Summary

Biological communities inhabiting streams draining the DuPage River-Salt Creek study area were limited primarily by stormwater impacts and habitat alterations, secondarily by sewer overflows, and indirectly by wastewater loadings. These limitations do not act singly, but often work in concert. For example, the effects of nutrient enrichment were most pronounced in impounded sections of the mainstems, where wide swings in diel dissolved oxygen concentrations often resulted in hypoxic conditions. Nowhere was this problem more manifest than in the dam pool at McDowell Grove on the West Branch, the dam pool at Churchill Woods on the East Branch where dissolved oxygen concentrations fluctuated by as much as 15 mg/l, and at the Hidden Lake Forest Preserve on the East Branch where minimum dissolved oxygen concentrations frequently fell below water quality standards during the summer months (Figure 2). Numerous stormwater detention ponds and other small impoundments in the headwaters contributed loadings of ammonia, total Kjeldahl nitrogen and oxygen demanding substances resulting in higher-than normal ambient concentrations for these parameters. Comparing the concentrations of these substances to total phosphorus concentrations by stream size reveals the spatial contribution from the diffuse headwater sources relative to point source loadings (Figure 3). Phosphorus concentrations in excess of 0.5 mg/l were the domain of treated effluent, and most of the publicly owned treatment plants in the survey area discharged to streams larger than 2 square miles in drainage area. Evidence for the stress created by urban/suburban stormwater was also manifest in elevated concentrations of polycyclic aromatic hydrocarbons (PAHs) in sediment samples collected throughout the study area. PAHs build up on road surfaces as a result of incomplete petroleum combustion and leakage. The concentrations of PAHs detected in sediment samples frequently exceeded levels where effects on benthic organisms are likely.

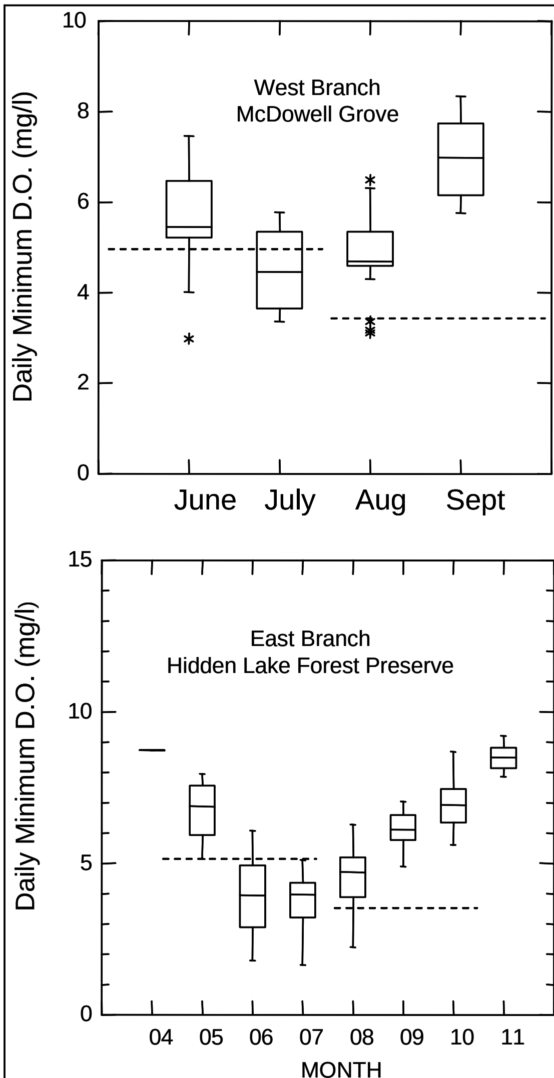


Figure 2. Minimum dissolved oxygen concentrations recorded from hourly observations in the West Branch at McDowell Grove, 2006, and in the East Branch at Hidden Lake FP in 2007. The water quality standards for seasonal instantaneous minimum concentrations are shown as dashed lines.

The biological communities were not, however, completely overwhelmed by the high degree of suburbanization in these watersheds, as habitat quality explained a significant amount of the variation in the biological indices (Figure 4). Degraded stream habitat with minimal function beyond water conveyance was frequently noted at headwater sites; however, habitat quality along the lower West Branch, East Branch and Salt Creek mainstems, exclusive of dam pools, was rated as good to excellent. Furthermore, biological communities sampled within forest preserve lands tended to score better than non-buffered sites. These results suggest that habitat restoration (i.e., both steam and riparian) is likely to have both a direct benefit in terms of biological condition, and an indirect benefit by improving assimilative capacity.

Concentrations of total dissolved solids (TDS) greater than 1000 mg/l were noted in water quality samples collected from headwater sites, especially for the Arlington Heights Branch and the Salt Creek mainstem. Concentrations of TDS greater than 1000 mg/l are toxic to certain macroinvertebrates, most notably mayflies. While specific source identification was beyond the scope of this study, treated effluent from point sources was clearly ruled-out.

An evaluation of effluent water quality data generally spanning five to ten years, submitted by publicly owned treatment works (POTWs) in the study area, indicated that treatment efficiency at all plants was generally high and effluent quality typically within applicable NPDES permit limits. There were two instances, however, where biological communities may have exhibited added stress downstream from POTWs: one in the East Branch downstream from the Bolingbrook and Woodridge WWTPs, and one in Addison Creek downstream from the Bensenville South STP. In the case of the East Branch, macroinvertebrate index of biotic integrity (MIBI) scores decreased 20 points downstream from the Bolingbrook and Woodridge plants relative to the sites immediately upstream. The habitat quality in the reach also declined, relative to upstream, lacking riffles, and the site downstream from the Woodridge plant had silt-muck substrates. Given the ubiquity of low dissolved oxygen readings recorded by continuous monitors at five locations in the East Branch, it is not unreasonable to suspect that dissolved oxygen concentrations in this reach, given the poor habitat, may have contributed to the low scores. The Bolingbrook plant was noted for having ammonia-nitrogen exceedences on two occasions between 2006 and 2007, and ammonia-nitrogen exceedences were noted for the Woodridge facility on three occasions in 2007. However, the timing (during winter), rarity, and magnitude (less than chronic thresholds) of these events, as recorded, are not likely to have caused such a precipitous decline in biological condition. Follow-up monitoring that includes both spot sampling and hourly profiles of dissolved oxygen during the summer low-flow period, more intensive water quality sampling for ammonia-nitrogen, and a visual inspection for fugitive sources is recommended for this reach. It should also be noted that given the number of plants evaluated in this study, observing occasional exceedences stemming from normal operation and maintenance is not unexpected.

In Addison Creek, high concentrations of ammonia-nitrogen were recorded in water quality samples collected downstream from the Bensenville plant. The Bensenville plant discharges to a zero flow stream, such that the plant discharge flow can circulate upstream from the plant. The watershed upstream from the plant is heavily urbanized, and has legacy sources including a scrap yard and industrial sites. As was the case for the East Branch, the rarity of exceedences clearly suggests that operational negligence is not, in any way, responsible for the exceedences.

Collectively, habitat degradation, stormwater pollution, high ambient oxygen demand and low dissolved oxygen concentrations, combined sewer overflows (CSOs), and a few instances of episodically high ammonia concentrations resulted in almost all of the study area sites being classified as impaired (i.e., non-attainment of minimum Clean Water Act goals) based on the current Illinois EPA assessment criteria. Exceptions to this pattern were a few sites located on the lower East Branch and West Branch mainstems.

