Kewaunee River, Kewaunee Baseline Monitoring Report

(MWBC 90700)

INTRODUCTION

The Kewaunee River watershed is located in central Kewaunee County and eastern Brown County and drains eastward toward Lake Michigan. The watershed is 139 square miles (81,266 acres) with 82 % located in Kewaunee County (WDNR 1984). The Kewaunee River is a large, low gradient stream with an average flow of 2.5 cubic meters per second (WDNR 1995).

The majority of bedrock in the watershed is Niagara dolomite which is covered with up to 100 feet of glacial drift in some locations (WDNR 1984). Most of the soils of the watershed are either Kewaunee-Manawa or Hortonville-Symco and have a high percentage of fine clays associated with them. These fine clays are susceptible to erosion (water or wind) and can cause degraded water quality in rivers and lakes. The remainder of the soil types range from Casco-Boyer which are sandy, well drained and provide groundwater to surface water streams, to Kolberg-Longrie which are shallow soils associated with the dolomite bedrock. Most of the watershed is gently sloping with a gradient less than 6% with steeper slopes located along the lower portion of the Kewaunee River.

Land use in the watershed is dominated by agriculture (Table 1). It was estimated in 1984 that 81% of the land was used as cropland, followed by wetlands 7.5% (including forested wetlands, woodlands 6%, grassland 3% and other uses including urban 2% (WDNR 1984).

Table 1. Land use in the subwatersheds of the Kewaunee River by acreage (WDNR 1984).

	Agriculture	Wooded	Wetland Vegetation	Grassland	Forested Wetland	Urban	Open Water	Barren	Total
Upper Kewaunee River	14,383	894	514	262	64			68	16,742
Lower Kewaunee River	13,836	2,083	1,085	1,096	1,542	128	101	192	20,063
Scarboro Creek	12,520	815	375	254	137			126	14,227
Luxemburg Creek	1,691	34	60	44	49	98		24	2,000
School Creek	14,440	441	277	314	44	592		115	16,224
Casco Creek	9,084	970	589	453	863			51	12,010
Total	65,954	5,237	2,900	2,423	3,256	819	101	576	81,266

In 1992, land use within the Kewaunee County portion of the basin was described as 79% agricultural, 7% woodland, 3% grassland, 8% wetland and 3% urban or other land uses (Andy Wallendar Kewaunee County LCD, personal communication 2000). Land use within any of the subwatersheds can be variable (Table 1). An example would be the percentage of agriculture, which varies from a low of 69% in the Lower Kewaunee River Subwatershed to a high of 89% in the School Creek Subwatershed. How the land is used can influence water quality, turbidity, erosion, dissolved oxygen levels, water temperature in streams and ultimately the biological communities that reside in them.

The Kewaunee River and its tributaries support a wide variety of fish species (Table 2). This list should be viewed cautiously, because of very limited data on fish distribution of non-game species from early surveys that did not collect this type of information.

Upper reaches of the watershed have forage fisheries because of low flows and warm water temperatures. Most of the remainder of the watershed supports warmwater sportfisheries, although several tributaries and one section of the Kewaunee River are designated as trout fisheries. All perennial streams within the watershed experience seasonal anadromous migrations of trout and salmon from Lake Michigan. The Wisconsin Department of Natural Resources (WDNR) built and operates an egg collection facility for Lake Michigan trout and salmon on the lower portion of the Kewaunee River.

Table 2. Fish species collected in the Kewaunee River and tributaries from past surveys. An x indicates the presence of the species in a past survey. No fish species information was available from Luxemburg Creek.

Common Names	Scientific Names	Kewaunee River	Casco Creek	Little Scarboro Creek	Scarboro Creek	School Creek	Luxemburg Creek
American Brook Lamprey	Icthyomyzon fossor			x	x		
Sea Lamprey	Petromyzon marinus	x	x				
Alewife	Alosa pseudoharengus	x					
Gizzard Shad	Dorosoma cepedianum	x					
Coho Salmon	Oncorhynchus kisutch	x		x			
Chinook Salmon	Oncorhynchus tshawytscha	x				x	
Steelhead-Rainbow Trout	Oncorhynchus mykiss	x		x		x	
Brown Trout	Salmo trutta	x	x		x		
Brook Trout	Salvelinus fontinalis		x	x	x		
Central Mudminnow	Umbra limi	x	x	x		x	
Northern Pike	Esox lucius	x					
Central Stoneroller	Campostoma anomalum	x	x		x	x	
Largescale Stoneroller	Campostoma oligolepis	x				x	
Redside Dace	Clinostomus elongatus	x	x		x	x	
Carp	Cyprinus carpio	x					
Brassy Minnow	Hybognathus hankinsoni		x				
Horny Headed Chub	Notropis biguttatus	x			x		
Emerald Shiner	Notropis atherinoides	x					

Common Names	Scientific Names	Kewaunee River	Casco Creek	Little Scarboro Creek	Scarboro Creek	School Creek	Luxemburg Creek
Northern Common Shiner	Notropis cornutus	x	x		x	x	
Spottail Shiner	Notropis Hudsonius	x					
Rosyface Shiner	Notropis rubellus	x					
Northern Redbelly Dace	Phoxinus eos	x				x	
Southern Redbelly Dace	Phoxinus erythrogaster	x	x		x	x	
Bluntnose Minnow	Pimephales notatus	x	x		x		
Northern Fathead Minnow	Pimephales promelas	x	x				
Blacknose Dace	*Rhinichthys atratulus*	x	x	x	x	x	
Longnose Dace	*Rhinichthys cataractae*	x	x	x	x		
Northern Creek Chub	*Semotilus atromaculatus*	x	x	x	x		
Northern Pearl Dace	*Semotilus margarita*	x	x	x	x		
Redhorse	*Moxostoma sp.*	x					
Common White Sucker	*Catostomus commersoni*	x	x	x	x		
Northern Black Bullhead	*Ameiurus melas*	x	x		x		
Yellow Bullhead	*Ameiurus natalis*	x					
Northern Brown Bullhead	*Ameiurus nebulosus*	x			x		
Channel Catfish	*Ictalurus punctatus*	x					
Stonecat	*Noturus flavus*	x					
Banded Killifish	*Fundulus diaphanus*	x				x	
Brook Stickleback	*Culaea inconstans*	x	x	x	x	x	
Northern Rock Bass	*Ambloplites rupestris*	x	x		x		
Green Sunfish	*Lepomis megalotis*	x			x		
Pumpkin Seed	*Lepomis gibbosus*	x					
Smallmouth Bass	*Micropterus dolomieu*	x					
Johnny Darter	*Etheostoma nigrum*	x	x		x		
Yellow Perch	*Perca flavescens*	x					
Northern Logperch	*Percina caprodes*	x			x		
Blackside Darter	*Percina maculata*	x	x		x		
Mottled Sculpin	*Cottus bairdi*	x	x	x	x	x	
Slimy Sculpin	*Cottus cognatus*		x		x		

Water quality has been and still remains a major concern within the watershed. Based on watershed models, it is estimated that the Kewaunee River delivers 1,900 tons of sediment per year to Lake Michigan (WDNR 1995). Along with sediment, phosphorus, nitrogen and manure can be found in runoff reaching the Kewaunee River. It was estimated that between 1969 and 1978 the average phosphorus load of the river was 42,000 pounds per year with values ranging from 11,000 lbs/yr to 106,000 lbs/yr (WDNR 1984). Because of high levels of point and non-point source pollution, the Kewaunee River was designated as a Priority Watershed in 1982. When the Priority Watershed program ended on the Kewaunee River in 1992, 89 of 300 landowners had agreed to participate in the program. Although low in percentage, participation was average for Priority Watersheds begun in this time period. The effectiveness of phosphorus/sediment reduction practices in this project was never measured.

The Kewaunee River Watershed contains 16 streams with a total mileage of 87.2 (WDNR 1995). The basin also contains one lake that is 12 acres in size. The basin can be divided into subwatersheds that roughly correspond to major streams or land types found in the watershed. The subwatersheds are Upper Kewaunee River, Lower Kewaunee River, Scarboro Creek, Luxemburg Creek, School Creek and Casco Creek.

