected scores and received passing evaluations (Table 1). With 100% of the sites passing, the pool was assessed as supporting its aquatic life use designation (Figure 9). Nine sites received an excellent rating (60%), five sites were found to be in good condition (33%) and one was in fair (7%) condition (Figure 10).

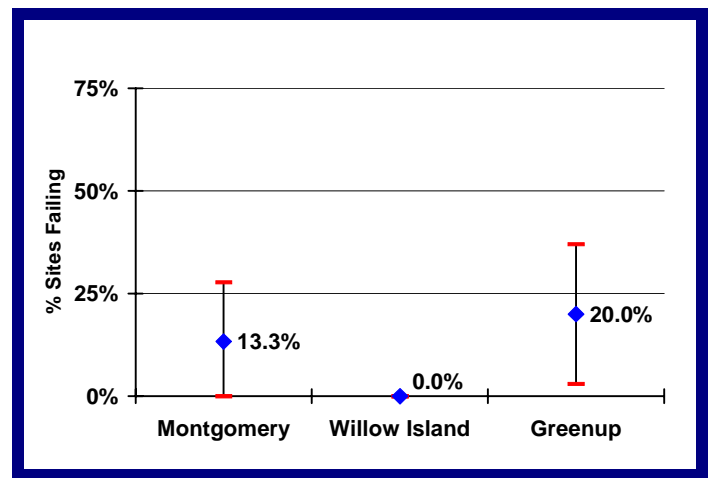


Figure 9. 2006 pool assessment results with 90% confidence intervals.

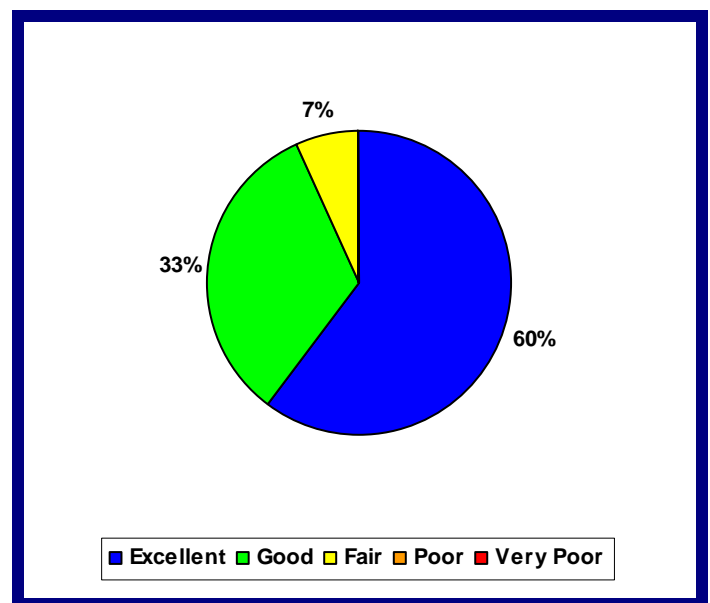


Figure 10. Condition of sites in the Willow Island pool based on ORFIn scores at 15 sites (Pass=Excellent-Fair, Fail=Poor-Very Poor)

5.0 Discussion

5.1 Fish Population

The fish population of Willow Island pool appears to be in exceptionally good condition. This is supported by the diversity and types of species collected from the pool. Multiple pollution intolerant species such as: northern hog sucker (*Hypentelium nigricans*), spotted sucker (*Minytremma melanops*), smallmouth redhorse (*Moxostoma breviceps*), river redhorse (*M. carinatum*), and channel darter (*Percina copelandi*); were collected from the Willow Island pool, indicating that pollution is not a problem in the area.

The number of gizzard shad collected was lower than expected. It is not known if this is related to the high flows that were experienced. Gizzard shad populations can fluctuate dramatically from year to year, so it could also be within the normal range of the dynamic populations.

The presence of white perch (*Morone americana*) in the pool may be cause for concern. This is an invasive species that may threaten some of the species native to the Ohio River. It is known to feed on the eggs of other fish such as walleye. Only three individuals were collected in the 2006 surveys of Willow Island pool. Future monitoring will reveal if the white perch is increasing in numbers and threatening native species.

5.2 Metric Performance

Most of the metric scores for the sites assessed in Willow Island pool were good, with one exception. The pool scored low for the # of great river species metric across all sites. This is not unexpected because the great river species metric is designed to show community response if/when these species return to the Ohio River system.

The highest scoring metrics were the % of non-native individuals, # of native species and # of DELT anomalies. These metrics indicate good overall health of the Willow Island pool.

5.3 Habitat Surveys

The habitat assessments show that the small substrate types (fines, sand) were most common in Willow Island pool. Larger substrates (gravel, cobble) were present at all sites, but in lower proportions. This indicates less than ideal habitat; however, both woody cover and aquatic vegetation were common. These cover types supplement the

available habitat, providing diverse and suitable habitats to support the fish population of the Willow Island pool.

5.4 Water Quality and Flow Conditions

There were no water chemistry measurements that were out of the ordinary or that provided any major insight into the assessment results for Willow Island pool. The moderately high flows did not appear to hinder the collections in 2006. In previous surveys of other pools, higher flows were associated with lower site scores. The higher flow conditions that were encountered can adversely affect capture efficiency by making boat maneuvering and fish netting more difficult. This did not seem to be a problem with the Willow Island pool. Several possibilities exist; one being that the fish population was negatively affected by the flows, despite the high scores. In this case, ORFIn scores could possibly have been even higher. Secchi depths indicated ample visibility for sampling, so fish collection may not have been hindered as much as originally suspected. This emphasizes the need to continue an assessment of the relationship between various river flows and assessment results.

5.5 Assessments of Condition and Conclusions

The data collected in 2006 indicate that the Willow Island pool meets its aquatic life use designation and is in outstanding condition. Despite conditions that can hinder sampling efficiency, all sites were in passing condition, with only one site rated below good condition. Species diversity was high, with intolerant species occurring commonly. The assessment of Willow Island pool meets the criteria established by ORSANCO biologists (Appendix A) and is therefore accepted as complete. No further monitoring of Willow Island pool is required at this time.



