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ASSESSMENTS OF THE IMPACTS OF DAMS ON THE DUPAGE RIVER

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICIES

INTRODUCTION

The DuPage River is a large tributary to the Des Plaines River, which originates in northwestern Cook County and joins the Des Plaines near the border between Kendall and Will Counties southwest of the greater Chicago metropolitan area. This 376 square mile watershed is heavily urbanized, with 48.5% of the total surface area being developed (IDNR CTAP, 1999). The DuPage is divided into three main catchments or subwatersheds; the West Branch DuPage River (124 sq. mi.) and the East Branch DuPage River (80 sq. mi.) drain much of central and western DuPage County and flow south into the main stem DuPage River (168 sq. mi.), which extends along the western edge of Will County to the confluence with the Des Plaines River. Most of the development and urbanization in the watershed is within the East and West Branches in DuPage County, whereas the main stem watershed of the DuPage River in Will County is largely agricultural.

Figure 1.1 DuPage River near Shorewood, IL.

Although water quality has improved dramatically in the watershed over the last twenty years, much of the river remains classified as an "Impaired Water" by the Illinois EPA due to excess nutrients, salinity & chlorides, and suspended solids. These problems are indicative of a watershed under stress from human impacts on the landscape. The purpose of this study is to assess one such impact, namely the impact of man-made dams on fish passage, recreational uses and water quality.

Figure 1.2 West Branch DuPage River near Warrenville, IL.

Physical assessments of the dams were made to provide information on structure, safety and recreational use of the river and the impoundments around each dam. Biological assessment data is used to provide an understandable water quality endpoint of relevance to society: the biological integrity of waterbodies. Fish and macroinvertebrates are good water quality indicators because they spend all or most of their lives in the water and are good integrators of environmental conditions.

STUDY AREA

This assessment is limited to the dams located on the main stem DuPage River and West Branch DuPage river. The dams on these reaches are shown in Figure 1. The first dam on the DuPage River is the Channahon Dam, located less than 0.5 miles from the DuPage's confluence with the Des Plaines River in the I&M Canal State Park in Channahon. This 9 foot high dam has effectively disconnected the DuPage River from the Des Plaines River, from a biological standpoint. The impoundment behind this dam extends upstream 4.1 miles and covers and area of 75 acres. The environment within the impoundment is characterized as a deep and slow-moving channel with little or no flow diversity, silty deposits over a rocky substrate. These conditions have resulted in a poor macroinvertebrate population and relatively low fish diversity.

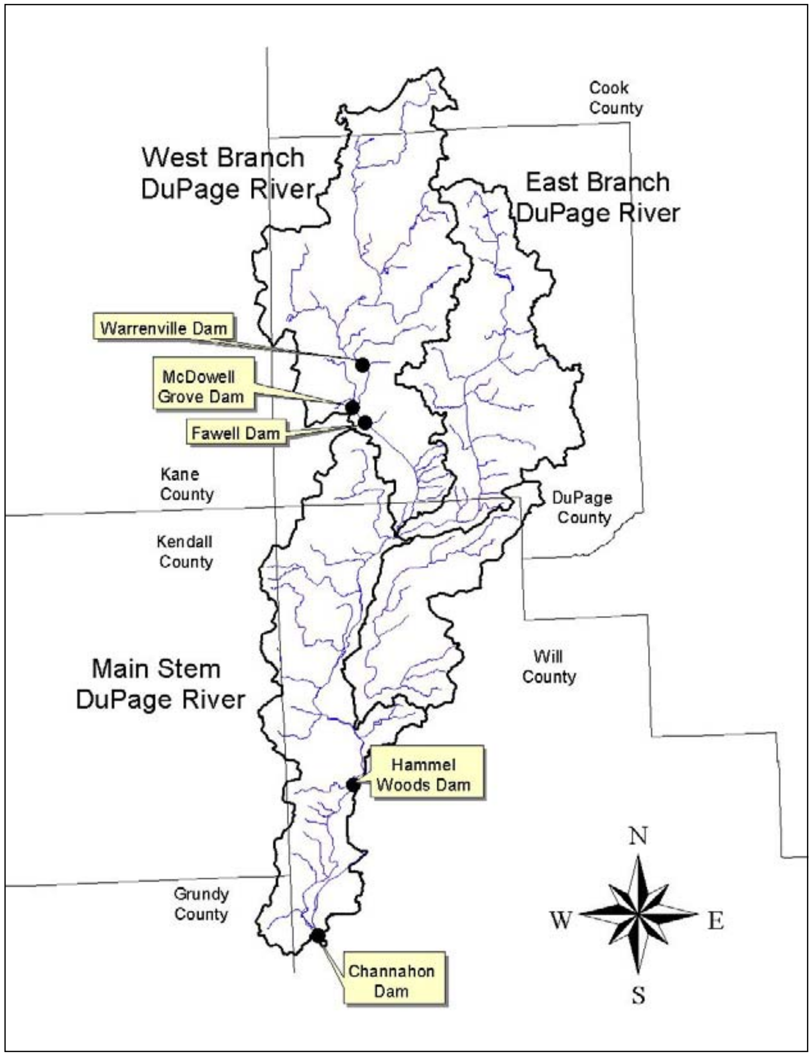


Figure 1.3 DuPage River Watershed Map with dams on the West Branch and main stem noted.

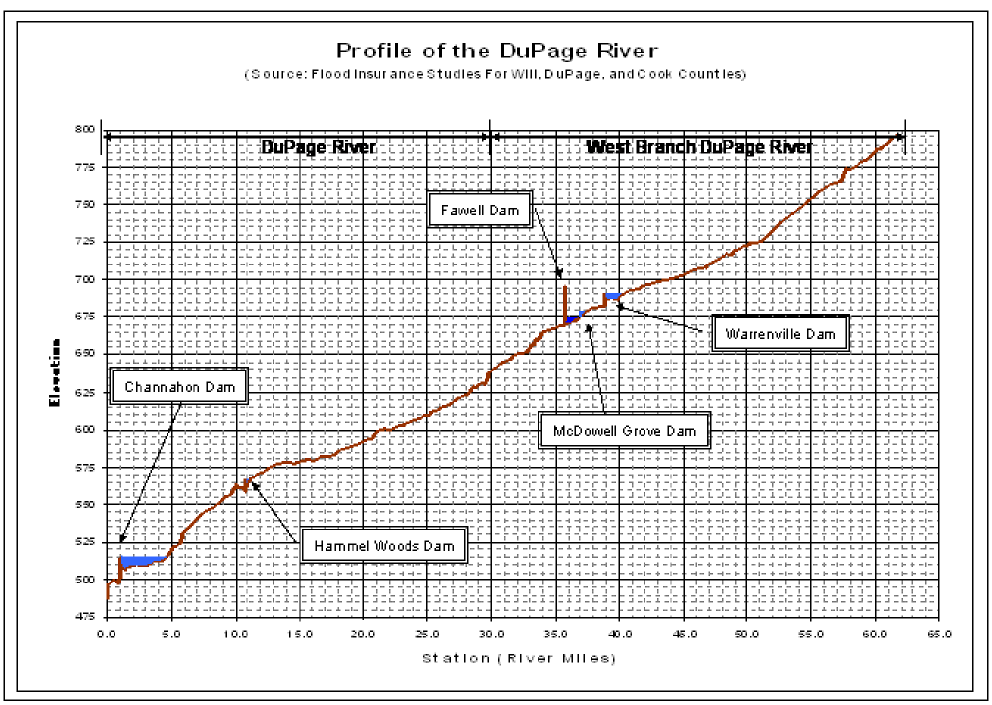
Approximately ten miles upstream of the Channahon Dam is the river's second dam, located in the Hammel Woods Forest Preserve just north of Route 52 in Shorewood (River Mile 10.59). This dam, known as the Hammel Woods Dam, is very small; only 2.3 feet in height. The impoundment created by this dam is therefore very small, having a length of only 1600 feet (0.3 mi.) and a surface area of 5.2 acres. The small nature of this dam and it's impoundment, along with the relatively steep gradient of the river is this area has resulted in a condition in which the river ecosystem is relatively unaffected by the dam, although this dam is considered to have the most threat to public safety due to its dangerous hydraulics.

Moving upriver into the West Branch subcatchment, a third dam is located at river mile 36 on the West Branch DuPage River. Known as the Fawell Dam, it can be found north of Ogden Avenue in Naperville. This dam could not be included in the study because it was undergoing major reconstruction, which precluded the investigators from collecting the data needed to analyze the impacts of the dam on both water quality and the biological resources in this segment of the river.

The next upstream dam on the West Branch is the McDowell Grove Dam, located at river mile 36.55 within the McDowell Grove Forest Preserve. This 4 foot high dam has an impoundment length of 2900 feet and a surface area of approximately 8 acres. Much of the impoundment is filled with fine-grained silts resulting in a mean depth of about 1.5 feet. The impoundment behind the McDowell Grove Dam contains a vast amount of fine-grained silt and sand which as blanketed most of the natural habitat on the channel bottom, resulting in poor fish and macroinvertebrate communities.

The upstream most dam on the West Branch DuPage River is located at river mile 38.8 in the Warrenville Grove Forest Preserve with the City of Warrenville. The impoundment has a length of 1.2 miles and a surface area of 16.9 acres. The characteristics of the impoundment are very similar to those observed a McDowell Grove Dam, as its slack water has caused large amounts of sediment to settle out and smother the natural aquatic habitat (coarse sand, gravel and cobbles).

Figure 1.4 Profile of the DuPage River and West Branch and locations of dams



METHODS

SAMPLE DESIGN

Three stations were established at each of the four dams included in this study. The first station, a segment of the river upstream of the impoundment, was intended to represent the free-flowing areas of the river. The second station, 50 – 500 feet upstream of the dam depending on safety precautions, represented the impoundments, and the third station, immediately downstream of the direct influence of the dam, represented free flowing segments below the dams. Station locations are listed in Table 1.1.

Table 1.1 Sampling locations

Stream	Sample Location	Latitude	Longitude
West Branch DuPage	Downstream of Mack Rd, Warrenville, IL	41.841614702	-88.198674109
West Branch DuPage	Warrenville Dam Pool, Warrenville, IL	41.822003431	-88.172691208
West Branch DuPage	Downstream Warrenville Dam, Warrenville, IL	41.821250483	-88.172310686
West Branch DuPage	Downstream Diehl Rd, Naperville, IL	41.804503191	-88.177334898
West Branch DuPage	McDowell Dam Pool, McDowell Woods, Naperville, IL	41.794836165	-88.187256224
West Branch DuPage	Downstream McDowell Dam, McDowell Woods, Naperville, IL	41.794271674	-88.187083569
DuPage River	Upstream of 119th St, NW of Plainfield, IL	41.667037179	-88.182991860
DuPage River	Hammel Dam Pool, Hammel Woods, Shorewood, IL	41.522500323	-88.192986806
DuPage River	Downstream Hammel Dam, Hammel Woods, Shorewood, IL	41.521871183	-88.194284600
DuPage River	Downstream Shepley Rd, N. of Channahon, IL	41.467749111	-88.209758132
DuPage River	Channahon Dam Pool, Channahon, IL	41.422349465	-88.229098538
DuPage River	Downstream Channahon Dam, Channahon, IL	41.421085553	-88.227716359

FISH

Fish community sampling was performed to assess the localized effects of dams on stream quality, and system-wide effects of dams on species distribution. A total of 11 stations were sampled during summer 2000 (Table 1.2) on the West Branch and main stem of the DuPage River. Two additional stations were sampled in September 2001 to supplement species distribution data. Stations were located in free-flowing areas downstream, and impounded areas upstream of each dam at Channahon, Shorewood, McDowell Grove, and Warrenville (Figure X.1), Due to access problems, samples were taken only in the downstream area of the Fawell Dam. Fish collections were also made at four stations in free-flowing areas away from the dams in order to provide additional information on species distribution (Figure 1.5). Sample design, and station labeling followed protocols established by Santucci and Gephart (2003) for a similar study evaluating the effects of dams on Fox River fish communities:

- MID FF = mid segment stations in free-flowing reaches away from dams.
- DS FF = downstream free-flowing reaches immediately below dams.

- US IMP = upstream-impounded areas immediately above dams.

Stations were 300-2000 feet in length, depending on width of the stream and accessible area available.

Table 1.2 Fish community station locations, habitat type, river mile above mouth and collection dates (DS FF = downstream free-flowing; US IMP = upstream impounded; MD FF = mid segment free-flowing).

River	Station Location	Habitat Type	River mile above mouth	Sampling Date
DuPage	Channahon below dam	DS FF	0.9	9/8/00
	Channahon above dam	US IMP	1.1	9/8/00
	Shepley Road	MD FF	5.6	9/27/01
	Hammel Woods above dam	DS FF	10.5	9/7/00
	Hammel Woods below dam	US IMP	10.7	9/7/00
	119th Street	MD FF	24.0	9/27/01
West Branch	Fawell below dam	DS FF	36.0	7/26/00
	McDowell Grove below dam	DS FF	36.4	7/26/00
	McDowell Grove above dam	US IMP	36.5	8/3/00
	Diehl Road	MD FF	37.6	7/26/00
	Warrenville below dam	DS FF	38.7	8/3/00
	Warrenville below dam	US IMP	38.8	8/3/00
	Mack Road	MD FF	41.2	7/25/00

Boat electro-fishing was utilized for fish collection at locations with water depth greater than 1.6 meters, using a boat equipped with a 3500 watt - 3 phase generator (AC). Where habitat and water depths permitted, supplemental collections were made at boat sites with a backpack electro-fishing unit. Areas too shallow for boat access were sampled using a small floating "barge" equipped with remote probes. For all techniques, larger fish specimens were weighed, measured and returned to the stream. Smaller individuals were preserved and identified in the laboratory. In addition to determining species distribution and abundance at each station, stream conditions were evaluated using the Index of Biotic Integrity (IBI, Smogor 2000). The IBI is a widely used stream quality measurement based on the fish community, taking into account the number and types of species present, their tolerance to degradation, food, habitat and spawning preferences. These attributes are evaluated using 10 different parameters, or metrics, each with a possible score of 0-6. Scoring is based on comparison to established reference conditions for unmodified streams of similar size and region of the State. Total IBI scores range from 0-60, with higher scores indicating better quality.

