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BRAIDWOOD STATION

2011 BENTHOS MONITORING AND HISTORICAL FISH AND BENTHOS COMPARISONS

Prepared for:

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200 Exelon Way
Kennett Square, Pennsylvania

Prepared by:

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July 2012

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1. INTRODUCTION

Benthos monitoring was conducted during the summer of 2011 in the Kankakee River upstream and downstream of Braidwood Station.

Current aquatic biological information was needed to support the preparation of the Environmental Report that is part of the U.S. Nuclear Regulatory Commission (NRC) License Renewal Application for the Braidwood Generating Station. The 2011 data were compared with historical data to determine if there have been changes in the Kankakee River that could be related to station operation.

Braidwood Station is located in Will County about 20 miles south of Joliet, Illinois near Godley, Illinois and approximately three miles southwest of the Kankakee River. Makeup cooling water for the two generating units is withdrawn from the Kankakee River approximately nine miles upstream of the Wilmington Dam. Braidwood Station has a closed cycle cooling system that uses a perched cooling pond. A river diffuser is used to discharge blowdown water from the cooling pond downstream of the intake.

The 2011 monitoring program was comprised of two primary elements:

- Benthos sampling using artificial substrate samplers and a grab sampler or kick net along transects that were established during pre-operational studies conducted in the late 1970's (INHS 1980).

- Obtain recent fish data collected in 2010 and 2011 at locations sampled during previous monitoring efforts.

The objectives of the 2011 Braidwood program were to:

- Determine the current species composition, relative abundance, and distribution of fish within the study area and compare results with available historical data from pre-operational studies.

- Determine current taxa richness, density, and relative abundance of benthos within the study area and compare results with available historical data from pre-operational studies.

- Determine status of 316(b) issues.

EA Engineering, Science, and Technology (EA) was contracted by the Exelon Generation Company, LLC to perform these tasks.

2. METHODS

2.1 FIELD

Benthic macroinvertebrates were collected along three of the transects (1, 4, and 5) that were established during the pre-operational studies (Figure 1). Sampling was conducted along one bank upstream (1L), along both banks adjacent to the discharge (4L and 4R), and along both banks downstream (5L and 5R). Each location was sampled using a combination of Hester-Dendy (HD) artificial substrates and Ponar grabs or kick nets.

Each modified HD artificial substrate sampler consisted of eight 3x3-inch plates constructed from 1/8 inch tempered hardboard and twelve 1/8 plastic spacers. The plates and spacers were arranged on a 1/4 inch eyebolt so that each sampler had three 1/8 inch spaces, three 1/4 inch spaces, and one 3/8 inch space among the plates. The total surface area of a single sampler, excluding the eyebolt, was 0.093 m^2 (1.01 ft^2). A single HD sample consisted of a five HD sampler array, arranged on a single cinder block, and deployed on the stream bottom. Duplicate HD sets were deployed at each location to minimize the loss of samplers (e.g., from vandalism). The HD samplers were set on 6 July 2011 and retrieved approximately eight weeks later on 1 September 2011. Retrieval of the HDs was accomplished by enclosing the samplers in a fine-mesh sweep-net and then carefully lifting the sampler array and net to the surface. The HDs were placed into a single labeled container, and preserved with 10% formalin.

The Ponar and/or kick net samples were collected concurrent with the HD sample retrieval. Ponar samples from each location consisted of four composite grab samples at each location using a full-sized 522.6 cm^2 (81 in^2) Ponar dredge sampler. For locations where the substrate was too coarse to obtain a Ponar grab sample, four, 522.6 cm^2 (81 in^2) kick net samples were collected. Each sample was sieved in the field using an U.S. Standard No. 35 (500 μm) mesh sieve and preserved. The material obtained in each sample was examined to qualitatively determine substrate characteristics and percent composition.

2.2 LABORATORY

Upon arrival at the laboratory, the samples were logged in and accounted for. Based on measured current velocity, the amount of silt/debris caught on the samplers and the numbers and types of organisms observed during retrieval, one of the duplicate HD arrays from each location was initially processed. The second HD array was kept as a backup. The five HDs from each array were disassembled in a water-filled enamel pan and cleaned of organisms and debris. This mixture was then passed through a No. 60 (250 μm mesh) U.S. Standard Testing Sieve and preserved in labeled containers containing 10% formalin.

Sorting of each HD and Ponar grab or kick net sample was conducted in gridded petri dishes under a dissecting stereo-scope at 10X magnification. The samples were initially pre-picked to remove any large or rare taxa (less than 20 individuals/sample) prior to subsampling. When necessary, a Folsum sample splitter was used to subsample until a manageable number of organisms was achieved. A minimum of 250 organisms in representative proportions was removed from the fractionated samples. Organisms from all sample types were sorted to higher taxonomic levels (generally Class or Order level) and preserved separately in labeled vials containing 70% ethyl alcohol. Sorted samples were routinely checked by senior EA personnel to assure a consistent level of quality and sorting efficiency.

Macroinvertebrate identifications were made to the lowest practical taxonomic level using the most current literature available. Chironomidae (midge) larvae were cleared in 10% potassium hydroxide and mounted in CMC-10 on glass slides prior to identification. For all sample types, specimens were enumerated, coded, and recorded on a standard laboratory bench sheet for data processing.

2.3. DATA ANALYSIS AND INTERPRETATION

The following data were used for spatial and temporal comparisons:

1) Density (no./m^2) – Density is the total number of individuals collected within a square meter. Extremely high or low density relative to other locations may be indicative of environmental stress.

2) Relative Abundance (%) – Relative abundance is the percent each taxon composes within a sample. Dominance by one taxon or relatively few taxa may suggest greater environmental stress.

3) Dominant Taxa – Based on relative abundance, similarities in the top five dominant taxa among stations suggests balance within the benthic community. Numerical dominance by one or a few taxa may suggest impairment.

4) Total Taxa Richness – Total number of different types of macroinvertebrates. Generally, the higher the taxa richness, the better the quality of the benthic community.

5) EPT Taxa Richness – Collectively, Ephemeroptera, Plecoptera, and Trichoptera are referred to as EPT. EPT richness is the number of taxa identified from these groups. Since EPT taxa are generally considered to be intolerant of environmental stress, a relatively higher number of EPT taxa typically represent a quality benthic community.

6) Tolerance Values – Developed by the Illinois Environmental Protection Agency (IEPA 1987) tolerance values are used to generally characterize the environmental sensitivity of the benthic community. The tolerance values were derived for individual macroinvertebrate taxa and reflect an increasing level of pollution tolerance from 0 (least tolerant) to 11 (most tolerant). A benthos community dominated by taxa with lower tolerance values is typically indicative of a healthy benthic community while a higher tolerance values suggest some degree of impairment.

For temporal comparisons, the 2011 results were compared to results from the final year of pre-operational benthos monitoring that was conducted by the Illinois Natural History Survey (INHS) in 1979 (INHS 1980). Due to taxonomic differences between the pre-operational study and 2011 study, the taxonomy was adjusted to a common level of taxonomic resolution to facilitate temporal comparisons in terms of total and EPT taxa richness. Appendix A provides the raw 2011 benthic macroinvertebrate data.

3.0 RESULTS

3.1 BENTHOS

During 2011, benthic macroinvertebrate sampling was conducted at five locations on the Kankakee River near Braidwood Station: 1L, 4L, 4R, 5L, and 5R (Figure 1). HD samples were collected from four of the five locations while Ponar grab or kick net collections were made at all five locations. Despite setting three duplicate HD sampler arrays at Location 5L, all were missing and presumably vandalized.

Overall, the 2011 benthos collections yielded 72 total taxa (Table 1). Chironomidae was the most taxa rich group with 24 taxa followed by Ephemeroptera with 15 taxa and Bivalvia with six taxa.

3.1.1 Hester-Dendy

The four HD samples yielded a combined 48 total taxa (Table 2). Chironomidae was the most taxa rich group with 18 taxa while Ephemeroptera contributed 11 taxa to the HD richness. Total taxa richness was highest at Locations 1L and 4R (30 taxa), slightly lower at Location 5R (27 taxa), and lowest at Location 4L with 20 taxa (Table 2). Location 4R also had the highest EPT richness with 11 taxa followed by Locations 1L and 5R with six taxa and Location 4L with four taxa (Table 2). Flow and water level on the Kankakee River dropped noticeably during the eight-week colonization period. As a result, portions of the Location 4L HDs were exposed above the water surface, which may have contributed to the low total and EPT taxa richness observed at that location.

As with the taxa richness measures, density (no./m^2) was highest at Location 4R, slightly lower at Locations 1L and 4L, and lowest at Location 5R (Table 2). Decreased river flow after the samplers were deployed exposed a sand bar adjacent to the Location 5R HDs, effectively isolating the samplers in a pool without flow. Since flow is only second to water quality in determining colonization success with HD samples (OEPA 1988), it is likely that the lack of flow for part of the deployment may have adversely affected colonization on the Location 5R HDs and contributed to the lower observed density.

The higher density observed at Location 4R was largely due to a high number of Turbellaria, which composed 60 percent of the total density (Table 2). Overall, dominant taxa among the four locations exhibited some similarities but no longitudinal trends.

HD Dominant Taxa in Order of Percent Abundance

1L	4L	4R	5R
Turbellaria	*Hyalella azteca*	Turbellaria	*Stenacron*
Stenacron	*D. neomodestus*	*Stenacron*	*Glyptotendipes*
Tricorythodes	*Stenacron*	*Stenochironomus*	*Tricorythodes*
D. neomodestus	*Argia*	*M. terminatum*	*Tribelos fuscicorne*
Argia	Turbellaria	*Polypedilum flavum*	*S. femoratum*

The relatively intolerant Ephemeroptera taxon *Stenacron* was among the dominant taxa at each of the four locations while the more facultative taxon Turbellaria was among the dominant taxa at three of the four locations. Based on the environmental tolerance values developed by the Illinois Environmental Protection Agency (IEPA 1987), the only tolerant taxon among the five most dominant taxa was *Glyptotendipes* at Location 5R. In contrast, facultative taxa or relatively intolerant taxa such as *Maccaffertium terminatum*, *Stenonema femoratum*, *Stenacron*, *Tricorythodes*, and *Stenochironomus* were generally more common among the four locations.