A paddlefish collected by ORSANCO

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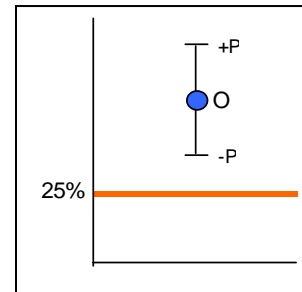
Riverboats at the Ohio River Tall Stacks Festival

Appendix A: Assessment Unit Criteria Details

- Each individual navigational pool will serve as a separate and distinct Assessment Unit (AU).
- All AUs will be sampled and assessed on a 5-year rotating basis. This is consistent with state schedules, and it allows ORSANCO (after one full rotation) in each 305(b) report, to incorporate 5 years worth of data and report on 100% of the resource. USEPA accepts 305(b) reports which use the most recent 5 years of data.
- AUs that yield >25% failure will be considered for listing as non-supporting.
 - Recognizing that even the least impacted (LI) sites in the Ohio River exhibit variability in condition, the 25th percentile of LI sites is used as the biocriteria within each habitat class.
 - Even among a random draw of LI sites, up to 25% of sites could be expected to fail, or fall below the criterion.
 - AUs with more than 25% failure rate could be listed as impaired if the BWQSC feels an “adequate assessment”, as defined below, is made.
- Characteristics of “Adequate Assessments”
 - Each AU is assessed with a minimum of 15 sites, regardless of pool length.
 - 1 of 3 situations occurs after sampling 15 sites (illustrated in figure below):

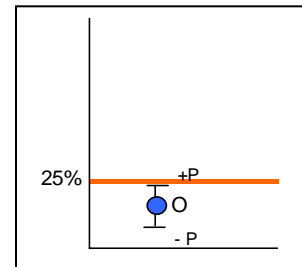
Situation ‘A’

- If an observation ‘O’ of > 25% of the sites failing is made and O minus (-) the estimated precision (P) is >25%, the assessment is accepted as valid, the AU is listed as ‘Assessed’ and failing to meet the established aquatic life use. The entire AU will be properly listed on the 303(d) list.
 - If $O - P > 25\%$ then AU fails.



$$\text{Precision } (P) = Z_{1-\alpha} * 100 * \text{Sqrt}[p(1-p)/n]$$

$Z_{1-\alpha}$ is related to the desired level of confidence
1.645 is used for 90% confidence
(use 1.96 for 95% confidence)

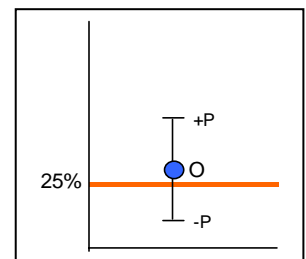


Situation ‘B’

- If an observation ‘O’ of < 25% of the sites failing is made and O + P (precision) is <25%, the assessment is accepted as valid, the AU is listed as ‘Assessed’ and as meeting the established aquatic life use.
 - If $O + P < 25\%$ then AU passes.

Situation ‘C’

- If after sampling 15 sites, O +/- P includes (overlaps) the criterion (25%), 1 of 2 scenarios will occur:
 - **C1:** if resources allow, an “Optimal Assessment” as defined below, will be conducted.
 - Additional probability sites will be sampled the next year to increase the sample size and improve precision (reducing the error bars).



- This process is repeated until one of the following occurs:
 - either Situation A or Situation B (above) is achieved.
 - precision of +/- 12 is achieved.
 - maximum of 45 samples is reached.
 - At that point the AU will be considered 'Assessed', the results will be considered valid and accepted, and condition will be reported.
- **C2:** in cases where resources are limited, the BWQSC will consider other available and relevant information when deciding to accept the assessment as valid or to require more sampling.
 - Additional information to be considered in these cases include (but are not limited to):
 - additional available statistics from the current assessment
 - additional available biological & water chemistry data
 - prior performance
 - presence of known impacts
 - In these cases, ORSANCO biologists will provide a narrative justification explaining how information other than the assessment in question was used to make the assessment
 - If O + P includes 25% and multiple lines of evidence indicate that the AU is in acceptable condition, then the AU may be listed as attaining.
 - If O – P includes 25% and multiple lines of evidence indicate that the AU is in unacceptable condition, then the AU may be listed as impaired.
 - If O +/- P includes 25% and multiple lines of evidence are inconclusive, then the AU will be listed as “unassessed” and additional samples would be needed.
- Listing on the 303(d) list as
 - 4a if the determined case already has an approved TMDL in place
 - 4b if the impairment is expected to be removed by other programs (SF, RCRA, NPDES, 319, harbor dredging)
 - 4c if the impairment is caused by something other than a pollutant
 - Habitat, natural, hydrologic, etc.
 - 5a if there is an impaired biological condition due to unknown stressor/cause.
 - Follow-up work would be needed.
 - e.g., examining WQ/Habitat/Bio interactions as a data exercise or through additional field work.
 - 5b if it is determined impairment is based on fish tissue contamination, in which case no TMDL is required.
 - 5c if a pollutant is positively identified, triggering the need for the development of a TMDL for that pollutant.

It is most likely that if any of the AUs fail, it will be listed as Category 5a.

- If follow-up work determines that a pollutant is the cause, it will be listed as Category 5c.
- If follow-up work shows impairment due to something other than a pollutant, it will be listed as Category 4c.

It will be possible to list an AU under any one of the categories shown above, although listing in any category other than 5a will require additional work, data integration, and the utmost certainty beforehand because of the resource implications of potentially triggering the need to develop a TMDL.

Appendix B. Fish survey data from the Willow Island pool.