The IBI is the basis for determining the letter-based Biological Stream Characterization (BSC, Bertrand et al. 1996), which includes the following IBI ranges and descriptors:

- 51-60 = A (Unique Aquatic Resource);
- 41-50 = B (Highly Valued Aquatic Resource);
- 31-40 = C (Moderate Aquatic Resource);
- 21-30 = D (Limited Aquatic Resource);
- 0-20 = E (Restricted Aquatic Resource).

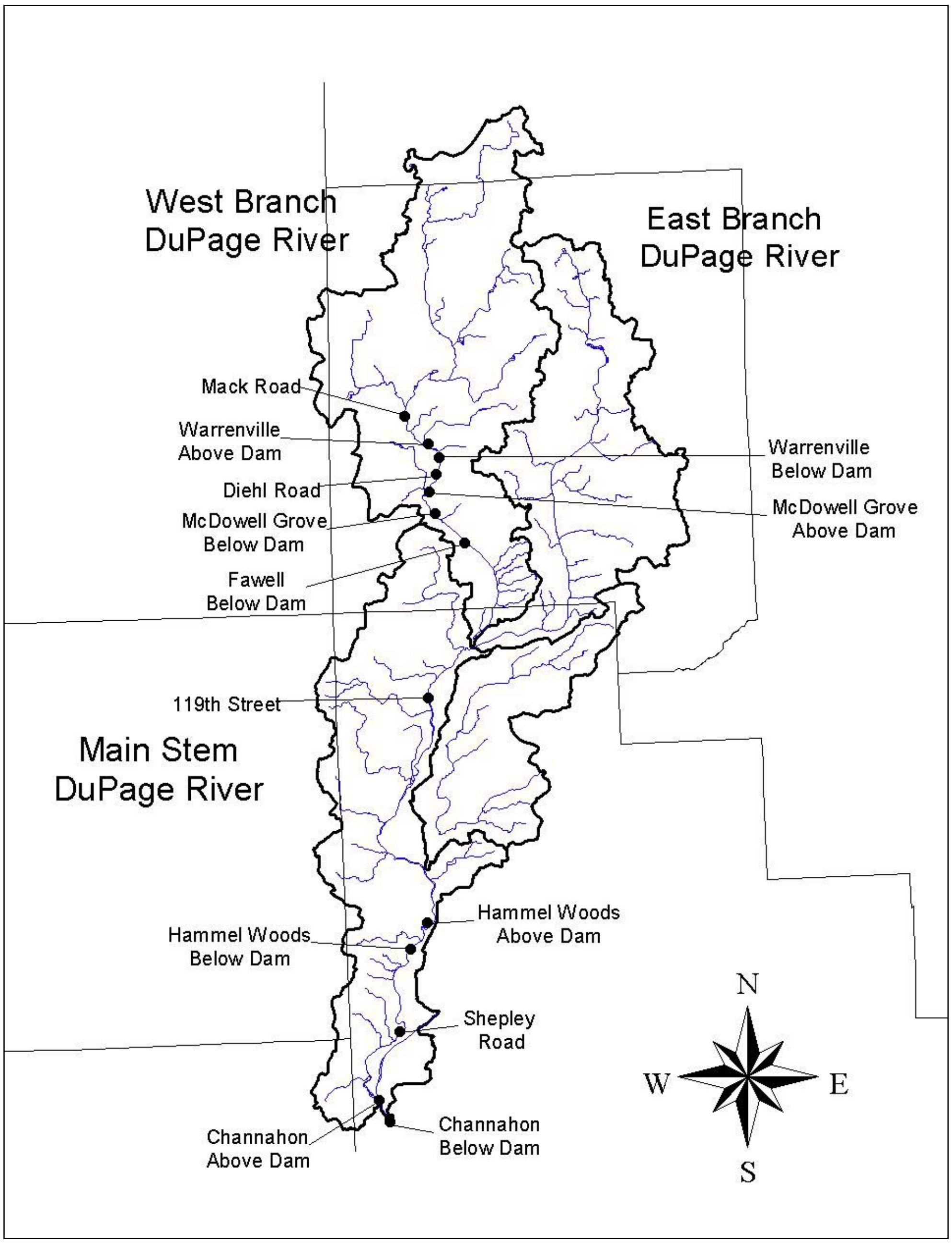


Figure 1.5 Sampling Locations for the study

Previous sampling in the DuPage Watershed includes a recent survey conducted at 6 stations by the Illinois Department of Natural Resources (DNR) in 1997 (unpublished data). These data were combined with results from the current study for analysis of species distribution.

MACROINVERTEBRATES

Macroinvertebrates were collected using both hand picking and D-frame kick nets. Forceps were used to pick invertebrates from various substrate including rocks, logs and submerged vegetation, while the kick nets were used in areas with faster moving water where the substrate could be kicked up and the invertebrates carried into the nets. One hour of sampling was completed for each site. Sampling time was divided proportionally according to available habitat types. A canoe was used where the water was too deep or too silted to wade.

Samples were preserved in 90% ethanol in the field. In the lab the samples were cleared of debris and sent to Mike Winnell of Freshwater Benthic Services in Michigan for identification to the lowest level of taxonomic resolution.

A multi-metric macroinvertebrate condition index (MCI), developed by Victor J. Santucci Jr. from Max McGraw Wildlife Foundation (Santucci & Gephard 2003), was used to analyze the data collected and is described below.

> The MCI is based on the U.S.EPA Rapid Bioassessment Protocols (Barbour et al. 1999). The index has seven metrics: the number of total taxa, EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera), and intolerant taxa; the percentages of EPT individuals, Chironomidae individuals (midge larvae) and clinger organisms; and the Macroinvertebrate Biotic Index (MBI). Intolerant taxa were those with tolerance ratings 4 (range 0-11) based on the latest Illinois macroinvertebrate tolerance list (IEPA 1995). Clinger organisms were filter-feeding insects that permanently attach to substrates (Merritt & Cummins 1996). This group of organisms is typically intolerant of poor water quality conditions (Barbour et al. 1999) The MBI is the Illinois version of the Hilsenhoff Biotic Index (Hilsenhoff 1987). It provides an overall community tolerance rating based on the mean of tolerance values weighted by organism abundance.
>
> Values for individual metrics were calculated and then adjusted to the same scale and direction of expected response to increase perturbation (with 95th percentiles of the data) and summed across the metrics to obtain a total condition index score for each station (Barbour et al. 1999). The range of values for the MCI was 0 to 700, with higher scores indicating higher quality macroinvertebrate community. The MCI was not appropriate for making comparisons to other studies or gauging ecological health relative to other rivers because only DuPage River kick-netting and hand picking data were used in its development. However the index provides a measure for documenting relative differences in macroinvertebrate communities among DuPage River sample stations.

AQUATIC HABITAT ASSESSMENT

Physical in-stream habitat was assessed at all sampling locations using both the Illinois Environmental Protection Agency (IEPA) Stream Habitat Assessment Protocol (SHAP) and Ohio Environmental Protection Agency's Qualitative Habitat Evaluation Index (QHEI). The assessments were completed by wading or canoeing the length of the fish sampling stations.

The SHAP combines 15 metrics that assess the quality and quantity of available aquatic habitat. The field metrics include Bottom Substrate, Deposition, Substrate Stability, In-stream Cover, Pool Substrate Characterization, Pool Quality, Pool Variability, Canopy Cover, Bank Vegetation Stability, Top of Bank Land Use, Flow Related Refugia, Channel Alteration, and Channel Sinuosity. Width/Depth Ratio and Hydrologic Diversity are calculated in the office. The metrics are summed for each station resulting in a score ranging from 15-208. The scores are then rated as Excellent (>= 142), Good (<142 & >=100), Fair (<100 & >= 59) and Poor (<59).

The QHEI uses six metrics to evaluate the quantity and quality of available aquatic habitat. The metrics include Substrate Type, In-stream Cover, Channel Morphology, Riparian Zone and Bank Erosion, Pool/Glide and Riffle/Run Quality and Gradient. The metrics are summed for each station resulting in a score of 0-100. Scores over 60 typically represent streams with good habitat that should support a diverse fish community. Index scores between 46 and 60 generally indicate degraded habitats that may or may not meet warm water criteria for supporting aquatic life. Scores below 46 typically represent severely degraded habitats that do not support quality fisheries. (Ohio EPA)

WATER CHEMISTRY

To determine the effects of algal respiration and photosynthesis on parameters chosen for this study samples were collected before sunrise and in the late afternoon at each sampling location, in anticipation of the extremes in the diurnal fluctuation of dissolved oxygen (DO). Water quality monitoring probes were set in each pool to record dissolved oxygen, temperature, pH and conductivity every fifteen minutes for a twenty-four hour period.

Because DO was the primary water quality variable of interest in this study, it was sampled most intensively. Using a Yellow Springs Instruments portable meter (YSI 95), DO and temperature were measured at three points in three transects across the pool of the dam. Measurements were taken at three depths (surface, mid-depth, and about 0.3 m from the bottom) at each point. If water was less than 1 m deep, only two measurements were taken. Measurements were also taken at three points across a single transect at the upstream and downstream sites. All measurements were collected before dawn and in the late afternoon. A Hydrolab Data Logger was placed in each pool approximately 0.3 meters above the substrate for a 24-hour period.

Readings for Dissolved Oxygen, temperature, pH and conductivity were recorded every five minutes for the duration.

Table 1.3. Water quality parameters collected at 12 sampling stations.

Recoded in the field	
Dissolved Oxygen (mg/L & % saturated)	pH
Temperature (celcius)	Conductivity (uS/cm)
Turbidity (NTU)	
Analyzed in the laboratory	
Total Organic Carbon (mg/L)	Total Phosporus (mg P/L)
Suspended Solids (mg/L)	Chlorophyll-a corrected (ug/L)
Ammonia Nitrogen (mg N/L)	Chlorophyll-b (ug/L)
Total Kjeldahl Nitrogen (mg N/L)	Chlorophyll-c (ug/L)
Nitrate/Nitrite mg N/L	Pheophytin-a (ug/L)
Total Dissolved Phosphorus (mg P/L)	

Nutrient, suspended solids, turbidity and chlorophyll samples were collected by taking grab samples at the center of flow and 0.3 meters below the surface of the water at each sampling location. Individual sample bottles were filled and preserved in the field and placed in coolers with ice. Nutrient and suspended solids samples were delivered to the USEPA lab within 48 hours after collection. Turbidity samples were analyzed in the field with a Turbidity meter. Chlorophyll samples were filtered after each round of collection and frozen until all sampling was concluded; they were then delivered to Illinois EPA for analysis. All parameters measured are listed in Table 1.3.

ACCUMULATED SEDIMENT

In order to assess current ecological conditions in the impounded areas and predict future conditions under a variety of dam modification or removal alternatives three objectives needed to be met. The first was to determine the quality of bulk sediment deposits that might be disturbed by dam modifications; the second was to determine the quantity of bulk sediment deposits that might be disturbed by dam modifications; and the third was to determine the quality of surficial sediment deposits (biota exposure layer) as they currently exist in the study area upstream and downstream of each dam.

To characterize the quality of the sediment a minimum of three hand-driven, 2-inch diameter, lexan tube core samples were taken within 50-100 feet above and below each dam. Each core sample was self-composited (vertically homogenized eliminating all horizon integrity) into a stainless steel bowl, mixed with a stainless steel spatula in the field, and placed in jars on ice until delivered to the USEPA Lab in Chicago. Samples were analyzed for metals, ABN's, pesticides and PCB's, ammonia nitrogen, Kjedahl nitrogen, total organic carbon, and grain size. All sampling locations were recorded with hand-held GPS units.

To provide a rough estimate of the volume of sediment behind each dam sediment was probed with a ½" steel pipe at 20-40 locations within 1000-2000 feet above and below each dam. Three transects at approximately 50-100 feet, 500-1000 feet and 1000-2000 feet distances upstream and downstream of the dam were sampled by zigzagging across the transect. Water depth to the top of the sediment and sediment depth to the bottom of pipe penetration were measured to the nearest 0.25 feet and recorded on an electronic data-logger with locational GPS data.

To assess the quality of the surficial sediment ponar grab samples were collected along the right-middle-left of three transects above and below the dams at distances of 50-100 feet, 500-1000 feet and 1000-2000 feet for a total of nine grabs above and nine below. The three grabs collected in each transect were composited in the field and placed in jars on ice until delivered to the USEPA lab in Chicago. The result was three upstream samples and three downstream samples for each dam. All sampling locations were recorded with hand-held GPS units.

QUALITY ASSURANCE AND QUALITY CONTROL

A Quality Assurance Project Plan was completed and approved by the USEPA before sampling commenced. All sampling equipment was cleaned using non-phosphate soap between stations to eliminate cross contaminations of samples. Duplicate and blank samples were collected to monitor precision of sampling techniques and laboratory operations. The duplicate was collected at the same time and location as every tenth sample. Blank samples were filled in the field using de-ionized water provided by the USEPA laboratory at the same time the duplicates were collected. Duplicate samples evaluate the variation in concentrations of constituents in the samples due to sampling and processing methods. Contamination of sampling equipment and processing water are assessed by the blank samples. The USEPA laboratory provided all sample bottles. YSI meters and Hydrolab data-loggers were calibrated daily or before each new deployment using standards provided by the USEPA laboratory.

STUDY RESULTS

FISH

For all stations combined, a total of 2,351fish, representing 41 species were collected, including two non-native species, carp and goldfish (Table 1.5). One hybrid taxa (bluegill X green sunfish) was also found. Although the mosquito fish is native to Illinois, the natural range is limited to southern half of the State. No endangered or threatened species were collected in this study.

Cyprinids (minnows and carp) were the most abundant and diverse family present, with 13 species accounting for 47% (1,109) of the total collection (Table 1.5). Centrarchids (sunfishes) were also abundant comprising 40% (945) of the total. The five most common species in order of abundance were: sand shiner, green sunfish, bluegill, spotfin shiner, and bluntnose minnow (Table 1.5). These species made up 68% of the fish sampled. Species abundance and composition for this study were similar to those found in the survey conducted in 1997 (Illinois Department of Natural Resources, unpublished data).

In order to evaluate the system-wide effects of dams on fish distribution, we determined species occurrences within each river segment created by the existing dams. For this analysis, data from the 1997 survey (IDNR unpublished data) were also included. Out of the 41 species collected from the main stem and the West Branch of the DuPage River, 18 species (42%) were found throughout the river system, and did not appear to be affected by the dams. In contrast, 23 of the 41 total species (58%) did appear to be affected by the dams, primarily by blocking upstream movement. Table 1.4 shows the distribution of the 23 affected species in each river segment between dams. The area downstream of the Channahon Dam, which is directly connected to the Illinois River, had the most diverse species assemblage, with all 23 affected species present. The number of species diminished upstream of Channahon, and Shorewood Dams (Table 1.4). Upstream of Fawell Dam, none of the 23 species were found in the 1997 or 2000 collections.

Historically, the DuPage River system experienced severe water quality degradation (IEPA 1983). The absence of intolerant species in the upper watershed may be due to the past water quality conditions, and the inability of species to re-colonize this area through recruitment from downstream areas of higher fish diversity. Results of our current study and more recent IEPA data (IEPA 2002), indicate that water quality in the DuPage River system has improved in recent years, however, the dams block movement of fish into the previously degraded areas, presenting an impediment to restoration efforts in the watershed.

In addition to system-wide effects, dams are known to have localized impacts on fish communities due to degraded habitat and water quality conditions in the upstream impounded area (Santucci and Gephart 2003, Kenehl et al. 1999). For the DuPage River, a total of 26 species, representing 65% of all species collected, were found only at the free-flowing stations downstream of the dams, and did not occur in the upstream impounded areas (Table 1.5).

With the exception of golden shiner, all species found in the impounded areas were also found in the free-flowing areas. For all stations combined, free-flowing areas held roughly twice as many species as the impounded areas upstream of the dams (Table 1.5).

Table 1.4. Fish species occurrence by river segment for those species whose distribution was affected by dams, for the DuPage River Dam Study (data from current study combined with IDNR 1997 Basin Survey data)

	River Segment					
	Downstream ---> Upstream					
COMMON NAME	**Downstream Channahon**	**Channahon Shorewood**	**Shorewood Fawell**	**Fawell McDowell**	**McDowell Warrenville**	**Upstream Warrenville**
Northern pike	■	■				
Hornyhead chub	■	■				
Central stoneroller	■	■	■			
Suckermouth minnow	■	■				
Emerald shiner	■	■				
Striped shiner	■					
Bigmouth shiner	■					
Quillback	■	■	■			
Northern hog sucker	■	■	■			
Shorthead redhorse	■	■	■			
Golden redhorse	■	■				
Silver redhorse	■					
Channel catfish	■	■	■			
Flathead catfish	■	■				
Stonecat	■	■				
Tadpole madtom	■	■	■			
Blackstripe topminnow	■	■	■			
Rock bass	■	■	■			
Longear sunfish	■	■				
Slenderhead darter	■					
Johnny darter	■	■	■			
Banded darter	■	■	■			
Freshwater drum	■	■				

Table 1.5 Summary of fish collection results at each station. (DS FF =downstream free flowing; US IMP = upstream impoundment; MD FF = mid segment free flowing.)

		Channahon Dam		Shepley Road	Hammel Woods Dam		119th Street	Fawell Dam	McDowell Grove Dam		Diel Rd.	Warrenville Dam		Mack Rd.
COMMON NAME	**Total No.**	**DS FF**	**US IMP**	**MD FF**	**DS FF**	**US IMP**	**MD FF**	**DS FF**	**DS FF**	**US IMP**	**MD FF**	**DS FF**	**US IMP**	**MD FF**
Gizzard shad	29	7	16	0	0	0	0	0	0	0	0	2	4	0
Goldfish	2	0	0	0	0	0	1	0	0	0	0	1	0	0
Carp	158	3	4	8	13	28	36	7	5	16	2	2	23	11
Golden shiner	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Creek chub	11	1	0	0	0	0	0	0	0	0	8	1	0	1
Hornyhead chub	2	0	0	2	0	0	0	0	0	0	0	0	0	0
Central stoneroller	10	2	0	7	0	0	1	0	0	0	0	0	0	0
Suckermouth minnow	9	4	0	5	0	0	0	0	0	0	0	0	0	0
Striped shiner	3	3	0	0	0	0	0	0	0	0	0	0	0	0
Spotfin shiner	301	15	0	0	0	0	8	14	111	6	80	37	1	29
Fathead minnow	2	0	0	0	0	0	0	0	0	0	0	2	0	0
Bluntnose minnow	208	9	0	3	0	4	33	5	75	4	5	19	1	50
Bigmouth shiner	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Sand shiner	401	0	0	0	0	0	0	0	56	0	227	4	0	114
Quillback	5	0	0	0	0	0	5	0	0	0	0	0	0	0
White sucker	85	0	0	5	0	2	42	8	1	2	15	1	4	5
Northern hog sucker	17	3	0	2	4	5	2	1	0	0	0	0	0	0
Shorthead redhorse	28	8	0	12	1	0	3	4	0	0	0	0	0	0
Golden redhorse	15	11	0	4	0	0	0	0	0	0	0	0	0	0
Silver redhorse	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	13	3	0	3	2	2	0	3	0	0	0	0	0	0
Yellow bullhead	14	0	0	6	0	0	5	1	0	0	0	0	0	2
Flathead catfish	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Stonecat	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Tadpole madtom	21	0	0	3	0	0	18	0	0	0	0	0	0	0
Blackstripe topminnow	44	3	7	19	0	3	12	0	0	0	0	0	0	0
Mosquitofish	14	6	0	0	0	0	3	0	0	0	0	4	1	0
Yellow bass	5	0	0	0	0	0	0	0	5	0	0	0	0	0
Black crappie	12	2	0	0	3	1	1	1	0	1	0	2	1	0
Rock bass	35	0	0	28	5	0	2	0	0	0	0	0	0	0
Largemouth bass	53	2	7	6	0	0	4	4	5	7	2	6	8	2
Smallmouth bass	44	1	0	12	3	0	5	2	5	0	3	5	0	8
Green sunfish	382	2	0	57	15	5	13	29	147	11	72	11	5	15
Sunfish hybrid	27	1	0	0	2	0	0	12	6	1	5	0	0	0
Bluegill	304	4	11	18	14	15	13	62	12	57	68	24	2	4
Longear sunfish	15	0	1	14	0	0	0	0	0	0	0	0	0	0
Orangespotted sunfish	68	0	0	2	0	9	0	10	17	8	5	3	9	5
Slenderhead darter	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Johnny darter	2	0	0	0	0	0	2	0	0	0	0	0	0	0
Banded darter	4	0	0	4	0	0	0	0	0	0	0	0	0	0
Freshwater drum	2	1	0	0	1	0	0	0	0	0	0	0	0	0
	2351	**94**	**46**	**221**	**64**	**74**	**209**	**163**	**445**	**113**	**492**	**124**	**60**	**246**
	41	**23**	**6**	**22**	**11**	**10**	**20**	**14**	**11**	**9**	**11**	**16**	**12**	**12**

Table 1.6 Index of Biotic Integrity (IBI) and species numbers at each sampling location. (DS FF =downstream free flowing; US IMP = upstream impoundment; MD FF = mid segment free flowing.)

River	Station Location	Habitat Type	IBI	No. Species
DuPage	Channahon below dam	DS FF	48	23
	Channahon above dam	US IMP	14	6
	Shepley Road	MD FF	42	22
	Shorewood below dam	DS FF	28	11
	Shorewood above dam	US IMP	21	10
	Ferguson Road	MD FF	33	20
West Branch	Fawell below dam	DS FF	27	14
	McDowell Grove below dam	DS FF	18	11
	McDowell Grove above dam	US IMP	17	9
	Diel Road	MD FF	19	11
	Warrenville below dam	DS FF	22	16
	Warrenville above dam	US IMP	18	12
	Mack Road	MD FF	19	12

Free-flowing communities included game species such as smallmouth bass and rock bass, as well as many intolerant varieties such as darters and suckers. The area upstream of the Shorewood Dam was the only area containing intolerant stream species (smallmouth bass and northern hogsucker). Based on observations conducted during sampling, and results of the habitat study (QHEI, Table 1.10), the area upstream of the Shorewood Dam exhibits free-flowing characteristics due to the low height of the dam (3.2 feet) and the accumulation of coarser bedload sediments such as sand and gravel.

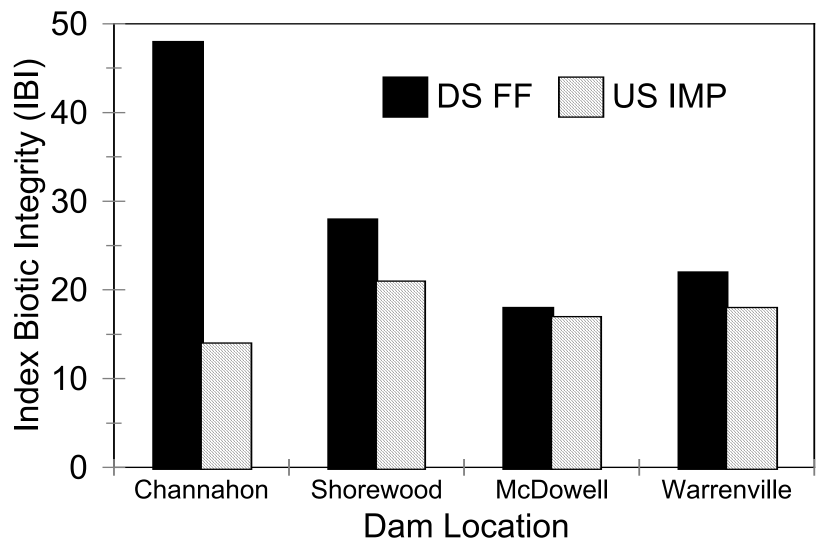
Local effects were evaluated by comparing IBI for the downstream free-flowing (DS FF) and upstream impounded (US IMP) areas at four dams (Tables 1.4 and 1.6). As expected, the DS FF area at Channahon Dam had a higher IBI (48) than the US IMP area (IBI = 16). Due to the low height of the dam (as noted above), the difference in IBI between US IMP and DS FF at Shorewood was minimal. Although the upstream dams at McDowell Grove (height 5.1 feet) and Warrenville (8.0 feet) are high enough to create distinct impounded areas, there was little difference in IBI between DS FF and US IMP at these dams. The effectiveness of the IBI in evaluating stream quality was greatly reduced at these upstream dam locations due to the overall low species numbers, and generally degraded nature of the fish communities, which

Table 1.7 Distribution of fish species by habitat type (DS FF = downstream free-flowing; US IMP = upstream impounded; MD FF = mid segment free-flowing).