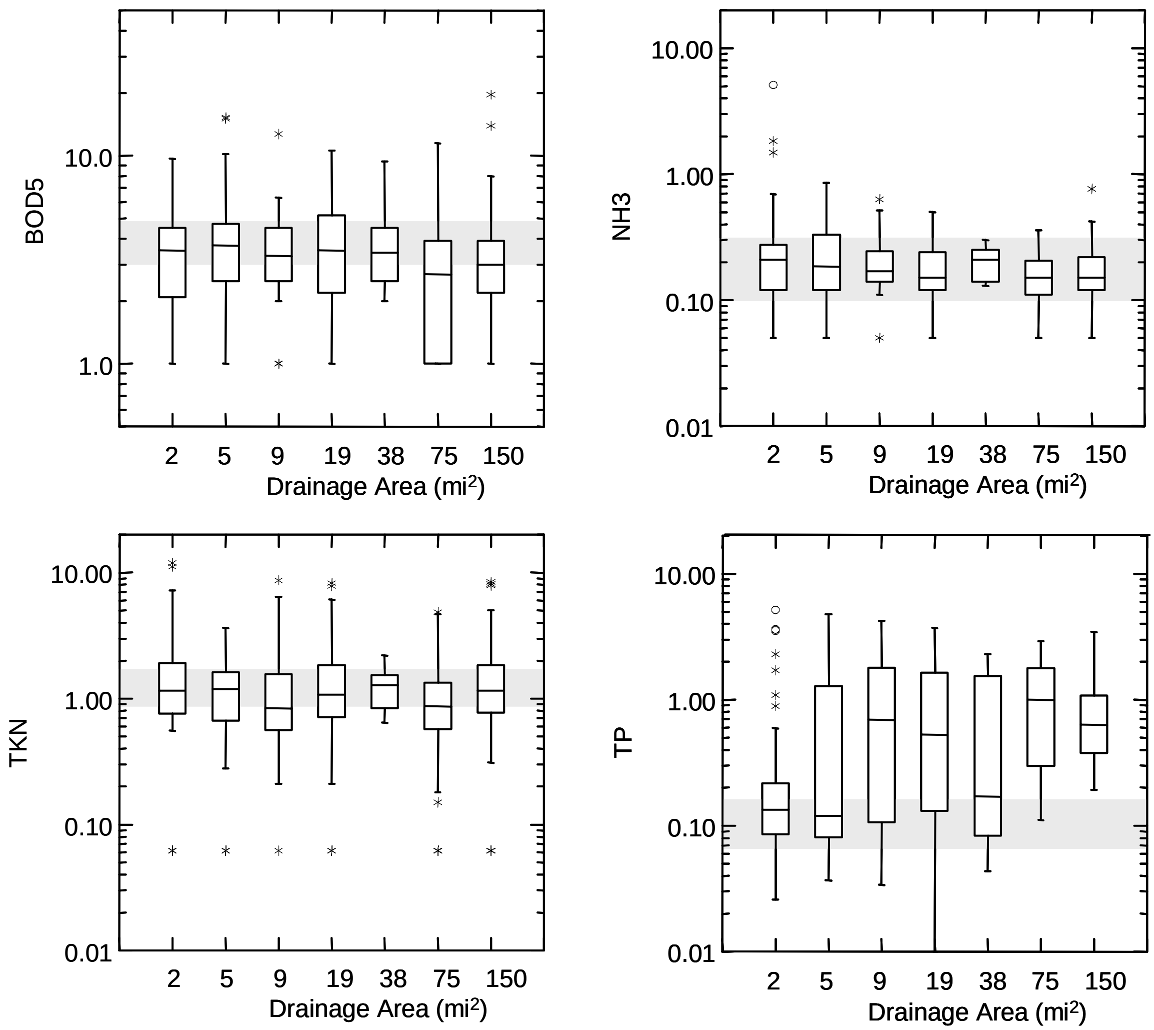


Figure 3. Concentrations of selected water quality parameters, in mg/l, measured during the Salt Creek - DuPage River watershed survey stratified by geometric stream size category. Boxes enclose the lower and upper quartiles (25th and 75th percentiles), whiskers encompass the range of the data, and outliers, shown as asterisks, are more than twice the interquartile range. The shaded area in each plot shows the upper range of concentrations typical of unpolluted waters (U.S. EPA 2004, Ohio EPA 1999, Wetzel 1981).

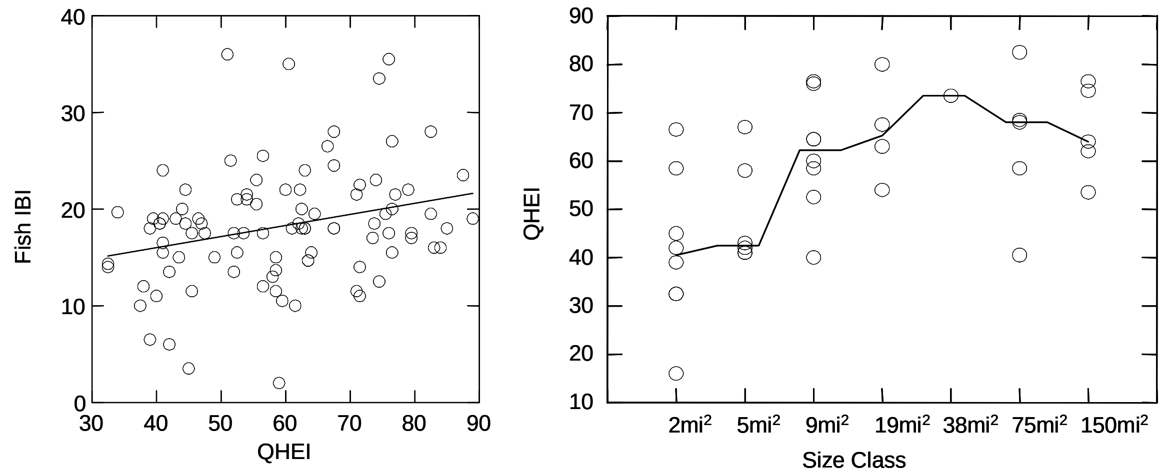


Figure 4. Left Panel - Fish Index of Biotic Integrity (IBI) scores for the Salt Creek - DuPage River study area plotted against Qualitative Habitat Evaluation Index (QHEI) scores. The trend line is from an ordinary least squares regression. Right Panel - QHEI scores for the –DuPage River-Salt Creek study area plotted by geometric stream size category. The trend line is drawn through the median value for each size category.

Relationship to Existing TMDLs

The 2006-2007 biological and water quality survey of the DuPage River-Salt Creek River watershed documented how the biological communities throughout the study area are limited by multiple stressors (Table 1). The two predominant stressors are stormwater and habitat degradation. Stormwater is used here as a catchall for the suite of water quality problems associated with urbanization, i.e., the build-up and runoff of heavy metals and polycyclic aromatic hydrocarbons from roads and other surfaces, sediment, pesticides, nutrients, leaking sewers, and hydrologic instability (high peak flows and low residual base flow). The latter directly affects habitat quality by scouring and entrenching the stream channel, and indirectly because countermeasures such as revetments, dams, and channelization are used to stabilize the stream channel. All of these countermeasures are, in their own right, deleterious to aquatic life. The net result, in the extreme, is a flush of toxic stormwater flowing through degraded stream channels that have a limited capacity to support aquatic life, assimilate pollutants, and attenuate high flows.

Causes of impairment to water bodies in the DuPage River-Salt Creek River study area appearing on the 2008 303(d) list of impaired waters for Illinois essentially lists the pollutants frequently associated with stormwater, i.e., heavy metals, priority organics, suspended sediment, dissolved solids, and nutrients (Table 1). However, the list gives no mention, by design, to habitat alteration as it lacks a numeric water quality standard, or other stressors that are not pollutants (e.g., low dissolved oxygen) because TMDLs in Illinois are restricted to addressing pollutants for which a water quality standard exists (i.e., low dissolved oxygen is not a pollutant, it results from pollution). Consequently, TMDLs developed for Salt Creek, the East Branch, and the West Branch have indirectly and partially addressed stormwater pollution by using either chloride or total dissolved solids (TDS) as proxies. Similarly, $cBOD_5$ has been used as a proxy for low dissolved oxygen in

TMDLs developed for Salt Creek and the East Branch. Also, habitat has been tangentially addressed in the Salt Creek and East Branch TMDLs by broaching the subject of dam removal as a means to help assimilate cBOD5 loads. Although connections to the predominant stressors identified by this study are apparent in the existing TMDLs, they are indirect and incomplete.

For example, implementation of a TDS or chloride TMDL developed to address stormwater pollution should simultaneously address co-occurring stressors, and require that remedial measures to reduce loads be distributed on a watershed basis, the pollutant-specific focus clearly side steps habitat quality, ignores impaired sites if the impairment cannot be attributed to a specific pollutant, even in cases where the cause is known (e.g., low dissolved oxygen), and may lead to spurious listings in cases where a chemical exceedence triggers a listing without corroborating biological information. Many of the pollutants listed on the 2008 303(d) list were not detected in concentrations exceeding water quality criteria in the 2006-2007 biosurvey. In this case, absence of evidence does not necessarily provide evidence of absence. Rather, it illustrates the point that reliance on pollutants and chemical criteria can be misleading. Iron concentrations exceeding 1.0 mg/l are routine in unpolluted waters, have shown little or no association with biological condition, yet constitute a water quality standard exceedence (Ohio EPA 1998). Having information from an integrated biosurvey helps to rank stressors and eliminate potentially spurious chemical exceedences. For example, copper exceedences were noted for two sites in the West Branch subbasin, yet these were not considered significant in light of the magnitude of other stressors. For many of the impaired water bodies identified during this survey, neither specific chemical pollutants nor local habitat quality could be ascribed as the cause of impairment. The impairment in these cases clearly falls under the rubric of stormwater, but also relates to watershed-scale habitat degradation.