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
1	127.4	LDB	7/10/06	bluegill	Lepomis macrochirus	6	0.25
1	127.4	LDB	7/10/06	common carp	Cyprinus carpio	1	2.984
1	127.4	LDB	7/10/06	emerald shiner	Notropis atherinoides	15	0.047
1	127.4	LDB	7/10/06	flathead catfish	Pylodictis olivaris	3	5.042
1	127.4	LDB	7/10/06	gizzard shad	Dorosoma cepedianum	3	0.538
1	127.4	LDB	7/10/06	golden redhorse	Moxostoma erythrurum	27	3.148
1	127.4	LDB	7/10/06	logperch	Percina caprodes	5	0.03
1	127.4	LDB	7/10/06	longear sunfish	Lepomis megalotis	3	0.11
1	127.4	LDB	7/10/06	longnose gar	Lepisosteus osseus	2	1.135
1	127.4	LDB	7/10/06	mimic shiner	Notropis volucellus	83	0.125
1	127.4	LDB	7/10/06	morone sp	Morone sp	1	0.002
1	127.4	LDB	7/10/06	quillback	Carpodes cyprinus	2	0.594
1	127.4	LDB	7/10/06	river carpsucker	Carpodes carpio	1	0.045
1	127.4	LDB	7/10/06	sauger	Sander canadensis	13	0.806
1	127.4	LDB	7/10/06	silver redhorse	Moxostoma anisurum	4	1.649
1	127.4	LDB	7/10/06	smallmouth bass	Micropterus dolomieu	1	0.068
1	127.4	LDB	7/10/06	smallmouth buffalo	Ictiobus bubalus	3	2.307
1	127.4	LDB	7/10/06	smallmouth redhorse	Moxostoma breviceps	24	3.177
1	127.4	LDB	7/10/06	spotfin shiner	Cyprinella spiloptera	3	0.013
1	127.4	LDB	7/10/06	spotted bass	Micropterus punctulatus	4	0.244
1	127.4	LDB	7/10/06	white bass	Morone chrysops	2	0.194
2	128.0	RDB	7/10/06	black redhorse	Moxostoma duquesnei	2	0.31
2	128.0	RDB	7/10/06	bluegill	Lepomis macrochirus	6	0.454
2	128.0	RDB	7/10/06	common carp	Cyprinus carpio	2	4.68
2	128.0	RDB	7/10/06	emerald shiner	Notropis atherinoides	18	0.044
2	128.0	RDB	7/10/06	freshwater drum	Aplodinotus grunniens	1	0.273
2	128.0	RDB	7/10/06	gizzard shad	Dorosoma cepedianum	6	0.655
2	128.0	RDB	7/10/06	golden redhorse	Moxostoma erythrurum	33	3.52
2	128.0	RDB	7/10/06	largemouth bass	Micropterus salmoides	5	3.399
2	128.0	RDB	7/10/06	logperch	Percina caprodes	6	0.046
2	128.0	RDB	7/10/06	longear sunfish	Lepomis megalotis	3	0.108
2	128.0	RDB	7/10/06	longnose gar	Lepisosteus osseus	9	3.321
2	128.0	RDB	7/10/06	mimic shiner	Notropis volucellus	56	0.088
2	128.0	RDB	7/10/06	northern hog sucker	Hypentelium nigricans	6	0.231
2	128.0	RDB	7/10/06	quillback	Carpodes cyprinus	4	0.227
2	128.0	RDB	7/10/06	river redhorse	Moxostoma carinatum	1	1.555
2	128.0	RDB	7/10/06	sauger	Sander canadensis	17	1.33
2	128.0	RDB	7/10/06	silver redhorse	Moxostoma anisurum	2	0.106
2	128.0	RDB	7/10/06	smallmouth bass	Micropterus dolomieu	2	0.067
2	128.0	RDB	7/10/06	smallmouth buffalo	Ictiobus bubalus	9	11.128
2	128.0	RDB	7/10/06	smallmouth redhorse	Moxostoma breviceps	18	1.198
2	128.0	RDB	7/10/06	spotfin shiner	Cyprinella spiloptera	4	0.014
2	128.0	RDB	7/10/06	spotted bass	Micropterus punctulatus	4	0.303

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
2	128.0	RDB	7/10/06	white bass	Morone chrysops	1	0.091
3	128.5	RDB	7/12/06	bluegill	Lepomis macrochirus	5	0.305
3	128.5	RDB	7/12/06	channel catfish	Ictalurus punctatus	7	3.41
3	128.5	RDB	7/12/06	common carp	Cyprinus carpio	1	2.63
3	128.5	RDB	7/12/06	emerald shiner	Notropis atherinoides	2	0.005
3	128.5	RDB	7/12/06	flathead catfish	Pylodictis olivaris	2	0.464
3	128.5	RDB	7/12/06	gizzard shad	Dorosoma cepedianum	6	0.778
3	128.5	RDB	7/12/06	golden redhorse	Moxostoma erythrurum	56	7.844
3	128.5	RDB	7/12/06	largemouth bass	Micropterus salmoides	1	0.223
3	128.5	RDB	7/12/06	logperch	Percina caprodes	5	0.035
3	128.5	RDB	7/12/06	longear sunfish	Lepomis megalotis	1	0.064
3	128.5	RDB	7/12/06	longnose gar	Lepisosteus osseus	1	0.485
3	128.5	RDB	7/12/06	mimic shiner	Notropis volucellus	4	0.006
3	128.5	RDB	7/12/06	northern hog sucker	Hypentelium nigricans	4	0.139
3	128.5	RDB	7/12/06	quillback	Carpionodes cyprinus	12	1.133
3	128.5	RDB	7/12/06	sauger	Sander canadensis	28	1.973
3	128.5	RDB	7/12/06	silver redhorse	Moxostoma anisurum	5	0.473
3	128.5	RDB	7/12/06	smallmouth bass	Micropterus dolomieu	2	1.687
3	128.5	RDB	7/12/06	smallmouth buffalo	Ictiobus bubalus	5	4.634
3	128.5	RDB	7/12/06	smallmouth redhorse	Moxostoma breviceps	21	1.755
3	128.5	RDB	7/12/06	spotfin shiner	Cyprinella spiloptera	1	0.006
3	128.5	RDB	7/12/06	spotted bass	Micropterus punctulatus	2	0.138
3	128.5	RDB	7/12/06	white bass	Morone chrysops	3	0.37
4	130.6	LDB	7/12/06	bluegill	Lepomis macrochirus	2	0.177
4	130.6	LDB	7/12/06	channel catfish	Ictalurus punctatus	2	0.26
4	130.6	LDB	7/12/06	channel darter	Percina copelandi	1	0.001
4	130.6	LDB	7/12/06	freshwater drum	Aplodinotus grunniens	1	0.515
4	130.6	LDB	7/12/06	gizzard shad	Dorosoma cepedianum	5	0.768
4	130.6	LDB	7/12/06	golden redhorse	Moxostoma erythrurum	23	4.973
4	130.6	LDB	7/12/06	green sunfish	Lepomis cyanellus	1	0.069
4	130.6	LDB	7/12/06	logperch	Percina caprodes	39	0.309
4	130.6	LDB	7/12/06	mimic shiner	Notropis volucellus	8	0.016
4	130.6	LDB	7/12/06	northern hog sucker	Hypentelium nigricans	1	0.048
4	130.6	LDB	7/12/06	river carpsucker	Carpionodes carpio	1	2.333
4	130.6	LDB	7/12/06	sauger	Sander canadensis	30	1.689
4	130.6	LDB	7/12/06	silver redhorse	Moxostoma anisurum	1	0.177
4	130.6	LDB	7/12/06	smallmouth bass	Micropterus dolomieu	13	1.564
4	130.6	LDB	7/12/06	smallmouth buffalo	Ictiobus bubalus	2	1.239
4	130.6	LDB	7/12/06	smallmouth redhorse	Moxostoma breviceps	20	2.092
4	130.6	LDB	7/12/06	warmouth	Lepomis gulosus	1	0.065
4	130.6	LDB	7/12/06	white bass	Morone chrysops	2	0.225
5	132.4	RDB	7/11/06	bluegill	Lepomis macrochirus	2	0.18