FAMILY	COMMON NAME	SCIENTIFIC NAME	MD FF	DS FF	US IMP
Clupeidae	Gizzard shad	*Dorosoma cepedianum*	+	+	-
Cyprinidae	Goldfish	*Carassius auratus*	+	-	-
	Carp	*Cyprinus carpio*	+	+	+
	Golden shiner	*Notemigonus crysoleucas*	-	-	+
	Creek chub	*Semotilus atromaculatus*	+	+	-
	Hornyhead chub	*Nocomis biguttatus*	+	-	-
	Central stoneroller	*Campostoma anomalum*	+	+	-
	Suckermouth minnow	*Phenacobius mirabilis*	+	+	-
	Striped shiner	*Luxilus chrysocephalus*	-	+	-
	Spotfin shiner	*Cyprinella spiloptera*	+	+	-
	Fathead minnow	*Pimephales promelas*	-	+	-
	Bluntnose minnow	*Pimephales notatus*	+	+	+
	Bigmouth shiner	*Notropis dorsalis*	-	+	-
	Sand shiner	*Notropis ludibundus*	+	+	-
Catostomidae	Quillback	*Carpiodes cyprinus*	-	+	-
	White sucker	*Catostomus commersoni*	+	+	+
	Northern hog sucker	*Hypentelium nigricans*	+	+	+
	Shorthead redhorse	*Moxostoma macrolepidotum*	+	+	-
	Golden redhorse	*Moxostoma erythrurum*	+	+	-
	Silver redhorse	*Moxostoma anisurum*	-	+	-
Ictaluridae	Channel catfish	*Ictalurus punctatus*	+	+	+
	Yellow bullhead	*Ameiurus natalis*	+	+	-
	Flathead catfish	*Pylodictis olivaris*	-	+	-
	Stonecat	*Noturus flavus*	+	-	-
	Tadpole madtom	*Noturus gyrinus*	+	-	-
Cyprinodontidae	Blackstripe topminnow	*Fundulus notatus*	+	+	+
Poeciliidae	Mosquitofish	*Gambusia affinis*	+	+	+
Percichthyidae	Yellow bass	*Morone mississippiensis*	-	+	-
Centrachidae	Black crappie	*Pomoxis nigromaculatus*	+	+	+
	Rock bass	*Ambloplites rupestris*	+	+	-
	Largemouth bass	*Micropterus salmoides*	+	+	+
	Smallmouth bass	*Micropterus dolomieu*	+	+	-
	Green sunfish	*Lepomis cyanellus*	+	+	+
	Sunfish hybrid	*Lepomis hybrid*	+	+	+
	Bluegill	*Lepomis macrochirus*	+	+	+
	Longear sunfish	*Lepomis megalotis*	-	+	+
	Orangespotted sunfish	*Lepomis humilis*	+	+	+
Percidae	Slenderhead darter	*Percina phoxocephala*	-	+	-
	Johnny darter	*Etheostoma nigrum*	+	-	-
	Banded darter	*Etheostoma zonale*	+	-	-
	Freshwater drum	*Aplodinotus grunniens*	+	-	-
		total no. species	**31**	**33**	**15**

effectively masked the difference between the DS FF and US IMP. For example, we examined IBI scores for all free-flowing areas only, from Channahon Dam to Mack Road, and found decreasing stream quality moving from the downstream to upstream areas (Table 1.4). The number of species also decreased in the upstream areas (Table 1.7)

Figure 1.6. Index of Biotic Integrity for downstream free flowing (DS FF) and upstream impounded (US IMP) habitats each dam location for the DuPage River Dam Study.



Despite the similarity in IBIs for the upstream and downstream areas at McDowell Grove and Warrenville Dams, the effects of the dams were still apparent as indicated by the total abundance of fish collected. The total number of fish collected at DS FF was 2X greater than US IMP at the McDowell Grove Dam, while DS FF was 4X greater than US IMP at Warrenville (Table 1.5). The mean abundance for all dams was lower for the US IMP areas, compared to the DS FF (Figure 1.5). MID FF areas appeared to be more productive than the DS FF area as indicated by the mean abundance.

Overall, the mean number of species and mean IBI for all dam locations (n=4) were higher for DS FF areas than for US IMP (Figure X.5). Poor habitat, as determined by measured indices (Table XX), and water quality (Table XX) appeared to be the primary factors affecting fish communities in the upstream impounded areas of the dams (with the exception of the low dam at Shorewood).

The local and system-wide effects on fish communities observed in this for the DuPage River, are similar to those found in the Fox River Dam study (Santucci and Gephard 2003). Other studies conducted in Illinois (Pescitelli and Rung 1997) and Wisconsin (Kenehl et al 1997) have also documented the negative effects of low-head dams on stream quality.

Figure 1.7. Index of Biotic Integrity (IBI) for free-flowing stations only at each sampling location (CH = Channahon Dam, SP = Shepley Road, SH = Shorewood Dam, FR = Ferguson Road, FA = Fawell Dam, MID = McDowell Grove Dam, DR = Diel Road, WV = Warrenville Dam, MR = Mack Road).

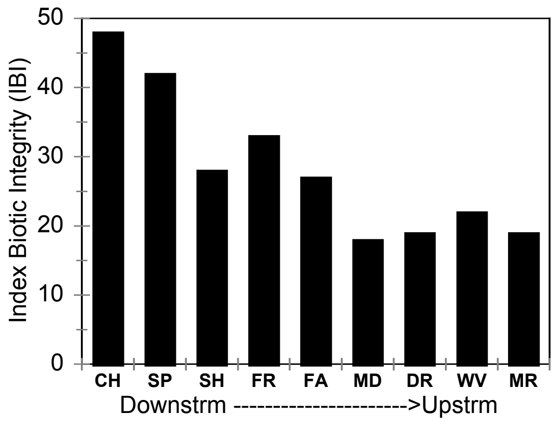
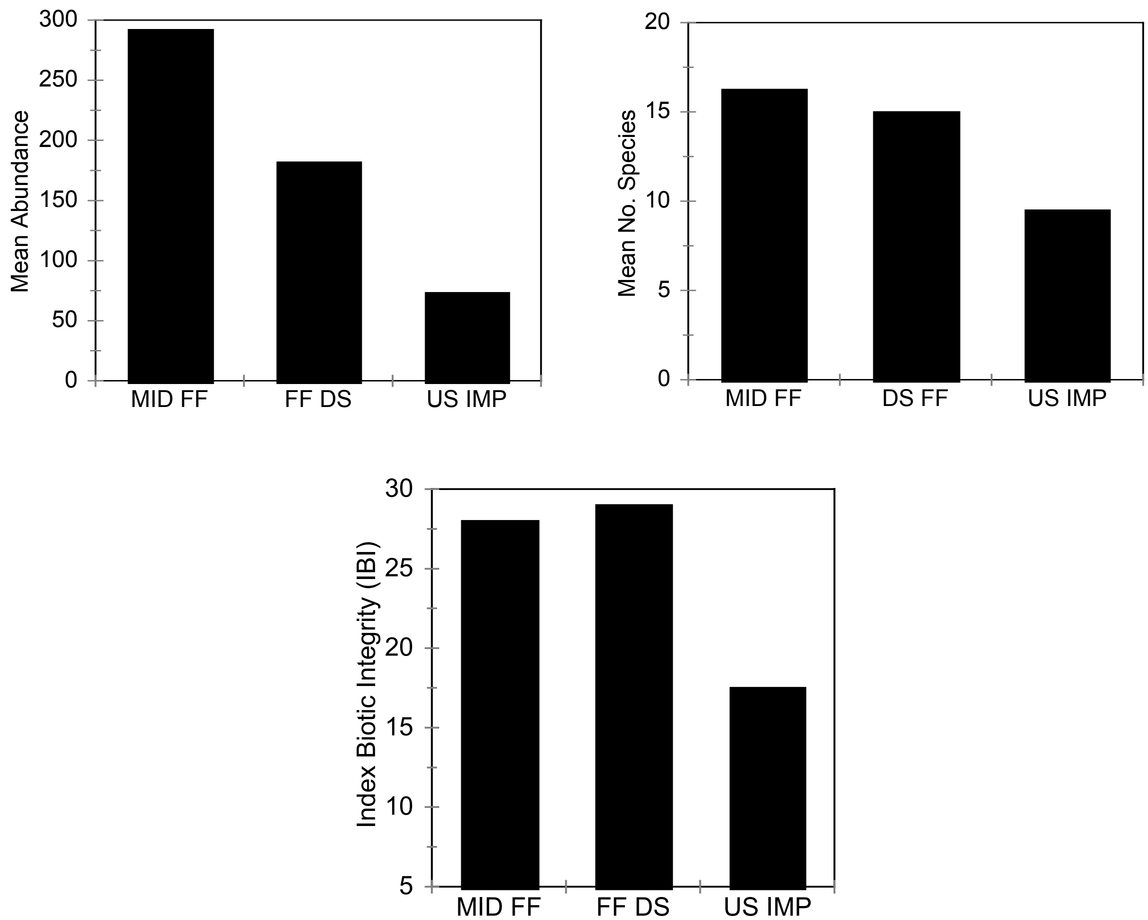


Figure 1.8. Mean abundance, No. of species and IBI for each habitat type for all locations (DS FF = downstream free-flowing; US IMP = upstream impounded; MID FF = mid segment free-flowing).



MACROINVERTEBRATES

Macroinvertebrates and fish communities are indicators of changes in water quality and aquatic habitat in the watershed. Macroinvertebrates make good indicators of water quality and habitat because they:

- live in the water for all or most of their lives
- stay in areas suitable for their survival
- are easy to collect and identify
- differ in their tolerance to amounts and types of pollution
- have limited mobility
- are integrators of environmental condition

(USEPA Office of Science and Technology Biocriteria website)

Dams do not directly impact macroinvertebrates because if conditions worsen adults can move to more suitable habitat, upstream or downstream, to lay eggs. If conditions improve the inverts can quickly repopulate an area. The absence of intolerant macroinvertebrates from the impounded areas behind the dams suggests either poor water quality, poor habitat or a combination of the two.

Sampling resulted in the collection of 2,051 individuals representing 104 taxa of macroinvertebrates. The macroinvertebrate community scores (Table 1.8, Figure 1.9) were the lowest in the Warrenville, McDowell Grove and Channahon pools respectively. This correlates with the poor quality habitat found in each of these pools. Much higher scores were found in the free flowing areas, which also had better habitat diversity. The Hammel Woods pool scores very well due to unusually diverse in-stream habitat for impounded areas.

Table 1.9 shows taxa broken down by habitat type. There are 66 taxa found in the downstream free flowing (DS FF) areas, 42 taxa in the impoundments, excluding the Hammel Dam impoundment, and 73 taxa in the mid segment free flowing (MID FF) areas. The macroinvertebrate data correlates well with the habitat assessments as shown in figure 1.10 where QHEI scores are compared with the MCI scores. Where there is poor habitat there are low macroinvertebrate scores. The macroinvertebrate data exhibits the impacts that the dams at Channahon, McDowell and Warrenville have on the quality of the habitat in the impoundments they create.

Figure 1.9. Macroinvertebrate Community Index (MCI) by habitat type, downstream free flowing (DS FF), impoundments (IMP), and mid segment free flowing (MID FF).

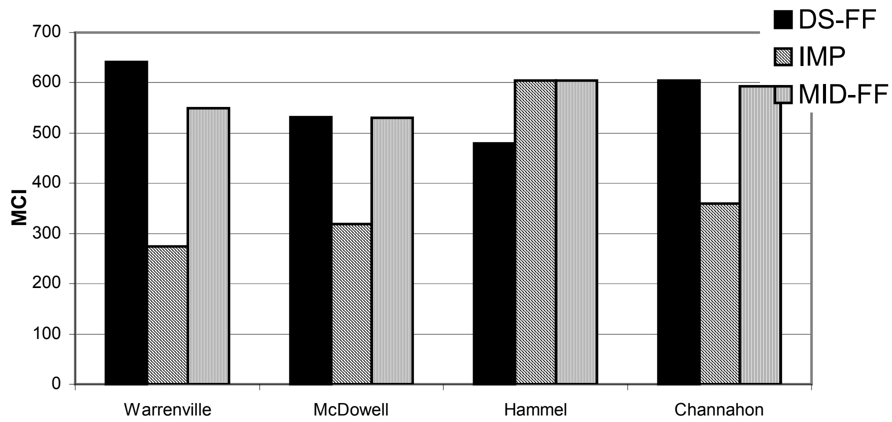


Figure 1.10. Qualitative Habitat Evaluation Index (QHEI) compared with the Macroinvertebrate Community Index (MCI).

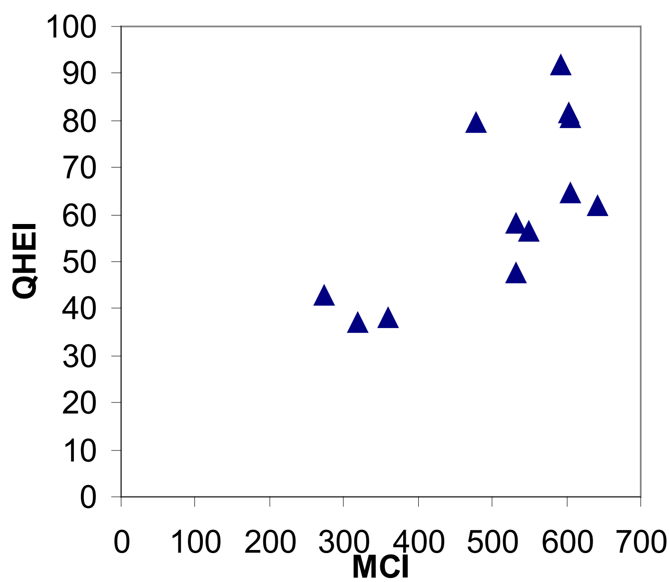


Table 1.8. Macroinvertebrate Community Index

Station	Total Benthos	EPT Taxa	Intolerant Taxa	% EPT Individuals	% Chiron-omidae	% Clinger	MBI	MCI
Warrenville/Mack Rd.	225	11	5	35.60	17.80	59.10	5.7	550
Warrenville Pool	9	1	0	11.10	11.10	33.30	5.7	274
Warrenville Downstream	220	11	5	63.20	5.00	81.40	5.8	641
Diehl Rd.	206	7	5	37.90	12.60	70.40	5.9	531
McDowell Grove Pool	62	3	2	11.30	17.70	17.70	5.5	319
McDowell Downstream	91	10	3	41.80	15.40	78.00	5.6	532
119th St.	191	6	9	65.40	3.10	78.50	5.6	605
Hammel Woods Pool	175	10	12	35.40	18.90	48.00	5.3	604
Hammel Woods Downstream	240	6	6	32.90	2.10	40.40	5.0	479
Shepley Rd.	350	11	7	41.40	5.40	48.90	5.1	593
Channahon Pool	63	2	5	11.10	19.00	25.40	5.5	360
Channahon Downstream	219	11	7	47.90	9.10	64.80	5.6	605

Table 1.9. Macroinvertebrates collected at downstream free flowing (DS FF), mid segment free flowing (MID FF) and at the Channahon, McDowell and Warrenville impoundments.

Taxa	DS-FF	Channahon, McDowell & Warrenville Pools	MID-FF
Turbellaria (flat worms)			
Dugesia tigrina	+	+	+
Oligochaeta (aquatic worms)	+	+	+
Hirudinea (leeches)			
Erpobdella punctata	-	-	+
Mooreobdella microstoma	+	-	+
unid. erpobdellid	+	-	+
Helobdella stagnalis	+	-	+
Helobdella triserialis	+	+	+
unid. glossiphoniid	+	-	-
Isopoda (aquatic sow bugs)	+	+	+
Amphipoda (scuds)			
Gammarus fasciatus	+	-	-
Gammarus pseudolimnaeus	+	-	-
Hyalella azteca	+	+	+
Ephemeroptera (mayflies)			
Baetis intercalaris	+	-	+
Callibaetis sp.	+	+	+
Caenis latipennis	+	-	+
Caenis spp. (EI)	+	-	-
Leucrocuta sp.	-	-	+
Stenacron interpunctatum	+	+	+
Stenonema terminatum	+	-	+
Tricorythodes sp.	+	+	+
Odonata			
Anax junius	+	-	+
Anax longipes	+	-	+
Hetaerina americana	+	-	+
Argia moesta	+	-	+
Argia sp. (inc., EI)	+	+	+
Enallagma divagans	-	-	+
Enallagma exsulans	+	-	+
Enallagma signatum	+	+	+
Enallagma sp. ?	+	+	+
Enallagma spp. (inc., EI)	+	+	+
Ischnura verticalis/posita (EI)	-	-	+
Ischnura sp. (inc., EI)	+	+	+
Perithemis tenera	-	+	-
Plathemis lydia	-	+	-
Megaloptera (dobson flies)			
Sialis sp.	-	-	-
Trichoptera (caddis flies)			
Protoptila sp.	+	-	-
Helicopsyche borealis	-	-	+
Cheumatopsyche sp.	+	+	+
Hydropsyche aerata	+	-	+
Hydropsyche bronta	+	-	+
Hydropsyche depravata complex	+	-	+
Hydropsyche morosa	+	-	+
Hydropsyche phalerata	+	+	+
Hydropsyche simulans	+	-	+
Hydropsyche valanis	+	-	+
Hydropsyche spp. (EI)	+	-	+
hydropsychid (EI)	+	-	+
Hydroptila sp.	-	-	+
Ceraclea sp.	-	-	-
Oecetis inconspicua complex	-	-	+
Coleoptera (beetles)			
Dubiraphia spp.	+	+	+
Macronychus glabratus	-	+	-
Stenelmis crenata	+	-	+
Stenelmis grossa	+	-	+
Stenelmis sexlineata	-	+	-
Stenelmis spp. (L)	+	-	+
Gyrinus sp.	-	-	+
Diptera (true flies)			
Ceratopogonidae			
Bezzia/Palpomyia sp.	-	+	-
Chironomidae			
Ablabesmyia mallochi	+	-	+
Ablabesmyia monilis	-	-	+
Chironomus sp.	-	+	-
Clinotanypus sp.	-	+	-
Corynoneura sp.	-	-	+
Cricotopus (C.) bicinctus	-	-	+
Cricotopus (I.) sylvestris	-	+	-
Cricotopus/Orthocladius	+	-	+
Cryptochironomus sp.	+	+	+
Dicrotendipes neomodestus	-	+	+
Dicrotendipes sp.	+	-	+
Harnischia sp.	-	+	-
Parachironomus tenuicaudatus complex	-	+	-
Polypedilum flavum	+	+	+
Polypedilum illinoense-gr.	+	+	+
Polypedilum scalaenum-gr.	+	+	+
Polypedilum sp.	-	+	-
Procladius sp.	+	+	+
Rheocricotopus robacki	+	-	-
Rheotanytarsus sp.	+	-	+
Tanypus neopunctipennis	-	+	-
Tanypus stellatus	-	+	-
Tanytarsus sp. 08-gr.	-	-	-
Tanytarsus sp. 13C	-	-	+
Thienemanniella lobapodema	-	-	-
Thienemanniella similis	-	-	+
Thienemanniella xena	+	-	+
Thienemanniella sp.	+	-	+
Tribelos fuscicorne	-	+	-
Xenochironomus xenolabis	-	-	-
Culicidae			
Anopheles sp.	-	+	-
Empididae			
Hemerodromia sp.	-	-	+
Simuliidae			
Similium vittatum complex	-	-	+
Gastropoda (snails and limpets)			
Ferrissia rivularis	+	+	+
Ferrissia walkeri	+	-	-
Ferrissia sp.	+	-	-
Physella sp.	+	+	+
Gyraulus circumstriatus	+	+	-
Amnicola limosa	+	-	+
Amnicola sp.	-	-	+
Elimia sp.	+	+	+
Pelecypoda (clams and mussels)			
Corbicula flumineum	+	-	+
Musculium transversum	-	-	+
Musculium sp.	+	-	+
Pisidium casertanum	+	-	-
Pisidium compressum	+	+	-

AQUATIC HABITAT

In-stream habitat is a key characteristic of a healthy stream ecosystem. Streams must exhibit well-developed and diverse habitats in order to support healthy macroinvertebrate and fish communities. "Habitat" takes into consideration attributes like substrate type, in-stream cover, flow diversity, channel formation (riffles, pools and runs), sinuosity, canopy cover, and riparian land uses. Many of our stream miles have been altered, directly or indirectly, by man through channelization, bridge crossings, dams, storm sewer and wastewater effluent discharges. These changes have greatly impacted the quality of in-stream habitat.

Overall stream habitat improves going down stream, this is most likely influenced by the greater amount of development and therefore the greater amount of impervious surfaces that drain directly into the upstream portions of the system. This increased drainage causes flows to be flashy and destructive. Many of the stream segments have eroded banks and are stripped of in-stream structure; this causes a lack of diversity of microhabitats and local flow conditions. SHAP and QHEI scores and rankings can be found in Table 1.10.

The Diehl Road station had the best SHAP and QHEI scores for the West Branch DuPage River with a good and intermediate ranking respectively. This segment had a few pools and one good riffle, but lacked diversity in substrate type and flow. This is a relatively characteristic site for the free flowing sections of the West Branch DuPage River. Both of the impounded pools ranked as "poor" using either metric. The pools were very silted in and relatively shallow with little to no diversity in substrate type, cover or flow.

Table 1.10. Habitat Assessment Scores

Site	SHAP Score	SHAP Rating	QHEI Score	QHEI Rating
Mack Road	86	Fair	56.5	Intermediate
Warrenville Dam Pool	81	Fair	43	Poor
Warrenville Downstream	80	Fair	62	Good
Diehl Road	109.5	Good	58	Intermediate
McDowell Dam Pool	76	Fair	37	Poor
McDowell Downstream	95.5	Fair	47.5	Intermediate
119th Street	99	Fair	64.5	Good
Hammel Dam Pool	134	Good	81.5	Good
Hammel Downstream	132	Good	79.5	Good
Shepley Road	148	Excellent	92	Good
Channahon Dam Pool			38	Poor
Channahon Downstream	135	Good	80.5	Good

The Shepley Road station ranked the best on the Main Stem DuPage River as well as over all with an "excellent" and a "high good" on the SHAP and QHEI respectively. This station is the best example of what a warm water stream should look like, it has excellent pool riffle development as well as diverse flow types.

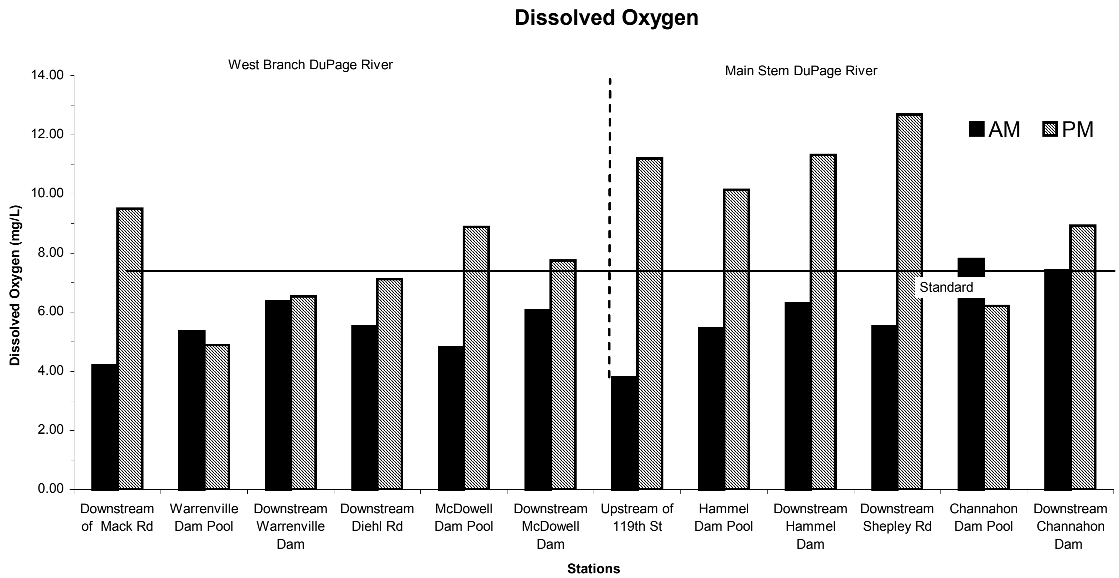
The two impounded pools on the main stem vary greatly. The Hammel Dam pool scored well on both metrics, had very little Siltation and had a diverse selection of microhabitats. This may be due to the relatively low height of the dam and the relatively young age for the structure. The Channahon Pool is much more comparable to the pools in the West Branch DuPage River, low metric scores, high levels of silt, lack of microhabitats and flow diversity. The extreme height of this dam and relatively shallow gradient of this segment of the river creates a long impoundment of more than four miles.

The habitat scores show evidence of the impacts the dams at Channahon, McDowell and Warrenville have on in-stream habitat. The impounded areas behind these dams slow down and homogenize flow and settle out fine sediments, which cover valuable substrate. These areas no longer support healthy fish or macroinvertebrate communities.

WATER CHEMISTRY

The DuPage River is highly enriched with nutrients throughout the system. For the most part nutrient levels do not appear to be affected by the dams. Dissolved oxygen (DO) is another indicator of stream health. The DO levels in the river fall below the minimum 5 mg/L standard (IEPA) at the Warrenville Dam Pool to as low as 3.98 mg/L, and at 119th Street to as low as 2.98 mg/L. The 119th Street sampling station was in a free flowing section of the main stem DuPage River and low DO levels at this station were not anticipated. Along with the low DO levels, another indicator of stress to the system are the diurnal fluctuations of DO. Diurnal fluctuations occur naturally in water bodies due to photosynthesis during the day and plant respiration at night. However, large variability between the daily high and low DO values is a potential indicator of nutrient enrichment.

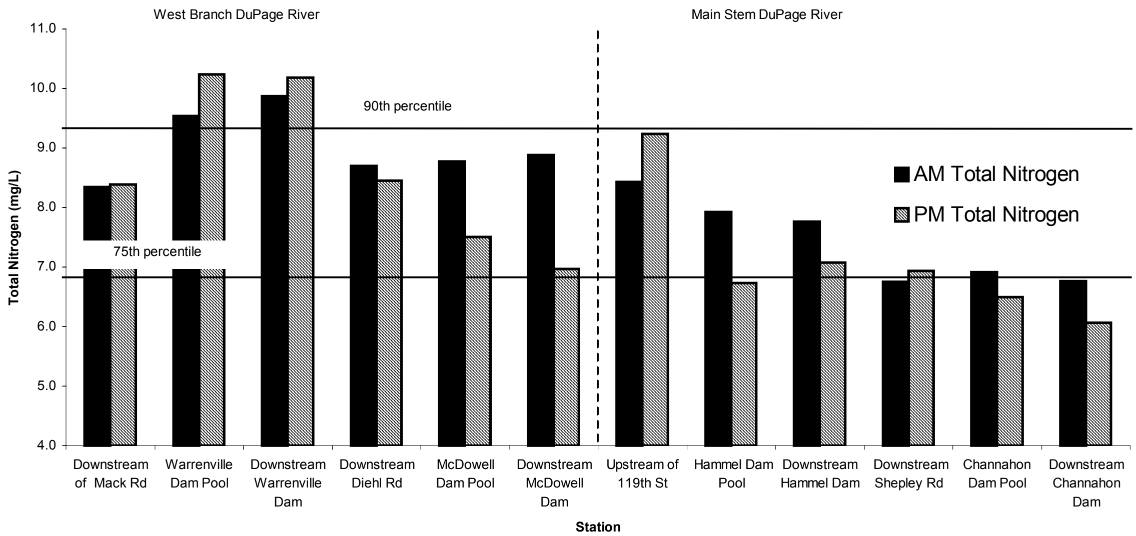
Figure 1.11. Total Dissolved Oxygen Values

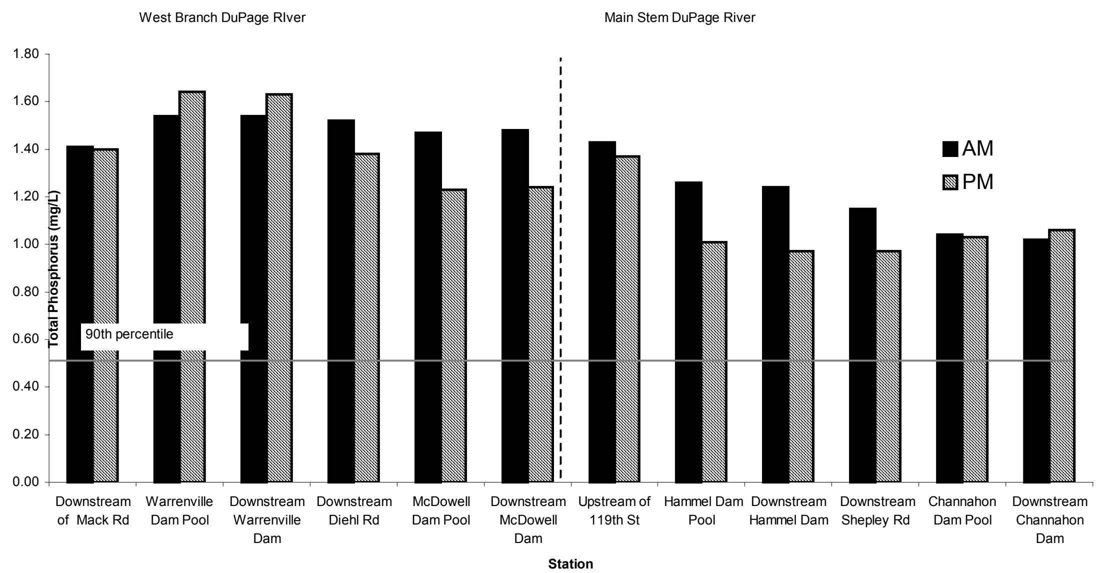


When compared to recommended guidelines for Nitrogen Zone 2 and Phosphorus Zone 4 for Midwestern Streams (Robertson et al. 2001), recorded values were highly elevated along the entire system. Total nitrogen values were for the most part between the 75th percentile (6.80 mg/L) and the 90th percentile (9.35 mg/L) with a high of 10.24 mg/L at the Warrenville Dam Pool and a low of 6.06 mg/L at the Channahon Dam Pool, well above the expected level of 1.24 mg/L for a minimally impacted site within the zone. Total phosphorus levels were all above the 90th (0.54 mg/L) percentile with a high of 1.64 mg/L at Warrenville Dam Pool and a low of 0.97 mg/L downstream of the Hammel Dam and at Shepley Road, well elevated above the expected value of 0.11 mg/L (Figure 1.12). High nutrient levels can be attributed to the fact that a significant portion of the flow comes from 19 wastewater treatment plants (WWTP) in the watershed as well as the mostly urbanized land cover in the upper portions of the watershed. These WWTP do not have permit limits for nutrients and are not required to provide nutrient removal.

Chlorophyll-a was sampled as an indicator of algal growth and nutrient enrichment in the water column. All samples were well below the recommended value of 7.3 mg/L based on the 25th percentile of all seasons data from aggregate ecoregion VI streams (USEPA 2000). Chlorophyll-a may be depressed due to the lack of a “seed source” for phytoplankton, the velocity of the flow, as well as the large beds of macrophytes and peryphyton throughout most of the system that uptake some of the nutrients. Retention time behind the dams is also much shorter than behind dams on the Fox River, which limits the potential for phytoplankton to build-up under normal flow conditions. A large amount of the nutrients that enter this system appear pass through the system and enter the Illinois River without having been converted to biomass.

Figure 1.12 Total Nitrogen And Total Phosphorus Values





The DuPage River watershed is plagued with usual impacts of urban streams, high nutrient levels from wastewater effluent and urban runoff, sedimentation from construction sites and streambank erosion as well as the remnants of past channelization. From the information collected in this study the dams themselves do not greatly impact the water chemistry of the river system.

ACCUMULATED SEDIMENT

Sediment depths were recorded at 135 locations behind the four dams studied. Sediment volumes ranged from 1,668 cubic yards behind the Hammel Woods dam to 30,686 cubic yards behind the Warrenville dam (Table 1.11). The estimated volumes may not include the entire volume of accumulated sediment because sampling only extended approximately 1000 feet above each dam. Sediment distribution maps are included with the summaries for each dam (see Part B of this report).

Table 1.11. Volume of bulk sediments accumulated behind the four dams studied Sediment depths were determined by probing at 31-42 locations within approximately 1,000 feet of the dam. Sediment volume estimates were made with GIS interpolation software (ESRI, Arcview 3.x).

Dam	**Number of probes**	**Sample area (sq ft)**	**Mean depth (ft.)**	**Sediment volume (cu. Yd.)**
Warrenville	31	216,236	3.9	30,686
McDowell	31	165,054	2.9	21,288
Hammel Woods	31	102,472	0.47	1,668
Channahon	42	295,491	0.379	24,920

Grain size analysis was conducted on 13 core and 13 ponar samples from impounded areas upstream of the four dams and 6 core and 16 ponar samples from free flowing areas below the four dams. Medium to fine sand (<0.5mm) made up approximately 65% of core and 58% of ponar samples by weight in the impounded areas and 60% of core and 31% of ponar samples by weight in the free flowing areas below the dams. Impoundment sediments also consisted of coarse to medium sand (16%), gravels (8% in core and 26% in ponar) and silts and clays (7%). Particle size distribution of gravel differed between core and ponar samples in both the impounded areas, 7.5% in core and 26% in ponar, and in free flowing areas, 14.2% in core and 40.3% in ponar. Medium to fine sands also differed between core and ponar samples in the free flowing areas, 60% in core and 31% in ponar. The impounded areas had more clays and silts than free flowing areas (7% vs. 1.5% respectively) and less gravels (7.5% in core and 26% in ponar vs. 14.2% in core and 40.3% in ponar). Silts and clays take longer to drop out of the water column, so more of these fine-grained materials accumulate in the slower moving water within the impounded areas.

Sediment quality analysis consisted of 2,784 individual analyses of 59 contaminants in 19 core and 29 ponar (87 ponar grabs) samples from four impoundments above the dams and four free flowing areas below the dams. 1,360 or 49 percent of the analyses were below the detection limits of the analysis methods. Most of the non-detects occurred in the alkylphenols (endocrine disruptors) and pesticides. Metals analysis had the greatest number of detect and PCB were not detected in any of the samples. Levels for Sediment Kjeldahl Nitrogen were considered low at <870 mg/kg and moderate at <4,790 mg/kg. None of the samples had levels above the moderate range. Levels of sediment phosphorus were considered low at <299 mg/kg and moderate at <2,160 mg/kg, 83% of the impoundment samples and 9% of the free flowing samples were elevated above the moderate range for phosphorus. Tables summarizing the sediment data can be found in Appendix B.

Specific information on structure, safety, and recreational uses are listed by dam in Sections 2 through 5 of the report.

Table 1.12 Mean grain size analysis (percent by weight) and specific gravity (g/cm3) for impounded and free flowing areas above and below the four dams.

	Core grain size (mean percent by weight)					Core
Habitat and Station	**Coarse gravel (4)**	**Coarse to fine gravel (10)**	**Coarse to medium sand (35)**	**Medium to fine sand (200)**	**Silt and Clay (tray)**	**specific gravity (mean g/cm3)**
Impounded						
Warrenville	0.00	5.54	26.75	52.49	15.31	2.49
McDowell	0.00	1.75	12.28	76.27	9.71	2.25
Hammel Woods	0.00	16.39	25.28	55.93	2.40	2.28
Channahon	1.73	5.81	18.72	64.83	8.91	2.23
All Impounded Areas	**0.74**	**6.90**	**18.86**	**65.31**	**8.20**	**2.27**
Free Flowing						
Warrenville	2.31	4.09	23.58	68.35	1.67	2.21
McDowell	8.88	7.24	19.30	62.63	1.94	2.26
Hammel Woods	8.45	7.12	25.28	56.26	2.31	2.31
Channahon	N/A	N/A	N/A	N/A	N/A	N/A
All Free Flowing Areas	**7.57**	**6.65**	**23.00**	**60.40**	**2.08**	**2.28**

	Ponar grain size (mean percent by weight)					Ponar
Habitat and Station	**Coarse gravel (4)**	**Coarse to fine gravel (10)**	**Coarse to medium sand (35)**	**Medium to fine sand (200)**	**Silt and Clay (tray)**	**specific gravity (mean g/cm3)**
Impounded						
Warrenville	4.94	11.26	29.14	49.90	4.75	2.61
McDowell	26.22	6.06	11.27	53.26	3.52	2.33
Hammel Woods	30.73	7.24	11.87	57.09	3.84	2.41
Channahon	0.00	8.19	17.12	65.67	9.02	2.14
All Impounded Areas	**18.82**	**7.46**	**14.43**	**57.93**	**5.29**	**2.32**
Free Flowing						
Warrenville	14.32	8.44	36.97	38.59	0.72	2.30
McDowell	39.74	16.17	20.91	22.33	0.86	2.41
Hammel Woods	20.88	17.31	30.25	30.84	0.72	2.58
Channahon	25.62	9.76	27.28	35.40	1.95	2.45
All Free Flowing Areas	**26.88**	**13.41**	**27.23**	**31.17**	**1.26**	**2.47**

SUMMARY CONCLUSIONS

Over the last fifteen years The Conservation Foundation and others have worked hard to improve and protect the quality of the DuPage River watershed. Many improvements have been seen both in water quality and the increased level of awareness people have for the river and river issues. Many more people view the river as an important part of the ecosystem and an amenity in their community.

Although great strives have been made, there is still much to do to meet the water quality goals of the Clean Water Act of fishable and swimable. Some of the greatest constituents of concern are nutrients, sediment and habitat alteration. Dams can increase the impacts of all three, with the greatest consequences to aquatic habitat.

This study has collected data that indicates that dams on the DuPage River are a significant contributor to the overall degradation of native aquatic species and their habitat. Water quality sampling performed as part of the study indicates that these low-head dams probably do not significantly exacerbate the existing, system-wide water quality problems of the DuPage River. As discussed in Sections 2 through 5 of this report, three of the five dams within the study area do not provide any useful function other than they maintain a flat water pool and create the sound of rushing water, both of which are usually considered attractive to many people visiting the public areas around these dams. Moreover, all of the dams (the ones at Channahon and Hammel Woods in particular) create an elevated safety hazard to the people using the river, be it for fishing, swimming, or boating.

Dam owners and local decision makers should actively consider options to address these safety and ecological concerns so that the safety of the general public and patrons to these facilities is improved and the health of the watershed's natural resources are preserved.

The next four sections of the report are organized into separate assessment reports for each of the four dams included in this study. Information on potential alternatives, their benefits, drawbacks and associated costs has been included to provide decision makers and stakeholders with as much site-specific information as possible to make the most informed decision as to how to manage the dams to ensure a safe and healthy future for residents, visitors and the river.

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Appendix A. Water quality analysis.

Parameter	Mack Rd		Warrenville Dam Pool		Warrenville Downstream	
Collection Time	05:24	16:26	04:47	15:35	04:50	15:32
Temperature (C)	25.52	27.75	27.80	28.92	27.87	27.42
Dissolved Oxygen mg/L	4.21	9.5	5.36	4.89	6.37	6.53
Dissolved Oxygen % Sat.	52.4	123.7	70.0	64.2	82.4	85
Conductivity (uS/cm)	1187	1239	1133	1149	1125	1266
pH	7.60	8.1	7.97	7.7	8.00	7.76
Total Organic Carbon mg/L	6.00	8	7.00	7	7.00	7
Suspended Solids mg/L	24	9	28	15	48	31
Turbidity (NTU)	20	10	39	22	43	24
Ammonia Nitrogen	0.05 U	0.05	0.13 M	0.05	0.11 M	0.06
Total Kjeldahl Nitrogen (mg/L)	0.92	1.22	1.09	1.24	1.28	1.43
Nitrate-Nitrite (mg/L)	7.42	7.17	8.45	9	8.59	8.75
Total Nitrogen (mg/L)	8.34	8.39	9.54	10.24	9.87	10.18
Total Dissolved Phosphorus (mg/L)	1.35	1.34	1.39	1.54	1.42	1.51
Total Phosphorus (mg/L)	1.41	1.4	1.54	1.64	1.54	1.63
Collection Time	05:24	16:26	04:47	15:35	04:50	15:32
Chlorophyll-a corrected (ug/L)	4.34	5.44	4.53	6.14	5.01	5.65
Chlorophyll-b (ug/L)	1	1	1	1	1	1
Chlorophyll-c (ug/L)	1	1	1	1	1	1
Pheophytin-a (ug/L)	3.39	1.51	3.84	1.47	5.78	1.78
Chlorophyll Volume Filtered (mL)	640	720	360	570	400	470

Parameter	Diehl Road		McDowell Dam Pool		McDowell Downstream	
Time	05:58	16:09	05:33	15:52	05:32	15:33
Temperature (C)	26.08	28.14	26.35	30.01	26.36	29.31
Dissolved Oxygen mg/L	5.52	7.12	4.81	8.88	6.06	7.75
Dissolved Oxygen % Sat.	69.2	93.0	61.1	120.4	76.7	104.4
Conductivity (uS/cm)	1100	1119	1207	1210	1129	1130
pH	7.60	7.66	7.65	8.08	7.67	8.00
Total Organic Carbon mg/L	7.00	7.00	7.00	7.00	8.00	7.00
Suspended Solids mg/L	67	27	42	19	51	17
Turbidity (NTU)	41	19	33	14	36	20
Ammonia Nitrogen	0.09	0.08	0.08	0.05	0.07	0.06
Total Kjeldahl Nitrogen (mg/L)	1.46	0.99	1.23	1.03	1.07	1.02
Nitrate-Nitrite (mg/L)	7.24	7.46	7.54	6.48	7.81	5.95
Total Nitrogen (mg/L)	8.70	8.45	8.77	7.51	8.88	6.97
Total Dissolved Phosphorus (mg/L)	1.34	1.28	1.32	1.17	1.35	1.15
Total Phosphorus (mg/L)	1.52	1.38	1.47	1.23	1.48	1.24
Chlorophyll-a corrected (ug/L)	5.36	2.89	3.09	2.58	3.55	3.35
Chlorophyll-b (ug/L)	1	1	1	1	1	1
Chlorophyll-c (ug/L)	1	1	1	1	1	1
Pheophytin-a (ug/L)	7.27	1.96	5.27	1	7.34	1.12
Chlorophyll Volume Filtered (mL)	600	700	520	835	460	750

Parameter	119th Street		Hammel Dam Pool		Hammel Downstream	
Time	06:25	16:29	05:26	15:28	05:27	15:18
Temperature (C)	23.71	28.28	25.60	30.10	25.61	30.00
Dissolved Oxygen mg/L	3.80	11.20	5.45	10.14	6.30	11.32
Dissolved Oxygen % Sat.	45.9	145.1	68.5	137.9	81.1	154.4
Conductivity (uS/cm)	1116	1094	1035	1019	1029	1009
pH	7.42	8.28	7.84	8.48	7.82	8.50
Total Organic Carbon mg/L	6.00	7.00	7.00	7.00	7.00	7.00
Suspended Solids mg/L	20	12	48	15	37	16
Turbidity (NTU)	14	10	29	12	25	13
Ammonia Nitrogen	0.08	0.05	0.05	0.05	0.05	0.05
Total Kjeldahl Nitrogen (mg/L)	0.97	1.80	1.16	1.04	1.08	1.32
Nitrate-Nitrite (mg/L)	7.46	7.44	6.76	5.69	6.68	5.75
Total Nitrogen (mg/L)	8.43	9.24	7.92	6.73	7.76	7.07
Total Dissolved Phosphorus (mg/L)	1.36	1.30	1.13	0.93	1.10	0.92
Total Phosphorus (mg/L)	1.43	1.37	1.26	1.01	1.24	0.97
Chlorophyll-a corrected (ug/L)	2.16	1.48	2.09	1.84	2.09	2.38
Chlorophyll-b (ug/L)	1	1	1	1	1	1
Chlorophyll-c (ug/L)	1	1	1	1	1	1
Pheophytin-a (ug/L)	2.06	1.03	1.45	1	2.64	2.9
Chlorophyll Volume Filtered (mL)	980	950	800	900	600	800

Parameter	Shepley Road		Channahon Dam Pool		Channahon Downstream	
Time	05:51	17:02	05:17	15:43	05:17	15:23
Temperature (C)	26.10	30.74	28.50	29.89	28.37	28.27
Dissolved Oxygen mg/L	5.52	12.69	7.80	6.21	7.42	8.93
Dissolved Oxygen % Sat.	69.2	168.9	102.4	83.7	97.6	109.7
Conductivity (uS/cm)	UA	1084	1007	1054	UA	UA
pH	7.88	8.82	8.54	8.10	8.51	8.11
Total Organic Carbon mg/L	6.00	7.00	7.00	8.00	7.00	7.00
Suspended Solids mg/L	17	7	18	13	18	12
Turbidity (NTU)	9	5	16	9	14	10
Ammonia Nitrogen	0.05	0.05	0.05	0.05	0.05	0.05
Total Kjeldahl Nitrogen (mg/L)	1.12	1.10	1.27	1.11	1.22	0.70
Nitrate-Nitrite (mg/L)	5.63	5.84	5.64	5.39	5.54	5.36
Total Nitrogen (mg/L)	6.75	6.94	6.91	6.50	6.76	6.06
Total Dissolved Phosphorus (mg/L)	1.03	0.92	0.91	0.96	0.94	0.98
Total Phosphorus (mg/L)	1.15	0.97	1.04	1.03	1.02	1.06
Chlorophyll-a corrected (ug/L)	2.58	1.97	1.86	3.25	1.92	3.11
Chlorophyll-b (ug/L)	1	1	1	1	1	1
Chlorophyll-c (ug/L)	1	1	1	1	1	1
Pheophytin-a (ug/L)	1.41	1	1.07	1	1.43	1
Chlorophyll Volume Filtered (mL)	980	900	800	900	900	700

Appendix B. Sediment quality characteristics of core and ponar samples.

Warrenvile Dam

		Above Dam						Below Dam					
Parameter	Unit	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3
Ammonia Nitorgen	mg N/Kg	491	216	282	124	290	199	184	49	42	8	13	14
Total Kjeldahl Nitrogen	mg N/Kg	3680	3130	3490	1470	2990	2840	1330	614	463	165	255	326
Total Phosphours	mg N/Kg	5210	3450	4500	3190	3630	4570	2460	2150	2020	1670	1530	1730
Total Solids	% Solids	43.2	41.9	39.4	56.8	37.8	41.7	50.4	67.5	71.7	79.1	75.8	69.3
Total Volatile Solids	% Solids	10.5	10.5	9.74	5.92	10.1	10.9	12.7	5.85	2.45	2.81	2.68	4.2
Total Organic Carbon	% C	4.5	3.9	3.5	2.5	5.2	4.5	4.9	1.7	1.3	1.1	0.6	1.1
Pesticides													
Aldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDD	ug/G	0.05	0.036	0.077	0.013	0.036	0.029	0.042	0.024	0.006	0.01	0.008	0.005
p,p'-DDE	ug/G	0.03	0.017	0.02	ND	0.013	0.011	0.014	0.01	ND	0.004	0.003	ND
p,p'-DDT	ug/G	ND	0.215	0.105	0.148	ND	0.145	0.031	0.019	ND	ND	0.039	ND
Dieldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	0.019	ND	ND	0.017	ND
Endrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Aldehyde	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/G	ND	0.295	0.39	ND	ND	0.76	0.529	0.279	0.051	ND	ND	ND
Endosulfan Sulfate	ug/G	ND	0.413	0.71	ND	ND	0.752	ND	ND	ND	ND	ND	ND
Heptachlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hept Epoxide	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lindane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Warrenvile Dam (continued)

Parameter	Unit	Above Dam						Below Dam					
		Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3
Metals													
Aluminum	mg/Kg	11000	11000	14000	7200	11000	10000	3900	3100	2700	1700	2900	2800
Barium	mg/Kg	170	160	160	120	140	140	95	100	63	46	55	60
Beryllium	mg/Kg	0.69	0.64	0.76	0.49	0.59	0.61	0.34	0.29	0.21	0.22	0.23	0.28
Boron	mg/Kg	7.7	9.2	8.5	10	9.4	9.8	8.8	ND	ND	ND	ND	ND
Cadmium	mg/Kg	0.7	0.79	ND	ND	ND	ND	0.26	ND	ND	ND	ND	ND
Calcium	mg/Kg	43000	42000	41000	68000E	40000	41000	64000	73000	55000	88000	73000	75000
Chromium	mg/Kg	30	23	22	13	20	20	9.6	8	5.8	2.6	5.7	5.7
Cobalt	mg/Kg	9.9	8.4	9.3	7.2	7.4	8.1	6.6	6.5	6.5	5.3	6.9	5
Copper	mg/Kg	88	71	86	29	49	47	25	18	9.5	1.5	3.3	6.3
Cyanide	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	mg/Kg	30000	27000	30000	20000	25000	26000	15000	12000	9800	9000	9600	9700
Lithium	mg/Kg	15	16	18	13	16	15	8.4	7.1	5.8	8.3	6.4B	7.6B
Lead	mg/Kg	47	40	36	23	32	29	23	19	13	13	11	10
Magnesium	mg/Kg	21000	18000	18000	35000	20000	19000	31000	32000	28000	50000	39000	38000
Manganese	mg/Kg	680	510	550	580	490	580	450	560	380	320	330	370
Mercury	mg/Kg	0.4	0.2	0.5	0.2	0.3	0.2	0.1	0.1	0.1	0.05	0.05	0.04
Molybdenum	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/Kg	22	19	25	12	17	17	12	8	ND	ND	9.1	ND
Potassium	mg/Kg	1400	1500	1800	1200	1600	1400	690	510	470	510	560	600
Sodium	mg/Kg	360	350	430	350	300	350	280	260	170	220	180	210
Silver	mg/Kg	2.5	1.6	2.6	1	1.4	1.4	ND	ND	ND	ND	ND	ND
Tin	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	mg/Kg	52	53	67	71	65	58	58	45	57	40	130	63
Vanadium	mg/Kg	17	17	20	10	17	15	7.7	4.7	4.8	2.8	8.4	4.8
Zinc	mg/Kg	240	200	170	120	170	170	96	71	43	22	30	41
Oil & Grease	mg/Kg	1547	1442	1324	856	1744	1491	847	700	ND	ND	672	817
Alkylphenols													
Bisphenol A	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total NP	ug/G	1066	1739	432	ND	ND	886	1398	1080	410	ND	ND	ND
Total NP1EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total NP2EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Octylphenol	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

McDowell Grove Dam

Parameter	Unit	Above Dam						Below Dam			
		Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Ponar 1	Ponar 2	Ponar 3
Ammonia Nitorgen	mg N/Kg	434	364	468	86	97	295	105	12	13	15
Total Kjeldahl Nitrogen	mg N/Kg	2530	2380	2060	1460	1230	2830	1640	462	807	191
Total Phosphours	mg N/Kg	3430	4960	4380	4020	998	3500	3650	1530	2030	375
Total Solids	% Solids	50.4	43.9	49.7	54.2	63.2	40.2	51.7	78.2	68	84.6
Total Volatile Solids	% Solids	8.81	10.2	9.02	7.7	5.26	9.78	10.7	4.07	4.75	1.81
Total Organic Carbon	% C	3.5	0.7	4.5	4.4	3.5	3.8	5.3	0.9	1.9	0.9
Pesticides											
Aldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDD	ug/G	0.034	0.099	0.073	0.02	0.007	0.069	0.031	0.007	0.026	ND
p,p'-DDE	ug/G	0.019	0.04	0.04	0.008	ND	0.019	0.013	ND	0.008	ND
p,p'-DDT	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Aldehyde	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/G	ND	0.007	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan Sulfate	ug/G	ND	ND	0.053	0.011	ND	ND	ND	ND	ND	ND
Heptachlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hept Epoxide	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lindane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

McDowell Grove Dam (continued)

Parameter	Unit	Above Dam						Below Dam			
		Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Ponar 1	Ponar 2	Ponar 3
Metals											
Aluminum	mg/Kg	11000	4200	8400	5600	5800	11000	5300	4400	3300	1500
Barium	mg/Kg	130	63	140	110	63	130	130	62	99	43
Beryllium	mg/Kg	0.63	0.33	0.65	0.42	0.46	0.65	0.51	0.4	0.36	0.3
Boron	mg/Kg	9	ND	16	7.1	8.8	ND	8.7	ND	ND	ND
Cadmium	mg/Kg	0.74	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/Kg	42000	77000	69000	70000	130000	50000	68000	81000	79000	120000
Chromium	mg/Kg	21	6.8	22	12	7.5	17	11	5.8	7.6	2.6
Cobalt	mg/Kg	8.6	5.2	8	6.6	5.4	9	6.3	4.4	4.4	ND
Copper	mg/Kg	56	7	79	26	10	64	32	6.6	18	ND
Cyanide	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	mg/Kg	25000	13000	25000	21000	12000	26000	20000	13000	12000	7800
Lead	mg/Kg	36	18	42	25	17	28	21	10	12	11
Lithium	mg/Kg	15	9.5	19	9	16	18	11	13	9	
Magnesium	mg/Kg	20000	35000	35000	34000	74000	24000	31000	40000	37000	65000
Manganese	mg/Kg	610	430	700	750	470	620	570	420	500	390
Molybdenum	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	mg/Kg	0.2	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.02
Nickel	mg/Kg	18	8.6	18	12	9	22	13	9.8	8.6	ND
Potassium	mg/Kg	1500	910	1300	870	1300	1600	810	900	610	420
Sodium	mg/Kg	340	280	410	280	420	370	280	300	310	240
Silver	mg/Kg	1.6	ND	1.5	0.69	ND	1.4	0.7	ND	ND	ND
Tin	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	mg/Kg	69	2	61	58	48	55	43	69	51	65
Vanadium	mg/Kg	19	8.5	14	11	7.6	18	9.6	9.2	7.1	6
Zinc	mg/Kg	150	36	200	120	42	140	110	43	65	
Oil & Grease	mg/Kg	930	1700	3047	976	725	1025	1082	ND	858	ND
Alkylphenols											
Bisphenol A	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total NP	ug/G	795	2485	930	547	169	494	212	ND	197	ND
Total NP1EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total NP2EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Octylphenol	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Hammel Wood Dam

Parameter	Unit	Above Dam						Hammel Woods Dam - Downstream					
		Core 1	Core 2	Ponar 1	Ponar 2	Ponar 3	Ponar 4	Core 1	Core 2	Ponar 1	Ponar 2	Ponar 3	Ponar 4
Ammonia Nitorgen	mg N/Kg	262	517	46	112	151	86	144	41	10	8	8	13
Total Kjeldahl Nitrogen	mg N/Kg	2560	3240	927	1150	3210	1620	1610	1160	460	74	394	574
Total Phosphours	mg N/Kg	1660	2380	888	1510	3690	4670	872	990	459	162	460	583
Total Solids	% Solids	54.2	51.1	64	61.1	43.4	49	52.2	58.3	76.7	84.3	83.2	77.1
Total Volatile Solids	% Solids	6.79	7.74	4.45	5.22	10.1	8.53	10.5	10.4	2.75	1.6	2.12	2.41
Total Organic Carbon	% C	7.4	3.3	6	3.4	0.2	8.1	3.5	0.6	1.2	0.7	0.5	1
Pesticides													
Aldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDD	ug/G	0.038	0.012	ND	ND	0.013	0.011	0.007	ND	ND	ND	ND	ND
p,p'-DDE	ug/G	0.012	0.009	ND	ND	0.008	0.006	ND	ND	ND	ND	ND	ND
p,p'-DDT	ug/G	ND	ND	ND	ND	ND	0.05	ND	ND	ND	ND	ND	ND
Dieldrin	ug/G	ND	ND	ND	ND	ND	ND	0.005	0.009	0.005	ND	ND	ND
Endrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Aldehyde	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/G	ND	ND	ND	ND	ND	ND	0.006	ND	ND	ND	ND	ND
Endosulfan Sulfate	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hept Epoxide	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lindane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Hammel Wood Dam (continued)

Parameter	Unit	Above Dam						Hammel Woods Dam - Downstream					
		Core 1	Core 2	Ponar 1	Ponar 2	Ponar 3	Ponar 4	Core 1	Core 2	Ponar 1	Ponar 2	Ponar 3	Ponar 4
Metals													
Aluminum	mg/Kg	8900	10000	5000	5200	8000	7900	6700	5500	4200	1300	3300	3600
Barium	mg/Kg	100	120	66	79	95	100	81	88	66	46	78	70
Beryllium	mg/Kg	0.6	0.66	0.45	0.5	0.59	0.56	0.56	0.46	0.44	0.26	0.4	0.39
Boron	mg/Kg	ND	ND	7	9.6	9.1	8.5	7.9	7.4	ND	ND	ND	ND
Cadmium	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/Kg	82000	84000	94000	160000	82000	89000	59000	90000	60000	99000	100000	110000
Chromium	mg/Kg	12	16	7.9	7	12	12	9	7.5	6	1.8	4.4	4.6
Cobalt	mg/Kg	6.7	7.4	ND	4	6.7	7.1	9.7	5.7	9.5	ND	6.2	5.1
Copper	mg/Kg	20	32	14	8.9	30	30	13	12	4.7	ND	2.4	1.9
Cyanide	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	mg/Kg	18000	22000	12000	11000	21000	24000	17000	14000	14000	6500	11000	11000
Lead	mg/Kg	31	43	21	18	38	33		16	23	10	17	11
Lithium	mg/Kg	16	16	14	17	14	14	12	14	7.9	11	9.4	9.9
Magnesium	mg/Kg	18000	18000	39000	44000	23000	22000	21000	20000	27000	52000	35000	28000
Manganese	mg/Kg	430	620	470	530	750	1000	540	490	630	500	630	560
Mercury	mg/Kg	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.04	0.02	0.04	0.03
Molybdenum	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	mg/Kg	ND	0.92B	ND	ND	0.82	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/Kg	320	320	290	360	300	300	230	260	190	190	330	260
Nickel	mg/Kg	16	20	11	8.2	17	17	16	12	11	ND	ND	8.3
Potassium	mg/Kg	1300	1400	960	930	1300	1300	1000	990	720	410	610	690
Tin	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	mg/Kg	37	40	34	39	49	51	62	38	55	24	50	46
Vanadium	mg/Kg	14	15	8.1	8.5	12	11	18	9.6	14	1.3	8.6	6.7
Zinc	mg/Kg	88	120	63	48	130	130	65	63	35	17	26	30
Oil & Grease	mg/Kg	916	849	728	720	1239	1180	625	787	ND	ND	617	869
Alkylphenols													
Bisphenol A	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total NP	ug/G	643	1105	202	944	764	879	428	360	ND	ND	ND	ND
Total NP1EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total NP2EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Octylphenol	ug/G	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Channahon Dam

Parameter	Unit	Above Dam							
		Core 1	Core 2	Core 3	Core 4	Core 5	Ponar 1	Ponar 2	Ponar 3
Ammonia Nitorgen	mg N/Kg	42	143	100	126	142	127	157	176
Total Kjeldahl Nitrogen	mg N/Kg	3220	2560	2460	2930	2750	3130	3260	3170
Total Phosphours	mg N/Kg	2380	1780	3840	3240	1510	3230	2400	2780
Total Solids	% Solids	44.6	48.2	49	45.6	48	39.6	33.9	35.6
Total Volatile Solids	% Solids	9.95	8.78	10.3	10.4	10.1	10.4	11.1	10.9
Total Organic Carbon	% C	8.7	3.3	3.8	3.8	3.8	6.4	3.9	4.1
Pesticides									
Aldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDD	ug/G	0.008	0.006	0.006	0.006	0.006	0.011	0.008	0.006
p,p'-DDE	ug/G	0.006	ND	0.004	0.005	0.005	0.007	0.008	0.005
p,p'-DDT	ug/G	0.029	0.023	0.019	0.050	0.028	0.022	0.027	0.035
Dieldrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Aldehyde	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/G	0.559	0.516	0.439	0.510	0.232	0.259	0.255	0.138
Endosulfan Sulfate	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Hept Epoxide	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Lindane	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
PCB (ug/G)	ug/G	ND	ND	ND	ND	ND	ND	ND	ND

Channahon Dam (continued)

Parameter	Unit	Above Dam							
		Core 1	Core 2	Core 3	Core 4	Core 5	Ponar 1	Ponar 2	Ponar 3
Metals									
Aluminum	mg/Kg	11000	11000	12000	11000	13000	11000	13000	10000
Barium	mg/Kg	120	110	110	110	110	120	120	110
Beryllium	mg/Kg	0.69	0.62	0.68	0.66	0.7	0.64	0.7	0.6
Boron	mg/Kg	10	8.8	11	ND	9	12	10	7.7
Cadmium	mg/Kg	2.7	ND	1.5	ND	ND	ND	0.76	1
Calcium	mg/Kg	56000	97000	53000	42000	52000	77000	55000	57000
Chromium	mg/Kg	34	13	23	15	17	18	19	19
Cobalt	mg/Kg	9.2	7.5	8.7	8.5	7.7	8.1	7.7	7.3
Copper	mg/Kg	48	22	32	25	26	39	40	37
Cyanide	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND
Iron	mg/Kg	27000	19000	24000	25000	23000	24000	26000	22000
Lithium	mg/Kg	18	16	16	16	19	17	20	16
Lead	mg/Kg	110	31	63	34	26	40	34	51
Magnesium	mg/Kg	15000	16000	13000	12000	13000	20000	17000	15000
Manganese	mg/Kg	410	520	440	590	340	660	580	500
Mercury	mg/Kg	0.7	0.2	0.4	0.2	0.3	0.1	0.2	0.4
Molybdenum	mg/Kg	0.33	ND	ND	ND	ND	ND	ND	ND
Nickel	mg/Kg	26	17	23	19	19	20	20	18
Potassium	mg/Kg	1600	1500	1600	1400	1800	1600	2000	1500
Silver	mg/Kg	1.2	0.68	1	0.87	0.86	1.3	1	1.2
Sodium	mg/Kg	330	300	270	260	240	290	270	270
Tin	mg/Kg	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	mg/Kg	70	75	70	31	66	69	69	35
Vanadium	mg/Kg	19	17	19	19	21	17	20	15
Zinc	mg/Kg	250	93	170	110	110	150	150	150
Oil & Grease	mg/Kg	767	901	800	1038	1780	1218	676	912
Alkylphenols									
Bisphenol A	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Total NP	ug/G	ND	ND	ND	ND	ND	332	470	521
Total NP1EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Total NP2EO	ug/G	ND	ND	ND	ND	ND	ND	ND	ND
Octylphenol	ug/G	ND	ND	ND	ND	ND	ND	ND	ND

Channahon Dam (continued)

Parameter	Unit	Below Dam					
		Ponar 1	Ponar 2	Ponar 3	Ponar 4	Ponar 5	Ponar 6
Ammonia Nitorgen	mg N/Kg	19	26	13	15	7	9
Total Kjeldahl Nitrogen	mg N/Kg	1520	2280	219	663	29	690
Total Phosphours	mg N/Kg	814	653	718	501	358	748
Total Solids	% Solids	49.2	55.5	69.1	77.7	90.3	71.2
Total Volatile Solids	% Solids	8.28	7.23	5.39	3.13	1.34	3.83
Total Organic Carbon	% C	4.2	3.6	1.4	4.1	1.8	2
Pesticides							
Aldrin	ug/G	ND	ND	ND	ND	ND	ND
alpha-BHC	ug/G	ND	ND	ND	ND	ND	ND
beta-BHC	ug/G	ND	ND	ND	ND	ND	ND
delta-BHC	ug/G	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/G	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/G	ND	ND	ND	ND	ND	ND
p,p'-DDD	ug/G	0.007	ND	0.009	ND	ND	0.011
p,p'-DDE	ug/G	0.005		0.005	ND	ND	ND
p,p'-DDT	ug/G	ND	ND	ND	ND	ND	ND
Dieldrin	ug/G	ND	ND	ND	ND	ND	ND
Endrin	ug/G	ND	ND	ND	ND	ND	ND
Endrin Aldehyde	ug/G	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/G	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/G	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/G	ND	ND	ND	ND	ND	ND
Endosulfan Sulfate	ug/G	ND	ND	ND	ND	ND	ND
Heptachlor	ug/G	ND	ND	ND	ND	ND	ND
Hept Epoxide	ug/G	ND	ND	ND	ND	ND	ND
Lindane	ug/G	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/G	ND	ND	ND	ND	ND	ND
PCB (ug/G)	ug/G	ND	ND	ND	ND	ND	ND

Channahon Dam (continued)

Parameter	Unit	Below Dam					
		Ponar 1	Ponar 2	Ponar 3	Ponar 4	Ponar 5	Ponar 6
Metals							
Aluminum	mg/Kg	9000	7100	2300	2300	5500	5500
Barium	mg/Kg	78	92	74	74	53	65
Beryllium	mg/Kg	0.65	0.53	0.26	0.26	0.44	0.5
Boron	mg/Kg	9.2	7.6	ND	ND	ND	ND
Cadmium	mg/Kg	ND	ND	ND	ND	ND	ND
Calcium	mg/Kg	75000	130000	80000	80000	77000	94000
Chromium	mg/Kg	17	7.9	3.1	3.1	8.5	10
Cobalt	mg/Kg	5.6	4.6	4.7	4.7	5.2	5.2
Copper	mg/Kg	34	6.5	2.3	2.3	5.8	14
Cyanide	mg/Kg	ND	ND	ND	ND	ND	ND
Iron	mg/Kg	14000	13000	14000	14000	14000	14000
Lithium	mg/Kg	15	13	6.6	6.6	14	11
Lead	mg/Kg	49	34	18	18	19	35
Magnesium	mg/Kg	21000	20000	27000	27000	29000	31000
Manganese	mg/Kg	200	440	1600	1600	420	390
Mercury	mg/Kg	0.2	0.05	0.05	0.1	0.02	0.1
Molybdenum	mg/Kg	ND	ND	ND	ND	ND	ND
Nickel	mg/Kg	18	10	9.1	8.1	13	14
Potassium	mg/Kg	1300	1100	460	460	980	910
Silver	mg/Kg	0.66	ND	ND	ND	ND	ND
Sodium	mg/Kg	310	320	200	200	210	300
Tin	mg/Kg	ND	ND	ND	ND	ND	ND
Titanium	mg/Kg	49	39	65	65	43	41
Vanadium	mg/Kg	15	9.8	4.7	4.7	13	11
Zinc	mg/Kg	110	36	36	36	36	62
Oil & Grease	mg/Kg	1297	1057	806	883	582	795
Alkylphenols							
Bisphenol A	ug/G	ND	ND	ND	ND	ND	ND
Total NP	ug/G	ND	ND	ND	ND	ND	ND
Total NP1EO	ug/G	ND	ND	ND	ND	ND	ND
Total NP2EO	ug/G	ND	ND	ND	ND	ND	ND
Octylphenol	ug/G	ND	ND	ND	ND	ND	ND