The identification of 33 previously unassessed waters as being impaired (Table 1) highlights the importance of study design, and represents another issue of contrast between the findings of this study and the current TMDL listings. The watershed-scale, geometrically-stratified spatial monitoring design employed by this study was greater in scope than that upon which the current TMDL list was based. The most common impairment causes identified by our study for these stream segments were TDS and habitat alterations, although other pollutant causes (BOD, PAHs, ammonia) were apparent in selected streams. The simple interpretation is that more monitoring produces a longer list of impaired waters. While this certainly holds for these watersheds, the contribution of the spatial context to understanding the most limiting issues in these watersheds has, up until this study, been overlooked. This additional information provides important data and context for addressing what are essentially watershed level issues and impairments. It also contributes to addressing the important issues of restorability and attainability, the latter becoming important as Illinois considers the development and application of tiered aquatic life uses (TALU). This type of information will be useful in developing more detailed stress:response relationships in future analyses.

Table 1. Total Maximum Daily Load studies completed or under consideration for development for waterbodies in the DuPage River-Salt Creek study area compared to leading causes of impairment identified in this study. Note that multiple stressors falling under the rubric of stormwater are a major cause of impairment to all waterbodies in the watershed.

RIVER/STREAM	Causes Identified in Present Study (appear in order of proximate magnitude). Italicized causes are considered "nonpollutants," bold causes have TMDLs developed or planned.	Causes Appearing on 2008 303(d) List. Causes in bold have TMDLs developed or planned.
Arlington Heights Branch Salt Creek	TDS, *Habitat Alterations*, PAHs	Not Assessed
Baldwin Creek	TDS	Not Assessed
Salt Creek	***D.O.***, **TDS**, *Habitat Alterations*, Organic Enrichment, PAHs	Aldrin, DDT, **fecal coliform**, heptachlorobenzene, mercury, PCBs, **pH**, phosphorus (total), **sedimentation & siltation, TSS**
Trib to Salt Creek (95-851)	TDS	Not Assessed
Trib to Salt Creek (95-852)	TDS	Not Assessed
Trib to Salt Creek (95-853)	TDS	Not Assessed
Trib to Salt Creek (95-855)	*Habitat Alterations*, TDS	Not Assessed
Trib to Salt Creek (95-856)		Not Assessed
Yeargin Creek	*Habitat Alterations*	Not Assessed
Ginger Creek	*Habitat Alterations*	Not Assessed
Sugar Creek		Not Assessed
Addison Creek	*Habitat Alterations*, Ammonia	Aldrin, alpha-BHC, chromium (total), copper, DDT, hexachlorobenzene, **fecal coliform**, phosphorus (total), PCBs
Trib to Addison Creek	*Habitat Alterations*	Not Assessed
Spring Brook	*Habitat Alterations*	DDT, endrin, hexachlorobenzene, phosphorus (total), **sedimentation/ siltation**
Meacham Creek	*Habitat Alterations*	Not Assessed
Oakbrook Creek	TDS	Not Assessed
Trib to Meacham Creek	*Habitat Alterations*	Not Assessed
Westwood Creek		Not Assessed
W. Br. DuPage River	***D.O.***, *Habitat Alterations*, PAHs	DDT, **fecal coliform**, hexachlorobenzene, **iron, manganese, pH,** phosphorus (total), sedimentation/ siltation, **silver**, TSS, **zinc**
Trib to W. Br. DuPage River (95 902)	*Habitat Alterations*, PAHs	Not Assessed
Trib to W. Br. DuPage River (95 904)	*Habitat Alterations*	Not Assessed
Trib to W. Br. DuPage River (95 905)	*Habitat Alterations*	Not Assessed
Trib to W. Br. DuPage River (95 906)	*Habitat Alterations*	Not Assessed
Kress Creek	*Habitat Alterations*	Not Assessed

Table 1. continued.

RIVER/STREAM	**Causes Identified in Present Study (appear in order of proximate magnitude). Italicized causes are considered "nonpollutants," bold causes have TMDLs developed or planned.**	**Causes Appearing on 2008 303(d) List. Causes in bold have TMDLs developed or planned.**
W. Br. Ferry Creek	*Habitat Alterations*	Not Assessed
W. Br. Cress Creek		Not Assessed
Bremme Creek	*Habitat Alterations*	Not Assessed
Spring Brook	*Habitat Alterations*, PAHs	Chloride, **copper**, **fecal coliform**, phosphorus (total)
Army Trail Creek	TDS, *Habitat Alterations*	Not Assessed
Armitage Ditch (trib to E. Branch DuPage)	*Habitat Alterations*	Not Assessed
Glencrest Creek		Not Assessed
Lacey Creek	TDS, BOD, *Habitat Alterations*	Not Assessed
Willoway Brook		Not Assessed
22nd St. trib to E. Branch DuPage River		Not Assessed
Rott Creek		Not Assessed
Winfield Creek	*Habitat Alterations*, TDS	Not Assessed
Klein Creek	BOD, *Habitat Alterations*	Not Assessed
East Banch DuPage River	***D.O.***, *Habitat Alterations*, BOD, PAHs	DDT, **fecal coliform**, hexachlorobenzene, mercury, PCBs, **pH**, phosphorus (total), sedimentation & siltation, TSS
St. Joseph Creek	*Habitat Alterations*	Oil and grease, TSS

Study Area Setting

The Salt Creek watershed includes 152 square miles of highly urbanized land in western Cook and eastern DuPage Counties, including Addison Creek and Spring Brook, the two major tributaries (Figure 5). The main stem of Salt Creek is approximately 42 linear miles and has a rise of 225 feet. Salt Creek flows into the Des Plaines River in Lyons, which is tributary to the Illinois River and ultimately tributary to the Mississippi River. There are 40 municipalities located within the watershed and 11 publicly owned treatment plants discharge effluent to Salt Creek. Additionally, 6 combined sewer overflow outfalls are present. Land uses in the Salt Creek watershed are shown in Table 2.

The East Branch DuPage River watershed includes 81 square miles of central DuPage and northern Will Counties (Figure 6). The major tributaries are St. Josephs and Prentiss Creeks. The main stem of the East Branch is approximately 26 linear miles. The East Branch joins the West Branch of the DuPage River on the Bolingbrook municipal line to form the main stem of the DuPage River. The DuPage River is a tributary to the Des Plains River. Sixteen municipalities are located within the watershed. A total of 11 publicly owned treatment plants discharge to the East Branch as does one combined sewer overflow. The land uses found in the East Branch watershed are mostly residential and urban (Table 2).

The West Branch DuPage River watershed includes 128 square miles of DuPage, Cook and northern Will Counties (Figure 7). The main stem of the West Branch measures 34 linear miles in length. There are 21 municipalities in the watershed and 7 publicly owned treatment plants discharge to the West Branch. There are no combined sewer overflows in the watershed. Like the East Branch and Salt Creek catchments, land uses in the West Branch are dominated by residential and urban uses (Table 2).

Table 2. Land uses types by area and percent for Salt Creek, and the East and West Branches of the DuPage River. Percentages based on total watershed area. Land use data is based on Chicago Metropolitan s Agency for Planning 2005 land use data.

Land Use Category	Salt Creek		East Branch		West Branch	
	area (acres)	area (percent)	area (acres)	area (percent)	area (acres)	area (percent)
Residential	48,657.50	49.9	27,899.10	53.6	36,082.40	44.2
Commercial and Services	10,824.80	11.1	4,732.00	9.1	6,199.90	7.6
Institutional	5,432.60	5.6	2,349.70	4.5	5,692.00	7.0
Industrial, Warehousing and Wholesale Trade	6,142.70	6.3	1,688.50	3.2	4,523.50	5.5
Transportation, Communication and Utilities	4,884.10	5.0	1,945.30	3.7	2,715.90	3.3
Sub Total non-Residential Urban	27,284.2	28.0	10715.5	20.5	19131.3	23.4
Agricultural Land	311.70	0.3	339.40	0.7	5,966.30	7.3
Open Space	16,426.20	16.8	10,370.40	19.9	13,661.90	16.7
Forest, Grassland and Wetlands greater than 2.5 acres	3,220.90	3.3	1,940.20	3.7	5,325.80	6.5
Water	1,670.00	1.7	761.00	1.5	1,524.40	1.9
Totals	97,570.50	100.0	52,025.60	100.0	81,692.10	100.0