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
5	132.4	RDB	7/11/06	bluntnose minnow	Pimephales notatus	1	0.001
5	132.4	RDB	7/11/06	central stoneroller	Campostoma anomalum	1	0.001
5	132.4	RDB	7/11/06	channel catfish	Ictalurus punctatus	4	2.613
5	132.4	RDB	7/11/06	emerald shiner	Notropis atherinoides	3	0.007
5	132.4	RDB	7/11/06	gizzard shad	Dorosoma cepedianum	16	1.376
5	132.4	RDB	7/11/06	golden redhorse	Moxostoma erythrurum	12	1.556
5	132.4	RDB	7/11/06	logperch	Percina caprodes	2	0.014
5	132.4	RDB	7/11/06	longear sunfish	Lepomis megalotis	1	0.015
5	132.4	RDB	7/11/06	longnose gar	Lepisosteus osseus	3	2.359
5	132.4	RDB	7/11/06	mimic shiner	Notropis volucellus	13	0.023
5	132.4	RDB	7/11/06	quillback	Carpionodes cyprinus	13	1.812
5	132.4	RDB	7/11/06	river carpsucker	Carpionodes carpio	1	0.25
5	132.4	RDB	7/11/06	sauger	Sander canadensis	23	1.385
5	132.4	RDB	7/11/06	smallmouth bass	Micropterus dolomieu	3	0.731
5	132.4	RDB	7/11/06	smallmouth buffalo	Ictiobus bubalus	3	4.245
5	132.4	RDB	7/11/06	smallmouth redhorse	Moxostoma breviceps	4	0.281
5	132.4	RDB	7/11/06	spotfin shiner	Cyprinella spiloptera	1	0.004
5	132.4	RDB	7/11/06	spotted bass	Micropterus punctulatus	4	0.327
5	132.4	RDB	7/11/06	white bass	Morone chrysops	6	0.678
6	135.9	LDB	7/11/06	bluegill	Lepomis macrochirus	1	0.06
6	135.9	LDB	7/11/06	channel catfish	Ictalurus punctatus	1	0.05
6	135.9	LDB	7/11/06	common carp	Cyprinus carpio	1	1.68
6	135.9	LDB	7/11/06	emerald shiner	Notropis atherinoides	10	0.03
6	135.9	LDB	7/11/06	flathead catfish	Pylodictis olivaris	1	1.14
6	135.9	LDB	7/11/06	freshwater drum	Aplodinotus grunniens	3	0.279
6	135.9	LDB	7/11/06	gizzard shad	Dorosoma cepedianum	4	0.242
6	135.9	LDB	7/11/06	golden redhorse	Moxostoma erythrurum	14	2.221
6	135.9	LDB	7/11/06	hybrid striper	Morone saxatilis x M. chrysops	1	0.323
6	135.9	LDB	7/11/06	largemouth bass	Micropterus salmoides	1	0.63
6	135.9	LDB	7/11/06	longnose gar	Lepisosteus osseus	1	0.545
6	135.9	LDB	7/11/06	mimic shiner	Notropis volucellus	18	0.033
6	135.9	LDB	7/11/06	morone sp	Morone sp	1	0.001
6	135.9	LDB	7/11/06	quillback	Carpionodes cyprinus	12	0.647
6	135.9	LDB	7/11/06	sauger	Sander canadensis	17	1.729
6	135.9	LDB	7/11/06	silver chub	Macrhybopsis storeriana	1	0.019
6	135.9	LDB	7/11/06	silver redhorse	Moxostoma anisurum	4	0.565
6	135.9	LDB	7/11/06	smallmouth buffalo	Ictiobus bubalus	6	8.65
6	135.9	LDB	7/11/06	smallmouth redhorse	Moxostoma breviceps	3	0.123
6	135.9	LDB	7/11/06	spotted bass	Micropterus punctulatus	1	0.095
6	135.9	LDB	7/11/06	white bass	Morone chrysops	20	2.261
7	137.8	RDB	9/5/06	bluegill	Lepomis macrochirus	1	0.001
7	137.8	RDB	9/5/06	emerald shiner	Notropis atherinoides	26	0.045