Upper Kewaunee River Subwatershed (UKR)

The UKR is primarily an agricultural subwatershed that is 16,742 acres in size (Table 1). Many small, unnamed tributaries flow into the Kewaunee River in this subwatershed. Most of these streams are intermittent and have low flows and high water temperatures that prohibit establishment of a fish community. These channels can transport substantial amounts of sediment and nutrients into the main river channel and degrade water quality. The upper Kewaunee River, which flows from eastern Brown County to its confluence with Casco Creek, is approximately 10 miles long (WDNR 1995). Gradient in this river section is low, and the river can experience spring flooding and very low summertime flows. Fish communities, which are limited by low flow and high water temperatures in summer, are classified as warm water sport fisheries in the lower sections to limited forage fisheries in upper reaches. However, during the spring and fall if water levels are high, some migratory salmon and trout use this portion of the stream, but no natural reproduction occurs. Water quality problems in this section include nutrient enrichment and turbidity (WDNR 1984).

Lower Kewaunee River Subwatershed (LKR)

The LKR subwatershed is 20,063 acres in size (Table 1). Although still primarily agricultural, the LKR has substantial acres of woodlands, grasslands and wetlands. The Lower Kewaunee River is approximately 16 miles long with a gradient of 4 to 6 feet per mile. The upper 2.5 miles of the river from Casco Creek to County Highway C is classified as a Class II trout stream. Instream water temperatures in this section are strongly influenced by the tributaries that receive groundwater influxes. From County Highway C to the village of Footbridge is approximately 6.5 miles. This portion of river has many riffle areas separated by pools which attract both migratory salmon and trout, as well as warmwater sport fish such as northern pike, sunfish, smallmouth bass and rock bass. The last portion of the river from Footbridge to the mouth of the river is about 6 miles long and is influenced by Lake Michigan. This portion is a valuable nursery with extensive wetlands that contain perch, bass, pike, walleye and Lake Michigan salmonids. Water quality in the Kewaunee River is considered to be fair to good, but impacted by suspended sediment from cropland erosion and nutrient enrichment from animal waste (WDNR 1995).

Two coldwater tributaries, Rogers Creek and Little Scarboro Creek are found in this subwatershed. Rogers Creek is a small (0.8 miles), spring feed creek that is found in the northwest corner of the subwatershed (WDNR 1995). It has excellent water quality and is classified as a Class I brook trout stream for its entire length. There is no public access to this stream.

Little Scarboro Creek is a coldwater, high gradient stream that flows 1.5 miles and empties into the Kewaunee River (WDNR 1995). The water quality in this stream rates

as excellent and has a diverse assemblage of stream macroinvertebrates. It is classified as a Class I brook trout water and is one of a very few Lake Michigan tributary streams in which natural reproduction of Lake Michigan trout and salmon occurs (Avery 1974 and 1999). Much of the watershed surrounding Little Scarboro Creek is state owned as part of the Besadny Fish and Wildlife Area, Little Scarboro subunit and thereby protected from many of the non-point source pollution problems that plague other tributaries in this watershed.

Seidl Lake, the only lake found in the watershed is found in this subwatershed.

Scarboro Creek Subwatershed (SCK)
The SCK subwatershed is 14,227 acres in size and is heavily agricultural in nature (Table 1). Scarboro Creek flows 15 miles from Brown County to its confluence with the Kewaunee River (WDNR 1995). The river, which has a gradient of 10 feet per mile for most of its length, increases its gradient rapidly to 30 feet per mile as it nears the Kewaunee River. The lower 4 miles of the Scarboro River is classified as a Class II brown trout water, with annual stockings to provide a trout fishery in the river. Recent surveys indicate that the section of the river may also have some natural reproduction of Lake Michigan steelhead. Upper sections of the river are classified as warmwater fisheries or limited forage fisheries. Water quality in the river has declined over the past several decades. While flow and water temperature conditions are conducive for trout, dissolved oxygen levels are not. Excessive nutrients and high turbidity are most likely the cause for depressed dissolved oxygen levels. Sedimentation is also a concern in the lower section of the river.

Luxemburg Creek Subwatershed (LCS)
Luxemburg Creek is a 3 mile, moderate to steep gradient (18-62 feet mile), shallow tributary to the Kewaunee River (WDNR 1995) that drains a 2000 acre agricultural subwatershed (Table 1). Upper reaches have been extensively channelized and stream water quality in the past was negatively impacted by discharges from the Luxemburg Sewage Treatment Plant. The stream fishery was limited to forage species because of the discharge. Recent removal of the discharge to the creek has resulted in the reduction of flow, but it is expected that water quality should improve.

School Creek Subwatershed (SCH)
School Creek drains a 16,224 subwatershed (Table 1), but only has 5.6 miles of perennially flowing stream, with heavily farmed upper reaches drained by intermittent channels or grass waterways (WDNR 1995). Stream gradient is low and the creek can experience high flows and flooding during spring melt or after heavy precipitation. Water quality is generally considered poor in School Creek because of low flow, warm water temperatures and severe degradation by agricultural runoff. The fish community is a forage fishery.

Casco Creek Subwatershed (CCK)
The 12,010 acre CCK is primarily agricultural in nature, but also contains a substantial amount of wetland acreage (Table 1). It's drained by Casco Creek which is a small, spring fed creek that flows 10 miles and empties into the Kewaunee River (WDNR

1995). Over the length of the stream, habitat, gradient and the fish community varies greatly. The 7 stream miles above the dam and millpond have a gradient 10 feet per mile and drains extensive wetlands. There is a forage fishery in headwater areas, with warmwater sportfish found in lower sections. Water quality is considered good, although in some areas impact from non-point source pollution has been noted. The millpond has fair water quality and is soft bottomed. The fishery in the pond is not considered to be significant and is limited by lack of habitat and water quality. The lower 1.4 miles of Casco Creek from the dam to the Kewaunee River has a steep gradient of 30 feet per mile and flows over gravel bottoms through wooded areas. Water quality is considered to be very good. The first 0.4 miles of the river is classified as a Class I brook trout water and the remaining mile is classified as a Class II brook trout stream. Access to this stream is limited to one road crossing.

Study Rationale

The purpose of the study described in this report was to measure environmental quality in streams located in the Kewaunee River Watershed by using the Hilsenhoff Biotic Index (HBI) for invertebrates and the Index of Biotic Integrity (IBI) for fish (Lyons et al. 1992). By quantifying the type and number of fish species, macroinvertebrates and plants as well as evaluating the physical habitat of a stream, We can judge the quality of the stream and compare that stream to other streams across the state. These types of studies are also called biological monitoring or bioassessment.

METHODS

Sampling locations were selected on the main stem of the Kewaunee River and each major tributary at the rate of 1 for every five miles of perennial water (Figure 1). These sites included two on the Kewaunee River above the Besadny Anadromous Fisheries Facility (BAFF) and one each on Little Scarboro Creek, Scarboro Creek, Luxemburg Creek, School Creek and Casco Creek. Sampling stations were determined by measuring 10 times the mean stream width (MSW) away from a bridge or other man made structure to determine the starting point. The end point was then determined by assessing MSW. For streams that had a MSW of less than 2.9 meters, the station length was 100 meters, for streams with a MSW of between 2.9 meters and 23 meters, the station length was 35 times the MSW and for streams with a MSW of greater that 23 meters the station was 800 meters in length. Transects within the sampling station were marked starting 1 MSW above the station starting point and then every three MSW thereafter following Wisconsin DNR wadeable stream protocol (WDNR 2000). Data was collected at each station following standard procedures for water characteristics and large-scale channel and basin characteristics (Simonson et al. 1994). Variables include stream name, waterbody code, location, air and water temperature, dissolved oxygen, flow, channel size, transect size and spacing, gradient, order, distances between bends, riffles and pools and a generalized stream map. All sampling was conducted during the open water portion of 2000 from April through August.

Discharge

Stream flow and depth were measured at 10 equally spaced locations along a transect at the non-Kewaunee River sites using a Marsh/McBirney instrument. Stream discharge

in Cubic Meters per Second (CMS) was calculated by multiplying velocity by depth by cell size, and then summing the products of each cell along the transect.