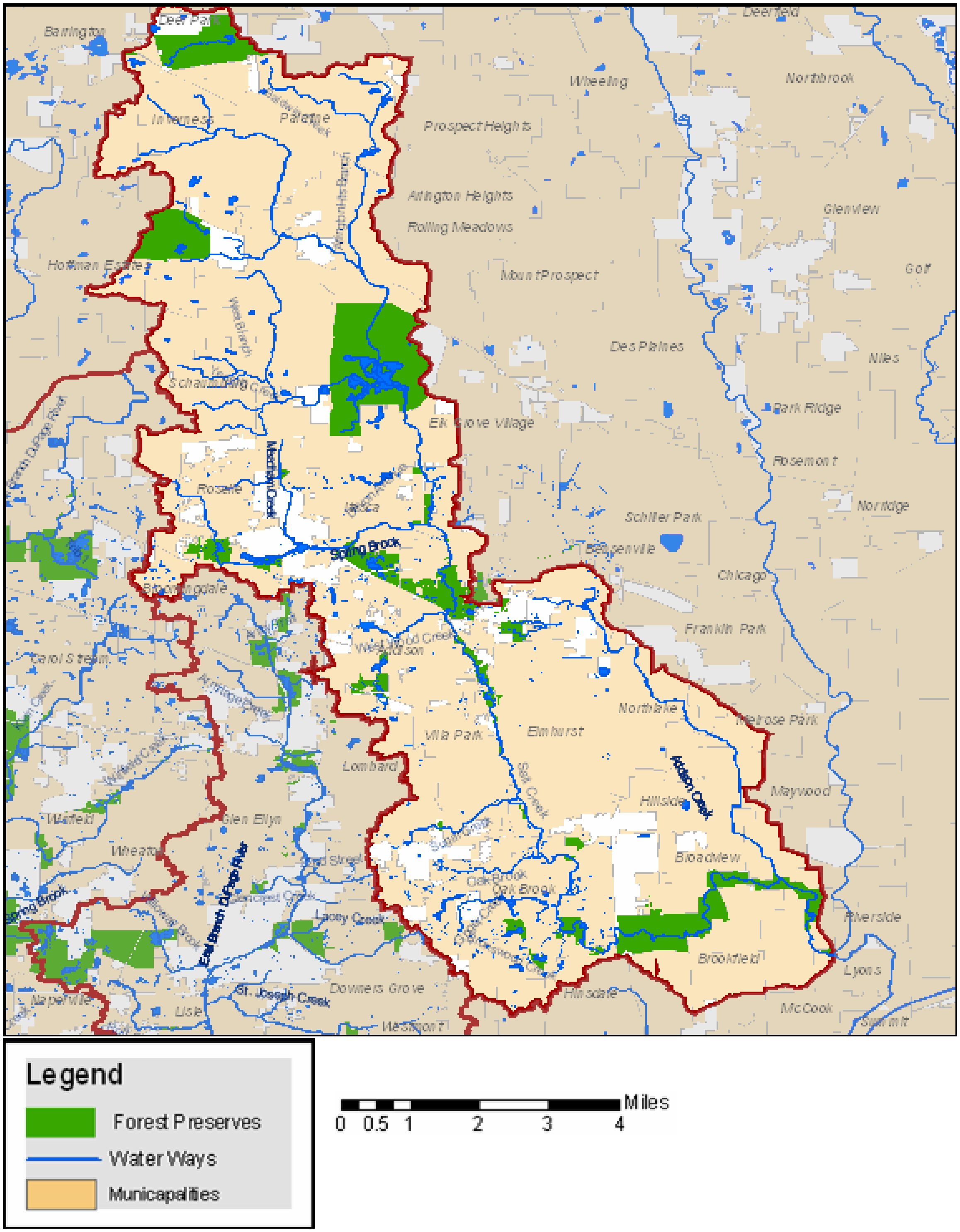


Figure 5. Municipal boundaries and forest preserves in the Salt Creek watershed.

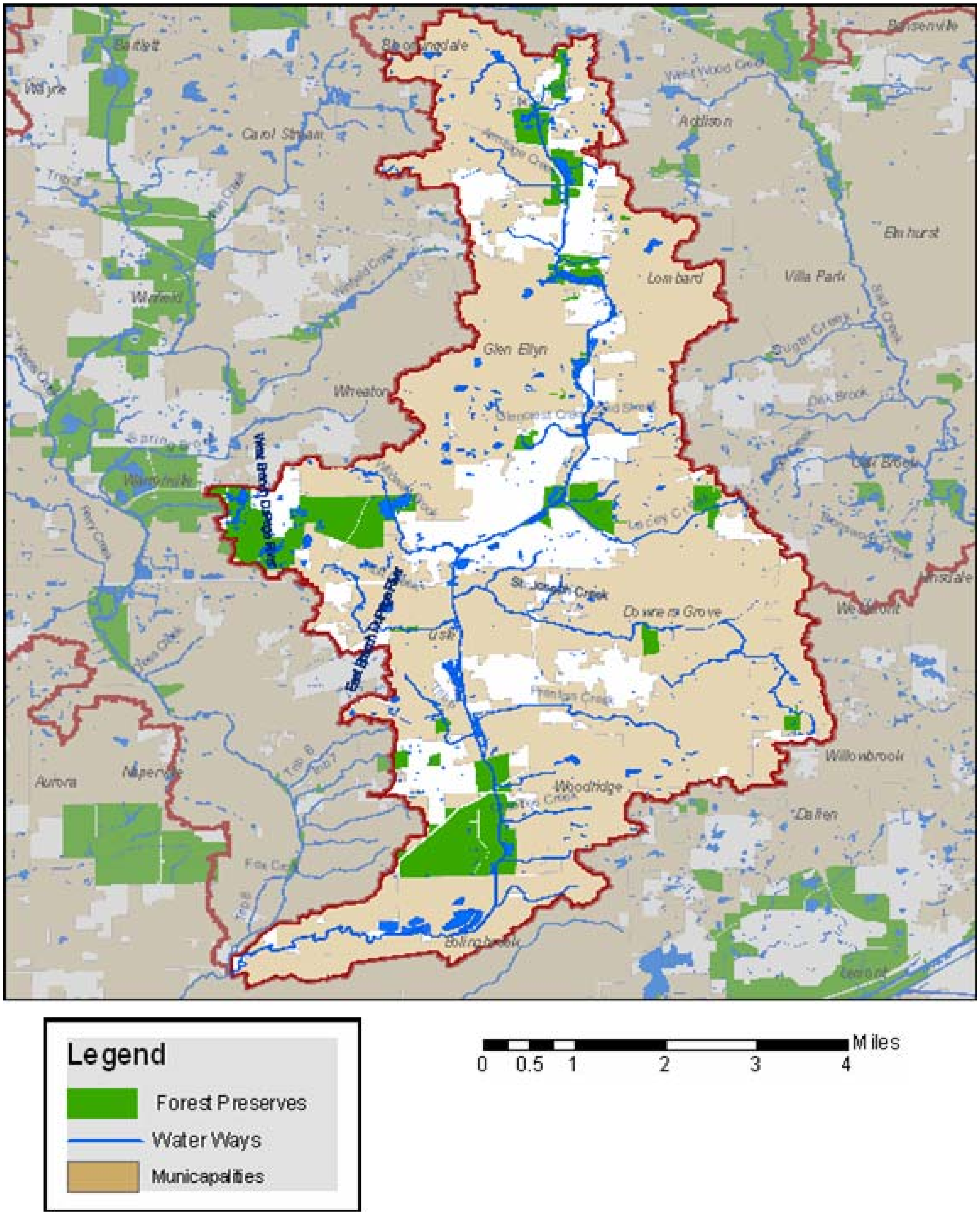


Figure 6. Municipal boundaries and forest preserves in the East Branch DuPage watershed.