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
7	137.8	RDB	9/5/06	freshwater drum	Aplodinotus grunniens	9	0.032
7	137.8	RDB	9/5/06	gizzard shad	Dorosoma cepedianum	39	4.145
7	137.8	RDB	9/5/06	golden redhorse	Moxostoma erythrurum	3	0.429
7	137.8	RDB	9/5/06	longear sunfish	Lepomis megalotis	1	0.144
7	137.8	RDB	9/5/06	longnose gar	Lepisosteus osseus	9	5.159
7	137.8	RDB	9/5/06	mimic shiner	Notropis volucellus	7	0.007
7	137.8	RDB	9/5/06	morone sp	Morone sp	6	0.13
7	137.8	RDB	9/5/06	quillback	Carpodes cyprinus	5	0.555
7	137.8	RDB	9/5/06	sauger	Sander canadensis	22	1.232
7	137.8	RDB	9/5/06	silver chub	Macrhybopsis storeriana	7	0.032
7	137.8	RDB	9/5/06	smallmouth buffalo	Ictiobus bubalus	1	0.128
7	137.8	RDB	9/5/06	smallmouth redhorse	Moxostoma breviceps	3	0.41
7	137.8	RDB	9/5/06	spotted bass	Micropterus punctulatus	3	0.263
7	137.8	RDB	9/5/06	white bass	Morone chrysops	1	0.073
8	138.9	RDB	9/5/06	bluegill	Lepomis macrochirus	8	0.163
8	138.9	RDB	9/5/06	bluntnose minnow	Pimephales notatus	3	0.002
8	138.9	RDB	9/5/06	channel catfish	Ictalurus punctatus	2	0.762
8	138.9	RDB	9/5/06	common carp	Cyprinus carpio	1	2.311
8	138.9	RDB	9/5/06	emerald shiner	Notropis atherinoides	42	0.056
8	138.9	RDB	9/5/06	freshwater drum	Aplodinotus grunniens	18	0.034
8	138.9	RDB	9/5/06	gizzard shad	Dorosoma cepedianum	32	3.456
8	138.9	RDB	9/5/06	golden redhorse	Moxostoma erythrurum	5	0.917
8	138.9	RDB	9/5/06	highfin carpsucker	Carpodes velifer	1	0.151
8	138.9	RDB	9/5/06	logperch	Percina caprodes	1	0.003
8	138.9	RDB	9/5/06	longear sunfish	Lepomis megalotis	3	0.038
8	138.9	RDB	9/5/06	longnose gar	Lepisosteus osseus	5	2.967
8	138.9	RDB	9/5/06	mimic shiner	Notropis volucellus	13	0.014
8	138.9	RDB	9/5/06	morone sp	Morone sp	1	0.033
8	138.9	RDB	9/5/06	quillback	Carpodes cyprinus	10	0.605
8	138.9	RDB	9/5/06	sauger	Sander canadensis	9	0.733
8	138.9	RDB	9/5/06	silver chub	Macrhybopsis storeriana	1	0.006
8	138.9	RDB	9/5/06	silver redhorse	Moxostoma anisurum	1	0.289
8	138.9	RDB	9/5/06	smallmouth buffalo	Ictiobus bubalus	2	2.441
8	138.9	RDB	9/5/06	smallmouth redhorse	Moxostoma breviceps	6	0.664
8	138.9	RDB	9/5/06	spotfin shiner	Cyprinella spiloptera	1	0.001
8	138.9	RDB	9/5/06	spotted bass	Micropterus punctulatus	2	0.129
8	138.9	RDB	9/5/06	striped bass	Morone saxatilis	1	0.017
8	138.9	RDB	9/5/06	white bass	Morone chrysops	2	0.188
9	140.9	RDB	9/5/06	bluegill	Lepomis macrochirus	14	0.506
9	140.9	RDB	9/5/06	bluntnose minnow	Pimephales notatus	11	0.015
9	140.9	RDB	9/5/06	channel catfish	Ictalurus punctatus	13	6.203
9	140.9	RDB	9/5/06	channel darter	Percina copelandi	2	0.001
9	140.9	RDB	9/5/06	common carp	Cyprinus carpio	4	10.366

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
9	140.9	RDB	9/5/06	emerald shiner	Notropis atherinoides	23	0.021
9	140.9	RDB	9/5/06	flathead catfish	Pylodictis olivaris	2	0.609
9	140.9	RDB	9/5/06	freshwater drum	Aplodinotus grunniens	20	0.034
9	140.9	RDB	9/5/06	gizzard shad	Dorosoma cepedianum	2	0.213
9	140.9	RDB	9/5/06	golden redhorse	Moxostoma erythrurum	12	1.572
9	140.9	RDB	9/5/06	lepomis sp	Lepomis sp	1	0.001
9	140.9	RDB	9/5/06	logperch	Percina caprodes	16	0.13
9	140.9	RDB	9/5/06	longnose gar	Lepisosteus osseus	3	1.938
9	140.9	RDB	9/5/06	mimic shiner	Notropis volucellus	11	0.012
9	140.9	RDB	9/5/06	orangespotted sunfish	Lepomis humilis	2	0.002
9	140.9	RDB	9/5/06	rock bass	Ambloplites rupestris	1	0.022
9	140.9	RDB	9/5/06	sauger	Sander canadensis	42	2.829
9	140.9	RDB	9/5/06	silver redhorse	Moxostoma anisurum	1	0.242
9	140.9	RDB	9/5/06	smallmouth bass	Micropterus dolomieu	7	1.153
9	140.9	RDB	9/5/06	smallmouth buffalo	Ictiobus bubalus	3	1.012
9	140.9	RDB	9/5/06	smallmouth redhorse	Moxostoma breviceps	27	3.192
9	140.9	RDB	9/5/06	spotted bass	Micropterus punctulatus	1	0.128
9	140.9	RDB	9/5/06	white bass	Morone chrysops	2	0.199
10	141.1	LDB	9/6/06	bluegill	Lepomis macrochirus	4	0.196
10	141.1	LDB	9/6/06	bluntnose minnow	Pimephales notatus	1	0.001
10	141.1	LDB	9/6/06	channel catfish	Ictalurus punctatus	4	2.36
10	141.1	LDB	9/6/06	common carp	Cyprinus carpio	2	4.82
10	141.1	LDB	9/6/06	emerald shiner	Notropis atherinoides	20	0.02
10	141.1	LDB	9/6/06	flathead catfish	Pylodictis olivaris	1	0.4
10	141.1	LDB	9/6/06	freshwater drum	Aplodinotus grunniens	2	0.005
10	141.1	LDB	9/6/06	gizzard shad	Dorosoma cepedianum	23	3.381
10	141.1	LDB	9/6/06	golden redhorse	Moxostoma erythrurum	30	6.322
10	141.1	LDB	9/6/06	logperch	Percina caprodes	1	0.01
10	141.1	LDB	9/6/06	longear sunfish	Lepomis megalotis	6	0.149
10	141.1	LDB	9/6/06	longnose gar	Lepisosteus osseus	2	2.5
10	141.1	LDB	9/6/06	mimic shiner	Notropis volucellus	6	0.003
10	141.1	LDB	9/6/06	northern hog sucker	Hypentelium nigricans	1	0.058
10	141.1	LDB	9/6/06	quillback	Carpodes cyprinus	3	0.705
10	141.1	LDB	9/6/06	river carpsucker	Carpodes carpio	1	0.58
10	141.1	LDB	9/6/06	rock bass	Ambloplites rupestris	1	0.051
10	141.1	LDB	9/6/06	sauger	Sander canadensis	21	1.681
10	141.1	LDB	9/6/06	silver redhorse	Moxostoma anisurum	7	2.015
10	141.1	LDB	9/6/06	smallmouth bass	Micropterus dolomieu	8	1.917
10	141.1	LDB	9/6/06	smallmouth buffalo	Ictiobus bubalus	3	5.26
10	141.1	LDB	9/6/06	smallmouth redhorse	Moxostoma breviceps	8	0.977
10	141.1	LDB	9/6/06	spotted bass	Micropterus punctulatus	12	0.985
10	141.1	LDB	9/6/06	white bass	Morone chrysops	4	0.315
11	141.7	RDB	9/6/06	black buffalo	Ictiobus niger	1	1.64