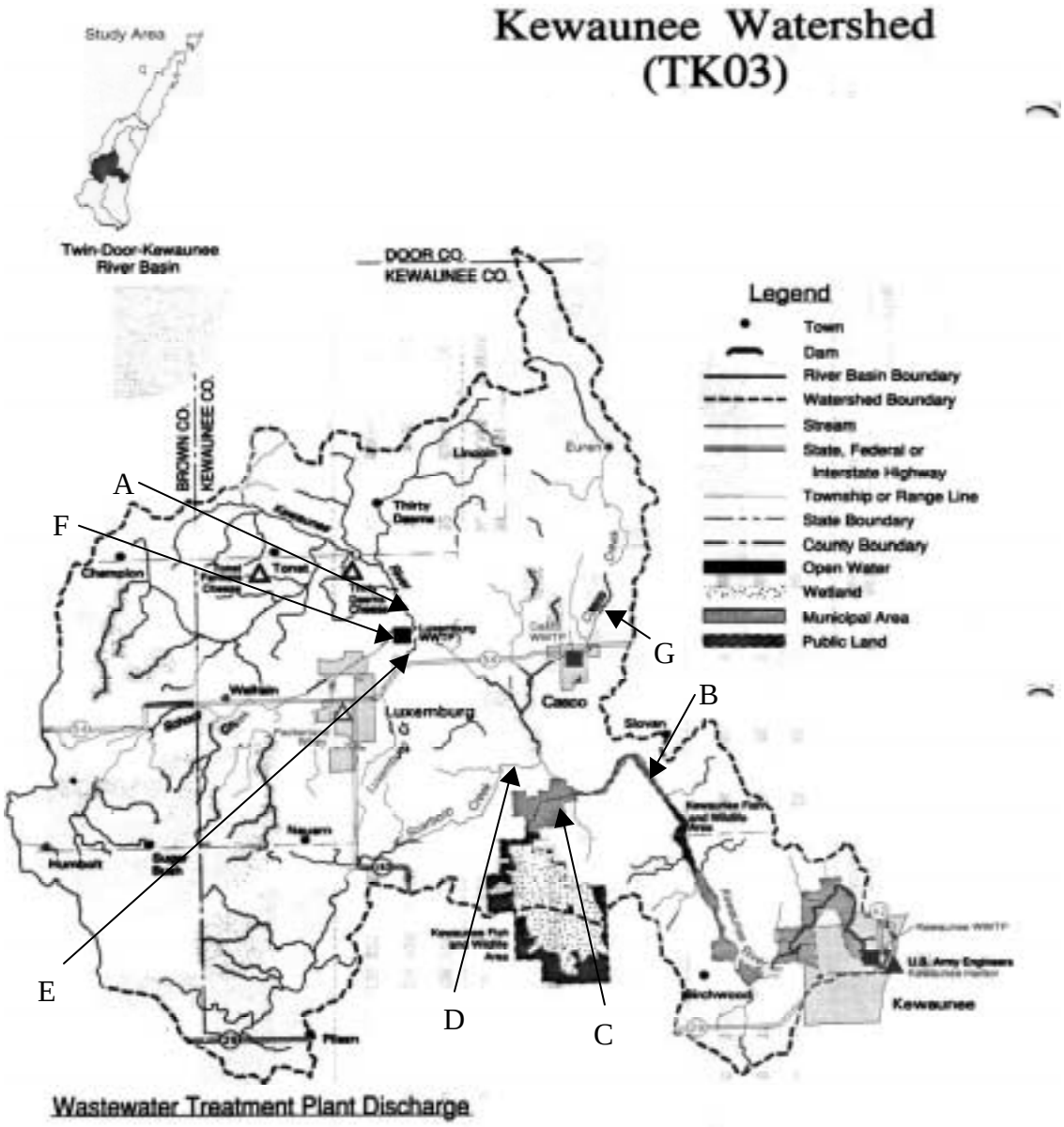

Figure 1. Sampling locations on the Kewaunee River for the 2000 baseline survey. The sampled sites included (A) Kewaunee River at River Road, (B) Kewaunee River at Clydes Hill, (C) Little Scarboro Creek, (D) Scarboro Creek, (E) Luxemburg Creek, (F) School Creek and (G) Casco Creek.

Flow and ultimately discharge at the Kewaunee River sites were determined from data from the United States Geological Survey (USGS) continuous flow recording station at Footbridge. Discharge from the gauging station was extrapolated to the Kewaunee River sites using watershed size ratios.

Habitat Assessment
Habitat along each of the 12 transects per site were evaluated using standard procedures (Simonson et al. 1994). The host of variables measured included depth and width parameters, bottom characteristics, plant growth, percent shading from vegetation, fish cover, stream bank erosion and surrounding land use.

Biological Assessments
Biological assessment work included collecting stream invertebrates and fish. Collected invertebrates were sent to UW-Stevens Point for identification and calculation of the Hilsenhoff Biotic Index (HBI) which relates species diversity, abundance and pollution sensitivity to water quality. Invertebrate samples were collected from streams that had riffle areas following standard invertebrate collection procedures.

Fish were sampled using electrofishing techniques during the summer. In the small streams surveyed, Luxemburg Creek, Little Scarboro and Casco Creek, a backpack shocker was used, while in the larger streams, Kewaunee River and Scarboro Creek, a stream shocker was used. DC current was used to capture the fish regardless of the gear type.

One upstream pass was made collecting all fish observed with small nets. Fish were identified and the number of each species tallied. Unidentifiable fish were returned to the office to be identified. One gram of MS-222 per 5 gallons of water was used to anesthetize unidentified fish, which were then transferred into 10% formalin to be preserved for later identification and as a reference for future collections.

The Index of Biotic Integrity (IBI) based on the fish community at each sampling location was calculated. Similar to the HBI, IBI relates community structure to community health and water quality.

Water Quality
Water quality data was collected through grab samples or by continuous monitoring Hydrolabs, models Datasound 4a and 4 (Rasman 2000). Variables measured included dissolved oxygen (DO), temperature, specific conductance, pH, 5 day biological oxygen demand (BOD-5), alkalinity, nitrogen series, phosphorus series, and fecal coliform bacteria (MFFC).

All water chemistry grab samples were analyzed at the State Laboratory of Hygiene in Madison. Quality assurance guidelines provided by the laboratory were adhered to in the field.

Calibration of the Datasounds was done the day previous to deployment following the manufacturer's recommendations. At least weekly the data was downloaded and the

instruments were cleaned and recalibrated using standard solutions for pH and conductivity.

RESULTS

Upper Kewaunee River (UKR)-River Road

The study section was located just above the River Road crossing (Lat. N44°34.479, Long. W087°41.074) and continued 189 meters upstream (Lat. N44°34.523, Long. W087°41.125). The bottom was composed primarily of sand and silt with very few rocks or cobble (Appendix 1).

Figure 2. Looking upstream on the Kewaunee River from River Road, June 6, 2000.

The stream in this section ran through a wooded area and the banks of the river have been heavily eroded (Figure 2). This section of the river contained only runs and pools with 7 bends. The average width of the river in this stretch was 5.4 meters. There was one large logjam due to a downed tree near the end of the station (Figure 3).

Figure 3. Looking downstream on the Kewaunee River from the end of the study section, June 6, 2000. Note the beginning of a tangle of trees found just above this section.

Discharge

Discharge for the entire Kewaunee River watershed during May 2000 ranged from 1.3 to 8.1 cubic meters per second (CMS) at the USGS gauging station at Footbridge (USGS provisional data, May 2001).

The Kewaunee River at River Road drains 20,160 acres (24.8% of watershed) before it pools (during base flow) in this area. This translates to a discharge of 0.33 CMS for this station based on the average discharge at Footbridge. Discharge at the site was measured at 0.0298 CMS. The lower than average flow resulting in low water was notable at this location because of the pool-like condition of the river.

Biological Assessments

The Hilsenhoff Index (HBI) was not calculated for this site because of a lack of riffle areas in this study section.

A total of nine species and 122 individual fish were handled (Table 3). Central mudminnow was the most commonly captured species followed by substantially fewer johnny darter, white sucker and blackside darter. The IBI score for this section of the Kewaunee River was 35 giving it a rating of fair.

Table 3. Fish collected from the Kewaunee River at River Road.

COMMON NAME	Number	% of Catch
Central mudminnow	75	61.48%
Northern pike	5	4.10%
Bluntnose minnow	2	1.64%
White sucker	9	7.38%
Black bullhead	2	1.64%
Pumpkinseed	2	1.64%
Johnny darter	12	9.84%
Blackside darter	9	7.38%
Mottled sculpin	6	4.92%
Total	122	100%

Water Quality

Water quality parameters were measured using both continuous monitors and through collection of grab samples. A continuous monitor was in place in the stream between July 12 and July 18, 2000 to collect dissolved oxygen data and general chemical parameters.