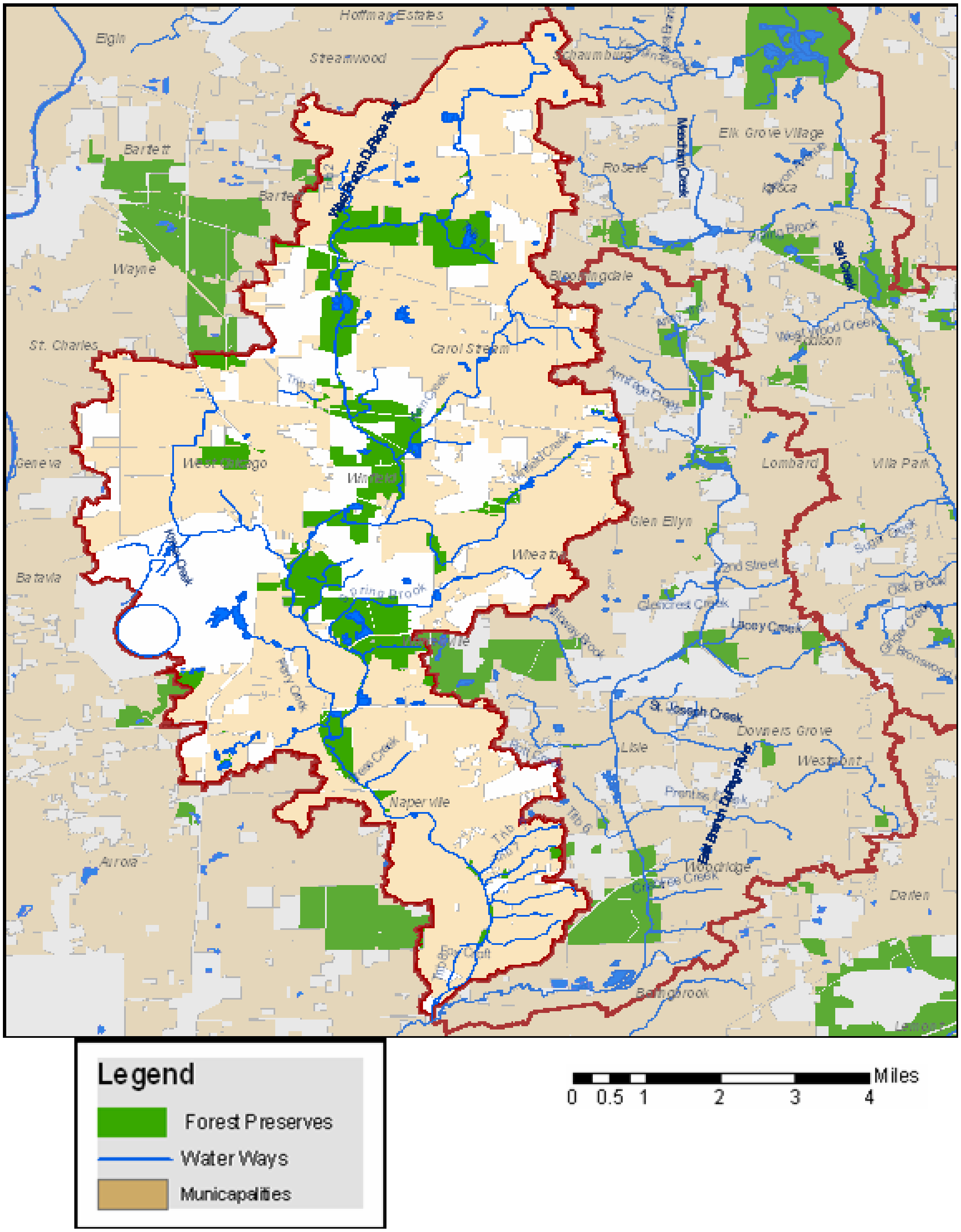


Figure 7. Municipal boundaries and forest preserves in the West Branch DuPage watershed.

Summary of Dams in the DuPage River-Salt Creek River Study Area

<u>Salt Creek</u> (dams are ordered north to south)

Busse Woods Reservoir South Dam: The Busse Woods Reservoir South Dam is located on Salt Creek within the Busse Woods Forest Preserve. The dam is owned and maintained by the Illinois Department of Natural Resources Office of Water Resources and is located within Elk Grove Village. Access is best granted off of Arlington Heights Road to picnic groves 26 and 27 or 32.

The dam was built for flood control and recreational purposes in 1977. The dam is of earthen construction and has a height of 23 feet and is 1381 feet long. The reservoir has a surface area of 415 acres.

Section of the Busse Woods Impoundment, looking upstream from spillway

Itasca Country Club Dam: Situated on Spring Brook 50 feet upstream of Prospect Avenue. Dam privately owned and maintained. No other information gathered at this time.

Lake Kadijah Dam: Medinah Country Club, ½ mile upstream of Rohlwing Road/Route 53. Managed by DuPage County Division of Stormwater Management, no other information gathered at this time.

Oak Meadows Golf Course Dam: The Oak Meadows Golf Course dam is located on Salt Creek within the Oak Meadows Golf Course. The golf course is maintained by the Forest Preserve District of DuPage County and is located east of Addison Road and north of I-290. The date of construction is unknown. The dam is on hole 14.

The dam was built by Elmhurst Country Club to provide a source of irrigation water for the golf course. The spillway is approximately 3 feet high and is 75 feet wide. The impoundment is approximately 4, 500 linear feet in length and covers approximately six acres.

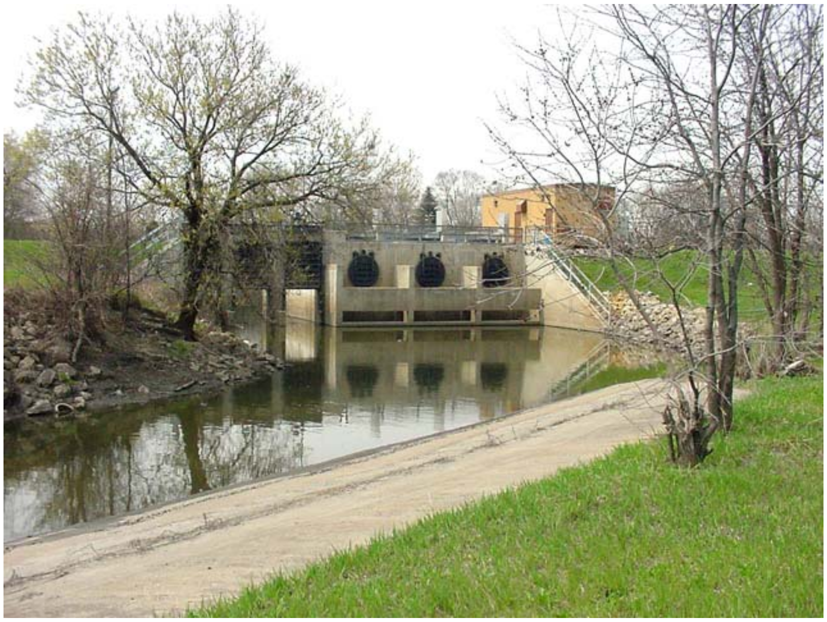
Table 3. Known dams or bed control structures in program watersheds. Sites listed as having impoundments size N/A (not applicable) are stormwater control structures and do not contain significant impoundments under non-storm conditions. Those listed as Un (unknown) means that it has not be ascertained if they impound waters to any significant degree and will require further investigation. Letters next to dam names correspond to those in Figures 11, 61, and 103 for the respective watersheds.

Dam Name	Watershed	Affected waterway	River Miles	Impoundment Size (acres)	Impedes Fish Passage
a) Busse Woods Reservoir South Dam	Salt Creek	Salt Creek	29.3	415	
b) Itasca Country Club dam	Salt Creek	Spring Brook	0.3	1	
c) Lake Kadijah	Salt Creek	Spring Brook	3.0	39	
d) Oak Meadows Golf Course Dam	Salt Creek	Salt Creek	22.8	6	Y
e) Westwood Creek Dam	Salt Creek	Westwood Creek	0.3	Un	
k) Redmond Reservoir Dam (George Street Dam)	Salt Creek	Addison Creek	10.0	13	
j) Mt Emblem Cemetery	Salt Creek	Addison Creek	8.7	3	
f) Graham Center Dam	Salt Creek	Salt Creek	16.5	Un	
g) Old Oak Brook dam	Salt Creek	Salt Creek	12.5	Un	??
h) Fullersburg Woods Dam picture	Salt Creek	Salt Creek	10.7	16	Y
i) Possom Hollow Woods	Salt Creek	Salt Creek	6.0	Un	
a) West Lake Dam	East Branch	East Branch	23.8	13	
d) Churchill Woods dam	East Branch	East Branch	18.7	31	Y
e) Maryknoll Gabion Weir Dam	East Branch	East Branch	16.8	None	N
f) Seven Bridges Dam	East Branch	East Branch	9.4	Un	
g) Prentiss Creek dam	East Branch	Prentiss Creek/East Branch	8.6/0.1	N/A	N
a)Warrenville Grove dam	West Branch	West Branch	38.89	17	Y
b) MacDowell Grove dam	West Branch	West Branch	36.55	8	Y
c) Fawell dam	West Branch	West Branch	8.0	N/A	Y

Oak Meadows Dam in Addison

Westwood Creek Dam (Salt Creek Trib. WWTP dam): The Westwood Creek dam is located on Westwood Creek, a tributary to Salt Creek in Addison. The dam is approximately 500 feet east of Addison Road and 200 feet southwest of I-290 and is maintained by the Village of Addison. Access to the dam is best gained from a driveway off of Addison Road, south of I-290.