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
11	141.7	RDB	9/6/06	black redhorse	Moxostoma duquesnei	1	0.542
11	141.7	RDB	9/6/06	bluegill	Lepomis macrochirus	15	0.431
11	141.7	RDB	9/6/06	bluntnose minnow	Pimephales notatus	5	0.006
11	141.7	RDB	9/6/06	channel catfish	Ictalurus punctatus	6	3.596
11	141.7	RDB	9/6/06	common carp	Cyprinus carpio	2	2.139
11	141.7	RDB	9/6/06	emerald shiner	Notropis atherinoides	90	0.209
11	141.7	RDB	9/6/06	flathead catfish	Pylodictis olivaris	1	1.145
11	141.7	RDB	9/6/06	freshwater drum	Aplodinotus grunniens	17	0.445
11	141.7	RDB	9/6/06	gizzard shad	Dorosoma cepedianum	21	3.253
11	141.7	RDB	9/6/06	golden redhorse	Moxostoma erythrurum	23	4.336
11	141.7	RDB	9/6/06	largemouth bass	Micropterus salmoides	1	0.39
11	141.7	RDB	9/6/06	lepomis hybrid	Lepomis hybrid	2	0.051
11	141.7	RDB	9/6/06	lepomis sp	Lepomis sp	1	0.001
11	141.7	RDB	9/6/06	logperch	Percina caprodes	3	0.011
11	141.7	RDB	9/6/06	longnose gar	Lepisosteus osseus	3	1.322
11	141.7	RDB	9/6/06	mimic shiner	Notropis volucellus	13	0.019
11	141.7	RDB	9/6/06	morone sp	Morone sp	1	0.023
11	141.7	RDB	9/6/06	northern hog sucker	Hypentelium nigricans	2	0.116
11	141.7	RDB	9/6/06	river carpsucker	Carpodes carpio	2	2.432
11	141.7	RDB	9/6/06	river redhorse	Moxostoma carinatum	1	0.104
11	141.7	RDB	9/6/06	sauger	Sander canadensis	27	2.248
11	141.7	RDB	9/6/06	silver chub	Macrhybopsis storeriana	7	0.042
11	141.7	RDB	9/6/06	silver redhorse	Moxostoma anisurum	7	0.841
11	141.7	RDB	9/6/06	smallmouth bass	Micropterus dolomieu	10	1.754
11	141.7	RDB	9/6/06	smallmouth buffalo	Ictiobus bubalus	5	10.135
11	141.7	RDB	9/6/06	smallmouth redhorse	Moxostoma breviceps	21	2.582
11	141.7	RDB	9/6/06	spotfin shiner	Cyprinella spiloptera	1	0.001
11	141.7	RDB	9/6/06	spotted bass	Micropterus punctulatus	2	0.013
11	141.7	RDB	9/6/06	white bass	Morone chrysops	3	0.299
12	145.2	RDB	9/6/06	bluegill	Lepomis macrochirus	26	0.278
12	145.2	RDB	9/6/06	bluntnose minnow	Pimephales notatus	4	0.007
12	145.2	RDB	9/6/06	channel catfish	Ictalurus punctatus	7	5.968
12	145.2	RDB	9/6/06	common carp	Cyprinus carpio	2	0.005
12	145.2	RDB	9/6/06	emerald shiner	Notropis atherinoides	52	0.052
12	145.2	RDB	9/6/06	flathead catfish	Pylodictis olivaris	4	1.612
12	145.2	RDB	9/6/06	freshwater drum	Aplodinotus grunniens	13	0.037
12	145.2	RDB	9/6/06	gizzard shad	Dorosoma cepedianum	11	1.715
12	145.2	RDB	9/6/06	green sunfish	Lepomis cyanellus	1	0.001
12	145.2	RDB	9/6/06	lepomis hybrid	Lepomis hybrid	3	0.098
12	145.2	RDB	9/6/06	lepomis sp	Lepomis sp	1	0.001
12	145.2	RDB	9/6/06	logperch	Percina caprodes	14	0.112
12	145.2	RDB	9/6/06	longnose gar	Lepisosteus osseus	4	2.043
12	145.2	RDB	9/6/06	mimic shiner	Notropis volucellus	28	0.013
12	145.2	RDB	9/6/06	morone sp	Morone sp	1	0.025

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
12	145.2	RDB	9/6/06	pumpkinseed	Lepomis gibbosus	9	0.014
12	145.2	RDB	9/6/06	quillback	Carpionodes cyprinus	1	0.164
12	145.2	RDB	9/6/06	rainbow darter	Etheostoma caeruleum	1	0.001
12	145.2	RDB	9/6/06	river carpsucker	Carpionodes carpio	2	2.325
12	145.2	RDB	9/6/06	sauger	Sander canadensis	30	2.249
12	145.2	RDB	9/6/06	silver chub	Macrhybopsis storeriana	9	0.041
12	145.2	RDB	9/6/06	smallmouth bass	Micropterus dolomieu	7	0.478
12	145.2	RDB	9/6/06	smallmouth buffalo	Ictiobus bubalus	7	12.61
12	145.2	RDB	9/6/06	spotted bass	Micropterus punctulatus	9	0.204
12	145.2	RDB	9/6/06	walleye	Sander vitreus	1	0.083
12	145.2	RDB	9/6/06	white bass	Morone chrysops	3	0.309
13	150.8	LDB	9/7/06	banded killifish	Fundulus diaphanus	1	0.002
13	150.8	LDB	9/7/06	black redhorse	Moxostoma duquesnei	1	0.35
13	150.8	LDB	9/7/06	bluegill	Lepomis macrochirus	29	0.332
13	150.8	LDB	9/7/06	bluntnose minnow	Pimephales notatus	39	0.068
13	150.8	LDB	9/7/06	channel catfish	Ictalurus punctatus	14	7.678
13	150.8	LDB	9/7/06	common carp	Cyprinus carpio	2	6.712
13	150.8	LDB	9/7/06	emerald shiner	Notropis atherinoides	182	0.231
13	150.8	LDB	9/7/06	flathead catfish	Pylodictis olivaris	4	1.936
13	150.8	LDB	9/7/06	freshwater drum	Aplodinotus grunniens	13	0.065
13	150.8	LDB	9/7/06	gizzard shad	Dorosoma cepedianum	21	2.262
13	150.8	LDB	9/7/06	golden redhorse	Moxostoma erythrurum	26	3.876
13	150.8	LDB	9/7/06	johnny darter	Etheostoma nigrum	1	0.001
13	150.8	LDB	9/7/06	lepomis hybrid	Lepomis hybrid	2	0.034
13	150.8	LDB	9/7/06	logperch	Percina caprodes	5	0.042
13	150.8	LDB	9/7/06	longear sunfish	Lepomis megalotis	3	0.008
13	150.8	LDB	9/7/06	longnose gar	Lepisosteus osseus	1	0.329
13	150.8	LDB	9/7/06	mimic shiner	Notropis volucellus	31	0.024
13	150.8	LDB	9/7/06	morone sp	Morone sp	2	0.046
13	150.8	LDB	9/7/06	northern hog sucker	Hypentelium nigricans	1	0.085
13	150.8	LDB	9/7/06	quillback	Carpionodes cyprinus	2	0.196
13	150.8	LDB	9/7/06	river carpsucker	Carpionodes carpio	2	2.401
13	150.8	LDB	9/7/06	river darter	Percina shumardi	1	0.004
13	150.8	LDB	9/7/06	sauger	Sander canadensis	34	2.598
13	150.8	LDB	9/7/06	silver chub	Macrhybopsis storeriana	17	0.074
13	150.8	LDB	9/7/06	silver redhorse	Moxostoma anisurum	13	1.453
13	150.8	LDB	9/7/06	smallmouth bass	Micropterus dolomieu	4	0.827
13	150.8	LDB	9/7/06	smallmouth buffalo	Ictiobus bubalus	1	0.098
13	150.8	LDB	9/7/06	smallmouth redhorse	Moxostoma breviceps	3	0.366
13	150.8	LDB	9/7/06	spotfin shiner	Cyprinella spiloptera	12	0.028
13	150.8	LDB	9/7/06	spotted bass	Micropterus punctulatus	5	0.496
13	150.8	LDB	9/7/06	white bass	Morone chrysops	2	0.183
13	150.8	LDB	9/7/06	white perch	Morone americana	2	0.009

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
14	153.2	RDB	9/7/06	black buffalo	Ictiobus niger	1	1.2
14	153.2	RDB	9/7/06	bluegill	Lepomis macrochirus	54	0.782
14	153.2	RDB	9/7/06	bluntnose minnow	Pimephales notatus	52	0.082
14	153.2	RDB	9/7/06	common carp	Cyprinus carpio	2	5.401
14	153.2	RDB	9/7/06	emerald shiner	Notropis atherinoides	232	0.322
14	153.2	RDB	9/7/06	flathead catfish	Pylodictis olivaris	1	0.33
14	153.2	RDB	9/7/06	freshwater drum	Aplodinotus grunniens	10	4.033
14	153.2	RDB	9/7/06	gizzard shad	Dorosoma cepedianum	10	1.874
14	153.2	RDB	9/7/06	golden redhorse	Moxostoma erythrurum	11	1.588
14	153.2	RDB	9/7/06	johnny darter	Etheostoma nigrum	1	0.001
14	153.2	RDB	9/7/06	largemouth bass	Micropterus salmoides	3	0.358
14	153.2	RDB	9/7/06	lepomis sp	Lepomis sp	13	0.004
14	153.2	RDB	9/7/06	logperch	Percina caprodes	7	0.037
14	153.2	RDB	9/7/06	longnose gar	Lepisosteus osseus	2	1.122
14	153.2	RDB	9/7/06	mimic shiner	Notropis volucellus	11	0.007
14	153.2	RDB	9/7/06	pumpkinseed	Lepomis gibbosus	9	0.052
14	153.2	RDB	9/7/06	quillback	Cariodes cyprinus	1	0.112
14	153.2	RDB	9/7/06	rainbow darter	Etheostoma caeruleum	1	0.001
14	153.2	RDB	9/7/06	redeer sunfish	Lepomis microlophus	1	0.04
14	153.2	RDB	9/7/06	river carpsucker	Cariodes carpio	4	3.874
14	153.2	RDB	9/7/06	rock bass	Ambloplites rupestris	1	0.005
14	153.2	RDB	9/7/06	sauger	Sander canadensis	17	1.49
14	153.2	RDB	9/7/06	silver chub	Macrhybopsis storeriana	11	0.042
14	153.2	RDB	9/7/06	silver redhorse	Moxostoma anisurum	2	0.268
14	153.2	RDB	9/7/06	smallmouth bass	Micropterus dolomieu	2	0.052
14	153.2	RDB	9/7/06	smallmouth buffalo	Ictiobus bubalus	6	10.675
14	153.2	RDB	9/7/06	smallmouth redhorse	Moxostoma breviceps	7	0.823
14	153.2	RDB	9/7/06	spotted bass	Micropterus punctulatus	5	0.258
14	153.2	RDB	9/7/06	spotted sucker	Minytrema melanops	1	0.087
14	153.2	RDB	9/7/06	white bass	Morone chrysops	3	0.248
14	153.2	RDB	9/7/06	white perch	Morone americana	1	0.006
15	157.4	LDB	9/7/06	bluegill	Lepomis macrochirus	59	0.974
15	157.4	LDB	9/7/06	bluntnose minnow	Pimephales notatus	4	0.012
15	157.4	LDB	9/7/06	bullhead minnow	Pimephales vigilax	4	0.005
15	157.4	LDB	9/7/06	channel catfish	Ictalurus punctatus	1	0.26
15	157.4	LDB	9/7/06	common carp	Cyprinus carpio	2	3.922
15	157.4	LDB	9/7/06	emerald shiner	Notropis atherinoides	13	0.015
15	157.4	LDB	9/7/06	flathead catfish	Pylodictis olivaris	2	1.5
15	157.4	LDB	9/7/06	freshwater drum	Aplodinotus grunniens	13	0.954
15	157.4	LDB	9/7/06	gizzard shad	Dorosoma cepedianum	17	1.039
15	157.4	LDB	9/7/06	golden redhorse	Moxostoma erythrurum	2	0.248
15	157.4	LDB	9/7/06	green sunfish	Lepomis cyanellus	2	0.019
15	157.4	LDB	9/7/06	largemouth bass	Micropterus salmoides	5	0.472
15	157.4	LDB	9/7/06	lepomis hybrid	Lepomis hybrid	2	0.092

Site #	River Mile	Bank	Date	Common Name	Latin Name	Count	Weight (kg)
15	157.4	LDB	9/7/06	logperch	Percina caprodes	4	0.022
15	157.4	LDB	9/7/06	longear sunfish	Lepomis megalotis	2	0.01
15	157.4	LDB	9/7/06	longnose gar	Lepisosteus osseus	1	0.3
15	157.4	LDB	9/7/06	mimic shiner	Notropis volucellus	4	0.003
15	157.4	LDB	9/7/06	morone sp	Morone sp	4	0.072
15	157.4	LDB	9/7/06	quillback	Carpiodes cyprinus	1	0.144
15	157.4	LDB	9/7/06	river carpsucker	Carpiodes carpio	4	2.506
15	157.4	LDB	9/7/06	sauger	Sander canadensis	11	1.904
15	157.4	LDB	9/7/06	silver chub	Macrhybopsis storeriana	4	0.015
15	157.4	LDB	9/7/06	silver redhorse	Moxostoma anisurum	4	0.259
15	157.4	LDB	9/7/06	smallmouth bass	Micropterus dolomieu	2	0.576
15	157.4	LDB	9/7/06	smallmouth buffalo	Ictiobus bubalus	4	3.515
15	157.4	LDB	9/7/06	smallmouth redhorse	Moxostoma breviceps	3	0.266
15	157.4	LDB	9/7/06	spotfin shiner	Cyprinella spiloptera	1	0.001
15	157.4	LDB	9/7/06	spotted bass	Micropterus punctulatus	8	0.607
15	157.4	LDB	9/7/06	white bass	Morone chrysops	4	0.315

Appendix C. Habitat survey data from the Willow Island pool.

Site #	River Mile	Bank	% Boulder	% Cobble	% Gravel	% Sand	% Fines	% Hardpan	Depth	% Submerged Vegetation	% Woody Cover	% Overhanging Vegetation	Land Use	Human Influence	Bank Profile	% Bank Erosion
1	127.4	LDB	4.8	11.0	22.6	38.5	19.7	3.4	10.8	0	10.6	0	R, NF	barges, boats, docks	sloped	very light
2	128.0	RDB	0.9	18.9	28.0	41.8	8.1	2.3	7.2	15	18	10	R, NF	boats, docks	gradual/sloped	none
3	128.5	RDB	0.0	17.3	34.8	35.8	12.1	0.0	8.0	0	8	11	R, NF	none	sloped	none
4	130.6	LDB	7.3	29.6	35.4	18.8	8.9	0.0	10.2	0	8	0	NF	none	sloped	none
5	132.4	RDB	0.4	11.2	28.7	41.5	17.4	0.8	5.7	0	22	2	R, NF	none	sloped	none
6	135.9	LDB	0.0	1.3	13.6	40.9	44.2	0.0	7.6	0	9	13	NF, R, A	none	gradual	none
7	137.8	RDB	0.0	2.8	10.5	61.6	25.1	0.0	7.6	6	19	6	NF	none	flat	very light
8	138.9	RDB	0.0	0.5	3.5	17.2	78.8	0.0	8.1	15	6	4	NF	none	gradual	very light
9	140.9	RDB	4.4	16.9	46.9	2.9	28.9	0.0	8.2	20	31	10	A, NF	boats, docks	gradual	very light
10	141.1	LDB	0.0	11.4	22.0	26.5	40.2	0.0	8.1	19	10	6	R, NF	boats, docks	sloped	moderate
11	141.7	RDB	1.9	13.0	35.0	12.2	37.9	0.0	7.7	19	20	9	NF, R	none	steep	very light
12	145.2	RDB	1.7	9.5	33.7	15.5	39.6	0.0	8.7	31	7	7	NF, A	boats, docks, ramps	sloped	very light
13	150.8	LDB	0.0	5.6	30.0	38.3	24.2	1.9	8.6	38.2	27	4.4	NF, R	barges, boats, docks	sloped	very light
14	153.2	RDB	2.4	6.4	16.4	17.9	53.3	3.6	9.1	5	5	5.6	R, NF	boats, docks	flat/gradual	very light
15	157.4	LDB	3.8	5.4	4.2	10.6	76.0	0.0	9.1	1.4	15	1.4	R, NF, I	boats, docks	steep/sloped	none

I = Industry, NF = Natural Forest, R = Residential lawns, A = Agriculture (Listed in order of prevalence)

Appendix D. Parameters measured at sites in Willow Island pool.

River Mile	pH	Temp (°C)	Dissolved Oxygen (mg/L)	Conductivity	Secchi (in)
127.4	6.57	24.6	7.13	368	54
128.0	6.57	24.6	7.13	368	54
128.5	6.77	25.12	7.27	348	48
130.6	6.77	25.12	7.27	348	48
132.4	6.72	25.02	7.16	360	48
135.9	6.74	25.13	7.4	361	54
137.8	N/A	N/A	N/A	N/A	60
138.9	N/A	N/A	N/A	N/A	60
140.9	N/A	N/A	N/A	N/A	60
141.1	7.31	23.74	7.54	353	48
141.7	7.31	23.74	7.54	353	42
145.2	7.31	23.74	7.54	353	48
150.8	7.1	23.47	7.38	330	36
153.2	7.1	23.47	7.38	330	33
157.4	7.1	23.47	7.38	330	32