The dissolved oxygen data indicates that for much on the period of July 12 through July 18, D.O. levels were below the State standard of 5 mg/l (Figure 4). Low D.O. levels such as those recorded at this site certainly indicates the fish community at this site will be limited to those species that are tolerant of low levels of D.O.

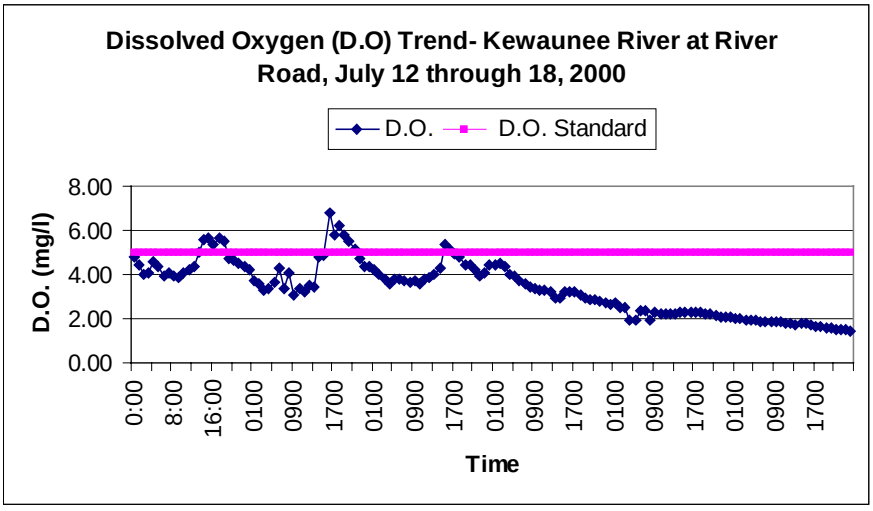

Figure 4. Dissolved oxygen readings on the Kewaunee River at River Road, July 12 through July 18,2001. The dissolved oxygen standard for this section of river is 5.0 mg/l.

Additional chemical data collected indicates that this site had the lowest level of D.O. saturation, and experienced swings in total phosphorus, pH and suspended solids (Table 4).

Table 4. Chemical collected on the Kewaunee River from the River Road site in 2000.

Site	Date	Temp. (C)	Conductance (uS/cm)	D.O. (mg/l)	D.O. Saturation %	pH	MFF CC (#/100 ml)	BOD-5 day	Alkalinity (mg/l)	Ammonia (mg/l)	NO2+NO3 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Dissolved Phosphorus (mg/l)	Suspended Solids	Flow (CMS)
Kewaunee R. @ River Rd.	04/03/ 2000	10		12.9												0.1
	05/23/ 2000	14.6	748	6.89	68	8.13	240	1	269	0.05	1.93	1.4	0.14	0.077	<5	0.3
	05/31/ 2000	18.9	644	18.55	999.9	9.35	240						0.154		7	0.2
	06/28/ 2000	16.8	836	4.38	45.3	7.9	150						0.332		14	0.1
	07/11/ 2000	19.7	756	6.04	66.4	7.92										0.3
Retrieve Hydrolab	07/18/ 2000	18.2	666	4.36	46.4	8										0.1
	08/01/ 2000	19.8	716	4.68	50.7	7.91										0.1

Kewaunee River-Clyde's Hill Road

The Clyde's Hill station was located at Lat. N44°31.056, Long. W087°35.273 and continued 595 meters upstream to Lat. N44°31.331, Long. W087°35.472 (Figures 5 and 6).

Figure 5. Looking upstream at the start of the Clyde's Hill station. Note the abundant filamentous algae found on the boulders of this section.

Figure 6. Looking downstream from the end of the Clyde's Hill station. Abundant filamentous algae was found at this station.

This section of the river was wide with a mean width of 17 meters and flowed through a mostly wooded area. Several small areas of grassland were also found in this section (Appendix 1). The river bottom was almost entirely cobble with some boulders and gravel interspersed. Twelve riffles, 11 runs with 4 pools and 4 bends (greater than 60° angle) were found in this study section. Most of the cobble was covered with filamentous algae with only a few patches of macrophytes.

Discharge

Discharge at the Clyde's Hill site was measured at 0.2320 CMS. Similar to the River Road site the river at this site was noticeably low, with water in runs nearly motionless. The low flow conditions may have been favorable for the development of the large mats of algae observed in this section.

Biological Assessments

Invertebrate samples were taken just downstream of Clyde's Hill bridge. The biotic index value was 5.536 indicating fair water quality at this site.

A total of 18 fish species representing 6,261 individuals were captured (Table 5). This site had the most diverse population and the largest number of fish captured at any station during this survey. The most common species was common shiner, followed by substantially fewer hornyhead chub and southern redbelly dace. The most common gamefish were rainbow trout and smallmouth bass. The IBI score for this site was 60 resulting in an IBI rating of good.

Table 5. Fish collected at the Clyde's Hill site on the Kewaunee River, July 2000.

COMMON NAME	Number	% of Catch
Rainbow trout	10	0.16%
Central mudminnow	2	0.03%
Largescale stoneroller	129	2.06%
Hornyhead chub	891	14.23%
Rosyface Shiner	1	0.02%
Common shiner	3787	60.49%
Southern redbelly dace	481	7.68%
Bluntnose minnow	341	5.45%
Blacknose dace	250	3.99%
Longnose dace	207	3.31%
Creek chub	25	0.40%
Brassy minnow	1	0.02%
White sucker	38	0.61%
Stonecat	80	1.28%
Brook stickleback	1	0.02%
Rock bass	4	0.06%
Smallmouth bass	1	0.02%
Johnny darter	12	0.19%
Total	**6,261**	**100%**

Water Quality

Water quality parameters were measured using both continuous monitors and through collection of grab samples. A continuous monitor was in place in the stream between July 21 and July 26, 2000 to collect dissolved oxygen data and general chemical parameters.

The dissolved oxygen data indicates that for much on the period of July 21 through July 26, D.O. levels were above the State standard of 5 mg/l (Figure 7). Daily D.O. sags are expected because of photosynthesis/respiration cycles, but when the D.O. drops below 5 mg/l at the Besadny Fisheries Facility, an important link in the DNR Lake Michigan fishery program there is a great amount of concern. Additionally, of great concern was that the trend was worsening with D.O. peaks declining in level and the amount of time below the D.O. standard increasing.

Continuous monitoring data for D.O. and other parameters showed similar results throughout the monitoring period (Table 6).

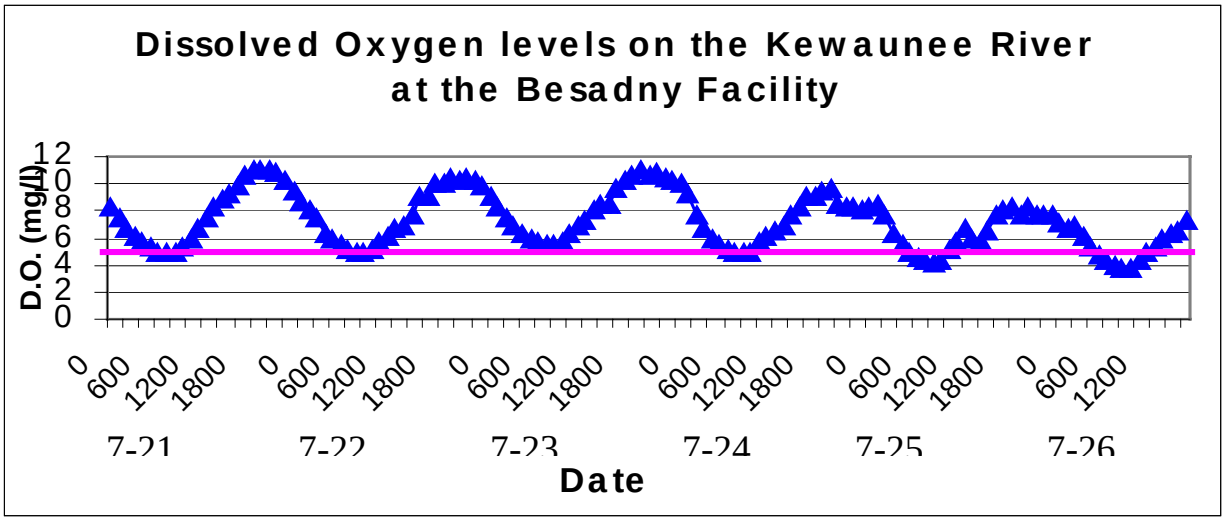

Figure 7. Dissolved oxygen levels measured on the Kewaunee River July 21 through July 26 at the Besadny Fisheries Facility. The State standard for dissolved Oxygen for this river section is shown by the horizontal line at 5 mg/l D.O.

Table 6. Chemical data collected through continuous monitors at the Besadny Facility or Clyde's Hill Bridge throughout 2000.

Site	Date	Temp. (C)	Conductance (uS/cm)	D.O. (mg/l)	D.O. Saturation %	pH	MFF CC (#/100 ml)	BOD-5 day	Alkalinity (mg/l)	Ammonia (mg/l)	NO2+NO3 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Dissolved Phosphorus (mg/l)	Suspended Solids	Flow (CMS)
Kewaunee R. @ Clyde Hill Rd	04/03/ 2000	8.3		12.8												0. 4
	05/23/ 2000	18.1	708	14	148	8.77	20									1.1
	05/31/ 2000	18.9	644	18.6	999	9.35	60						0.103		<10	0.6
	06/28/ 2000	17.8	715	13.0	137	8.33	60									0. 4
Place Hydrolab 0n 18th, 19th vandalized	07/18/ 2000	19.4	665	16.3	177	9.25										0. 4
	08/01/ 2000	27.2	561	15.9	999	9.12										0. 3

Little Scarboro Creek

The section studied was 100 meters in length just upstream of County A (start Lat. N44°30.799, Long. W087°37.711, end Lat. N44°30.786, Long. W087°37.758). This small stream had a mean width of 2.6 meters and flowed through a cedar forest (Figure 8 and 9). This meandering stream had a mixture of structure including 5 riffles, 3

Figure 8. The start of the Little Scarboro study section. The grassy area in the top of the picture was one of the few open spots in this river section.

Figure 9. Looking downstream from the end of the study section. Note the sand bottom and the lack of vegetation on the banks.

pools, 5 runs and 9 bends (greater than 60° angle). This stream remains very cool because it is continually fed by ground water seeps and is hidden under a thick cedar canopy. The bottom of the stream is mostly sand with a small amount of gravel and cobble (Appendix 1).

Discharge

Stream discharge was measured on the Little Scarboro several times and ranged from 0.03 to 0.05 CMS. Flow on this stream appears to remain stable because of the amount of base flow contributed by groundwater through numerous seeps in this area.

Biological Assessment

Invertebrate samples were taken just below County A. The Hilsenhoff index of biotic integrity was 3.07 indicating excellent water quality on Little Scarboro Creek.

A total of 65 individual fish representing six species were captured (Table7). The IBI score for the Little Scarboro was 50, which gave it a rating of good. Many of the collected fish were salmonids, however most were non-native salmonids from Lake Michigan that have naturally reproduced in this river. Based on past surveys the native stock of brook trout have declined substantially since the 1970's (Avery 1974 and 1999) when a thousand brook trout per mile shocked was not uncommon.

Table 7. Fish species collected on Little Scarboro during the summer of 2000.

COMMON NAME	Number	% of Catch
Coho salmon	3	4.62%
Rainbow trout	20	30.77%
Brook trout	20	30.77%
Central mudminnow	1	1.54%
Pearl dace	3	4.62%
Mottled sculpin	18	27.69%
Total	65	100%

Water Quality

A continuous water sampler was not deployed at this site and the data consists of a series of grab samples. Dissolved oxygen levels ranged from 8.7 to 11.2 mg/l throughout the sampling period and always exceeded the State D.O. limit for trout waters of 6.0 mg/l (Table 8). Other measured parameters varied very little during the sample period.

Table 8. Water chemistry data collected through grab samples in 2000 from Little Scarboro Creek.

Site	Date	Temperature (C)	Specific Conductance (uS/cm)	Dissolved Oxygen (mg/l)	D.O. Saturation %	pH	MFF CC (#/100/ml)	BOD-5 (mg/l)	Alkalinity (mg/l)	Ammonia (mg/l)	N02+N03 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Suspended Solids (mg/l)	Discharge (CMS)
Lit. Scarboro @ CTH "A"	04/03/ 2000	7		11											
	05/23/ 2000	11.8	654	10.5	97.3	8.62			277	ND	6.49	0.25	0.02	<5	0.05
	05/31/ 2000	11.8	647	10.95	101	8.71	170						0.012	<10	0.05
	06/28/ 2000	11.5	701	11.18	102	8.24	60								0.03
	08/01/ 2000	15.3	663	8.74	87	8.28									

Scarboro Creek

The study section was 147 meters long and was located downstream of County A (start Lat. N44°31.220, Long. W087°38.906, end Lat. N44°31.147, Long W087°38.974). The bottom of the stream was almost entirely bedrock with a few stretches containing some cobble (Figures 10 and 11).

-

Figure 10. Looking upstream at the start of the Scarboro Creek station.

Figure 11. Looking downstream at the end of the study section. A large pool and open canopy dominated this location.

The mean width of this section was 4.2 meters (Appendix 1). This stream had a mixture of structure with 5 riffles, 3 pools, 5 runs and 3 bends (greater than 60° angle). A small stretch of this section has been modified by concrete wall. There also is an unrecognizable concrete structure further upstream, which could have been a dam for a millpond or a railroad bridge abutment. Under this old structure two deep pools have formed.

Discharge

Discharge at this site ranged between 0.05 CMS to 0.15 CMS as measured during continuous monitoring. It was also measured when other stream samples were collected at 0.11 CMS. Flow rates on Scarboro Creek appeared to be consistent during the sample period because of groundwater infiltration into the system.

Biological Assessments

Invertebrate samples were taken just below CTH A. The index value was 4.816 indicating good water quality at this site on Scarboro Creek.

There were several patches of curly-leaf pondweed (*Potamogeton crispus L.)* at some of the riffle areas as well as moss because of the open canopy of this river. The curly-leaf pondweed is a Eurasian invader that prefers soft substrates, shallow water, is tolerant of turbidity and is often associated with degraded water quality (Nichols 1999).

A total of 587 individual fish representing 14 species were captured during shocking (Table 9). These fish translated into an IBI score of 50 and an IBI rating of good for Scarboro Creek.

Table 9. Fish collected on Scarboro Creek during 2000.

COMMON NAME	Number	% of Catch
Chinook salmon	1	0.17%
Rainbow trout	8	1.36%
Brown trout	1	0.17%
Largescale stoneroller	6	1.02%
Common shiner	125	21.29%
Southern redbelly dace	6	1.02%
Bluntnose minnow	8	1.36%
Blacknose dace	67	11.41%
Longnose dace	114	19.42%
Creek chub	139	23.68%
White sucker	66	11.24%
Brook stickleback	1	0.17%
Johnny darter	2	0.34%
Mottled sculpin	43	7.33%
Total	587	100%

Water Quality

Dissolved oxygen readings taken at one hour intervals on July 31 from Scarboro Creek over a 24 hour period were typical of other readings from this site between July 26 through August 2, 2000 (Figure 12). There were no dissolved oxygen readings from this site below 5 mg/l, the state standard, during the study.

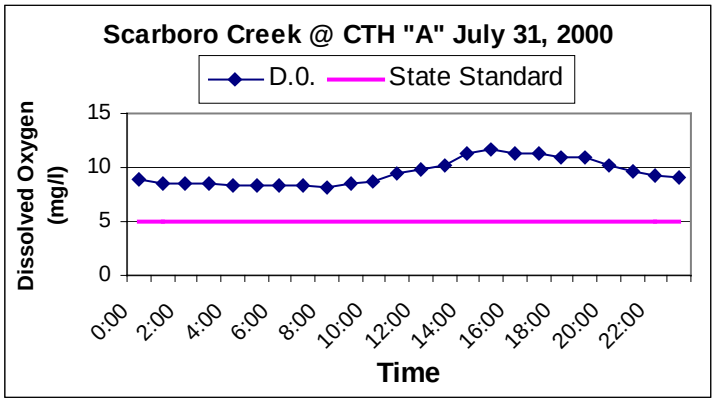

Figure 12. Dissolved oxygen levels measured on Scarboro Creek, July 31, 2000.

Table 10. Chemical data collected from continuous monitors on Scarboro Creek during 2000.

Site	Date	Temperature (c)	Specific Conductance (uS/cm)	Dissolved Oxygen (mg/l)	D.O. Saturation %	pH	MFF CC (#/100 ml)	BOD-5 (mg/l)	Alkalinity (mg/l)	Ammonia (mg/l)	N02+N03 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Suspended Solids (mg/l)	Discharge (CMS)
Scarboro Cr. @ CTH "A"	04/03 /2000	8.9		12											
	05/23 /2000	15.4	771	11.1	111	8.5	80	0.8	295	0.041	4.32	0.83	0.07	<5	0.15
	05/31/ 2000	15.7	709	11.4	114	8.56	130						0.05		0.03
	06/28/ 2000	16.1	761	9.27	94.5	7.99	150								0.05
	08/01/ 2000	20.3	727	8.88	97.8	8.12									

A continuous water sampler was deployed at this site for one week. Dissolved oxygen levels ranged from 8.88 to 9.27 mg/l throughout the sampling period (Table 10). Other parameters that were measured varied little during this time.

Luxemburg Creek

Luxemburg Creek was the smallest of the streams studied in this project with an average width of 1.7 meters (start Lat. N44°33.485, Long. W087°40.971, end Lat. N44°33.451, Long. W087°40.993). Although this creek is short and narrow, the section we examined contained 2 pools, 5 riffles, 4 runs and 1 bend (greater than 60° angle). The creek bottom was mixed cobble, silt and gravel (Appendix 1). This section of the creek runs through open fields of oats with a buffer strip of reed canary (*Phalaris arundinacea*) averaging 5 meters on each side (Figures 13). The reed canary grass was also found in the middle of the stream in shallow areas and as overhanging vegetation bank cover along the sides of the stream. There was some filamentous and attached algae on the bottom substrate as well as some aquatic moss. There was a thin layer of silt covering the cobble and moss.

Figure 13. Looking upstream at the start of the study section. Note the small size of the stream and the abundance of reed canary grass. Looking downstream at the end of the study section was similar in stream size and vegetation cover.

Discharge

As in the other streams, low flow was seen in Luxemburg Creek. Discharge was measured at 0.009 CMS.

Biological Assessments

Invertebrate samples were taken at this site just below Valley Drive. The Hilsenhoff Biotic Index value was 5.563 indicating fair water quality at this site on Luxemburg Creek.

A total of 5 fish species representing 35 individuals were captured at this site (Table 11). Creek chub and mottled sculpin were the most commonly caught species. The IBI score for this section was 45 resulting in an IBI rating of fair.

Table 11. Fish collected from Luxemburg Creek during the 2000 survey.

COMMON NAME	Number	% of Catch
Central mudminnow	3	8.57%
Longnose dace	4	11.43%
Creek chub	12	34.29%
Brook stickleback	4	11.43%
Mottled sculpin	12	34.29%
Total	**35**	**100%**

Water Quality

Continuous readings were not taken at this site because of the lack of continuous flow and inadequate depth. Data was collected on a periodic basis and that information is reported below (Table 12).

Table 12. Water Chemistry collected from Luxemburg Creek during 2000.

Site	Date	Temperature (C)	Specific Conductance (uS/cm)	Dissolved Oxygen (mg/l)	D.O. Saturation %	pH	MFF CC (3/100 ml)	BOD-5 (mg/l)	Alkalinity (mg/l)	Ammonia (mg/l)	N02+N03 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Suspended Solids (mg/l)	Discharge (CMS)
Luxemburg Cr. - Valley Dr.	04/03/ 2000	9.6		14.9											
	05/23/ 2000	12.7	995	14.6	137.8	8.7	120	0.5	288	0.016	12.4	0.64	0.053	<5	0.01
	05/31/ 2000	12.7	802	12.6		8.57	700						0.057	<5	0.01
	06/28/ 2000	14.8	942	10.0	98.6	8.04	240						0.171	<5	0.0
	08/01/ 2000	16.8	943	8.0	81.7	8.01									

Throughout the sampling period dissolved oxygen remained well above the State standard of 5 mg/l. Bacteria (MFF CC) was measured at 700 organisms per 100 ml, on May, 31 and was one the highest readings recorded during this survey. Other parameters that measured high at this site included NO2+NO3 and total phosphorus.

School Creek

The section of School Creek (start N44°33.905, Long. W087°40.990 and end Lat. N44°33.975, Long W087°41.108) that was within the 238 meter study section was wooded and the bottom consisted mostly of cobble with some gravel and boulders (Figures 14 and 15, Appendix 1). The shoreline appeared to be stable with little erosion. The average width of this section of the creek is 6.8 meters and consisted of 9 riffles, 5 pools, 5 runs and 3 bends (greater than 60° angle).

Figure 14. Looking upstream at the start of the study section on School Creek. Low water had exposed the cobble bottom creating pools within the stream thread.

Figure 15. Looking upstream of the study section on School Creek. Note the heavy growth of filamentous algae at this location.

Discharge

As in the other streams, low flow was observed in School Creek. Discharge was measured at 0.01 CMS.

Biological Assessments

Invertebrates were collected just below the Valley Drive Bridge in a large riffle area to determine general water quality based on Hilsenhoff's biotic index. The index resulted in an HBI score of 6.366 indicating fair water quality in School Creek.

A total of 344 fish representing 15 species were captured during the survey (Table 13). The most common species were creek chub followed by mottled sculpin and white sucker. The IBI score for School Creek was 25 resulting in a stream rating of poor.

Low water created many isolated small pools that made electroshocking difficult (Figure 16). Abundant filamentous algae were observed in this stream that also made seeing shocked fish difficult reducing collection efficiency.

Table 13. Fish collected on School Creek during the 2000 survey.

COMMON NAME	Number	% of Catch
Central mudminnow	24	6.98%
Hornyhead chub	1	0.29%
Common shiner	33	9.59%
Southern redbelly dace	3	0.87%
Bluntnose minnow	25	7.27%
Fathead minnow	1	0.29%
Blacknose dace	31	9.01%
Longnose dace	27	7.85%
Creek chub	81	23.55%
Pearl dace	1	0.29%
White sucker	39	11.34%
Black bullhead	1	0.29%
Brook stickleback	31	9.01%
Blackside darter	4	1.16%
Mottled sculpin	42	12.21%
Total	**344**	**100%**

Figure 16. Electrofishing in a small pool created by low water on School Creek.

Water Quality

Data collected with continuous monitoring equipment indicated that dissolved oxygen levels fluctuated between 5.5 mg/l and 7.5 mg/l and that the D.O. level did not fall below State standards at any time during the monitoring. Figure 17 is a representative sample of the data that was collected.

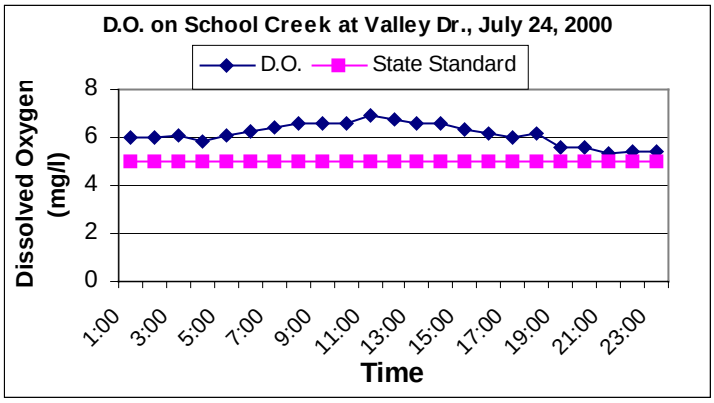

Figure 17. Dissolved oxygen data collected on July 24, 2000 from continuous samplers on School Creek.

Dissolved oxygen samples collected during the survey year indicate that D.O. and D.O saturation % was high in the stream (Table 14). Specific conductance was also high at this site. Other chemical parameters changed little during the sample period with the exception of total phosphorus that showed a marked increase in the June sample.

Table 14. Chemical data collected from School Creek during the 2000 survey.

Site	Date	Temperature	Specific Conductance (uS/cm)	D.O. (mg/l)	D.O. Saturation %	pH	MFCC (#/100 ml)	BOD-5 (mg/l)	Alkalinity (mg/l)	Ammonia (mg/l)	NO2+NO3 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Suspended Solids (mg/l)	Discharge (CMS)
School Creek - Valley Dr.	04/03/ 2000	13.9		10.8											
	05/23/ 2000	15.6	818	11.4	115.8	8.7	10	1.1	226	0.032	3.57	1.56	0.214	<5	0.2
	05/31/ 2000	14.4	914	11.0	107.3	8.6	40						0.193	<5	0.04
	06/28/ 2000	17.0	1011	10.4	109	8.2	60						0.405	<5	0.03
	07/1/ 2000	18.2	1057	9.93	105.8	8.5									
	07/25/ 2000	17.5	1062	9.34	98.2	8.2									
	08/01 2000	17.1	975	8.05	84.8	7.9									

Casco Creek

The start of the study section was located at Lat. N44°32.745, Long. W087°38.118 and continued 280 meters upstream through a cedar forest to Lat. N44°32.896, Long. W087°38.068 (Figures 18 and 19). Casco Creek is a shallow stream with a bottom composed of a mix of gravel and cobble with a few boulders (Appendix 1). Silt and filamentous algae cover the rocks in many locations in the study section. The average width of the creek in this section was 8 meters. This section of the creek was very diverse in appearance with a total of 13 riffles, 10 runs, 8 pools and 4 bends (greater than 60° angle).

Discharge

Flow appeared to be more consistent on Casco Creek then on some of the other studied streams. On Casco Creek flow was measured at 0.0333 CMS.

Biological Assessments

Invertebrate samples were taken at this site just above Rockledge Rd. The index value was 4.096 indicating very good water quality at this site on Casco Creek.

A total of 13 species of fish represented by 424 individuals were captured at this site (Table 15). Four species dominated the catch, with creek chub the most common followed by blacknose dace, longnose dace and mottled sculpin. The IBI score for Casco Creek was 45 that resulted in an IBI rating of fair.

Figure 18. Looking upstream at the start of the study section. Downed wood and cobble are evident in the low flow conditions of the river.

Figure 19. Looking upstream at a riffle that marked the end of the study section on Casco Creek.

Table 15. Fish captured on Casco Creek during the 2000 survey.

COMMON NAME	Number	% of Catch
Hornyhead chub	1	0.24%
Common shiner	2	0.47%
Southern redbelly dace	5	1.18%
Blacknose dace	138	32.55%
Longnose dace	56	13.21%
Creek chub	141	33.25%
Pearl dace	6	1.42%
White sucker	11	2.59%
Brook stickleback	1	0.24%
Rock bass	1	0.24%
Johnny darter	17	4.01%
Blackside darter	5	1.18%
Mottled sculpin	40	9.43%
Total	**424**	**100%**

Water Quality

Continuous samples were not taken from this site because of a lack of flow and water levels therefore the chemical data that was collected was from a series of grab samples throughout 2000 (Table 16).

Dissolved oxygen and discharge decreased during the sample period while other parameters remained relatively stable (Table 16).

Table 16. Chemical data collected on Casco Creek during the 2000 survey.

Site	Date	Temperature (C)	Specific Conductance (uS/cm)	Dissolved oxygen (mg/l)	D.O. Saturation %	pH	MFF CC (#/100 ml)	BOD-5 (mg/l)	Alkalinity (mg/l)	Ammonia (mg/l)	NO2+NO3 (mg/l)	Total Kjeldahl (mg/l)	Total Phosphorus (mg/l)	Suspended Solids (mg/l)	Discharge (CMS)
Casco Cr. @ Rockledge Rd.	04/03/ 2000	8		11.6											
	05/23/ 2000	16.6	709	10.4	107	8.68			264	0.03	1.49	1.23	0.13	7	0.13
	05/31/ 2000	15.6	748	10.1	101	8.77	190						0.15	6	0.08
	06/28/ 2000	15.7	832	9.22	93	8.31	27								0.03
	08/01/ 2000	20.5	802	8.8	97.9	8.45									

DISCUSSION

A combination of biological, chemical and physical data may show trends of watershed health better than an individual metric. Chemical monitoring was very limited in this case with the best data being continuous dissolved oxygen, conductivity, pH and temperature from selected sites. Biological samples were also collected as a part of this study (Hilsenhoff's Index – macroinvertebrates [HBI] and the Index of Biotic Integrity – fish [IBI]). Habitat assessments were also conducted at various sites. Discharge was measured at tributary sites and extrapolated for the Kewaunee sites from the continuous gauging station at CTH "F" on the Kewaunee River. Through this sampling effort we hope that the collected trend data will be used to help make management decisions that will improve the condition of the watershed.

Discharge

Flow or discharge measured at the gauging site at CTH "F" during the study indicated low flow or base flow conditions. Maximum historical discharge at the USGS site is 64 CMS with a mean flow of 4.9 CMS. Discharge at this site from the beginning of our study on April 3, 2000 until the end of our study on August 1, 2000 ranged from a low of 0.3 CMS on July 26, 2000 to a high of 8.2 CMS on May 19, 2000. The May 2000 high flows lasted only three days going from 1.3 CMS on May 17, to 8.2 CMS on May 18, and back down to 1.6 CMS on May 22.

Flow or discharge was most limiting at Luxemburg Creek where the stream consisted of a series of small pools with no measurable flow at times during the study (Table 17). Flow, although at times low on Little Scarboro Creek was continuous due to groundwater inputs into the stream channel. Other streams exhibited continuous, although low flow throughout the survey and were most likely not limiting to the biological communities that inhabited them.

Biological Assessments

Application of Hilsenhoff's Biotic Index in 2000 showed good to excellent water quality at Casco, Scarboro and Little Scarboro Creeks. Fair water quality was indicted at the other three sites where the HBI was applied. Data from 1984 (Bougie 1990) indicated that water quality ranged from poor at three locations to excellent at two locations (Table 17). Direct comparisons should be made with caution because sampling locations between 1984 and 2000 may not be identical. However, results from 2000 as compared to those collected in 1984, appear to indicate that the HBI hasn't changed substantially, although there has been some improvement on School and Scarboro Creeks and a decline in HBI at Clydes Hill on the Kewaunee River.

A total of 30 species of fish were captured during the surveys on the Kewaunee River system (Tables 3,5,7,9,11,13 and 15). Although historical surveys had identified 48 species in the system (Table 2), a number species that were not collected are Lake Michigan species and are more likely to be captured in sections of the lower Kewaunee River that were not surveyed.

However, redside dace, a Wisconsin species of concern, historically collected in 4 of the 6 streams surveyed was not captured during this survey and is of concern. Redside dace are reported to be sensitive to sedimentation (Becker 1980). This may be an indication of a decline in water quality in the watershed since the 1980's.

Fish IBI ratings ranged from poor (School Creek) to good (Clydes Hill, Little Scarboro and Scarboro Creeks) (Table 17). For streams that were surveyed in 1984 and 2000 similar scores and rankings were noted except for Casco Creek which declined from an IBI rating of good in 1984 to fair in 2000. This decline was mostly likely due to the absence of trout and reside dace in 2000. This may be due to sampling different locations in each survey year and not due to declines in water quality or habitat.

However, there is concern with the IBI ratings because they reflect that few warmwater gamefish and intolerant species were captured during this survey. This most likely is due to poor water quality, i.e. high nutrients and large swings in dissolved oxygen level, or from habitat loss through erosion and sedimentation or from low flow conditions because of watershed scale changes in water movement and storage.

Table 17. The summary of discharge, dissolved oxygen, and Hilsenhoff and Fish IBI's from the study streams during the 2000 survey in the Kewaunee River watershed and from historical data complied by Bougie (1990).

Site	Discharge CMS (range)	Dissolved Oxygen-1983 < 5 mg/l	Dissolved Oxygen-2000 < 5 mg/l	Hilsenhoff HBI-1984	Hilsenhoff HBI-2000	Fish IBI-1984	Fish IBI-2000
Kewaunee R. At River Road	0.08 to 0.3	Not Continuous, some violations Range 4.8 to 5.2	Continuous, most violations some < 2 mg/l	Poor	N/A	N/A	35-Fair
Kewaunee R. At Clyde Hill Rd	0.3 to 1.1	N/A	No continuous recorder Big diurnal swings no <5mg/l	Fair to Good	5.536-Fair	50- Good	60-Good
Kewaunee R At Besadny	0.3 to 1.2	Not Continuous Diurnal swings Range 7.6 to 11.6	Continuous, Diurnal swings	N/A	N/A	N/A	N/A
Little Scarboro Creek	0.003 to 0.03	N/A	No continuous recorder All > 5 mg/l	Excellent	3.07-Excellent	N/A	50-Good
Scarboro Creek	0.05 to 0.15	No continuous recorder Range 5.4 to 6	Continuous recorder All > 5 mg/l	Poor to Good	4.816-Good	60-Good	50-Good
Luxemburg Creek	0.0 to 0.03	N/A	No continuous recorder All > 5 mg/l Low/no flow during 2000	N/A	5.563-Fair	N/A	45-Fair
School Creek	0.03 to 0.15	No continuous recorder Range 5.7 to 8.4	Continuous, All > 5 mg/l	Poor	6.366-Fair	N/A	25-Poor
Casco Creek	0.03 to 0.13	N/A	No continuous recorder All > 5 mg/l	Fair to Excellent	4.096-V. Good	60-Good	45-Fair

Water Quality

The greatest level of impairment measured during the study was on the main stem of the Kewaunee River where continuous dissolved oxygen at River Road regularly went below the 5 mg/l state standard and a level of 2 mg/l was measured over a 12+ hour period on July 18, 2000 (Table 17). This area is a pool during base flow with an accumulation of soft sediments. The soft sediments are likely a major source of oxygen demand for this area. The diurnal dissolved oxygen swings on the main stem at Clyde Hill Road are the result of excessive primary production that includes the growth of filamentous algae, and macrophytes as well as some leafy moss. At times dissolved oxygen approached super saturation through photosynthesis with some measurements greater than 16 mg/l. Saturation was 177% when measured that day. High amounts of phosphorus and nitrogen from surrounding poor land use activities are the likely cause of the excessive plant growth in this area. Further downstream just above the Besadny facility dissolved oxygen dipped below 5 mg/l, as a result of respiration. The Besadny area consists of a long run in the River before a series of riffles or reaeration sites provide some recovery for dissolved oxygen. Oxygen demand likely occurs from the accumulation of soft sediments in the area.

The five tributaries that were surveyed all had dissolved oxygen levels above 5 mg/l during the study. This is likely due to more continuous flow because of groundwater influences.

Conductivity and pH did not indicate any signs of gross pollution but did reflect the heavy clay soils and geology of the area in terms of the normal high readings. Alkalinity or total carbonate hardness also reaffirmed the heavy clay soils and geology of the area and its affect on higher readings.

CONCLUSIONS

- Although HBI and IBI ratings have changed little since 1984, it appears that fish populations chiefly native warmwater gamefish and sensitive forage species are nearly absent in surveyed sections of the Kewaunee River. Trout populations in Little Scarboro, Scarboro and Casco Creeks have also declined below historic levels. Declines in these species are most likely due to poor water quality (D.O. swings below State standards), habitat loss through sedimentation and erosion and from competition with non-native trout from Lake Michigan.

- Water quality on the Kewaunee River, School Creek and Luxemburg Creek have not improved through implementation of Priority Watershed management actions. On the Kewaunee River dissolved oxygen swings and a HBI rating of fair have been measured during this survey. On School and Luxemburg Creeks a HBI rating of fair indicate that water quality may be limiting to some organisms.

- Flow in the Upper Kewaunee River, Luxemburg Creek and School Creek can be very low at times and may limit the ability of those areas to support diverse aquatic life. Lack of flow in these streams may be due to the loss of wetlands and natural vegetation within their watersheds.

RECOMMENDATIONS

Kewaunee River

- Continue to work with Kewaunee County LCD in identifying critical areas on the river.

- Work with the Kewaunee County LCD and NRCS to implement CRP and CREP projects on the Kewaunee that improve water quality by placement of buffers along streambanks, and improve flow characteristics by reestablishing wetlands or through creation of retention ponds.

- Work Kewaunee County LCD and DNR Animal Waste programs to protect water quality in the river by adopting stricter rules regarding manure management.

- Monitor water quality in the stream on a regular basis to measure trends in water quality and Hilsenhoff HBI.

- Develop instream habitat practices to improve habitat for warmwater sportfish if water quality improves in the river.

Little Scarboro Creek

- Monitor landuse (non-metallic mining) in the watershed to limit potential impacts of groundwater withdrawal or movement of sand into the river.

- Continue to make instream improvements in habitat for native brook trout through tree removal or placement of structure.

- Continue to work with DNR Lands personnel to manage the surrounding watershed in a manner to protect the fishery of the stream and groundwater seep areas.

Scarboro Creek

- Continue to work with Kewaunee County LCD in identifying critical areas on the river.

- Work with the Kewaunee County LCD and NRCS to implement CRP and CREP projects on Scarboro Creek that will improve water quality through placement of streambank buffers, and by reestablishing wetlands or retention ponds.

- Work Kewaunee County LCD and DNR Animal Waste programs to protect water quality in the river by adopting stricter rules regarding manure management.

- Monitor water quality in the stream on a regular basis to measure trends in water quality and Hilsenhoff HBI.

- Develop instream habitat practices to improve habitat for brown trout if water quality improves in the river.

Luxemburg Creek

- Continue to work with Kewaunee County LCD in identifying critical areas on the river.

- Work with the Kewaunee County LCD and NRCS to implement CRP and CREP projects on Luxemburg Creek that will improve water quality through placement of streambank buffers, and by reestablishing wetlands or retention ponds.

- Work Kewaunee County LCD and DNR Animal Waste programs to protect water quality in the river by adopting stricter rules regarding manure management.

School Creek

- Continue to work with Kewaunee County LCD in identifying critical areas on the river.

- Work with the Kewaunee County LCD and NRCS to implement CRP and CREP projects on School Creek that will improve water quality through placement of streambank buffers, and by reestablishing wetlands or retention ponds.

- Work Kewaunee County LCD and DNR Animal Waste programs to protect water quality in the river by adopting stricter rules regarding manure management.

- Monitor water quality in the stream on a regular basis to measure trends in water quality and Hilsenhoff HBI.

Casco Creek

- Continue to work with Kewaunee County LCD in identifying critical areas on the river.

- Work with the Kewaunee County LCD and NRCS to implement CRP and CREP projects on Casco Creek that will protect water quality.

- Work with owners of the dam in Casco and the village Casco to remove the dam and millpond in Casco to allow the stream to flow freely.

- Monitor water quality in the stream on a regular basis to measure trends in water quality and Hilsenhoff HBI.

- Develop instream habitat practices to improve habitat for brown trout if water quality improves in the river.

REFERENCES

Avery, E. 1974. Reproduction and recruitment of anadromous salmonids in Wisconsin tributaries of Lake Michigan. Wisconsin Department of Natural Resources Research Report. 32 pages.

Avery, E. 1999. Heritage Brook Trout in Wisconsin: Identification and Genetic variability among populations. Final Report. Wisconsin Department of Natural Resources. 50 pages.

Becker G. 1983. Fishes of Wisconsin. University of Wisconsin Press. 1053 pages.

Bougie, C. 1990. Interim evaluation monitoring report: Kewaunee River Priority Watershed. Wisconsin Department of Natural Resources. 11 pages.

Lyons, J. 1992. Using the Index of Biotic Integrity (IBI) to Measure Environmental Quality in Warmwater Streams of Wisconsin. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. General Technical Report NC-149. St. Paul, Minnesota

Nichols, Stanley A. 1999. Distribution and habitat descriptions of Wisconsin lake plants. Wisconsin Geological and Natural History Survey.

Rasman, T. 2000. Kewaunee River and it's tributaries: A water resources study. Wisconsin Department of Natural Resources. Nov. 2000. 15 pages.

Simonson T. D., J. Lyons and P.D. Kanehl. 1994. Guidelines for Evaluating Fish Habitat in Wisconsin Streams. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, General Technical Report NC-164.

Wallender A. 2000. Kewaunee River Watershed Goals. Personal Communication. Kewaunee County LCD. Kewaunee, WI.

WI DNR. 1984. The Kewaunee River Priority Watershed Management Plan. Wisconsin Department of Natural Resources. April 1984.

WI DNR. 1995. Twin-Door-Kewaunee River Basin Water Quality Management Plan. Wisconsin Department of Natural Resources Publ-WR-316-93-REV. March 1995.

WI DNR. 2000. Wisconsin Department of Natural Resources Guidelines for Evaluating Habitat of Wadable Streams. Wisconsin Department of Natural Resources. May 2000 revision. 22 pages.