The dam was put on line in 1994 as part of an effort by the DuPage County Stormwater Management Division to reduce flooding in the area. Residential areas to the west along Westwood Creek are protected during flood events by closing the gates of the dam and pumping Westwood Creek to Louis' Reservoir, a two stage 210 foot retention and detention area at the southwest corner of Lake Street and Villa Avenue.



Westwood Creek Dam in Addison

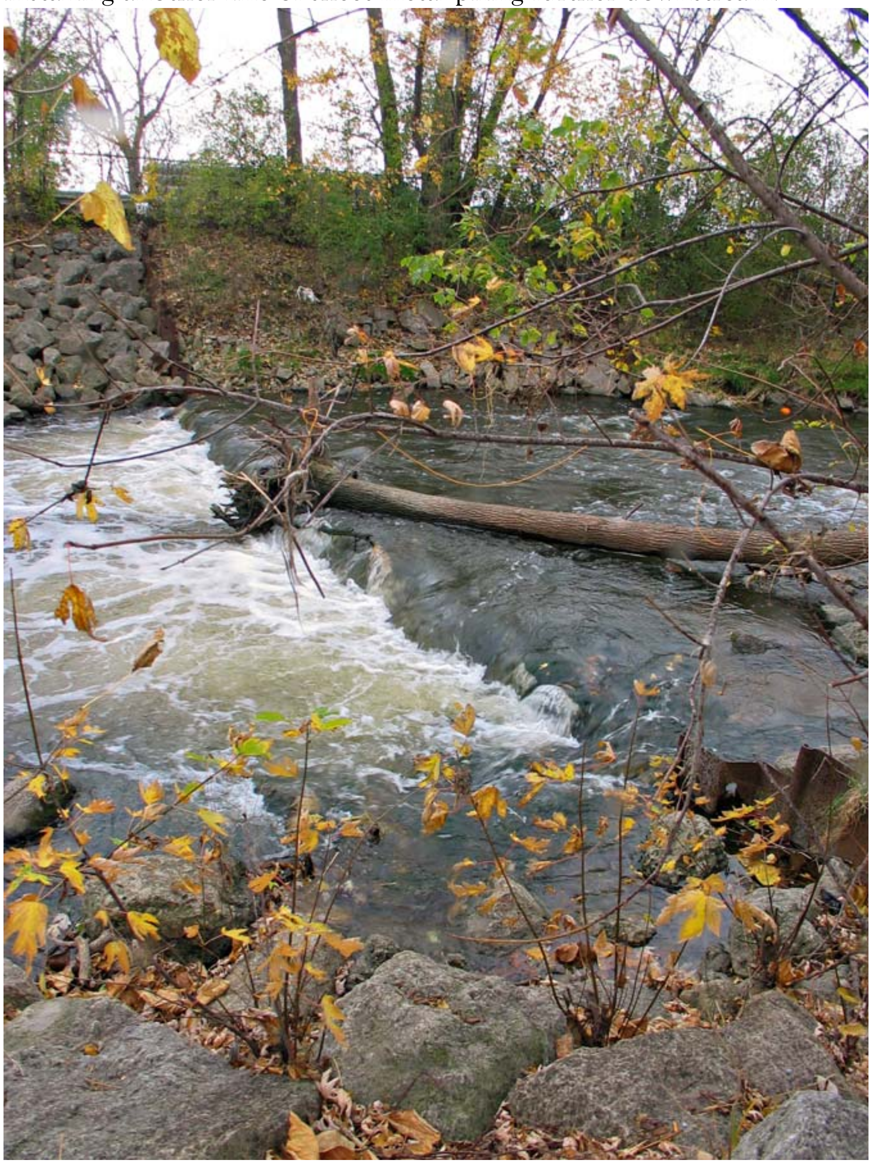
Redmond Reservoir Dam (George Street Reservoir): Addison Creek in Bensenville. Operated by the Village of Bensenville. Constructed in 1999. Headwaters originate in Wood Dale and Bensenville. http://dnr.state.il.us/OWR/Williamredmond.htm

Redmond Reservoir Dam in Bensenville

Mt Emblem Cemetery Pond: in Bensenville. Southwest corner of Grand Avenue and County Line Road

Graham Center Dam (Elmhurst Co. Forest Preserve Dam) The dam is located on Salt Creek near Elmhurst. The dam is ¼ mile east of Route 83 and ¼ mile south of Monroe Street. Access is best granted from Monroe Street on the west side of Salt Creek.

The dam was constructed in the early 1990's as a result of dredging on Salt Creek from Oak Brook north to this point. The structure was installed to allow for a step down between the dredged and undredged portions of the river and to prevent sedimentation of the dredged portions. The structure was not intended to be a dam, but in low flow conditions acts as one. The dam originally consisted of a single line of sheet metal piling. However, the creek began to erode the banks at the point of contact with the sheet metal piling. This was repaired by cutting a notch in the original sheet metal piling and installing another line of sheet metal piling further downstream.



Graham Center Dam in Elmhurst

Old Oak Brook Dam: The Old Oak Brook dam is located on Salt Creek, downstream of 31st Street in Oak Brook. The dam is maintained by the Village of Oak Brook and is approximately 85 years old. Access to the dam is best gained from Natoma Drive with permission of landowner (on private land).

The dam was originally built by Paul Butler in the 1920's to maintain an aesthetic pool on his property during low flow periods. The original structure of the Oak Brook Dam has undergone major rehabilitation over the last 20 years. There are two main spillway components: the fixed elevation spillway and a gated "emergency" spillway. The gated spillway section consists of two steel vertical slide gates. The dam was rehabilitated in 1992. The primary spillway is sixty-five feet wide, with about three feet of head at normal flow conditions, and consists of grouted stone with a concrete cap. The left and right training walls consist of grouted stone and reinforced concrete, overlain to a larger extent by concrete filled fabriform mats.

Old Oak Brook Dam

Fullersburg Woods Dam: The Fullersburg Woods Dam is located on Salt Creek associated with Graue Mill and within the Fullersburg Woods Forest Preserve. The dam is 300 feet upstream of York Road near the Village of Oak Brook. The dam is owned by the Forest Preserve District of DuPage County (FPDDC) and is 74 years old. Access to the dam is best granted from a trail and parking lot off of Spring Road.

The adjacent historic mill was originally constructed in 1852. The mill and dam were rebuilt by the Civilian Conservation Corps in the 1934. The dam is 123 feet across and 6.3 feet high. The impoundment created by the dam covers 16 acres and 3,900 linear feet.

Fullersburg Woods Dam, Village of Oak Brook

Possom Hollow Woods: in Westchester 0.5 miles east of Wolf Road, ¼ mile north of 31st Street FPDCC. No additional data collected at this time.

__East Branch__

West Lake Dam: Bloomingdale, West Lake Park, ½ mile north of Army Trail Road, 500 feet west of Glen Ellyn Road

Churchill Woods Dam: The Churchill Woods Dam is located on the East Branch of the DuPage River within the Churchill Woods Forest Preserve in Lombard. The dam is immediately upstream of Crescent Boulevard. The low head dam is owned by the Forest Preserve District of DuPage County (FPDDC) and is approximately 70 years old. Access to the dam is best granted from the Forest Preserve Parking Lot on Crescent Boulevard.

The dam was originally built in the 1930's as part of the Works Progress Administration. It was rebuilt with the reconstruction of Crescent Boulevard in 1983. The dam is a concrete gravity dam with a dewatering gate on the right side. The dam is 50 feet across and has a total height of 3.5 feet.

The impoundment created by the dam is approximately 31 acres in size.

Maryknoll Gabion Weir Dam: The Maryknoll gabion weir dam is located on the East Branch of the DuPage River, adjacent to the Maryknoll residential subdivision in Glen Ellyn. The dam is located east of Maryknoll Circle, approximately ¼ mile south of Route 38, and 200 feet west of I-355. Access to the dam is best granted from Maryknoll Circle.

The dam was constructed in the early 1980's as part of Maryknoll Development in order to provide stormwater detention for the development. Flow at normal water level is not impeded. The dam consists of gabions with no concrete caps. The impoundment does not extend further upstream than Route 38.

Seven Bridges Dam: Located in the Village of Woodridge

Prentiss Creek Dam: The Prentiss Creek Dam is located on the East Branch of the DuPage River within the Seven Bridges Golf Club in Woodridge. The dam actually consists of two structures, one on the East Branch and one at the mouth of Prentiss Creek, both located immediately upstream of Hobson Road. The structures are owned by the Village of Woodridge and are 19 years old. Access to the dams is best granted from the golf course, although it is possible to access the dam from Double Eagle Drive using the sidewalk.

