Biological Programs 2004
Intensive Survey Results
Series 1
Report 1

ORSANCO

OHIO RIVER VALLEY WATER SANITATION COMMISSION · AN INTERSTATE AGENCY · ESTABLISHED JUNE 30, 1948

A Biological Study of the New Cumberland Pool of the Ohio River

Executive Summary

- In 2004, ORSANCO introduced the use of a random probabilistic design for sampling fish communities in the Ohio River.

- The Ohio River was divided into assessment units based primarily on the locations of navigational dams.

- Based on the random design, each assessment unit was assigned 15 sampling locations.

- Once sampled, each site was graded as passing or failing to meet its aquatic life use designation.

- For an assessment unit to be considered in passing condition, at least 75% of the sites assessed must be in passing condition.

- In 2004, the sites sampled in the New Cumberland pool failed to meet these criteria, with with 73% failing.

- Therefore, the New Cumberland pool would be reported as failing to meet its aquatic life use designation.

- This assessment, however, is questionable based on unusually high flows that occurred during the 2004 sampling season.

- Recommendations include re-sampling the New Cumberland pool in 2005, and more intense analysis of the relationship between flow and assessment results.

The Ohio River Valley Water Sanitation Commission
5735 Kellogg Avenue
Cincinnati, OH 45228
Phone: 513-231-7719
Fax: 513-231-7761
www.orsanco.org

TABLE OF CONTENTS

APPENDICES

TABLES

FIGURES

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 could 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 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 suited 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 (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.

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). It is ORSANCO's goal to implement this approach on the Ohio River.

An objective of this program is to apply the probability- based monitoring design to the Ohio River to assess individual pool reaches based on the fish population. In 2004, four pools in the Ohio River were surveyed: New Cumberland, Racine, Markland, and J.T. Myers. This report will focus on the fish assemblage, the performance of the ORFIn and the effectiveness of the probabilistic design in the New Cumberland pool.

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 acts 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 New Cumberland Pool

The New Cumberland pool is 22.7 miles long, extending from Montgomery Lock and Dam (ORM 31.7) to New Cumberland Lock and Dam (ORM 54.4) (Figure 2). The pool has a gradient drop of 0.2 feet per mile, averages 1439 feet wide and 22 feet deep. The pool is entirely in the state of Pennsylvania (PA) for the upper 9 miles and is bordered by Ohio (OH) and West Virginia (WV) for the remaining 13.7 miles. This pool lies in a portion of the Ohio River heavily influenced by industry and is just 31.7 miles below the city of Pittsburgh. The New Cumberland pool receives water from three major sub-basins: the Allegheny, Monongahela, and Beaver rivers, consisting of primarily forested and cropland watershed activities, but also with significant urban influences.

Pittsburgh, PA, located 31 miles upstream from the New Cumberland pool, is an example of the many uses to which the Ohio River is subjected.

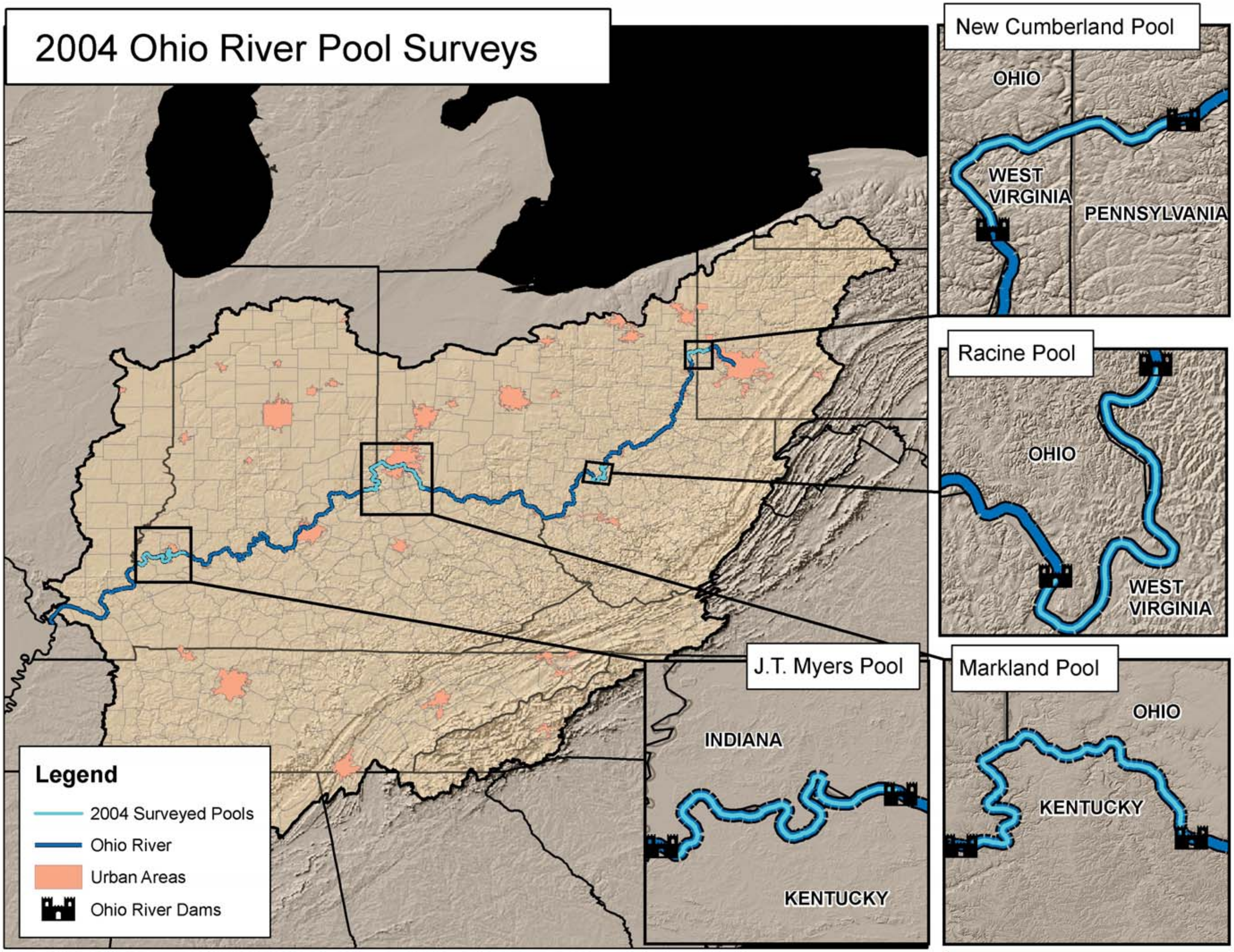


Figure 1. The Ohio River Basin and the four pools selected for 2004 sampling.

3.0 Methods

3.1 Survey Design

A random, probability-based survey design was used to select sampling site locations within each Ohio River survey pool. The U.S. EPA 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 New Cumberland pool of the Ohio River from mile marker 31.7 (Montgomery Lock and Dam) to 54.4 (New Cumberland Lock and Dam). The total linear extent of the target population was approximately 45.4 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.

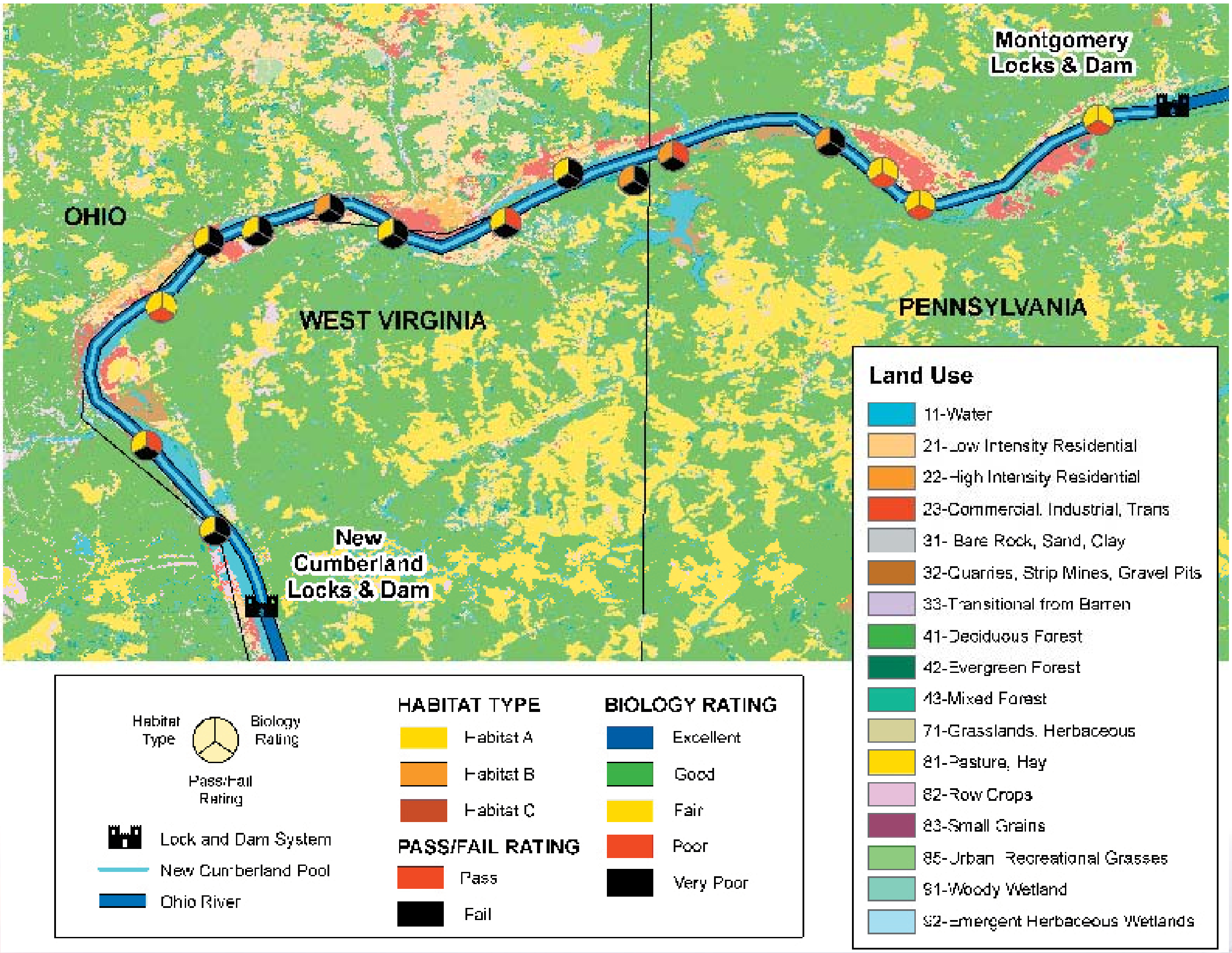
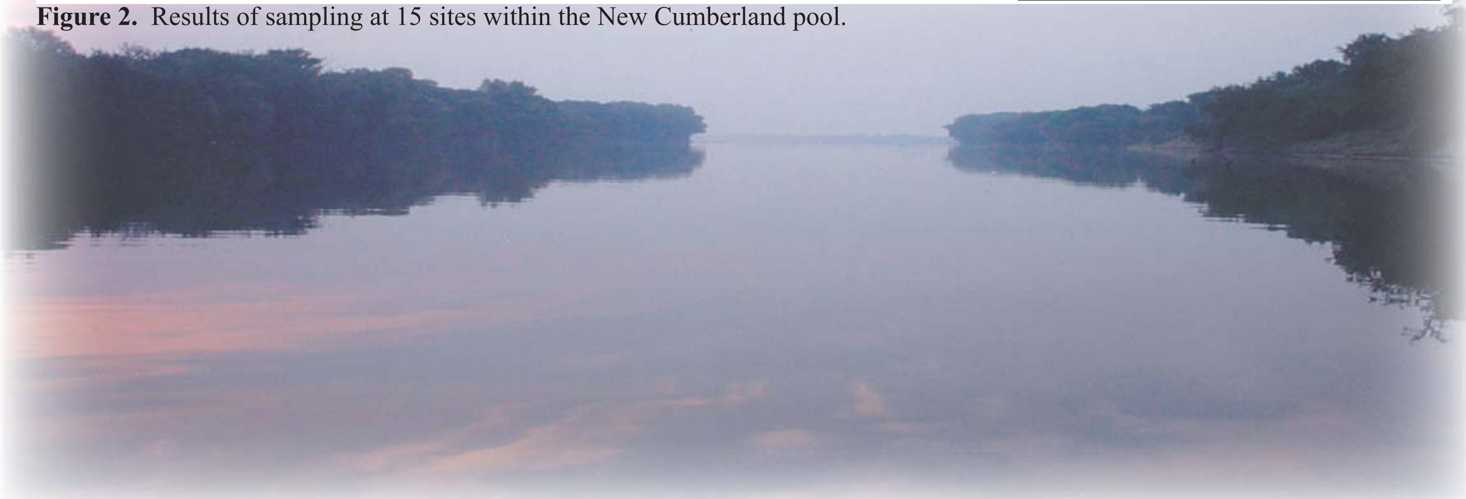


Figure 2. Results of sampling at 15 sites within the New Cumberland pool.



3.2 Index Period and Sampling Frequency

All sampling was conducted between July 1 and October 31, 2004. This sampling period reduces community variability by increasing the likelihood that samples are collected during the stable, low-flow conditions usually present on the Ohio River during the summer and early fall months. Seventy-four electrofishing events were conducted on the Ohio River from July through October, 15 of which were in the New Cumberland pool. Most sites were sampled precisely in the location generated from the design, but in a few cases sampling zones were shifted (maximum of 500m up- or downstream) due to restricted access or unsafe sampling conditions.

Typical 500 meter electrofishing reach.

3.3 Fish Collections

Standard collection techniques were employed throughout the surveys as described by ORSANCO's Standard Operating Procedures (1999). Fish were collected using boat electrofishing techniques at night. Nighttime electrofishing typically yields samples of increased diversity and richness (Sanders 1992). One three-person crew collected samples 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 section of 500 meter near-shore habitat for a minimum of 2000 seconds (Gammon 1983). Time could vary depending upon the density 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 confidently be identified in the field (e.g. minnows) were preserved in a ten percent formalin solution and identified in the laboratory.

3.4 Habitat Characterizations

Large rivers have distinct habitat zones, including unique microhabitats (Reash 1999). Therefore, extensive habitat surveys were conducted for each electrofishing zone. The surveys included thorough substrate and depth measurements, as well as woody cover estimates and riparian zone descriptions. 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 3m intervals beginning at the shore/water interface and moving out away from the shore for 30m. Woody cover, which included submerged brush, logs, and stumps, was estimated visually. Using these data each zone was assigned a habitat classification of A, B, or C. This habitat information was used by biologists to describe the influence of habitat on fish communities, and to determine if trends observed in populations are habitat induced or result from other factors.

3.5 Water Quality and Flow

Basic measures of water quality were collected at each sampling 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 flows 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).

ORSANCO crew conducting night-time electrofishing.

3.6 Assessment

As described above, each electrofishing site is classified as containing 'A', 'B', or 'C' habitat characteristics. Based on this habitat designation, the longitudinal location of a given site, and the time of year (Julian day) the sample was collected, an expectation is developed for each electrofishing site in the form of a predicted ORFIn score. By comparing this expected ORFIn score to the observed ORFIn score, biologists are able to determine whether or not a given site is meeting its aquatic life use designation. Each site is then labeled as either passing or failing and given a condition rating of excellent, good, fair, poor, or very poor. Once each site has been designated as passing or failing, all sites sampled within the pool are aggregated. If upon aggregation it is observed that more than 25% (within a particular confidence interval, see Appendix C) of the sites are deemed in failing condition, then the entire pool would be designated as being in failing condition, and therefore subject to further sampling.

4.0 Results

4.1 Fish Population

In 2004 crews collected fish population data (Appendix A) from 15 sites (Table 1) throughout the length of the New Cumberland pool. These collections produced 35 taxa representing 9 families (Table 2). Among these taxa there is one species listed as endangered in PA, the silver chub, (*Macrhybopsis storeriana*), two species listed as threatened in PA, the smallmouth buffalo (*Ictiobus bubalus*) and the channel darter (*Percina copelandi*), and one species listed as a special concern in PA, the longnose gar (*Lepisosteus osseus*). The channel darter is also listed as threatened in Ohio. The minnow family (Cyprinidae) was the most abundant in the collections, comprising 41.5% of the total abundance captured (Figure 3). The sucker family (Catostomidae) and the herring and shad family (Clupidae) were the next most abundant groups, combining to make 36% of the total abundance (Figure 3). At the species level, abundance was dominated by the mimic shiner (*Notropis volucellus*) and the emerald shiner (*Notropis atherinoides*),

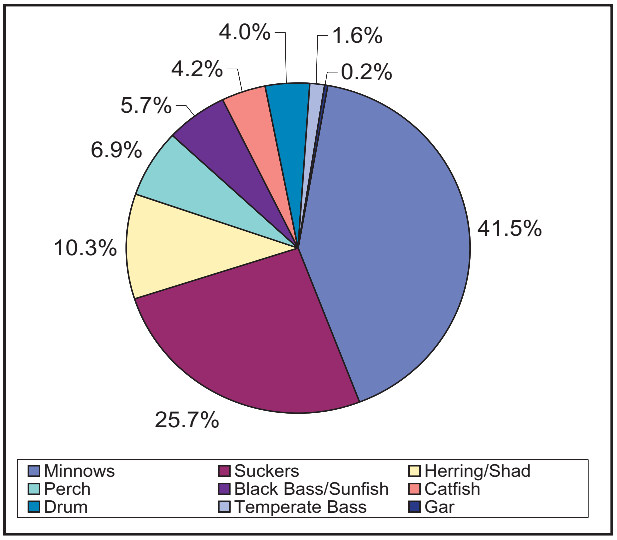


Figure 3. Fish composition by family in the New Cumberland pool.

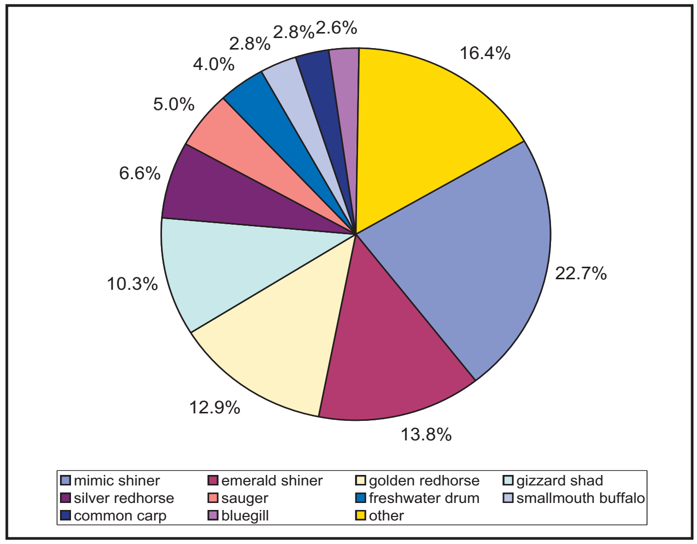


Figure 4. Species composition of fish sampled in the New Cumberland pool.

Table 1. Electrofishing site list for the New Cumberland pool, including habitat designation, ORFIn scores and status.

Rmi	Bank	Date	Latitude	Longitude	Habitat Type	Exp ORFIn	Obs ORFIn	Site Pass/Fail	Rating
37.2	RDB	10-Aug-04	40.639	80.468	B	33	13	FAIL	Very Poor
36.0	LDB	10-Aug-04	40.624	80.458	A	39	41	PASS	Fair
40.2	LDB	13-Jul-04	40.635	80.522	B	33	19	FAIL	Very Poor
42.5	LDB	08-Jul-04	40.619	80.559	A	39	27	FAIL	Poor
53.4	RDB	12-Jul-04	40.539	80.634	A	39	16	FAIL	Very Poor
48.3	LDB	06-Jul-04	40.597	80.648	A	39	43	PASS	Fair
46.4	LDB	07-Jul-04	40.617	80.623	A	39	25	FAIL	Very Poor
44.2	LDB	08-Jul-04	40.616	80.588	A	39	22	FAIL	Very Poor
32.8	LDB	13-Jul-04	40.645	80.402	A	39	41	PASS	Fair
46.8	LDB	12-Jul-04	40.614	80.631	A	39	23	FAIL	Very Poor
41.4	RDB	14-Jul-04	40.632	80.543	A	39	18	FAIL	Very Poor
39.9	LDB	14-Jul-04	40.636	80.516	B	33	23	FAIL	Poor
45.3	LDB	07-Jul-04	40.623	80.605	B	33	21	FAIL	Very Poor
51.6	RDB	06-Jul-04	40.561	80.652	A	39	37	FAIL	Poor
36.5	RDB	26-Jul-04	40.632	80.462	A	39	43	PASS	Fair

Rmi – River mile
RDB – Right Descending Bank
LDB – Left Descending Bank

Exp ORFIn – Expected ORFIn Score
Obs ORFIn – Observed ORFIn Score

Table 2. Species collected in the New Cumberland pool in the 2004 survey.

Family	Scientific name	Common name	PA Status	WV Status	OH Status
Lepisosteidae	*Lepisosteus osseus*	longnose gar	*SC*		
Clupeidae	*Dorosoma cepedianum*	gizzard shad			
Cyprinidae	*Cyprinus carpio*	common carp			
Cyprinidae	*Notropis hudsonius*	spottail shiner			
Cyprinidae	*Cyprinella spiloptera*	spotfin shiner			
Cyprinidae	*Notropis atherinoides*	emerald shiner			
Cyprinidae	*Notropis volucellus*	mimic shiner			
Cyprinidae	*Macrhybopsis storeriana*	silver chub	*E*		
Cyprinidae	*Pimephales notatus*	bluntnose minnow			
Catostomidae	*Catostomus commersonii*	white sucker			
Catostomidae	*Carpiodes cyprinus*	quillback carpsucker			
Catostomidae	*Carpiodes carpio*	river carpsucker			
Catostomidae	*Carpiodes velifer*	highfin carpsucker			
Catostomidae	*Moxostoma breviceps*	smallmouth redhorse			
Catostomidae	*Moxostoma anisurum*	silver redhorse			
Catostomidae	*Moxostoma duquesnei*	black redhorse			
Catostomidae	*Moxostoma erythrurum*	golden redhorse			
Catostomidae	*Ictiobus bubalus*	smallmouth buffalo	*T*		
Catostomidae	*Ictiobus niger*	black buffalo			
Ictaluridae	*Ictalurus punctatus*	channel catfish			
Ictaluridae	*Pylodictis olivaris*	flathead catfish			
Moronidae	*Morone sp*	morone sp			
Moronidae	*Morone saxatilis x chrysops*	hybrid striper			
Centrarchidae	*Ambloplites rupestris*	rock bass			
Centrarchidae	*Lepomis macrochirus*	bluegill			
Centrarchidae	*Micropterus dolomieu*	smallmouth bass			
Centrarchidae	*Micropterus salmoides*	largemouth bass			
Centrarchidae	*Micropterus punctulatus*	spotted bass			
Centrarchidae	*Pomoxis nigromaculatus*	black crappie			
Percidae	*Perca flavescens*	yellow perch			
Percidae	*Percina caprodes*	logperch			
Percidae	*Percina copelandi*	channel darter	*T*		*T*
Percidae	*Sander canandensis x vitreus*	saugeye			
Percidae	*Sander canadensis*	sauger			
Sciaenidae	*Aplodinotus grunniens*	freshwater drum			
35 taxa collected, representing 9 Families					

SC = Special Concern

T = Threatened

E = Endangered

comprising 22% and 14% respectively (Figure 4). The golden redhorse (*Moxostoma erythrurum*) comprised 13% of samples collected, followed by the gizzard shad (*Dorosoma cepedianum*) comprising 10% (Figure 4). Raw fish population data for each site sampled are displayed in Appendix A.

4.2 Metric Performance

Thirteen metrics were used to produce ORFIn scores at each electrofishing site (Emery et al. 2003). The performance of each metric and its score are listed in Table 3. The number of native species ranged from seven to 18 per site, with an average of just over 13. The number of sucker species ranged from two to seven, averaging around four per site. The number of centrarchid species ranged from zero to four with an average of two. The number of great river species recorded for each site was never higher than one. The number of intolerant species ranged from zero to five, averaging 2.4 per site. The percent tolerant individuals ranged from zero to 19.35%, averaging 5.8% per site. Percent simple lithophils ranged from 2.5% to 77.8% with an average value of 43.9%. Percent non-native individuals ranged from zero to 19.3% and averaged 7.4%. The three feeding guild metrics of % detritivores, % invertivores and % piscivores averaged 13%, 54.9% and 20.2% respectively. The number of DELT (deformities, eroded fins, lesions and tumors) anomolies at each site ranged from zero to four, averaging 1.3. The CPUE metric (catch per unit effort) ranged from 26 to 259 individuals per site, averaging just over 85 individuals per site. Additionally, of the 15 sites sampled, eight were subjected to the low-end scoring mechanism built into the ORFIn that applies when a given site produces fewer than 50 individuals, not including gizzard shad, emerald shiners, and exotic, hybrid, and tolerant species (Emery et al. 2003).

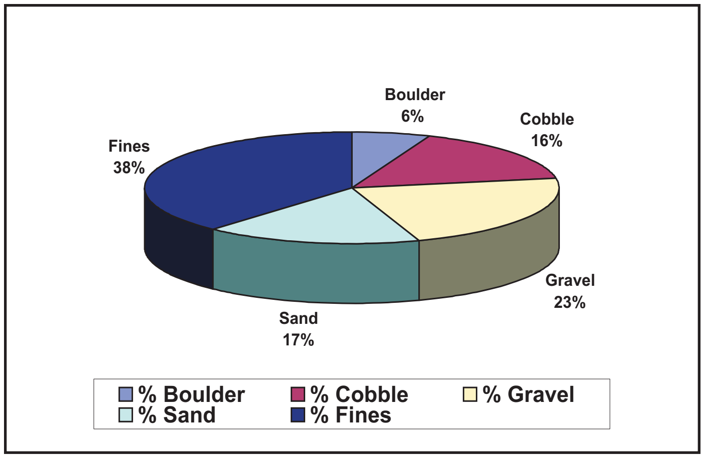


Figure 6. Substrate composition in the New Cumberland pool.

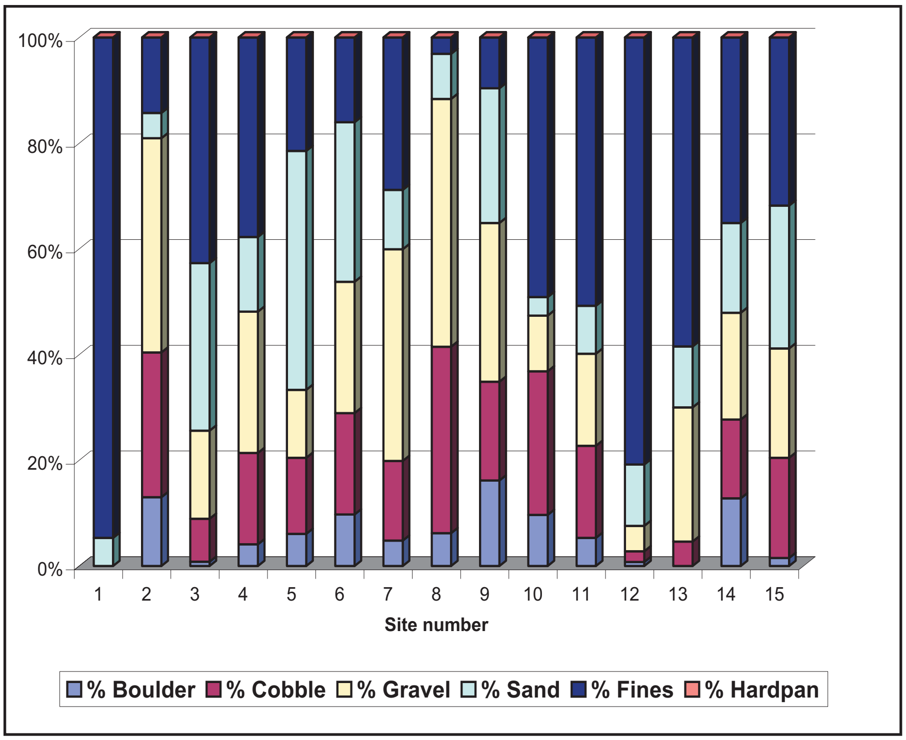


Figure 5. Sediment composition at each site.

4.3 Habitat Surveys

Intensive habitat surveys at each of the 15 sampling locations (Figure 5) revealed that the bottom substrate in the New Cumberland pool was dominated by fines, which comprised 38% of the substrate (Figure 6). The remaining substrate consisted of 23% gravel, 17% sand, 16% cobble, and six percent boulder. The substrate variables were compiled within a habitat index to give each site a habitat classification of 'A', 'B', or 'C' (Table 1). The New Cumberland pool was dominated by 'A' habitats, which accounted for 73% of the samples (Figure 7). The remaining 27% of the samples were made up of 'B' habitats. There were no 'C' habitats sampled in the pool. Woody cover was present in 13 of the 15 sites sampled, riparian land use was primarily industrial, and barge influence was present throughout the majority of the pool, directly affecting nearly 50% of the sites (Appendix B).

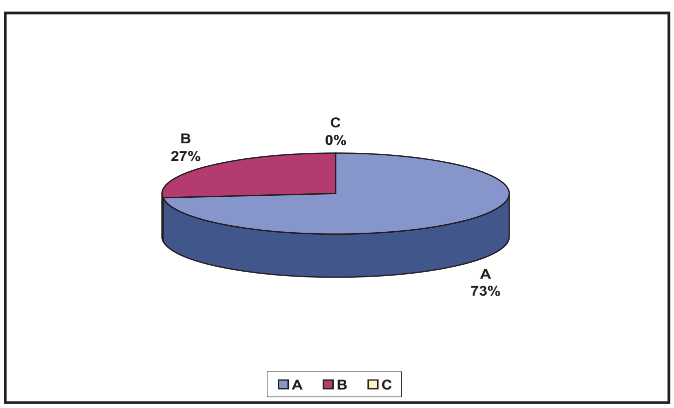


Figure 7. Habitat classes sampled in the New Cumberland pool.

Table 3. ORFIn metrics and scores from the New Cumberland pool 2004 survey.

River Mile	Bank	# Individuals	# Individuals w/o gizzard shad and emerald shiners	# Individuals w/o gizzard shad, emerald shiners and exotic, hybrid, and tolerant species	# Species	Species Score	# Sucker Species	Sucker Species 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	DELTs Score	CPUE	CPUE Score	Expected ORFIn Score	Observed ORFIn Score	Site Score Pass/Fail
37.2	RDB	73	40	37	7	1	2	1	0	0	0	0	1	1	2.50	1	2.50	1	7.50	1	5.00	1	42.50	1	40.00	1	2	3	70	1	33	13	FAIL
36	LDB	166	54	52	10	3	3	3	0	1	0	1	2	1	0.00	5	40.74	3	3.70	5	0.00	5	72.22	5	9.26	1	1	5	164	3	39	41	PASS
40.2	LDB	42	27	26	9	1	3	3	1	1	1	1	1	1	3.70	1	77.78	1	3.70	1	7.41	1	62.96	1	25.93	1	1	5	41	1	33	19	FAIL
42.5	LDB	63	57	50	16	3	6	5	3	3	1	1	3	3	1.75	1	63.16	1	12.28	1	10.53	1	63.16	1	21.05	1	0	5	56	1	39	27	FAIL
53.4	RDB	30	30	28	8	1	2	1	2	1	0	0	1	1	3.33	1	20.00	1	6.67	1	6.67	1	33.33	1	30.00	1	1	5	28	1	39	16	FAIL
48.3	LDB	68	68	66	16	3	6	5	2	1	1	1	3	3	1.47	5	67.65	5	2.94	5	11.76	3	63.24	5	14.71	1	0	5	66	1	39	43	PASS
46.4	LDB	64	47	43	18	3	6	5	3	3	1	1	3	3	8.51	1	48.94	1	8.51	1	29.79	1	48.94	1	14.89	1	2	3	60	1	39	25	FAIL
44.2	LDB	59	46	42	17	3	5	3	2	1	0	0	5	3	8.70	1	45.65	1	6.52	1	17.39	1	52.17	1	21.74	1	0	5	55	1	39	22	FAIL
32.8	LDB	259	236	236	15	3	3	3	2	1	1	1	4	3	0.00	5	8.05	1	0.00	5	0.00	5	92.80	5	5.93	1	0	5	259	3	39	41	PASS
46.8	LDB	42	40	35	11	3	6	5	1	1	1	1	2	1	12.50	1	55.00	1	12.50	1	30.00	1	52.50	1	17.50	1	0	5	37	1	39	23	FAIL
41.4	RDB	32	31	25	10	3	3	3	1	1	1	1	0	0	19.35	1	35.48	1	19.35	1	29.03	1	38.71	1	9.68	1	3	3	26	1	39	18	FAIL
39.9	LDB	48	33	29	14	3	3	3	3	3	1	1	2	1	12.12	1	45.45	1	12.12	1	18.18	1	36.36	1	36.36	1	0	5	44	1	33	23	FAIL
45.3	LDB	52	46	41	14	3	5	3	3	3	1	1	2	1	6.52	1	63.04	1	8.70	1	10.87	1	41.30	1	30.43	1	3	3	47	1	33	21	FAIL
51.6	RDB	112	111	104	18	3	7	5	4	3	0	1	3	3	6.31	3	51.35	5	6.31	3	16.22	3	67.57	5	10.81	1	4	1	105	1	39	37	FAIL
36.5	RDB	226	148	147	17	3	4	3	3	3	1	1	4	3	0.68	5	34.46	3	0.68	5	2.70	5	56.08	5	14.86	1	3	3	225	3	39	43	PASS

RDB – Right Descending Bank
LDB – Left Descending Bank
Centrarchid Species – black bass, sunfishes, crappie
Great River Species – fish expected to predominate in great rivers
Intolerant Species – species of fish with low pollution/disturbance tolerance
Tolerant Individuals – individuals with high pollution/disturbance tolerance
Simple Lithophils – reproductive grouping of fish species that are sensitive to substrate disturbance
Detritivore – feeding guild of fish species that feed primarily on detritus
Invertivore – feeding guild of fish species that feed primarily on invertebrates
Piscivore – feeding guild of fish species that feed primarily on fish
DELT – Deformities, Eroded fins, Lesions, and Tumors
CPUE – Catch Per Unit Effort

Table 4: Water quality data from the New Cumberland pool 2004 survey.

Rmi	pH	Temp (C)	Dissolved Oxygen (mg/L)	Conductivity	Secchi (in)
32.8	7.36	26.25	9.29	427	36
36	7.2	22.9	11.2	280	33
36.5	7.36	23.11	N/A	300	30
37.2	7.2	22.9	11.2	280	36
39.9	7.42	26.19	9.4	430	30
40.2	7.38	26.32	9	440	36
41.4	7.5	26.02	9	433	30
42.5	7.4	24.6	8.9	410	36
44.2	7.4	24.6	8.9	410	30
45.3	N/A	N/A	N/A	N/A	36
46.4	7.38	24.47	9.7	400	30
46.8	7.32	25.86	8.1	430	36
48.3	7.47	24.9	9	400	42
51.6	7.8	25.3	9.7	400	48
53.4	7.59	27.8	8	424	48

4.4 Water Quality and Flow

The basic water quality parameters of temperature, dissolved oxygen (DO), conductivity and pH were recorded at the electrofishing sites (Table 4). Additionally, secchi depth readings were collected as a measure of turbidity before each electrofishing event. Temperature ranged from 22.9° C to 27.8° C and averaged 25.1° C. DO ranged from 8 mg/l to 11.2 mg/l with an average of 9.33 mg/l. Conductivity readings ranged from 280 µS/cm to 440 µS/cm and averaged 390 µS/cm. Readings for pH ranged from 7.2 to 7.8 and averaged 7.41. Secchi depth readings ranged from 76.2 cm to 121.9 cm and averaged 90.9 cm. The harmonic mean flow of the Ohio River used for this area is 20.5 kcfs based on streamflow data analyzed by USGS. Flows for the New Cumberland pool during the sampling season ranged from 55.1 kcfs to 163.9 kcfs, averaging 91.8 kcfs (Figure 8).

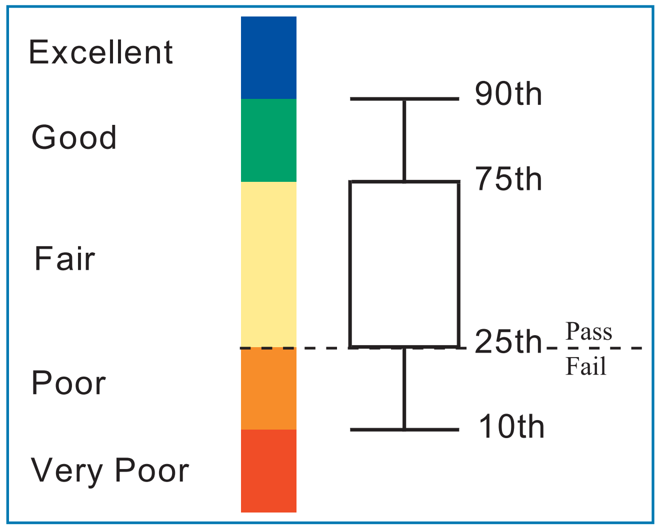


Figure 9. The approach used for assigning various condition ratings, using data from least impacted sites for each of the three habitat classes.

4.5 Assessment of Condition

The data collected from each zone were used to calculate an ORFIn score (Emery et al. 2003). The performance of each metric can be seen in Appendix C. The maximum score achieved by any site in this pool was 43 and the minimum was 13. An expected ORFIn score was generated from least impacted site data (Emery et al. 2003) for each zone based on habitat type. Observed ORFIn scores (Table 1) in the New Cumberland pool averaged 9.9 points below what was expected. By comparing observed and expected ORFIn scores, ORSANCO assigns sites a classification of passing or failing. Of the 15 sites sampled in 2004, only four received passing evaluations (Table 1). All sites sampled are assigned to one of the three habitat classes based on substrate composition. Sites determined to be 'least impacted' are used in lieu of true reference sites to develop expectations for each habitat class. For each of the three habitat classes, condition ratings are assigned based on statistical distribution of the data as shown in Figure 9. Those four passing sites received a fair condition rating, while the remaining 11 sites were found to be in either poor or very poor condition (Figure 10).

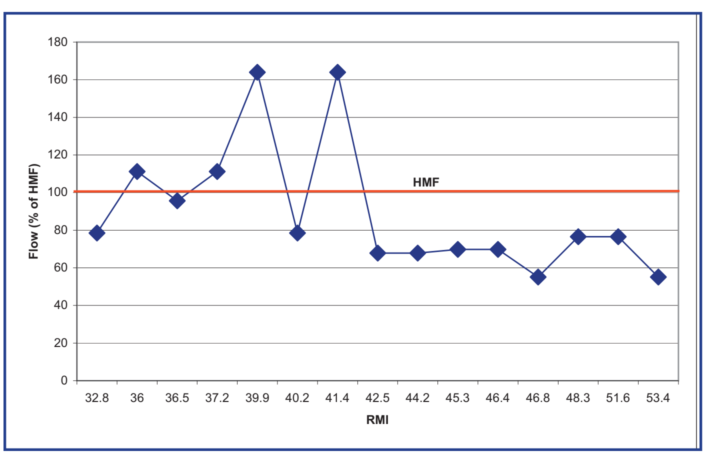


Figure 8. Daily flow for sampling events in the New Cumberland pool.

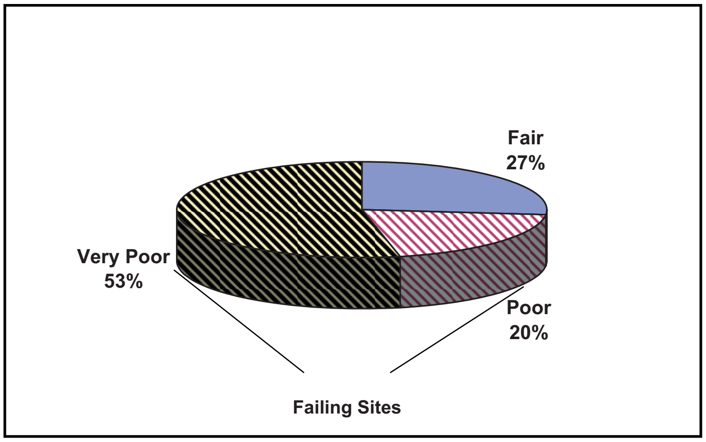


Figure 10. Condition of the New Cumberland pool based on ORFIn scores at 15 sites.

5.0 Discussion

5.1 Fish Population

In general, the fish population appeared healthy, as indicated by the lack of external anomalies present. Of the 35 species collected, several are currently listed as species of concern on state threatened and endangered lists. The two most notable of these species, the silver chub (*Macrhybopsis storeriana*) and the smallmouth buffalo (*Ictiobus bubalus*), were collected in fair numbers at 20 and 38 individuals respectively. Both of these species are common in the Ohio River, and the status of the species may be a function of their natural range distributions and limitations. It is also important to note the low percentage of non-native species collected. Recent invasions of exotic species, such as the silver and big-head carp (*Hypophthalmichthys molitrix* and *H. nobilis*), which are becoming more dominant in the lower stretches of the Ohio River have not become an issue in this pool.

5.2 Metric Performance

The "low-end" scoring technique (Emery et al. 2003) caused lower overall ORFIn scores at several sites. This was most notable in the Great River Species metric, scoring a zero on three occasions. Other metrics associated with low ORFIn scores include Percent Simple Lithophils, scoring one at 11 of the 15 sites, and Percent Piscivores, scoring one at all sites sampled. Based on the combined experience of biologists conducting this survey and findings of Emery et al. (2003), higher species diversity was expected. It was anticipated that 15 sites concentrated within a relatively small spatial area encompassing diverse habitat types would have produced higher abundance and diversity. Again, since this was the first application of a probability design and since unusual flow and weather conditions were encountered, it is not known which factor(s) singularly or in concert contributed to the observed conditions.

5.3 Habitat

Three distinct habitat classes, 'A', 'B', and 'C', have been identified on the Ohio River. 'A' habitats are generally deeper and dominated by more course substrates. Additionally, 'A' habitats generally score higher than 'B' or 'C'. Generally speaking, 'A' and 'B' habitats tend to support a more diverse and abundant fish population (unpublished data). In the New Cumberland pool, 'A' habitats were dominant. It would be expected that a pool dominated by such high quality habitats would produce more diverse fish populations, and higher ORFIn scores. This leads researchers to believe that poor metric performance, and subsequently, poor ORFIn performance is not a function of poor habitat.

5.4 Water Quality and Flow

Parameters collected at each electrofishing site provided no explanation for the low ORFIn scores generated from the data at these sites. Values for temperature, DO, conductivity, and pH all fell into a range that would be considered normal or background for this section of the river. In addition, other monitoring activities conducted by ORSANCO provided no data that could indicate low scores being attributed to a water quality issue. Flow values, in contrast, were elevated on several occasions during the sampling period. In some cases, flows reached values over twice that of the harmonic mean flow. Higher flows can cause several problems during sampling, including decreased capture efficiency, which could potentially reduce metric and index performance.

5.5 Assessment and Conclusions

The probabilistic design was implemented on the Ohio River in order to biologically assess a navigational pool. Hence, each navigational pool will serve as a distinct assessment unit (AU) and will be reported on individually in the 305(b) report to EPA.

The criteria for reporting on the condition of an AU are based on the performance of the ORFIn in relation to the habitat at the 15 sites sampled in each unit. Each site, based upon its habitat classification, will have an "expected" ORFIn score generated. This score reflects how a particular site should perform. The observed score for each site within the AU is then compared to the expected score, with each site assigned as passing or failing. The sites are then aggregated and the AU is viewed as a percentage of sites passing and failing. If an AU is assessed and exhibits greater than 25%, + or – the estimated precision (see Appendix C), of the sites as failing, then the assessment is accepted as valid, and the AU would be reported as failing to meet the established aquatic life use designation. If the estimated precision was not achieved, then the AU would be considered unassessed and further sampling would be needed. Less than 25% failing sites (+/- estimated precision) would indicate that the AU meets the aquatic life use designation.

In the New Cumberland pool, nearly 75% of the sites sampled were deemed as failing, causing the pool to be reported as impaired and not supporting its designated aquatic life use criteria. Designating the AU as impaired leads to implications that would require the AU to be included in the 305(b) report on stream condition required by the Clean Water Act (CWA). Reporting this stream segment as impaired would also require that it be placed on the list of impaired streams as directed by section 303(d) of the CWA. This list has several categories for classifying streams based on the type of stressor involved and whether or not a specific stressor or pollutant can be identified as the source of the impairment. Based on 2004 data, it is likely that the New Cumberland pool AU would be placed on the 303(d) list in category 5a, which states that an impaired biological condition has been detected, but due to an unknown stressor or cause. Listing the AU in category 5a would require that additional sampling efforts (e.g. intense chemical and/or physical habitat measurements) be undertaken to identify the cause. If this follow-up work identifies the source of impairment as a pollutant, then the AU would be reclassified as category 5c, which would require the development of a Total Maximum Daily Load (TMDL) for that stressor. If it is determined that impairment is caused by something other than a pollutant (e.g. habitat, natural, hydrologic), then the AU would be reclassified as category 4c, again requiring additional sampling to allow for a more precise determination of cause without requiring TMDL development.

An explanation for the high proportion of failing sites remains unclear. By design, the probability-based method eliminates human bias in the selection of sample sites. Sampling locations avoided in the past due to elevated human activity were sampled in this design. The New Cumberland pool was designated as "fully supporting" the aquatic life use based on water quality. This assessment was determined using water quality data from bimonthly and clean metals sampling sites. Parameters such as dissolved oxygen, ammonia, and various dissolved metals have criteria that must be met to provide protection of warm water aquatic life. No violations of the aquatic life criteria for clean metals or bimonthly parameters were observed. This indicates that multiple factors other than water quality may be influencing fish populations and therefore affecting ORFIn scores.

As described above, water quality results did not indicate impairment during 2004, nor were any significant differences in parameters observed during this time period that could have led to a drastic change in the fish community. This suggests that based on ORSANCO's monitoring, water quality conditions did not affect the fish community in 2004. Explanations for low ORFIn scores other than water quality may include elevated flows and river stage that occurred during the 2004 sampling season. Higher stage and flow conditions are generally associated with higher turbidity levels, which can hinder effective fish collection. Swift flows can also affect capture efficiency by making both boat operation and netting proficiency more difficult. Additionally, many species normally common in the mainstem seek refugia during these periods of high flow. Future sampling and more intense analysis of flow data may offer better explanations of the lower observed scores.

The probabilistic assessment design was successfully conducted in the New Cumberland pool. The primary goals of this method were to adequately assess a given AU while minimizing resource expenditure, reduce or eliminate human bias, and provide statistically valid results. Although further sampling is needed to confirm the results, this design appears to have accomplished these goals.

Literature Cited

Emery, E.B., T.P. Simon, F.H. McCormick, P.L. Angermeier, J.E. Deshon, C.O. Yoder, R.E. Sanders, W.D. Pearson, G.D. Hickman, R.J. Reash, and J.A. Thomas 2003. Development of a multimetric index for assessing the biological condition of the Ohio River. Transactions of the American Fisheries Society. 132: 791-808.

Gammon, J.R. 1998. The Wabash River Ecosystem. Indiana University Press, Bloomington.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers. 77: 179-190.

ORSANCO (Ohio River Valley Water Sanitation Commission) 1994. Ohio River Fact Book. ORSANCO, Cincinnati, OH.

ORSANCO (Ohio River Valley Water Sanitation Commission) 1999. Boat Electrofishing Standard Operating Procedure. ORSANCO, Cincinnati, OH.

Reash, R.J. 1999. Considerations for characterizing Midwestern large river habitats. Pages 463-473 *in* Simon (1999). Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities. CRC Press, Boca Raton, FL

Sanders, R.E. 1992. Day versus night electrofishing catches from near-shore waters of the Ohio and Muskingum Rivers. Ohio Journal of Science. 92: 51-59.