3.1.2 Ponar and Kick Net Samples

Due to the abundance of coarse substrate, kick net samples were substituted for Ponar samples at Locations 1L, 4L, and 4R, whereas Ponar grab samples were collected at Locations 5L and 5R. Combined, the Ponar grab and kick net samples from the five locations yielded 53 taxa (Table 3). As with the HD results, Chironomidae was the most taxa rich group with 17 taxa while 11 Ephemeroptera taxa were also observed. Total taxa richness was highest at Location 1L (31 taxa) and lower but similar at Locations 4L, 4R, 5L, and 5R with 20 to 23 total taxa (Table 3). EPT richness also was highest at Location 1L (11 taxa), similar at Locations 4L and 4R (eight taxa), and lowest at Locations 5L and 5R with four and five taxa, respectively (Table 3).

Total density (no./m^2) was highest at Location 5R, lower at Locations 1L and 5L, and lowest at Locations 4L and 4R (Table 3). The higher density observed at Location 5R was largely due to a high number of Tubificidae, which composed nearly 40 percent of the total density (Table 3). No single taxon was dominant at all five locations; however, the snail *Pleurocera* was among the dominant taxa at three of the five locations:

Kick Net and Ponar Dominant Taxa in Order of Percent Abundance

1L Kick Net	4L Kick Net	4R Kick Net	5L Ponar	5R Ponar
Caenis	*Tricorythodes*	*Stenelmis*	Tubificidae	Tubificidae
Turbellaria	*D. neomodestus* *Pleurocera*	*Baetis intercalaris*	*Chironomus*	*P. scalaenum grp.*
C. vanderwulpi grp.	*M. terminatum* *Hydroptila*	*Ephemera*	*Procladius*	*Hexagenia limbata*
Tricorythodes	*Caenis* *Microtendipes*	Turbellaria	*Pleurocera*	*Pleurocera*
A. myops *Microtendipes*	*A. mallochi*	*Stenacron*	*P. scalaenum grp.*	*Cryptochironomus*

Based on IEPA environmental tolerance values (IEPA 1987), relatively intolerant Ephemeroptera taxa such as *Caenis*, *Tricorythodes*, *Maccaffertium terminatum*, *Stenacron*, *Anthopotamus myops*, and *Ephemera* were more common among the kick net samples whereas generally tolerant taxa such as Tubificidae, *Procladius*, *Chironomus*, and *Cryptochironomus* were more common in the Ponar samples.

Overall, the spatial differences in terms of EPT richness, dominant taxa, and benthic community structure differed primarily by sample type. Kick net samples were collected from locations dominated by coarse substrate (i.e., boulder, cobble, and gravel), whereas Ponar grabs were collected in areas dominated by fine substrate (silt and sand).

Kick Net and Ponar Percent Substrate Composition

Substrate	1L	4L	4R	5L	5R
Boulder	5	10			
Cobble	45	80	80		
Gravel	20	10	10		
Coarse Sand	20		10	60	40
Fine Sand				10	20
Silt				10	20
Detritus	10			20	20

As indicated by the substrate composition at each location, substrate complexity and habitat quality was better among the upstream locations, particularly at Location 1L. Immediately upstream of Locations 5L and 5R, the river broadens, slows, and the substrate consists largely of depositional sand and silt. Benthic community quality generally corresponds to habitat and substrate complexity. Intolerant EPT taxa generally prefer areas with good exchange associated with flow as well as coarse and clean substrate while tolerant taxa will often dominate relatively poor habitat with slow current velocity and fine substrate. As such, it appears the spatial differences observed among the kick net and Ponar samples are attributable to longitudinal changes in habitat quality.

4. DISCUSSION

4.1 BENTHOS

4.1.1 Pre-Operational Studies

An aquatic monitoring program to define baseline ecological conditions in the Kankakee River and Horse Creek near the Braidwood Station intake and discharge structures was initiated by Westinghouse Electric Corporation (WEC) in October 1972 and continued through March 1975 (WEC 1975). The baseline aquatic monitoring program included both fisheries studies and benthos studies. The fisheries studies are described in Section 4.2. The INHS conducted annual pre-operational benthos sampling near Braidwood Station from 1977 through 1979 (INHS 1980).

In 1979, the INHS collected seasonal HD and Ponar grab or kick net samples from the Kankakee River (INHS 1980). HDs were collected in June, August, and September while Ponar grabs or kick nets were collected in May, August, and November. HD and grab or kick net sampling was conducted at eight Kankakee River locations: 1L, 1R, 4L, 4R, 5L, 5R, 6L, and 6R (Figure 1).

The August 1979 benthos collections from Locations 1L, 4L, 4R, 5L, and 5R yielded 82 total and 29 EPT taxa (INHS 1980). Chironomidae was the most taxa rich group with 26 taxa followed by Ephemeroptera and Trichoptera with 15 and 14 taxa, respectively (INHS 1980).

Hester Dendy Results

Among the HDs, total taxa richness was highest at Location 4R and similar at Locations 1L, 4L, and 5R (INHS 1980, Tables 4E-2 through 4E-6). EPT richness was highest at Locations 4R and 4L, lower at Location 1L, and lowest at Location 5R (INHS 1980, Tables 4E-2 through 4E-6).

Summary of HD Results – August 1979

Parameter	**1L**	**4L**	**4R**	**5R**
Density (no./m^2)	1,877	2,547	4,418	1,404
Total Taxa Richness	32	34	45	30
EPT Taxa Richness	13	21	21	8

As with the taxa richness measures, density (no./m^2) was highest at Location 4R, slightly lower at Location 4L, and similarly lowest at Locations 1L and 5R (INHS 1980, Table 4-91). The higher density observed at Location 4R was largely due to a high number of the Trichoptera taxa *Cheumatopsyche* (INHS 1980, Table 4-5). Overall, dominant taxa among the four locations were generally similar.

HD Dominant Taxa in Order of Percent Abundance

1L	**4L**	**4R**	**5R**
Cheumatopsyche	*Cheumatopsyche*	*Cheumatopsyche*	*Tricorythodes*
M. integrum	*H. phalerata*	*Rheotanytarsus* *M. integrum*	Tubificidae
Tricorythodes	*M. integrum*	*Polypedilum*	*M. integrum*

Stenacron	*Polypedilum*	*Isonychia*	*Tanytarsus*
Psephenus herricki	*Simulium*	*Ceratopsyche morosa*	*Polypedilum*

The relatively intolerant Ephemeroptera taxon *Maccaffertium integrum* was the only taxon to be among the dominants at each of the four stations while *Cheumatopsyche* and *Polypedilum* were among the dominant taxa at three of the four locations. Based on the environmental tolerance values developed by the Illinois Environmental Protection Agency (IEPA 1987), the only tolerant taxon among the most dominants was Tubificidae at Location 5R. In contrast, facultative taxa or relatively intolerant taxa such as *Maccaffertium integrum*, *Stenacron*, *Tricorythodes*, *Ceratopsyche morosa*, and *Hydropsyche phalerata* were generally more common among the four locations.

Benthic Grab Results

Due to the abundance of coarse substrate, Ponar samples were not collected at Locations 1L, 4L, and 4R. For these locations, the substrate in an area equivalent to the Ponar sampling area was handpicked. However, Ponar samples were collected at Locations 5L and 5R. Total taxa richness was highest at Location 1L, slightly lower but similar at Locations 5L and 5R, and lowest at Locations 4L and 4R (INHS 1980, Tables 3D-1 and 3D-4 through 3D-7). EPT richness also was highest at Location 1L as well as Location 5R and similarly lower at Locations 4L, 4R, and 5L (INHS 1980, Tables 3D-1 and 3D-4 through 3D-7).

Summary of Benthic Grab Results – August 1979

Parameter	**1L**	**4L**	**4R**	**5L**	**5R**
Density (no./m^2)	745	664	475	3,758	5,058
Total Taxa Richness	26	17	14	23	22
EPT Taxa Richness	6	3	4	3	6

Total density (no./m^2) was highest at Location 5R, slightly lower at Location 5L, and lowest at Locations 1L, 4L, and 4R (INHS 1980, Tables 3D-1 and 3D-4 through 3D-7). The higher densities observed at Locations 5L and 5R were largely due to a high number of Tubificidae, which composed approximately 60 percent of the total density (INHS 1980, Table 3-5). Two tolerant taxa, Tubificidae and *Procladius*, were among the dominant taxa at all five locations while the relatively intolerant *Stenacron* was among the dominant taxa at three of the five locations.

HD Dominant Taxa in Order of Percent Abundance

1L	**4L**	**4R**	**5L**	**5R**
Tubificidae *Stenacron*	*Stenacron*	*Stenacron*	Tubificidae	Tubificidae
Pisidium	*Tricorythodes*	Tubificidae	*Sphaerium*	*Hexagenia*
Corixidae	Tubificidae	*Hexagenia*	*Procladius*	*Sphaerium*
Hyalella azteca *Polycentropus*	*Procladius*	*Dubiraphia*	Corixidae	*Dubiraphia*
Sphaerium *Procladius*	*P. herricki* *Dicrotendipes*	*Procladius*	*Polypedilum*	*Procladius*

Based on IEPA environmental tolerance values (IEPA 1987), relatively intolerant Ephemeroptera taxa such as *Tricorythodes* and *Stenacron* were more common among the handpicked substrate samples whereas generally tolerant taxa such as Tubificidae and *Procladius* were more common in the Ponar samples.

Overall, the spatial differences in terms of total richness, dominant taxa, and benthic community structure differed primarily by sample type. Handpicked substrate samples were collected from locations dominated by coarse substrate (i.e., bedrock, boulder, and cobble), whereas Ponar grabs were collected in areas dominated by fine substrate (silt and sand).

Mean Particle Size Percent Composition – August 1979

Substrate	1L	4L	4R	5L	5R
Bedrock	66.7	100.0	33.3		
Gravel	2.7		3.0	0.9	
Coarse Sand	0.7		3.0	0.4	0.1
Medium Sand	7.0		16.8	2.8	9.2
Fine Sand	19.4		36.0	23.2	57.6
Silt	3.4		7.4	68.0	31.9
Clay	0.1		0.5	4.7	1.2

Based on the percent composition by mean particle size, Locations 1L, 4L, and 4R were dominated by coarse substrate while the substrate at Locations 5L and 5R largely consisted of depositional sand and silt (INHS 1980, Table 3B-2). Intolerant EPT taxa generally prefer areas with good exchange associated with flow as well as coarse and clean substrate while tolerant taxa will often dominate relatively poor habitat with slow current velocity and fine substrate. As such, it appears the spatial differences observed among the three upstream and two downstream locations are attributable to longitudinal changes in habitat quality.

4.1.2 Summary

Comparisons between the August 1979 and 2011 benthos surveys are challenging due largely to variations in sampling methods such as different types of modified HDs (four round 0.061 m^2 versus five square 0.093 m^2), different size Ponar samplers (530 cm^2 versus 522.6 cm^2), and differences in methods substituted for Ponar grabs (e.g., handpicked substrate vs. kick net samples). In addition, although the general locations are known, the exact locality of where the HDs were deployed and the benthic grabs were collected in 1979 compared to 2011 is unknown. Finally, the effects of inherent changes that have occurred in the Kankakee River and watershed over the past 32 years are not completely understood. Despite these differences and challenges, the 1979 and 2011 results exhibited several similarities.

For the HD results, density, total richness, and EPT richness at Location 4R were either the highest or tied for the highest in both 1979 and 2011. Likewise, results from Location 5R, where the river broadens and slows, were among the lowest observed for the HDs in both years. In terms of taxa composition, the benthic community in both 1979 and 2011 was dominated by primarily facultative or intolerant taxa while tolerant taxa were common only in the Location 5R HD samples.

Ponar grab, kick netting, and handpicking results from 1979 and 2011 also exhibited many similarities. In both surveys, total and EPT taxa richness were highest or tied for highest at Location 1L. The 1979 and 2011 Ponar samples from Locations 5R and 5L produced the highest density while Location 4R had the lowest density. In terms of taxa composition, intolerant taxa were generally more abundant among the upstream locations while tolerant taxa were more abundant downstream during each year. In both surveys, these longitudinal differences appear to be largely attributable to changes in substrate composition.

Although some differences in the benthic community were evident between years, overall, the 2011 benthic community in the Kankakee River near Braidwood Station was rather similar to the community observed in 1979. In both surveys, longitudinal changes occurred in the benthic community. However, in both the 1979 and 2011 surveys, the disparity appears to be attributable to differences in habitat quality related to stream velocity and substrate composition rather that the operation of Braidwood Station.

4.2 FISH

4.2.1 Post-Operational Studies

Braidwood Unit 1 began commercial operation on 29 July 1988 followed by Unit 2 on 17 October 1988. The Illinois Natural History Survey (INHS), which had conducted pre-operational studies, continued to conduct studies through 1990. Beginning in 1988, the long-term monitoring program conducted for Braidwood Station was modified to include only fish sampling during August. This program continues, with the most recent survey completed in August 2011 (HDR 2012). The Illinois Department of Natural Resources (IDNR) conducts Kankakee River Basin Surveys, which includes a sampling location near the Braidwood Station river screen house. In recent years these surveys are conducted every five years. The most recent final report is for the 2005 basin survey (Pescitelli and Rung 2008). Although the report for the 2010 basin survey is not yet available, information on species composition, abundance, and IBI scores was provided by S. Pescitelli, IDNR Region II Stream Specialist (personal communication).

<u>IDNR Kankakee River Basin Surveys</u>

The IDNR conducted fish surveys in July 2005 and 2010 at 13 stations on the Kankakee River main stem and 11 stations on 10 tributary streams. Sampling locations for the 2010 survey were similar to those used for previous basin surveys in 1994, 2000, and 2005. Station F-08 encompasses the Braidwood Station river facilities. Sampling began upstream of the river screen house at the railroad bridge and continued past the screen house. Fish were collected with a number of gear including boat electrofishing and standard seining.

In 2005, 442 fish comprised of 30 species were collected by the IDNR at F-08, whereas in 2010, 829 fish were collected comprised of 31 species. The five most abundant species in 2005 were golden redhorse, mimic shiner, smallmouth bass, spotfin shiner, and bluntnose minnow. In 2010, the five dominant species were spotfin shiner, mimic shiner, rosyface shiner, longear sunfish, and golden shiner.

In both 2005 and 2010, the IDNR collected two species listed by Illinois as threatened (river redhorse and starhead topminnow) at a number of main stem stations throughout the Kankakee River Basin. However, they did not collect pallid shiner a species listed as endangered by Illinois, which is known to be present in Kankakee River. Starhead topminnow were only collected at locations well upstream of the Braidwood Station river facilities, whereas river redhorse were collected throughout the river. In 2005, river redhorse were collected at eight of the 13 main stem locations and in 2010 at 11 of the 13 locations. Of the 53 river redhorse collected in 2005, three were collected at location F-08 and in 2010 seven out of 51 were collected at F-08. River redhorse were collected both upstream and downstream of the Braidwood Station river facilities.

The IDNR evaluates each location using the Index of Biotic Integrity (IBI) (Smogor 2004). The IBI is based on attributes of the fish assemblage including: number and types of species present, food, habitat, and spawning preferences, and tolerance to environmental degradation. These attributes are evaluated using ten metrics, based on comparison to established reference conditions for unmodified streams. IBI scores range from 0-60 with higher scores indicating better quality. In 2005, results from the IBI index indicated that the main stem of the Kankakee River had a high degree of biotic integrity with many of the locations scoring near the top of the 60 point scale. The extrapolated IBI score for F-08 was 55 in 2005 and 52 in 2010.

Long-term Fish Monitoring

Fish are collected with boat electrofishing and standard seining at five locations in the Kankakee River and one site in Horse Creek. Fish are examined for external anomalies, species composition and relative abundance is determined, and catch-per-effort, diversity indices, and relative weights are calculated. In 2011, samples were collected on 3 and 17 August (HDR 2012).

In August 2011, 3,647 fish comprising 48 species and weighing 143.8 kg were collected during the program. Spotfin shiner (33.3%), longear sunfish (13.6%), bullhead minnow (9.4%), bluntnose minnow (8.8%), sand shiner (6.7%), golden redhorse (4.6%), bluegill (3.7%), largemouth bass (3.0%), gizzard shad (2.2%), and rock bass (2.1%) were the ten most abundant species collected in 2011. Common carp (28.8%), golden redhorse (14.7%), walleye (8.2%), bigmouth buffalo (7.4%), channel catfish (7.0%), smallmouth bass (6.1 %), freshwater drum (4.7%), longear sunfish (3.5%), rock bass (3.5%), and smallmouth buffalo (2.4%), comprising 86.3% of the total biomass were collected during the 2011 electrofishing and seining efforts (HDR 2012).

The 2011 mean electrofishing catch-per-effort (CPE) for fish collected at all locations combined was 246.1 fish/hr. The 2011 CPE is higher than the 34-year average (177.7 fish/hr) and within range of CPEs reported since 1977. Electrofishing CPEs since 1994 have been higher than reported during the earlier years of these studies (1977-1993). Electrofishing CPE has ranged from 35.2 fish/hr in 1982 to 486.3 fish/hr in 2002.

Mean seining CPE for all locations combined in 2011 was 32.5 fish/seine haul. The 2011 seine CPE is lower than the 34-year average of 57.3 fish/seine haul. Seining CPEs have been highly variable on an annual basis. Fewer sunfish species were collected in 2009, 2010, and 2011 than during most recent years, which may be attributed to the decline in aquatic vegetation observed throughout the entire sampling area (HDR 2012).

Mean diversity indices were calculated for each of the electrofishing and seining locations in 2011. Electrofishing diversity values ranged from 2.44 at Location 5L to 3.72 at Location 6L. The average diversity index for all locations in 2011 was 3.18. This value is higher than most years since 1977. Annual mean diversity has ranged from 2.36 in 1982 to 3.74 in 2005. Mean diversity indices for each location sampled by seining ranged from 1.27 at Location 6L to 2.57 at Location 4R. Diversity indices in the Kankakee River appear to reflect habitat quality and flow characteristics at each location during the time of collection, rather than any affect associated with the Braidwood Station intake or cooling pond blowdown. Average seining diversity indices (all locations) by year has ranged from 1.08 in 1983 to 2.97 in 2001. The average seining diversity index of 2.01 in 2011 was the lowest reported since 2000, but well within the range reported during the 34 years of this long-term monitoring program (HDR 2012).

Only twelve (0.33%) of the 3647 fish collected in 2011 exhibited some form of external anomaly. Eroded fins (46.7%), lesion (26.7%), and tumors (26.7%) accounted for all of the anomalies observed. Deformities, fish lice, black spot, leeches, anchor worm, and cysts were not observed in 2011. Nine of the 12 fish with anomalies were golden redhorse, while walleye, spotted sucker, and river carpsucker accounted for the remaining three individuals. The largest percentage (1.49%) of fish collected with anomalies was observed at Horse Creek, which is upstream of the river screen house. The very low incidence of DELT (Deformities, Eroded fins, Lesions, and Tumors) anomalies observed in 2011 indicates that the fish assemblage in this portion of the Kankakee River was in good condition during the August sampling period (HDR 2012).

Relative weights (W*r*) is a condition index that quantifies fish condition (i.e., how much does a fish weigh for its length) and provides an indication of physiological well-being. A W*r* range of 90-100 is a typical objective for most fish species. When mean W*r* values are well below 100 for a size group, problems may exist in food and feeding relationships. Mean relative weights (W*r*) of fish near Braidwood Station ranged from 87 for bigmouth buffalo (three individual) to 115 for largemouth bass. With the exception of a few individuals, fish collected in the Kankakee River during the August sampling period were in good to excellent condition. Six species (gizzard shad. smallmouth buffalo, rock bass, bluegill, largemouth bass, and freshwater drum) exhibited mean relative weight scores of more than 100 (HDR 2012).

Two pallid shiner were collected during the 2011 fisheries surveys in the Kankakee River near Braidwood Station. River redhorse was not collected in 2011. Pallid shiner is listed as endangered and river redhorse is listed as threatened in Illinois (IESPB 2011). No other protected species were observed in 2011. River redhorse have been collected on an irregular basis during some years of this sampling program. Since 1990, the number of river redhorse collected (14 specimens) has declined from those observed in the 1970's and 1980's (357 specimens). Based on these data, river redhorse has become much less abundant in the Kankakee River near Braidwood Station during recent years, although as discussed above, the IDNR basin program collected river redhorse in the area of Braidwood Station as well as other sections of the Kankakee River in 2005 and 2010. All but two of the river redhorse collected since 1977 during the long-term monitoring program have been captured by electrofishing, whereas 390 of the 570 pallid shiner have been captured by minnow seine.

No identifiable change in the fish community occurred in 2011 due to the operation of the Braidwood Station intake and discharge. The placement of a new diffuser system on the bottom of the river in 2010 modified the Braidwood Station discharge sampling location. The placement of the new diffuser system obviously altered the habitat within the sampling area. Fewer fish were captured at this location in 2011 compared to most previous years. The discharge canal design that was in existence prior to 2011 attracted fish to that area because of the increased flow when it was in operation. The blowdown from the cooling pond that discharges through the diffuser system comes from the cold side of the cooling pond.

4.2.2 Pre-Operational Studies

An aquatic monitoring program to define baseline ecological conditions in the Kankakee River and Horse Creek near the intake and discharge structures was initiated by Westinghouse Electric Corporation (WEC) in October 1972 and continued through March 1975 (WEC 1975). The baseline aquatic monitoring program included both fisheries studies and benthos studies. The benthos studies were discussed in Section 4.1. Construction began in 1976. Excluding 1980 when no biological sampling occurred, INHS conducted annual pre-operational surveys near Braidwood Station from 1977 through 1988, (Larimore and Peterson 1989). After commercial operation began in 1988, operational fish sampling began and continues through the present.

In 1974-75, using a variety of collection techniques (electroshocking, seining, gill nets, and hoop nets) 2,221 fish comprising 46 species were collected from the Kankakee River and Horse Creek. The majority of the species belonged to the Cyprinidae (minnows and carp), Centrachidae (sunfish), and Catostomidae (suckers) families. Spotfin shiner (19.5%), rock bass (13.1%), mimic shiner (11%), bluegill (8.3%), spottail shiner (6.2%), green sunfish (5.1%), northern (now shorthead) redhorse (4.5%), white crappie (4.4%), and smallmouth bass (3.8%) were the most abundant species collected in 1974-1975 (WEC 1975).

The INHS 1988 survey was conducted in early August and was the last survey before commercial operation of both units. In August 1988, 6,058 fish comprised of 47 species weighing 217 kg were collected during the program. Smallmouth bass (21.4%), gizzard shad (15.8%), longear sunfish (7.8%), rosyface shiner (6.8%), bluntnose minnow (6.5%), striped shiner (5.7%), rock bass (4.9%), sand shiner (4.2%), golden redhorse (2.8%), and spotfin shiner (2.7%) were the ten most abundant species collected in 1988 comprising 78.6% of the total catch. Golden redhorse (25.3%), smallmouth bass (13.5 %), gizzard shad (12.6%), carp (10.3%), quillback carpsucker (9.9%), and rock bass (8.3%) comprised 79.9% of the total biomass collected during the 1988 electrofishing and seining efforts (Larimore and Peterson 1989).

The 1988 mean electrofishing CPE (all locations combined) was 200.4 fish/hour and for seining it was 46.6 fish/seine haul. Mean diversity indices were calculated for each of the electrofishing and seining locations in 1988. Electrofishing diversity ranged from 2.14 at Location 3L to 3.68 at Location 5R. The average electrofishing diversity index for all locations in 1988 was 2.89.

Mean diversity for each location sampled by seining ranged from 0.96 at Location 6L to 2.64 at Locations 5L and5R. The average seining diversity index was 1.87 in 1988 (Larimore and Peterson 1989).

External anomalies (macroparasites diseases, injuries, or malformations) were found on 12% of the total catch in 1988. *Neascus* (black spot disease) was responsible for 10% of the anomalies. All other anomalies (leech, *Lernaea*, fungus, malformations, ich, *Argulus*, and injuries) rates were in most cases <0.5% of the total catch. Fulton's condition factor (K-factor, a calculated relationship between length and weight) is an index of well being of fish and was determined for fish collected in 1988. Changes in body condition can indicate that an environmental factor, biological factor, or a combination of factors have altered the growth characteristics of an individual. The mean condition factors for smallmouth bass (1.16-1.33), golden redhorse (0.99-1.57), rock bass (1.85-2.18), largemouth bass (1.12-1.38), and spottail shiner (0.69-0.94), indicated these species had maintained stable conditions over the 1977-1988 study record (Larimore and Peterson 1989).

4.2.3 Summary

The fish community in the Kankakee River is comprised of forage, game, and rough/commercial fish as would be expected in a midwestern stream. During the 1975 and 1988 pre-operational studies, 46 species and 47 species were collected, respectively, whereas during the 2011 post-operational study 48 species were observed. The pre-operational and post-operational fish assemblages were similar. The same or comparable species were often in the ten most abundant species by number or biomass. They included forage fish such as spottail shiner, spotfin shiner, sand shiner, bluntnose minnow, and gizzard shad; game species such as smallmouth bass, largemouth bass, bluegill, longear sunfish, rock bass, and channel catfish; and commercial/ rough species such as golden redhorse, common carp, and various sucker species (quillback, shorthead redhorse, and bigmouth buffalo).

The catch-per unit effort rates for 2011 were also within historical ranges. The 1988 mean electrofishing CPE for fish collected at all locations combined was 200.4 fish/hour and for seining, it was 46.6 fish/seine haul. In comparison, the 2011 mean electrofishing CPE for fish collected at all locations combined was 246.1 fish/hour and for seining, it was 32.5 fish/seine haul. CPEs of fish collected by minnow seine have been highly variable on an annual basis ranging from 8.4 to 240.4 fish/seine haul during the pre-operational studies and 10.8 to 126.5 fish/seine haul during the operational studies. The mean CPEs for the 1977-1988 pre-operational studies were 105.0 and 65.6 for electroshocking and seining, respectively. The mean electroshocking CPE for the 1989-2011 operational studies was higher (258.3), whereas the seining CPE was slightly lower (53.3) for the same period of time (HDR 2012).

The mean electrofishing species diversity index for all locations in 1988 was 2.89 and 3.18 in 2011. The mean electrofishing diversity for the pre-operational studies (1977-1988) and the operational studies (1989-2011) were also comparable, 2.85 and 3.12, respectively. The seining diversity index had a similar relationship. The mean seining species diversity index for all locations in 1988 was 1.87 and 2.01 in 2011. The mean seining diversity for the pre-operational studies (1977-1988) and the operational studies (1989-2011) were 1.79 and 2.37, respectively

(HDR 2012).

Fish with external anomalies in 2011 remained low, 0.3%, whereas in 1988 12% had external anomalies, of which 10% was attributable to black spot disease. Black spot disease was not observed in 2011. During operational studies (1991-2010), fish with external anomalies accounted for 0.1% of the fish examined in 2001 to 4.9% of the fish examined in 1993. The majority of fish during those years were afflicted with parasitic leeches, cysts, eroded fins, or anchor worm (HDR 2012). Based on the 2011 body condition factors, with the exception of a few individuals, fish collected in the Kankakee River during the August sampling period were in good to excellent condition.

Two species on the Illinois list of endangered and threatened species have been recorded throughout the sampling history for this site. River redhorse and pallid shiner continue to be collected in the area of Braidwood Station as well as other sites in the Kankakee River and the upper Illinois Waterway. Their populations have continued to survive and expand their range.

According to the IDNR, results of the 2005 basin survey indicate that fish communities and conditions in the Kankakee River have shown no significant changes since the 2000 survey and there were only minor changes between 1994 and 2000, suggesting relatively stable conditions within the system over that 11-year period. In addition, no significant changes or trends in species richness or species composition were noted at tributary or main stem stations for the three basin surveys. Analysis of IBI scores from the three basin surveys indicated no major changes in stream quality in the Kankakee Basin. Based on the 2005 basin survey, sport fish populations in the Kankakee River appeared to be in very good condition. The IDNR indicated that the results of the 2010 survey would likely support similar conclusions (Pescitelli, personal communication). The IDNR felt that the high quality of biotic communities in the Kankakee River is due in large part to good water quality conditions (IEPA 2002), and the wide range of habitat types present throughout the tributaries and main stem (Pescitelli and Rung 2008).

4.3 ENTRAINMENT AND IMPINGEMENT

As part of the NPDES permitting process, the Illinois Environmental Protection Agency (IEPA) required entrainment and impingement studies to be conducted at the river intake for Braidwood Station to evaluate the intake in respect to §316(b) requirements of the Clean Water Act. Entrainment, macroinvertebrate and ichthyoplankton river surveys, and ichthyoplankton survival studies were conducted from 19 April to 13 September 1988, and impingement studies were conducted from 11 October 1988 to 4 October 1989 and again from April through June 1991. In order to allow the ichthyoplankton studies to begin, the station operated the intake pumps before the commercial service dates of 29 July 1988 for Unit 1 and 17 October 1988 for Unit 2. However, the intake pumps were not operated for the 35 days from 8 July to 22 August 1988 because an agreement with the Illinois Department of Conservation, now the Illinois Department of Natural Resources (IDNR), required that pumping be curtailed due to critical low-flow conditions in the river.

4.3.1 Studies

Ichthyoplankton

Between 19 April and 13 September 1988, ichthyoplankton collections were made during both the night and day at four locations: the Kankakee River, the Braidwood Station intake, the Braidwood Station discharge, and Horse Creek. Night sampling was initiated no earlier than 0.5 hours after sunset. Samples were taken using a conical 505-micron mesh plankton net (2.5 meters in length with a 0.5-meter diameter opening) attached to a 0.4-meter square frame. A plankton bucket was attached to the cod end of the net and a calibrated General Oceanics (GO) flow meter (Model 2030) was positioned in the center of the square frame (EA 1990).

A total of 7,197 larvae and 271 eggs were found in the samples collected at the intake. Densities were highest during the period 10 May to 28 June 1988. Throughout the study, densities were much higher at night than during the day. The intake larval collections were dominated by minnows (38% excluding common carp), common carp (17%), suckers (15%), and *Percina* spp. (14%). One specimen of a sand darter (either eastern or western) was collected; both are protected species in Illinois.

The Kankakee River samples yielded 2,590 larvae and 41 fish eggs. Densities were highest during the period 24 May to 7 June 1988. Densities at night averaged three times higher than during the day. The river samples were dominated by suckers (33%), minnows (26% excluding common carp), and common carp (18%). No differences in the lateral (i.e., bank to bank) or vertical (i.e., within the water column) distribution of larvae were found.

Collections in Horse Creek yielded 7,087 larvae and 89 fish eggs. Densities were very high in late May and early June 1988, the period corresponding to the peak drift of sucker larvae. Densities at night were more than 60-fold higher than during the day. The Horse Creek samples were dominated by suckers (73%) and minnows (15% excluding carp).

Collections at the discharge from the cooling pond yielded 631 larvae and 182 fish eggs. Peak densities occurred during the period 17-24 May 1988. Densities at night were about twice as high as during the day. Ichthyoplankton collected at the discharge was much different from that at the other sites; the discharge samples were dominated by gizzard shad (39%) and Pomoxis spp (33%).

Intake and discharge ichthyoplankton survival studies were conducted three times at each site from early June through early July, with all sampling being at least 6 days apart. The discharge studies were conducted only during the day, whereas the intake studies were conducted once during the day and twice at night. For the studies combined, 68% of the larvae survived passage from the river screenhouse to the one-acre holding pond that flows into the cooling pond. Among frequently collected taxa, *Lepomis* spp. had a survival rate of 78% while minnows exhibited 60% survival. At the discharge from the cooling pond, the survival rate for all taxa combined was 75%, largely the result of 80% survival for *Lepomis* spp., the dominant taxa collected. Collectively, the data gathered during the survival studies suggests that approximately two-thirds of the larvae entrained at Braidwood Station survive passage through the plant.

Macroinvertebrates

A total of 23,509 macroinvertebrates representing 161 taxa were found in the ichthyoplankton samples analyzed (23%) for macroinvertebrate drift. The breakdown by location was as follows:

	Intake	River	Horse Creek	Discharge
No. of Taxa	121	132	107	61
No. of Organisms	7,190	13,056	1,612	1,651

The drift in the river was dominated by mayflies (59%) and midges (17%). At the intake, the dominant organisms were mayflies (46%), midges (23%), and naidid worms (13%). In Horse Creek, the dominant organisms were midges (29%), naidid worms (22%), mayflies (18%), and the amphipod *Hyalella azteca* (10%). In the discharge, the dominant organisms were midges (59%), caddisflies (20%), and mayflies (10%).

Entrainment Estimates

Extrapolations of the ichthyoplankton and macroinvertebrate data yielded the following entrainment estimates:

	Actual Case	Worst Case
Fish eggs	0.7 million	1.0 million
Fish larvae	5.8 million	11.2 million
Macroinvertebrates	50.3 million	123.8 million

Based on the estimated number of each of these groups in the Kankakee River, Braidwood Station entrains between 84 and 122% of the fish eggs in the river, between 17and 29% of the fish larvae, and between 8 and 19% of the macroinvertebrates depending on whether actual or worst-case (maximum pumping rate) estimates are used.

The percentage of eggs entrained was anomalously high, either as the result of spawning taking place near the intake or other unknown factors, although river flow was likely a factor. It was determined that impacts to fish were unlikely when entrainment losses were considered in relation to fish populations throughout the Kankakee River.

River flows (cfs) in 1988 during the period when most of the larvae were entrained (i.e., May-July) were well below historical norms, as were flows in July – September and constituted worst-case conditions:

Mean River Discharge (cfs)	May	June	July	August	September
1988	2,852	997	467	451	729
1981-2011	7,832	6,983	4,180	2,484	2,682

The next lowest river discharge flow compared to the 1988 monthly flows was 2,899 in May 2005, 1,932 in June 2005, 811 in July 2005, 757 in August 1991, and 544 in September 1998. The flows in September 1988 were the second lowest river flow in the 30-year period from 1981-2011 (HDR 2012).

Since the station would withdraw a much smaller percentage of the river flow under normal flow conditions, impacts are much less likely during normal flows than under the worst-case conditions that prevailed in 1988. Based on the lower percentage of the population affected, impacts to macroinvertebrates are less likely than to fish.

<u>1988-1989 Impingement Study</u>

The 12-month impingement study conducted in 1988-89 resulted in the collection of 59 fish species and 17,680 individuals. Gizzard shad dominated the catch (69%), with rock bass (10%), smallmouth bass (3%) and longear sunfish (3%) also being well represented. In terms of biomass, gizzard shad accounted for 63% of the total, followed by rock bass (9%), smallmouth bass (4%), and common carp (3%). Most of the rock bass and all of the smallmouth bass were young-of-the-year (YOY) or juveniles. Impingement rates were much higher during fall, winter, and spring than during the summer. Highest rates occurred in late December and early January (EA 1990).

A total of 78 fish species were collected during Kankakee River surveys by the Illinois Natural History Survey (INHS) from 1977 through 1988 (Larimore and Peterson 1989). All species collected during the 1988-1989 impingement study had been previously collected from the river. Sixteen pallid shiners were collected during the impingement study, whereas none were collected during the 1988 river surveys (Larimore and Peterson 1989). A survey was completed in 1989 to obtain more information on the distribution of pallid shiner after the pallid shiner [pallid chub before reclassification] was listed as endangered on 15 March 1989. The 1989 survey collected 96 pallid shiner from 32 localities (EA 1989). River redhorse, listed as threatened in Illinois were collected by INHS each year from 1977 to 1988. The 1988 INHS river collections yielded nine river redhorse compared to two individuals that were collected during the 1988-89 impingement study.

Extrapolation of the impingement data yielded an annual impingement estimate of 53,111 fish including 36,608 gizzard shad (69%), 5,129 rock bass (10%), and 1,594 smallmouth bass (3%). The number of pallid shiners impinged was estimated because it is listed as endangered in Illinois. The annual estimate was 73, all of which were impinged from mid-April to early June.

Gizzard shad, which accounted for 69% of the fish impinged at the Braidwood Station makeup water intake, is very prolific. Bodola (1964) found that production of 0.5 million eggs per female was not uncommon. Furthermore, 78% of the gizzard shad were impinged from early December through early February. Gizzard shad impingement is usually highest during the winter (EA 1987, 1988), probably as a result of impinging individuals that had experienced winter stress or mortality (Trautman 1981). Thus, the impingement of gizzard shad at Braidwood Station is biologically insignificant. Rock bass, the second most frequently impinged species, is also prolific. The Wisconsin DNR describes it as "a very prolific fish with a tendency toward overpopulation" (WDNR 1973). The 5,000 rock bass estimated to be impinged at

Braidwood Station represent the average egg production from a single adult female (Becker 1983).

It should be noted that gizzard shad is not the only species that is subject to winter mortality or the only species impinged in poor condition. It is likely that a percentage of the fish impinged at Braidwood Station were already dead or stressed. The low average velocities measured at the intake (~0.35 ft/sec) supports this hypothesis, as healthy fish would be able to avoid impingement at velocities this low.

The estimated impingement losses are also tempered by the fact that more than 90% of the fish impinged (except for minnows) were either YOY or juveniles. For example, 90% of the impinged rock bass were <90 mm and 93% of the impinged smallmouth bass were <130 mm. Most of the fish impinged at Braidwood Station during the 1988-89 study were small individuals that have naturally high mortality rates due to predation and other factors.

<u>April through June 1991 Impingement Study</u>

One of the requirements in Braidwood Station's NPDES permit in 1991 was that impingement collections be made whenever the makeup pumps to the cooling pond operated from April through June 1991. Because sampling was conducted whenever pumping occurred, no extrapolations of the 1991 data were necessary and the values presented represent the actual number of each species impinged during this three-month period. Collections were made on 14 dates in April, 12 dates in May, and 23 dates in June, for a total of 49 dates (EA 1991).

The 49 collections yielded a total 42 species and 813 individuals. The collections were strongly dominated by common carp which accounted 65.8 percent of the fish impinged. Stonecat, the next most commonly impinged species, accounted for 4.6 percent of the total catch. Eight other species accounted for ≥1% of the catch:

Longear sunfish - 33 individuals, 4.1%
Rock bass - 28 individuals, 3.4%
Fathead minnow - 19 individuals, 2.3%
Carpsucker/Buffalo YOY - 15 individuals, 1.8%
Golden shiner - 13 individuals§ 1.6%
Bullhead minnow - 10 individuals, 1.2%
Green sunfish - 10 individuals§ 1.2%
Orangespotted sunfish - 8 individuals, 1.0%

Only 53 sport fish were collected: 28 rock bass, 7 bluegill, 5 white crappie, 5 channel catfish, 4 black crappie, 2 smallmouth bass, and 2 northern pike. Most of the sport fish were YOY and juveniles. Similarly, common carp, which dominated the collections, were represented almost exclusively by YOY. The only threatened or endangered species that was collected was a single pallid shiner, which is considerably lower than the 16 pallid sinner collected during the same period in 1989. This decline could reflect a change in the abundance or distribution of the pallid shiner, differences in river flows, or differences in the frequency and time of pumping.

Except for common carp and stonecat, impingement in 1991 of all commonly encountered species either declined considerably or was similar to those in 1989. Declines were particularly noticeable among cyprinids and centrarchids. It seems likely that the declines were the result of differences in river flow (perhaps affecting the distribution of fishes in the river), differences in local abundance near the plant intake, or other unknown factors. Impingement catches in April through June 1991 were so low as to clearly not be a threat to any desirable species.

4.3.2 Summary

Results of the 1988-89 studies were presented to and discussed with the IEPA staff in 1990. The agency and Commonwealth Edison Company (now Exelon Generation) corporate and station staff discussed ways to reduce potential entrainment and impingement impacts. The design of Braidwood Station already incorporates a number of elements that reduce aquatic impacts:

- The amount of cooling water pumped from the river is minimized because Braidwood Station has a closed cycle condenser cooling water system;
- Approach velocities at the river screen house traveling screens are less than 0.5 fps; and
- Blowdown to the river from the cooling pond is from the cold side.

The group process resulted in the development of pumping restrictions. In addition, Exelon Generation agreed to conduct another impingement study during April-June, 1991. Braidwood Station's pumping restrictions, which are set forth in Special Condition 7 of NPDES Permit No. IL0048321, specify that:

> "Intake impacts will be reduced by limiting pumping from the river during the peak entrainment period. For a four-week period (last three weeks in May and first week in June), pumping will be allowed only during the day (between one hour after sunrise and one hour before sunset). In addition, during the four-week period, pumping will be minimized during the day. Pumping will occur when needed to fill the freshwater holding pond and to maintain efficient operation of the cooling pond. In an extreme emergency, and upon immediate notification of the Agency, pumping could occur at night. Such pumping would cease as soon as the emergency was over. Records of all pumping during the four-week period will be maintained. Such records will include dates, number of pumps operating and start and end times."

This Special Condition in the NPDES permit was based on the 1988-89 entrainment data, which showed that 73% of a year's entrainment occurs during the four-week period to which the pumping limitation is directed, and approximately 73% of this entrainment occurs at night. It was largely designed to protect pallid shiner because the 1988-89 data suggested that this species may be vulnerable for impingement for only a short period each year as they were impinged only from 16 April to 10 June, with most of the impingement occurring on the screens in May and early June. To provide additional data, another impingement survey was required during these months; the results of which (only one pallid shiner was collected) are presented in Section 4.3.1.

Each renewed Braidwood Station NPDES permit since 1991 has contained Special Condition 7. Hence, the requirements of the CWA Section 316(b) have been and continue to be addressed for Braidwood Station through implementation of the NPDES permit.

It is reasonable to expect that if entrainment and/or impingement at the Braidwood Station were adversely affecting fish populations, then it would be manifested in consistently lower catches during the operational studies that have been conducted through 2011 near the Braidwood Station, but such effects have not been observed.

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FIGURES

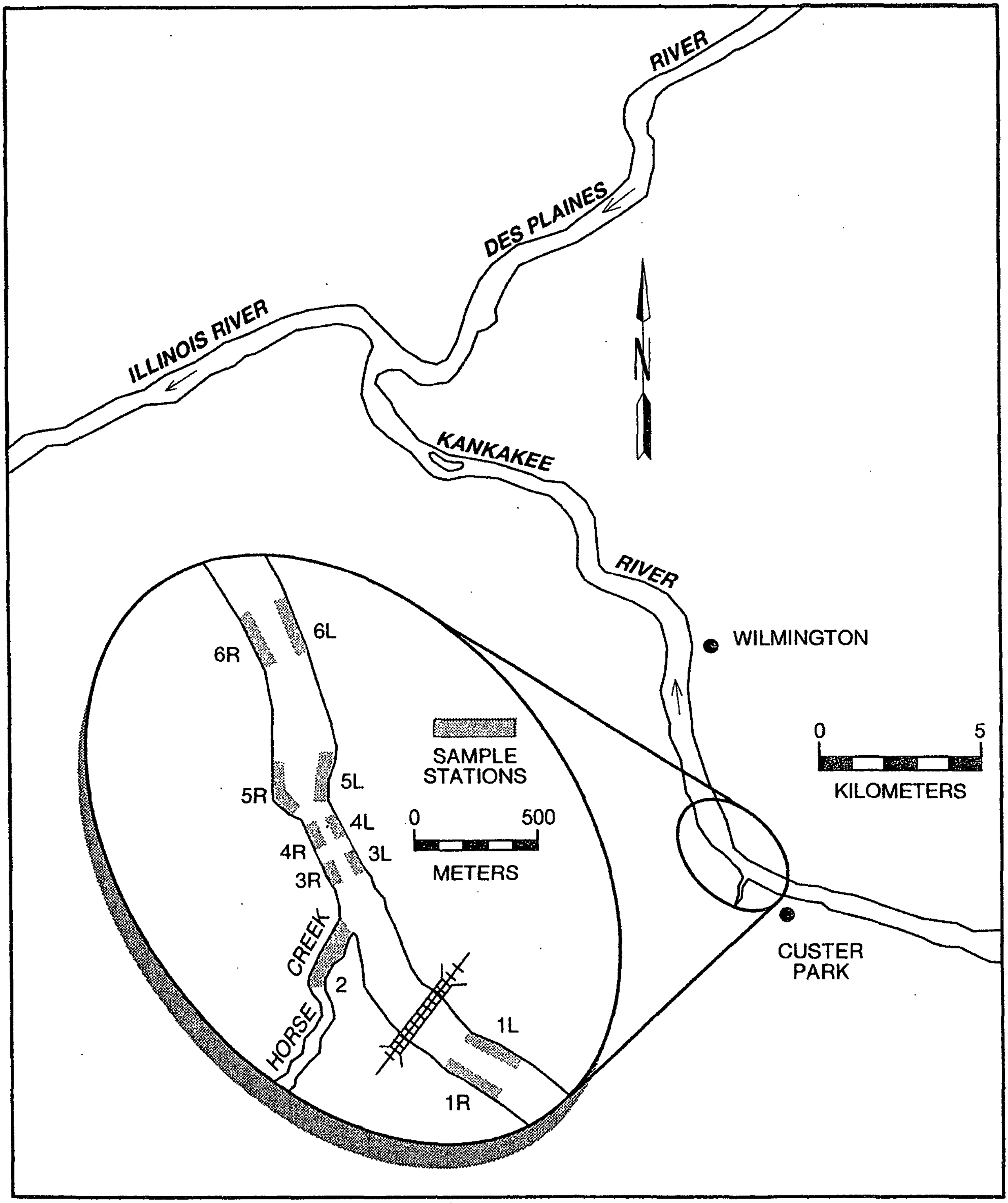

Figure 1 Sampling locations in the Kankakee River near Braidwood Station

TABLES

Table 1. Benthic macroinvertebrate taxa collected from the Kankakee River in the vicinity of Braidwood Station, September 2011.

TURBELLARIA (flatworms)

ANNELIDA

- **Oligochaeta (aquatic worms)**
  - Tubificidae
- **Hirudinea (leeches)**
  - Helobdella stagnalis
  - Placobdella multilineata
  - Placobdella nuchalis

CRUSTACEA

- **Amphipoda (sideswimmers)**
  - Hyalella azteca

ARACHNIDA

- **Hydracarina (water mites)**

INSECTA

- **Ephemeroptera (mayflies)**
  - Isonychia
  - Acentrella
  - Baetis intercalaris
  - Centroptilum
  - Procloeon
  - Leucrocuta
  - Maccaffertium integrum
  - Maccaffertium terminatum
  - Stenacron
  - Stenonema femoratum
  - Tricorythodes
  - Caenis
  - Ephemera
  - Hexagenia limbata
  - Anthopotamus myops
- **Odonata (damselflies and dragonflies)**
  - Argia
  - Enallagma
  - Macromia
  - Stylurus
- **Hemiptera (true bugs)**
  - Corixidae
- **Megaloptera (dobsonflies & alderflies)**
  - Corydalus cornutus
  - Sialis
- **Trichoptera (caddisflies)**
  - Polycentropus
  - Cheumatopsyche
  - Hydroptila
  - Oecetis
  - Pycnopsyche
- **Lepidoptera (aquatic moths)**
  - Petrophila
- **Coleoptera (beetles)**
  - Dineutus
  - Ancyronyx variegata
  - Dubiraphia
  - Macronychus glabratus
  - Stenelmis
- **Diptera (true flies)**
  - **Chironomidae (midges)**
  - Procladius
  - Ablabesmyia mallochi
  - Labrundinia
  - Thienemannimyia grp.
  - Cricotopus bicinctus grp.
  - Nanocladius crassicornus/rectinervis
  - Chironomus
  - Cryptochironomus
  - Cryptotendipes
  - Dicrotendipes neomodestus
  - Dicrotendipes lucifer
  - Glyptotendipes
  - Microtendipes
  - Parachironomus
  - Polypedilum flavum
  - Polypedilum illinoense
  - Polypedilum scalaenum grp.
  - Pseudochironomus
  - Stenochironomus
  - Stictochironomus
  - Tribelos fuscicorne
  - Cladotanytarsus vanderwulpi grp.
  - Rheotanytarsus
  - Tanytarsus

MOLLUSCA

Gastropoda (snails)

Campeloma

Pleurocera

Bivalvia (mussels & clams)

Musculium

Pisidium

Sphaerium

Lampsilis siliquoidea

Leptodea fragilis

Quadrula pustulosa

Table 2. Density (#/m^2) and relative abundance (%) of benthic macroinvertebrate taxa collected in Hester- Dendy samples from the Kankakee River near Braidwood Station, September 2011.

	1L		4L		4R		5R	
TAXA	#/m^2	%	#/m^2	%	#/m^2	%	#/m^2	%
Turbellaria	820.6	27.02	98.1	3.96	2542.9	60.01	59.7	4.96
Tubificidae	--[a]	--	--	--	--	--	8.5	0.71
Placobdella multilineata	--	--	--	--	8.5	0.20	--	--
Hyalella azteca	8.5	0.28	1255.5	50.69	--	--	--	--
Isonychia	--	--	--	--	38.4	0.91	--	--
Baetis intercalaris	--	--	17.1	0.69	--	--	--	--
Leucrocuta	--	--	--	--	17.1	0.40	--	--
Stenacron	434.8	14.32	296.3	11.96	360.2	8.50	364.5	30.32
Maccaffertium integrum	--	--	--	--	8.5	0.20	4.3	0.35
Stenonema femoratum	--	--	4.3	0.17	25.6	0.60	72.5	6.03
Maccaffertium terminatum	27.7	0.91	--	--	147.1	3.47	--	--
Tricorythodes	375.2	12.35	70.3	2.84	104.4	2.46	108.7	9.04
Caenis	--	--	--	--	25.6	0.60	--	--
Ephemera	12.8	0.42	--	--	8.5	0.20	10.7	0.89
Hexagenia limbata	--	--	--	--	--	--	14.9	1.24
Argia	164.1	5.40	170.5	6.88	42.6	1.01	46.9	3.90
Stylurus	2.1	0.07	--	--	--	--	--	--
Corydalus cornutus	--	--	--	--	6.4	0.15	--	--
Sialis	--	--	--	--	--	--	6.4	0.53
Polycentropus	8.5	0.28	--	--	--	--	--	--
Cheumatopsyche	--	--	--	--	4.3	0.10	--	--
Hydroptila	--	--	--	--	25.6	0.60	--	--
Pycnopsyche	2.1	0.07	--	--	--	--	--	--
Petrophila	153.5	5.05	21.3	0.86	--	--	--	--
Dineutus	19.2	0.63	19.2	0.77	--	--	4.3	0.35
Ancyronyx variegata	--	--	--	--	--	--	4.3	0.35
Macronychus glabratus	10.7	0.35	--	--	--	--	2.1	0.18
Stenelmis	113.0	3.72	17.1	0.69	42.6	1.01	17.1	1.42
Procladius	17.1	0.56	--	--	8.5	0.20	34.1	2.84
Ablabesmyia mallochi	8.5	0.28	46.9	1.89	51.2	1.21	42.6	3.55
Labrundinia	--	--	--	--	17.1	0.40	--	--
Thienemannimyia grp.	--	--	--	--	17.1	0.40	4.3	0.35
Cricotopus bicinctus grp.	8.5	0.28	4.3	0.17	--	--	--	--
Nanocladius crassicornus/rectinervis	--	--	4.3	0.17	25.6	0.60	4.3	0.35
Chironomus	8.5	0.28	--	--	--	--	--	--
Dicrotendipes neomodestus	341.0	11.23	306.9	12.39	8.5	0.20	55.4	4.61

Table 2 (cont)

TAXA	1L #/m^2	1L %	4L #/m^2	4L %	4R #/m^2	4R %	5R #/m^2	5R %
Dicrotendipes lucifer	25.6	0.84	8.5	0.34	--	--	--	--
Glyptotendipes	34.1	1.12	17.1	0.69	51.2	1.21	127.9	10.64
Microtendipes	25.6	0.84	--	--	8.5	0.20	--	--
Parachironomus	--	--	--	--	34.1	0.80	8.5	0.71
Polypedilum flavum	17.1	0.56	--	--	136.4	3.22	--	--
Polypedilum illinoense	34.1	1.12	8.5	0.34	--	--	12.8	1.06
Polypedilum scalaenum grp.	153.5	5.05	--	--	110.8	2.62	34.1	2.84
Stenochironomus	110.8	3.65	34.1	1.38	213.2	5.03	12.8	1.06
Tribelos fuscicorne	51.2	1.68	--	--	42.6	1.01	85.3	7.09
Tanytarsus	17.1	0.56	4.3	0.17	--	--	4.3	0.35
Pleurocera	29.8	0.98	72.5	2.93	104.4	2.46	51.2	4.26
Lampsilis siliquoidea	2.1	0.07	--	--	--	--	--	--
TOTAL BENTHOS (no./m^2)	3,037.4	100	2476.8	100	4237.5	100	1202.2	100
TOTAL TAXA RICHNESS	30		20		30		27	
EPT TAXA RICHNESS	6		4		11		6	

[a] Taxon absent.

Table 3. Density (#/m^2) and relative abundance (%) of benthic macroinvertebrate taxa collected in Ponar and kick net samples from the Kankakee River near Braidwood Station, September 2011.

	1L		4L		4R		5L		5R	
	KICK		KICK		KICK		PONAR		PONAR	
TAXA	#/m^2	%	#/m^2	%	#/m^2	%	#/m^2	%	#/m^2	%
Turbellaria	242.4	15.57	19.1	3.09	44.6	7.37	--[a]	--	--	--
Tubificidae	63.8	4.10	--	--	31.9	5.26	708.0	38.54	1581.8	39.81
Helobdella stagnalis	6.4	0.41	--	--	--	--	12.8	0.69	6.4	0.16
Placobdella nuchalis	--	--	--	--	--	--	6.4	0.35	--	--
Hydracarina	--	--	--	--	--	--	--	--	31.9	0.80
Acentrella	--	--	--	--	6.4	1.05	--	--	--	--
Baetis intercalaris	38.3	2.46	--	--	70.2	11.58	--	--	--	--
Centroptilum	51.0	3.28	--	--	--	--	--	--	25.5	0.64
Procloeon	12.8	0.82	--	--	--	--	--	--	--	--
Stenacron	--	--	19.1	3.09	38.3	6.32	--	--	--	--
Maccaffertium terminatum	19.1	1.23	57.4	9.28	--	--	--	--	--	--
Tricorythodes	102.1	6.56	95.7	15.46	6.4	1.05	12.8	0.69	133.9	3.37
Caenis	293.4	18.85	31.9	5.15	--	--	44.6	2.43	70.2	1.77
Anthopotamus myops	95.7	6.15	--	--	--	--	--	--	--	--
Ephemera	51.0	3.28	19.1	3.09	57.4	9.47	--	--	--	--
Hexagenia limbata	44.6	2.87	19.1	3.09	31.9	5.26	82.9	4.51	363.6	9.15
Argia	--	--	19.1	3.09	12.8	2.11	--	--	--	--
Enallagma	6.4	0.41	--	--	--	--	--	--	--	--
Stylurus	--	--	--	--	--	--	6.4	0.35	31.9	0.80
Macromia	6.4	0.41	12.8	2.06	--	--	6.4	0.35	--	--
Corixidae	38.3	2.46	--	--	--	--	6.4	0.35	25.5	0.64
Polycentropus	--	--	--	--	6.4	1.05	--	--	--	--
Cheumatopsyche	6.4	0.41	--	--	--	--	--	--	--	--
Hydroptila	--	--	57.4	9.28	31.9	5.26	--	--	--	--
Oecetis	--	--	6.4	1.03	--	--	12.8	0.69	25.5	0.64
Dineutus	--	--	--	--	--	--	6.4	0.35	--	--
Dubiraphia	6.4	0.41	6.4	1.03	--	--	102.1	5.56	51.0	1.28
Macronychus glabratus	--	--	--	--	6.4	1.05	--	--	--	--
Stenelmis	57.4	3.69	19.1	3.09	153.1	25.26	--	--	--	--
Procladius	--	--	12.8	2.06	12.8	2.11	178.6	9.72	51.0	1.28
Ablabesmyia mallochi	12.8	0.82	25.5	4.12	6.4	1.05	--	--	25.5	0.64
Chironomus	--	--	--	--	--	--	216.9	11.81	--	--
Cryptochironomus	12.8	0.82	--	--	--	--	70.2	3.82	204.1	5.14
Cryptotendipes	--	--	--	--	--	--	--	--	25.5	0.64
Dicrotendipes neomodestus	6.4	0.41	70.2	11.34	--	--	--	--	--	--
Dicrotendipes lucifer	--	--	--	--	--	--	6.4	0.35	--	--
Glyptotendipes	--	--	--	--	6.4	1.05	--	--	--	--

Table 3 (cont)

TAXA	1L KICK #/m²	%	4L KICK #/m²	%	4R KICK #/m²	%	5L PONAR #/m²	%	5R PONAR #/m²	%
Microtendipes	95.7	6.15	31.9	5.15	12.8	2.11	--	--	--	--
Polypedilum flavum	6.4	0.41	--	--	--	--	--	--	--	--
Polypedilum illinoense	6.4	0.41	--	--	--	--	--	--	102.1	2.57
Polypedilum scalaenum grp.	12.8	0.82	6.4	1.03	6.4	1.05	159.5	8.68	739.9	18.62
Pseudochironomus	--	--	--	--	--	--	--	--	25.5	0.64
Stictochironomus	--	--	--	--	--	--	--	--	25.5	0.64
Cladotanytarsus vanderwulpi grp.	127.6	8.20	--	--	--	--	--	--	--	--
Rheotanytarsus	19.1	1.23	--	--	--	--	--	--	--	--
Tanytarsus	--	--	12.8	2.06	--	--	--	--	25.5	0.64
Campeloma	--	--	--	--	--	--	6.4	0.35	--	--
Pleurocera	89.3	5.74	70.2	11.34	31.9	5.26	165.8	9.03	338.1	8.51
Sphaerium	--	--	--	--	--	--	6.4	0.35	--	--
Musculium	--	--	--	--	31.9	5.26	--	--	--	--
Pisidium	6.4	0.41	--	--	--	--	6.4	0.35	51.0	1.28
Quadrula pustulosa	6.4	0.41	--	--	--	--	--	--	--	--
Leptodea fragilis	12.8	0.82	6.4	1.03	--	--	12.8	0.69	12.8	0.32
TOTAL BENTHOS (no./m²)	1556.3	100	618.7	100	605.9	100	1837.0	100	3973.7	100
TOTAL TAXA RICHNESS	31		21		20		22		23	
EPT TAXA RICHNESS	10		8		8		4		5	

[a] Taxon absent.

APPENDIX A

BRAIDWOOD STATION MACROINVERTEBRATE DATA

APPENDIX A – Braidwood Station Macroinvertebrate Data

GEAR=HESTER-DENDY, DATE=SEP 2011, and LOCATION=1L

TAXA	#	#/m2	%
Turbellaria	385	820.6	27.02
Hyalella azteca	4	8.5	0.28
Stenacron	204	434.8	14.32
Maccaffertium terminatum	13	27.7	0.91
Tricorythodes	176	375.2	12.35
Ephemera	6	12.8	0.42
Argia	77	164.1	5.40
Stylurus	1	2.1	0.07
Polycentropus	4	8.5	0.28
Pycnopsyche	1	2.1	0.07
Petrophila	72	153.5	5.05
Dineutus	9	19.2	0.63
Macronychus glabratus	5	10.7	0.35
Stenelmis	53	113.0	3.72
Procladius	8	17.1	0.56
Ablabesmyia mallochi	4	8.5	0.28
Cricotopus bicinctus grp.	4	8.5	0.28
Chironomus	4	8.5	0.28
Dicrotendipes neomodestus	160	341.0	11.23
Dicrotendipes lucifer	12	25.6	0.84
Glyptotendipes	16	34.1	1.12
Microtendipes	12	25.6	0.84
Polypedilum flavum	8	17.1	0.56
Polypedilum illinoense	16	34.1	1.12
Polypedilum scalaenum grp.	72	153.5	5.05
Stenochironomus	52	110.8	3.65
Tribelos fuscicorne	24	51.2	1.68
Tanytarsus	8	17.1	0.56
Pleurocera	14	29.8	0.98
Lampsilis siliquoidea	1	2.1	0.07
TOTAL BENTHOS	1,425	3,037.4	100.00

GEAR=HESTER-DENDY, DATE=SEP 2011, and LOCATION=4L

TAXA	#	#/m2	%
Turbellaria	46	98.1	3.96
Hyalella azteca	589	1,255.5	50.69
Baetis intercalaris	8	17.1	0.69
Stenacron	139	296.3	11.96
Stenonema femoratum	2	4.3	0.17
Tricorythodes	33	70.3	2.84
Argia	80	170.5	6.88
Petrophila	10	21.3	0.86
Dineutus	9	19.2	0.77
Stenelmis	8	17.1	0.69
Ablabesmyia mallochi	22	46.9	1.89
Cricotopus bicinctus grp.	2	4.3	0.17
Nanocladius crassicornus/rectinervis	2	4.3	0.17
Dicrotendipes neomodestus	144	306.9	12.39
Dicrotendipes lucifer	4	8.5	0.34
Glyptotendipes	8	17.1	0.69
Polypedilum illinoense	4	8.5	0.34
Stenochironomus	16	34.1	1.38
Tanytarsus	2	4.3	0.17
Pleurocera	34	72.5	2.93
TOTAL BENTHOS	1,162	2,476.8	100.00

APPENDIX A (cont.)

GEAR=HESTER-DENDY, DATE=SEP 2011, and LOCATION=4R

TAXA	#	#/m2	%
Turbellaria	1,193	2,542.9	60.01
Placobdella multilineata	4	8.5	0.20
Isonychia	18	38.4	0.91
Leucrocuta	8	17.1	0.40
Stenacron	169	360.2	8.50
Maccaffertium integrum	4	8.5	0.20
Stenonema femoratum	12	25.6	0.60
Maccaffertium terminatum	69	147.1	3.47
Tricorythodes	49	104.4	2.46
Caenis	12	25.6	0.60
Ephemera	4	8.5	0.20
Argia	20	42.6	1.01
Corydalus cornutus	3	6.4	0.15
Cheumatopsyche	2	4.3	0.10
Hydroptila	12	25.6	0.60
Stenelmis	20	42.6	1.01
Procladius	4	8.5	0.20
Ablabesmyia mallochi	24	51.2	1.21
Labrundinia	8	17.1	0.40
Thienemannimyia grp.	8	17.1	0.40
Nanocladius crassicornus/rectinervis	12	25.6	0.60
Dicrotendipes neomodestus	4	8.5	0.20
Glyptotendipes	24	51.2	1.21
Microtendipes	4	8.5	0.20
Parachironomus	16	34.1	0.80
Polypedilum flavum	64	136.4	3.22
Polypedilum scalaenum grp.	52	110.8	2.62
Stenochironomus	100	213.2	5.03
Tribelos fuscicorne	20	42.6	1.01
Pleurocera	49	104.4	2.46
TOTAL BENTHOS	1,988	4,237.5	100.00

GEAR=HESTER-DENDY, DATE=SEP 2011, and LOCATION=5R

TAXA	#	#/m2	%
Turbellaria	28	59.7	4.96
Tubificidae	4	8.5	0.71
Stenacron	171	364.5	30.32
Maccaffertium integrum	2	4.3	0.35
Stenonema femoratum	34	72.5	6.03
Tricorythodes	51	108.7	9.04
Ephemera	5	10.7	0.89
Hexagenia limbata	7	14.9	1.24
Argia	22	46.9	3.90
Sialis	3	6.4	0.53
Dineutus	2	4.3	0.35
Ancyronyx variegata	2	4.3	0.35
Macronychus glabratus	1	2.1	0.18
Stenelmis	8	17.1	1.42
Procladius	16	34.1	2.84
Ablabesmyia mallochi	20	42.6	3.55
Thienemannimyia grp.	2	4.3	0.35
Nanocladius crassicornus/rectinervis	2	4.3	0.35
Dicrotendipes neomodestus	26	55.4	4.61
Glyptotendipes	60	127.9	10.64
Parachironomus	4	8.5	0.71
Polypedilum illinoense	6	12.8	1.06
Polypedilum scalaenum grp.	16	34.1	2.84
Stenochironomus	6	12.8	1.06
Tribelos fuscicorne	40	85.3	7.09
Tanytarsus	2	4.3	0.35
Pleurocera	24	51.2	4.26
TOTAL BENTHOS	564	1,202.2	100.00

APPENDIX A (cont.)

GEAR=KICK NET, DATE=SEP 2011, and LOCATION=1L

TAXA	#	#/m2	%
Turbellaria	38	242.4	15.57
Tubificidae	10	63.8	4.10
Helobdella stagnalis	1	6.4	0.41
Baetis intercalaris	6	38.3	2.46
Centroptilum	8	51.0	3.28
Procloeon	2	12.8	0.82
Maccaffertium terminatum	3	19.1	1.23
Tricorythodes	16	102.1	6.56
Caenis	46	293.4	18.85
Anthopotamus myops	15	95.7	6.15
Ephemera	8	51.0	3.28
Hexagenia limbata	7	44.6	2.87
Enallagma	1	6.4	0.41
Macromia	1	6.4	0.41
Corixidae	6	38.3	2.46
Cheumatopsyche	1	6.4	0.41
Dubiraphia	1	6.4	0.41
Stenelmis	9	57.4	3.69
Ablabesmyia mallochi	2	12.8	0.82
Cryptochironomus	2	12.8	0.82
Dicrotendipes neomodestus	1	6.4	0.41
Microtendipes	15	95.7	6.15
Polypedilum flavum	1	6.4	0.41
Polypedilum illinoense	1	6.4	0.41
Polypedilum scalaenum grp.	2	12.8	0.82
Cladotanytarsus vanderwulpi grp.	20	127.6	8.20
Rheotanytarsus	3	19.1	1.23
Pleurocera	14	89.3	5.74
Pisidium	1	6.4	0.41
Quadrula pustulosa	1	6.4	0.41
Leptodea fragilis	2	12.8	0.82
TOTAL BENTHOS	244	1,556.3	100.00

GEAR=KICK NET, DATE=SEP 2011, and LOCATION=4L

TAXA	#	#/m2	%
Turbellaria	3	19.1	3.09
Stenacron	3	19.1	3.09
Maccaffertium terminatum	9	57.4	9.28
Tricorythodes	15	95.7	15.46
Caenis	5	31.9	5.15
Ephemera	3	19.1	3.09
Hexagenia limbata	3	19.1	3.09
Argia	3	19.1	3.09
Macromia	2	12.8	2.06
Hydroptila	9	57.4	9.28
Oecetis	1	6.4	1.03
Dubiraphia	1	6.4	1.03
Stenelmis	3	19.1	3.09
Procladius	2	12.8	2.06
Ablabesmyia mallochi	4	25.5	4.12
Dicrotendipes neomodestus	11	70.2	11.34
Microtendipes	5	31.9	5.15
Polypedilum scalaenum grp.	1	6.4	1.03
Tanytarsus	2	12.8	2.06
Pleurocera	11	70.2	11.34
Leptodea fragilis	1	6.4	1.03
TOTAL BENTHOS	97	618.7	100.00

APPENDIX A (cont.)

GEAR=KICK NET, DATE=SEP 2011, and LOCATION=4R

TAXA	#	#/m2	%
Turbellaria	7	44.6	7.37
Tubificidae	5	31.9	5.26
Acentrella	1	6.4	1.05
Baetis intercalaris	11	70.2	11.58
Stenacron	6	38.3	6.32
Tricorythodes	1	6.4	1.05
Ephemera	9	57.4	9.47
Hexagenia limbata	5	31.9	5.26
Argia	2	12.8	2.11
Polycentropus	1	6.4	1.05
Hydroptila	5	31.9	5.26
Macronychus glabratus	1	6.4	1.05
Stenelmis	24	153.1	25.26
Procladius	2	12.8	2.11
Ablabesmyia mallochi	1	6.4	1.05
Glyptotendipes	1	6.4	1.05
Microtendipes	2	12.8	2.11
Polypedilum scalaenum grp.	1	6.4	1.05
Pleurocera	5	31.9	5.26
Musculium	5	31.9	5.26
TOTAL BENTHOS	95	605.9	100.00

GEAR=PONAR, DATE=SEP 2011, and LOCATION=5L

TAXA	#	#/m2	%
Tubificidae	111	708.0	38.54
Helobdella stagnalis	2	12.8	0.69
Placobdella nuchalis	1	6.4	0.35
Tricorythodes	2	12.8	0.69
Caenis	7	44.6	2.43
Hexagenia limbata	13	82.9	4.51
Stylurus	1	6.4	0.35
Macromia	1	6.4	0.35
Corixidae	1	6.4	0.35
Oecetis	2	12.8	0.69
Dineutus	1	6.4	0.35
Dubiraphia	16	102.1	5.56
Procladius	28	178.6	9.72
Chironomus	34	216.9	11.81
Cryptochironomus	11	70.2	3.82
Dicrotendipes lucifer	1	6.4	0.35
Polypedilum scalaenum grp.	25	159.5	8.68
Campeloma	1	6.4	0.35
Pleurocera	26	165.8	9.03
Sphaerium	1	6.4	0.35
Pisidium	1	6.4	0.35
Leptodea fragilis	2	12.8	0.69
TOTAL BENTHOS	288	1,837.0	100.00

GEAR=PONAR, DATE=SEP 2011, and LOCATION=5R

TAXA	#	#/m2	%
Tubificidae	248	1,581.8	39.81
Helobdella stagnalis	1	6.4	0.16
Hydracarina	5	31.9	0.80
Centroptilum	4	25.5	0.64
Tricorythodes	21	133.9	3.37
Caenis	11	70.2	1.77
Hexagenia limbata	57	363.6	9.15
Stylurus	5	31.9	0.80
Corixidae	4	25.5	0.64
Oecetis	4	25.5	0.64
Dubiraphia	8	51.0	1.28
Procladius	8	51.0	1.28
Ablabesmyia mallochi	4	25.5	0.64
Cryptochironomus	32	204.1	5.14
Cryptotendipes	4	25.5	0.64
Polypedilum illinoense	16	102.1	2.57
Polypedilum scalaenum grp.	116	739.9	18.62
Pseudochironomus	4	25.5	0.64
Stictochironomus	4	25.5	0.64
Tanytarsus	4	25.5	0.64
Pleurocera	53	338.1	8.51
Pisidium	8	51.0	1.28
Leptodea fragilis	2	12.8	0.32
TOTAL BENTHOS	623	3,973.7	100.00