The dam was constructed in 1989 to provide on line stormwater detention for the adjacent development. The dams are gravity structures consisting of rock filled gabions that impound water at a greater rate as the flow rate increases. The East Branch structure is 20 feet wide while the Prentiss Creek structure is 10 feet wide.

The dam creates a minor impoundment only on Prentiss Creek depending on flow conditions (storm control structure).

West Branch

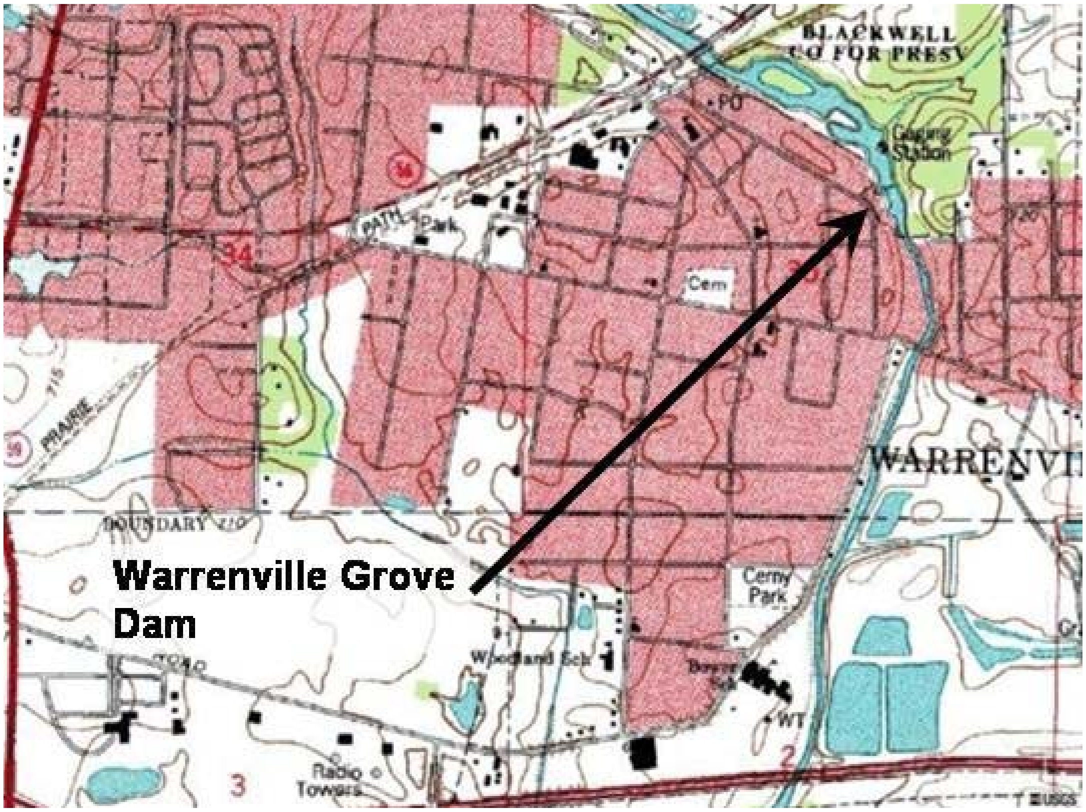
Warrenville Grove Dam: The Warrenville Grove Dam is located on the West Branch of the DuPage River within the Warrenville Grove Forest Preserve in the Village of Warrenville. The dam is one third of a mile upstream of Warrenville Road. The low head dam is owned by the Forest Preserve District of DuPage County (FPDDC) and is approximately 70 years old. Access to the dam is best grained via the Forest Preserve Parking Lot on Batavia Avenue.

The dam was constructed of limestone in a stair step configuration with a concrete foundation and headwall on the upstream face of the spillway. The dam is 107 feet across with a curving spillway face that has a total crest length of about 125 feet. The dam has a total height of 8.5 feet above the downstream river channel bottom and a total hydraulic height of 5.7 feet (from spillway crest to tailwater elevation under average flow conditions).

The dam also features a mill race that was partially retrofitted in 1995 to function as a fish ladder and canoe chute. The impoundment created by the Warrenville Grove Dam is approximately 1.2 miles in length and covers about 16.9 acres.

The dam was constructed by the Civilian Conservation Corps between 1936 and 1938. The dam was designed by the National Park Service and was part of a dam building program in the region that was conveyed as a way to "reduce bank erosion". The site for the dam was chosen due to the presence of an older abandoned dam in the same location that provided a power source to mills between 1847 and 1897.

Aerial view of the Warrenville Dam looking upstream (2001). Dam highlighted by arrow.



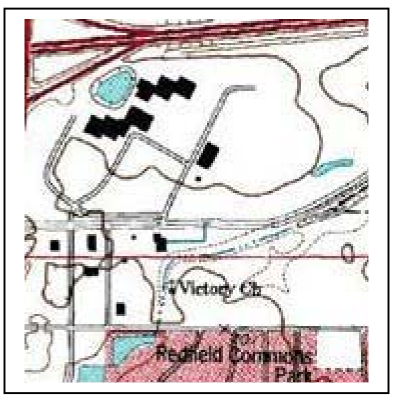
Map of Warrenville Grove Dam.

McDowell Grove Dam: The McDowell Grove Dam is located on the West Branch of the DuPage River within the McDowell Grove Forest Preserve in unincorporated DuPage County. The dam is one mile downstream of Interstate 88. The low head dam was built by the Civilian Conservation Corps and is approximately 70 years old. Access to the dam is best granted from the Forest Preserve Parking Lot located within McDowell Grove Forest Preserve.

The dam is constructed of limestone and is a run of the river structure. The stone spillway is likely cemented into place and supported by a reinforced concrete foundation and retaining wall on the upstream face. The dam has a concrete and stone fish ladder integrated into the spillway where it meets the left abutment. The dam is 96 feet across. The dam has a total height of 8.5 feet above the downstream river channel bottom and a total hydraulic height of 5.7 feet (from spillway crest to tailwater elevation under average flow conditions).

The impoundment created by the dam is approximately 2900 feet long and covers an area of 8 acres. Dam removed mid 2008 although impoundment remains due the to the installation of a temporary dam.


Aerial view of McDowell Grove Dam, looking upstream (2001). Dam highlighted by arrow.



Map of McDowell Grove Dam.

Fawell Dam One mile below McDowell Grove dam in McDowell Woods Forest Preserve. Large earthen berm with a floodgate. Stormwater control facility run by DuPage County Division of Stormwater management .

Methods

The collection of ambient biological, chemical, and physical data in the DuPage River-Salt Creek study area was conducted under a quality assurance project plan (QAPP; MBI 2006b) approved by Illinois EPA. Biological data was collected in accordance with methods adopted by the Illinois EPA and Illinois DNR whenever feasible. In cases where these methods were not applicable alternate methods used by MBI elsewhere in the Midwest were employed. Habitat was assessed using the Qualitative Habitat Evaluation Index (QHEI) by the fish sampling crew. Chemical/physical sampling was conducted by collecting multiple grab samples from the same sites and recording field measurements with water quality meters. Dissolved oxygen was recorded continuously over multiday periods using continuous recording devices.

Biological Methods: Macroinvertebrate Assemblage

The macroinvertebrate assemblage was sampled using the Illinois EPA multihabitat method at all level 1-5 sites. The MAIS (Macroinvertebrate Aggregated Index for Streams) method adapted for application to Illinois streams was used where the multihabitat method was either not applicable or feasible, mostly at the level 6 and 7 sites. Artificial substrates were used at a few non-wadeable sites in the lower mainstems using modified Hester-Dendy (H-D) artificial substrate samplers (Ohio EPA 1989).

The Illinois EPA multi-habitat method involves the selection of a sampling reach that has instream and riparian habitat conditions typical of the assessment reach, has flow conditions that approximate typical summer base flow, has no highly influential tributary streams, contains one riffle/pool sequence or analog (i.e., run/bend meander or alternate point-bar sequence), if present, and is at least 300 feet in length. This method is applicable if conditions allow the sampler to collect macroinvertebrates (i.e., to take samples with a dip net) in all bottom-zone and bank-zone habitat types that occur in a sampling reach. The habitat types are defined explicitly in Appendix E of the project QAPP (MBI 2006b). Conditions must also allow the sampler to apply the 11-transect habitat-sampling method, as described Appendix E of the Quality Assurance Project Plan (http://www.drscw.org/reports/DuPage.QAPP_AppendixE.07.03.2006.pdf) or to estimate with reasonable accuracy--via visual or tactile cues the amount of each of several bottom-zone and bank-zone habitat types. If conditions (e.g., inaccessibility, water turbidity, or excessive water depths) prohibit the sampler from estimating with reasonable accuracy the composition of the bottom zone or bank zone throughout the entire sampling reach, then the multi-habitat method is not applicable. In most cases, if more than one-half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of the bottom-zone and bank-zone habitat types are attainable; thus, the multi-habitat method is not applicable. The resulting samples were preserved in 10% formalin.

The MAIS method was used in lieu of the IEPA Multi-habitat Method where small channel size precluded its use primarily at the level 6 and 7 sites. MAIS samples are collected with a 1 m^2 fiber glass screened 500 micron kick net by sampling available riffle and run habitats at each site. The macroinvertebrates and debris are washed into a storage container after each consecutive kick and composited into a single sample. The sample is strained through a number 30 (600 micron mesh) standard sieve; large debris is washed and scrubbed into the container and then discarded. The entire sample including debris was placed into jars and preserved with 10% formalin.

Artificial substrate samples were collected using modified Hester-Dendy (H-D) samplers (Ohio EPA 1989). An H-D consists of a series of 8 hardboard plates (1/8" thickness) and 12 spacers. The plates and spacers are center drilled and mounted to a 4-in.-long eye bolt and secured by a nut and washer. A "set" consists of five H-D samplers attached to a single concrete block. Samplers are placed in the stream for colonization during June 15 to September 30 (the latest date for retrieval under normal circumstances). Ohio EPA (1989) describes details of placement of the samplers to ensure adequate stream flow over the plates, but in general samplers should be set where flow is 0.3 ft/sec over the plates. The H-D set is retrieved and preserved in 10 percent formalin as individual units and later combined to form a composite sample. A qualitative sample from the natural substrate is also collected at the time of substrate retrieval using a triangular frame 30-mesh dip net. All available habitats are sampled at a given site for a minimum time of 30 minutes and thereafter until no new taxa are observed. This generally includes 20+ jabs taken from all available habitats in the sampling area including snags, wood, submerged vegetation, vegetated banks, root wads, and riffles.

Laboratory procedures generally followed Illinois EPA methods. For the multi-habitat method this required the production of a 300 organism subsample with a scan and pre-pick of large and/or rare taxa from a gridded tray. For artificial substrates the laboratory processing includes the production of a sample by the disassembly and cleaning of the artificial substrates and subsampling procedures as followed by Illinois EPA. The MAIS and qualitative dip net/hand pick samples did not require initial laboratory reduction. Taxonomic resolution was performed at the lowest practicable resolution for the common macroinvertebrate assemblage groups such as mayflies, stoneflies, caddisflies, midges, and crustaceans. This goes beyond the genus level requirement of Illinois EPA; however, calculation of the macroinvertebrate IBI followed Illinois EPA methods in using genera as the lowest level of taxonomy for MIBI scoring.

Biological Methods: Fish Assemblage

Methods for the collection of fish at wadeable sites was performed using a tow-barge or long-line pulsed D.C. electrofishing equipment based on a T&J 1736 DCV electrofishing unit described by Ohio EPA (1989). A Wisconsin DNR battery powered backpack electrofishing unit was used as an alternative to the long line in the smallest streams and in accordance with the restrictions described by Ohio EPA (1989). A three person crew carried out the sampling protocol for each type of wading equipment. Sampling effort was indexed to lineal distance and ranged from 150-200 meters in length. Non-wadeable sites were sampled with a boat-mounted pulsed D.C. electrofishing device. A Smith-Root 5.0 GPP unit was mounted on a 12' john boat following the design of Ohio EPA (1989). Sampling effort for this method was 500 meters. A summary of the key aspects of each method appears the project QAPP (MBI 2006b). Sampling distance was measured with a GPS unit or laser range finder. Sampling locations were delineated using the GPS mechanism and indexed to latitude/longitude and UTM coordinates at the beginning, end, and mid-point of each site. The location of each sampling site was indexed by river mile (using river mile zero as the mouth of the river). Sampling was conducted during a June 15-October 15 seasonal index period.

Samples from each site were processed by enumerating and recording weights by species and in some cases by life stage (y-o-y, juvenile, adult). All captured fish were immediately placed in a live well, bucket, or live net for processing. Water was replaced and/or aerated regularly to maintain adequate dissolved oxygen levels in the water and to minimize mortality. Fish not retained for voucher or other purposes were released back into the water after they had been identified to species, examined for external anomalies, and weighed. Weights were recorded at level 1-5 sites only. Larval fish were not included in the data and fish measuring less than 15-20 mm in length were generally not included in the data as a matter of practice. The incidence of external anomalies was recorded following procedures outlined by Ohio EPA (1989) and refinements made by Sanders et al. (1999). While the majority of captured fish were identified to species in the field, any uncertainty about the field identification of individual fish required their preservation for later laboratory identification. Fish were preserved for future identification in borax buffered 10% formalin and labeled by date, river or stream, and geographic identifier (e.g., river mile). Identification was made to the species level at a minimum and to the sub-specific level if necessary. A number of regional ichthyology keys were used and included the Fishes of Illinois (Smith 1979) and updates available through the Illinois Natural History Survey (INHS). Vouchers were deposited and verified at The Ohio State University Museum of Biodiversity (OSUMB).

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with baseline Clean Water Act goal expectations (e.g., the General Use in the Illinois WQS). Scores greater than 75 frequently typify habitat conditions which have the ability to support an exceptional warmwater fish assemblage.

Data Management and Analysis

MBI employed the data storage, retrieval, and calculation routines available in the Ohio ECOS system as described in the project QAPP (MBI 2006b). Fish and macroinvertebrate data were reduced to standard relative abundance and species/taxa richness and composition metrics. The

Illinois Index of Biotic Integrity (IBI) was calculated with the fish data. The macroinvertebrate data were analyzed using the Illinois Macroinvertebrate Index of Biotic Integrity (MIBI).

Determination of Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine biological status (i.e., unimpaired or impaired, narrative ratings of quality) and assigning associated causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological indices are the principal arbiter of aquatic life use attainment and impairment following the guidelines of Illinois EPA. The rationale for using the biological results in the role of principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995).

Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures (Yoder and Rankin 1995; Yoder and DeShon 2003). Thus the assignment of principally associated causes and sources of biological impairment in this report represents the association of impairments (based on response indicators) with stressor and exposure indicators using linkages to the biosurvey data based on previous experiences within the strata of analogous situations and impacts. The reliability of the identification of associated causes and sources is increased where many such prior associations have been observed. The process is similar to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research which experimentally or statistically links symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experiences in interpreting symptoms (*i.e.*, multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and well-being of the patient, the ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including assemblage structure and function.

Hierarchy of Water Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. A tiered approach that links the results of administrative actions with true environmental measures was employed by our analyses. This integrated approach is outlined in Figure 8 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include:

1) actions taken by regulatory agencies (permitting, enforcement, grants);
2) responses by the regulated community (treatment works, pollution prevention);
3) changes in discharged quantities (pollutant loadings);
4) changes in ambient conditions (water quality, habitat);

Completing the Cycle of WQ Management: Assessing and Guiding Management Actions with Integrated Environmental Assessment

Indicator Levels

1: Management actions **2: Response to management**	***Administrative Indicators*** *[permits, plans, grants, enforcement, abatements]*
3: Stressor abatement	***Stressor Indicators*** *[pollutant loadings, land use practices]*
4: Ambient conditions **5: Assimilation and uptake**	***Exposure Indicators*** *[pollutant levels, habitat quality, ecosystem process, fate & transport]*
6: Biological response	***Response Indicators*** *[biological metrics, multimetric indices]*

Ecological "Health" Endpoint

Figure 8. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995) and further enhanced by Karr and Yoder (2004).

5) changes in uptake and/or assimilation (tissue contamination, biomarkers, assimilative capacity); and,
6) changes in health, ecology, or other effects (ecological condition, pathogens).

In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). An example is the aggregate effect of billions of dollars spent on water pollution control since the early 1970s that have been determined with quantifiable measures of environmental condition (Yoder et al. 2005). Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise the Illinois EPA biological endpoints. Other response indicators can include target assemblages, *i.e.*, rare, threatened, endangered, special status, and declining species or bacterial levels that serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each (Yoder and Rankin 1998).

Determining Causal Associations

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Illinois Water Resource Inventory (305[b] report), the Illinois Nonpoint Source Assessment, and other technical products.

Illinois Water Quality Standards: Designated Aquatic Life Uses

The Illinois Water Quality Standards (WQS; 303.204-206) consist of designated uses and chemical criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. The system of use designations employed in the Illinois WQS constitutes a general approach in that one or two levels of protection are provided and extended to all water bodies regardless of size or position in the landscape. In applications of state WQS to the management of water resource issues in rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses.