Pecatonica River Watershed (DRAFT5)

For statewide planning purposes, the Pecatonica River Watershed is part of the Grant-Platte-Sugar-Pecatonica Basin. In Dane County, the greater Pecatonica River Watershed includes the Gordon Creek Watershed (30,792 acres) and Upper East Branch Watershed (1,172 acres). The entire watershed lies within the unglaciated Driftless Area. Land use data are presented in Tables 1 and 2.

There are no named streams within the Upper East Branch Watershed. Surface waters are limited to an intermittent stream and small tributary that carries treated municipal wastewater from the Village of Blue Mounds to Williams-Barneveld Creek, a trout stream in Iowa County.

Seven named streams bisect the broad ridge tops within the Gordon Creek Watershed. The streams are currently managed for trout and coldwater communities. All are classified as Rural Streams and sensitive to impervious surfaces runoff. Until recently, the streams were degraded from decades of cropland erosion, over pasturing and feedlot runoff. The Dane County Animal Waste Management Plan (1985) identified livestock operations as serious threats and impacts to the streams. Significant pollution problems and limited potential for successful water quality improvements were important reasons why the watershed did not rank high for Priority Watershed designation under Wisconsin's former Nonpoint Source Water Pollution Abatement Program. Three of the streams, German Valley Creek, Syftestad Creek and Pleasant Valley Creek, were listed on the 303d impairs waters.

Recent monitoring data and research demonstrated significant improvements in Gordon Creek Watershed streams (Marshall 2003). Syftestad Creek is now classified as coldwater communities and has been removed from the 303d list. German Valley Creek was reclassified as a trout stream and is expected to be removed from the 303d list soon. The primary reasons for these and other water quality improvements are linked to trends in agriculture and conservation efforts (Marshall et al. 2008).

While water quality problems linked to intensive agriculture were well documented in the 1980s, competition from global commodities markets was gradually changing agriculture in Wisconsin. There was a long term shift from numerous small farms to fewer larger farms. Coinciding with these trends, conservation practices, such as contour strip plantings and improved manure management, had also become more widespread. Total animal unit numbers declined, along with associated problems such as over-grazing woodland corridors, as the numbers of farms declined. Ultimately, BOD and nutrient loading to the streams decreased (Marshall et al. 2008). Not surprising, research had demonstrated that runoff and peak flow rates in Driftless Area streams declined as farm land use practices were gradually improving and intensive agriculture was declining on less productive lands (Gebert and Krug 1996). Additional research suggested that long term increased minimum and median flows in Driftless Area streams were primarily linked land use changes rather than increased precipitation rates (Juckem et al. 2008, Kochendorfer and Hubbart 2010).

As some indicators suggested that agricultural land uses had softened across the landscape, the 1985 Farm Bill ushered in a transformative conservation effort know as the Conservation Reserve Program or CRP. The CRP offered farmers USDA rental payments for retiring highly erodible croplands into long term grass cover. In areas such as the Gordon Creek Watershed, reaching 20% CRP enrollments by 2002, environmental benefits were significant including improved hydrology, reduced soil erosion, reduced nutrient loading and increased wildlife habitat. Hydrology improved as surface runoff declined by 50% or more while infiltration increased inter-lateral groundwater flow to cold water streams. Sustained spring flow from perched hillside aquifers are important Driftless Area streams (Carter et al. 2010). Grass cover reduced phosphorus and sediment loading by 90% while the larger grassland tracts provide essential habitat for some of the most threatened bird populations in the United States, migratory grassland birds (Marshall et a. 2008). The relative high densities of these rare bird populations thrive in the Gordon Creek Watershed and surrounding Driftless Area watersheds in southwest Dane County and southeast Iowa County. This area is known as the Military Ridge Prairie Heritage Area (MRPHA) and lies within the greater Southwest Wisconsin Grassland and Stream Conservation Area (WDNR 2009). These projects focus on public-private partnerships designed to protect grasslands, prairie remnants, oak savannas, agriculture and water quality. The measured improvements in Gordon Creek Watershed streams reflect ecological and management connections between upland ridges and the streams that bisect them. In addition to environmental benefits, in some cases the CRP provided a social safety net that allowed struggling farmers to hold on their farms, and in return, provide important public benefits.

Without any direct management, fisheries in Gordon Creek Watershed streams gradually shifted from relatively diverse populations of eurythermal species to populations of stenothermal species more typical of ecologically healthy trout streams. Over the span of decades, species richness declined in the streams (Figure 1) while coldwater Index of Biotic Integrity scores greatly improved (Figure 2) (Marshall et al. 2008). There is a negative correlation between these two indicators of coldwater habitat. Healthy trout streams typically support low diversity of fish species adapted to living in perpetually cold water conditions (Lyons et al 1996). The changes that occurred in Gordon Creek Watershed streams also occurred in streams across MRPHA but did not occur in areas where CRP participation was substantially lower (Marshall 2008). Higher IBI scores generally occurred in watersheds where non-cropland uses, particularly grasslands, were higher (Figures 3 and 4)

State Special Concern redside dace had been collected in Gordon Creek and Syftestad Creek when eurythermal populations were dominant. The species is now considered extinct in the streams. While the loss of redside dace from the streams is unclear, a number of contributed factors may have influenced its distribution. It prefers cool water habitats while the streams now display cold water conditions. Redside dace is also vulnerable to the dominant species and top predator in the streams, brown trout. Finally, the occurrence of redside dace during the 1970s may have been a temporary artifact of more widespread habitat disturbances.

The combined long term hydrology/water quality improvements and management of trout streams in the Gordon Creek Watershed is a model of restoration. Improvements began at the watershed/landscape scale. Now, DNR, Dane County Department of Land and Water Resources and Trout Unlimited have fine-tuned the restoration at the stream corridor level. As the overall environmental conditions improved in the streams, numerous stream habitat improvement projects are now in various stages of planning and completion. These efforts have been reversing the long term habitat loss of box elder growth over incised channels with eroding stream banks.

The changes in agriculture and streams in the Gordon Creek Watershed is not the end of the story. Since 2002, anticipation of ethanol production and expectation of high corn prices precipitated significant withdrawals from the CRP. At a few locations, factory style farms replaced former CRP lands with very high animal unit densities that can have catastrophic effects on water quality (2005 manure spill in the West Branch Sugar River). In other areas, CRP lands were converted to low density housing. While impervious surfaces do not typically increase substantially under this form of development, potential impacts linked to surface runoff and groundwater contamination cannot be ignored. Low density development also destroys habitat for threatened migratory birds that require large tracts of un-fragmented grassland and can destroy scenic views that are important for the local tourism economy;

undermining the goals of MRPHA and Southwest Wisconsin Grassland and Stream Conservation Area (WDNR 2009).

Water quality and biological monitoring will continue in the watershed as DNR and local partners assess stream responses to local habitat restoration projects. Additional monitoring will involve watershed scale biological, chemical and physical data collections as part of a new pilot project (involving USEPA, WDNR, and Midwest Biodiversity Institute) that will develop sampling designs to improve monitoring strategies.

Table 1: Upper East Branch Watershed Characteristics

Resource Characteristics	In Acres
Hydric soils	0
Wetlands	0
Agriculture	832
Commercial	2
Institutional/Governmental	5
Industrial	11
Open Water	0
Vacant Land or Under Construction	45
Outdoor Recreation	38
Residential	103
Transportation, utilities etc.	101
Woodland	23
Total Watershed Area	89,791
Dane County Portion	1,172

Dane County State of the Waters Report

Table 2: Gordon Creek Watershed Characteristics

Resource Characteristics	In Acres
Hydric soils	1,293
Wetlands	394
Agriculture	20,534
Commercial	1
Institutional/Governmental	10
Industrial	46
Open Water	1
Vacant Land or Under Construction	3,092
Outdoor Recreation	81
Residential	270
Transportation, utilities etc.	906
Woodland	5,831
Total Watershed Area	49,260
Dane County Portion	30,792

Dane County State of the Waters Report

Figure 1: Species Richness changes after CRP Enrollments in Southwest Dane County and Southeast Iowa County. Low species richness reflects healthy trout streams.

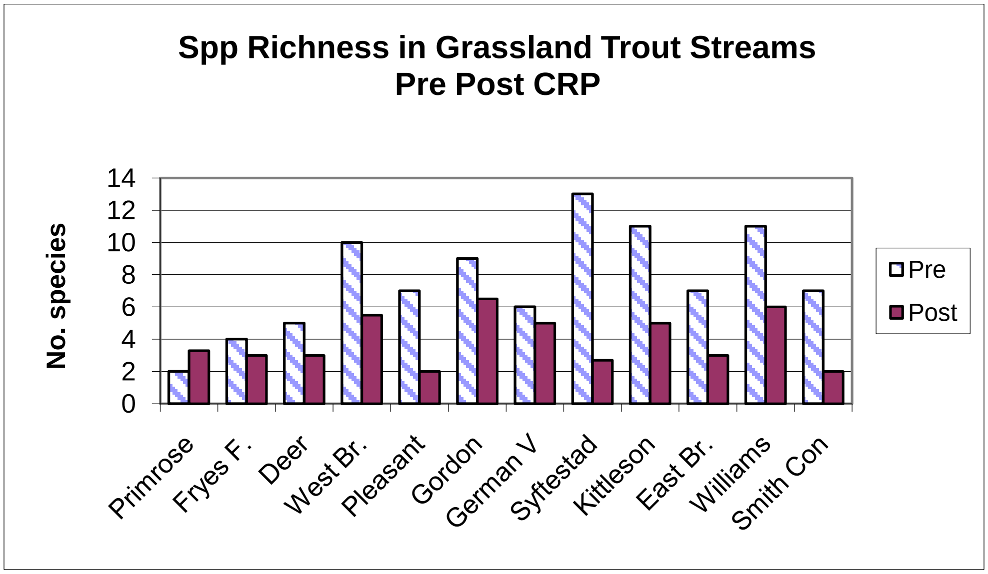


Figure 1: Cold water Index of Biotic Integrity (IBI) Scores for Southwest Dane County and Southeast Iowa County before and after CRP enrollments. IBI "good" range = 60-80.

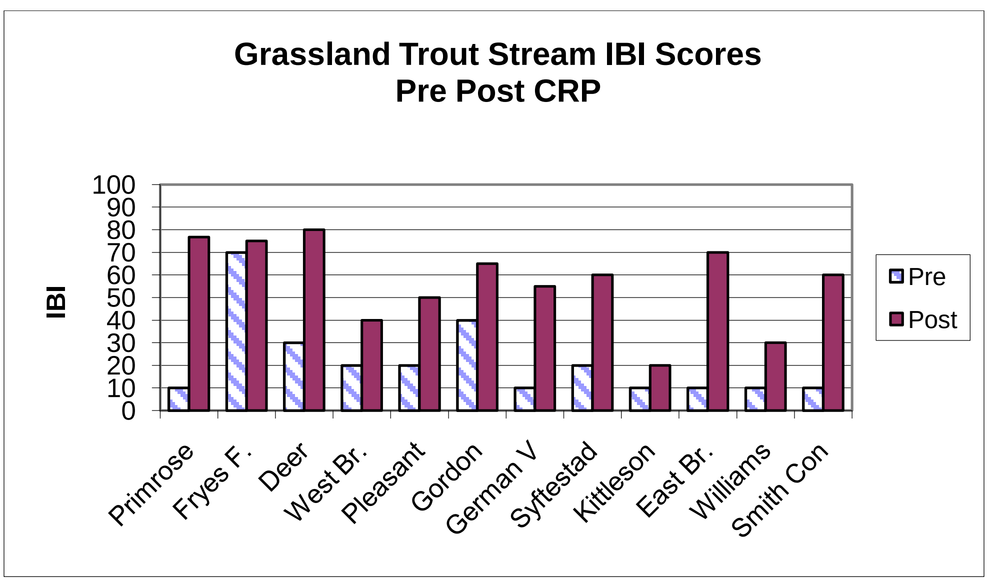


Figure 3: Higher IBI scores (left side) occurred in watersheds with lower intensity agriculture.

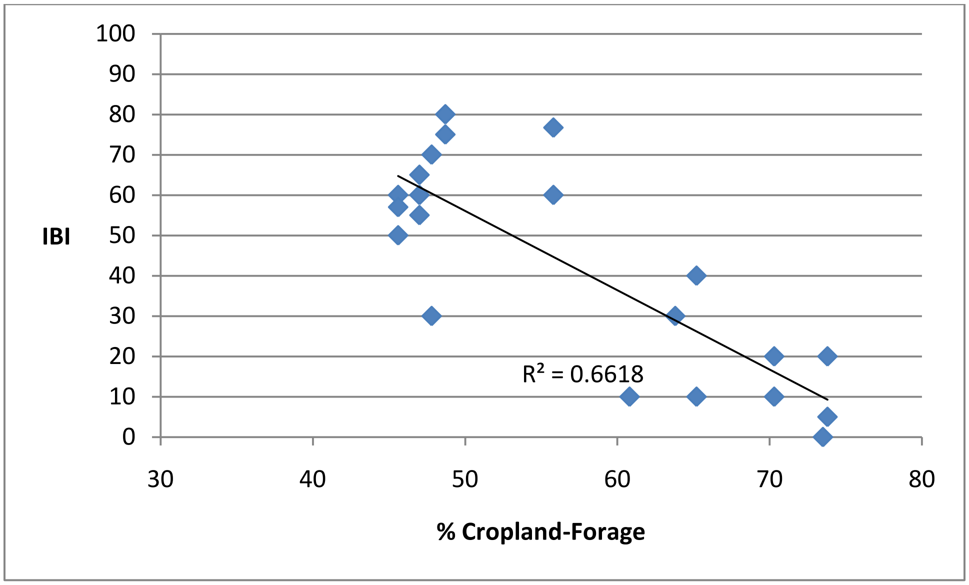
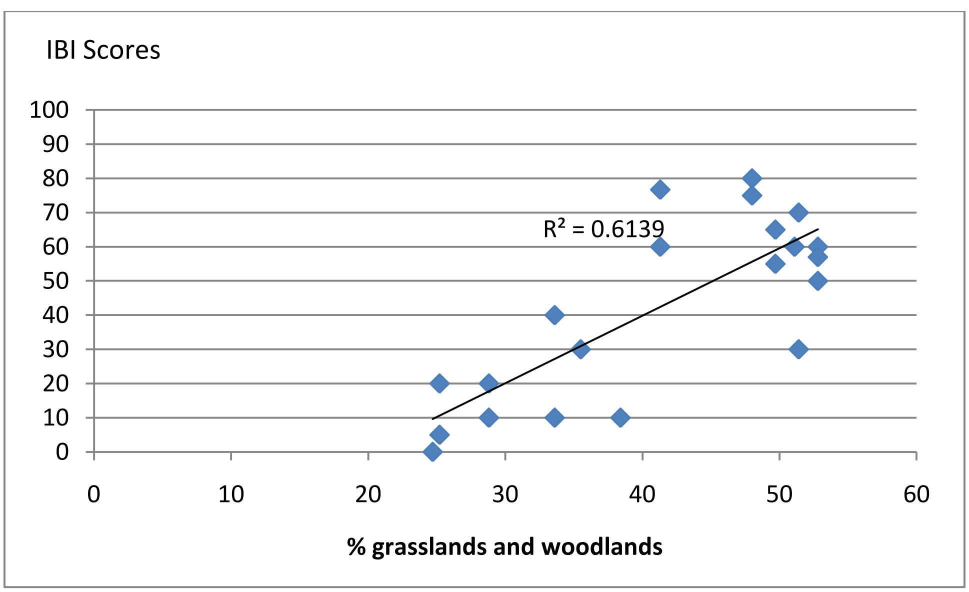


Figure 4: Lower IBI scores (left side) coincided with lower grasslands and woodlands



Gordon Creek

Gordon Creek (WBIC 907300, also known as Blue Mounds Branch and Big Spring Creek) arises in Section 8 of Blue Mounds Township and flows south for about six miles to the confluence with German Valley Creek. It is considered one of the premier trout streams in Dane and Iowa counties and has been the focus of extensive habitat restoration in recent years. In Dane County Gordon Creek is classified as Exceptional Resource Waters (ERW) and has been managed as a Class II trout stream for decades. The recent interest in the creek coincided with findings that it had significantly improved. Figure 5 demonstrates how the fish community changed over the years, from eurythermal populations to stenothermal/ environmentally intolerant fish populations more typical of healthy trout streams. Surveys completed from 2007 to 2009 demonstrated that good to excellent trout habitat in the stream continues. Gordon Creek previously supported State Special Concern redside dace but the current cold water temperatures and brown trout predation present survival obstacles for the rare fish. Figure 6 reveals improved cold water IBI scores over time with the best scores beginning in 2001. In 1994, the IBI score reflected poor cold water habitat eight years after CRP signups began. The poor coldwater conditions may have indicated a lag time for ecosystem response to improved conditions and/or lower numbers of CRP participants at that time. Figure 7 displays daily maximum mean temperatures and sustained cold water habitat based on Onset Hobo data loggers. Hilsenhoff Biotic Index scores from samples collected in 1994 through 2002 indicated very good water quality (HBI range 2.39-4.96, mean = 3.62). The highest HBI score (lowest water quality) coincided with a manure spill that caused a major fish kill. The favorable HBI score during that pollution event likely reflected macroinvertebrate escape into the groundwater fed hyporhyeic zone. The macroinvertebrate community in Big Spring-Gordon Creek typically supports abundant stonefly populations, primarily *Isoperla signata*).

German Valley Creek

German Valley Creek arises in Section 10 of Blue Mounds Township and flows about seven miles to the confluence with Gordon Creek. Until recently, GVC had never been managed for trout due to chronic low stream flows, poor habitat and poor water quality. However, while it has been more degraded than Gordon Creek, German Valley Creek followed a similar path toward restoration (Figure 6). GVC now supports primarily stenothermal cold water fish species and the trout stream classification reflects these fish community changes and angler opportunities. Surveys completed from 2007 through 2009 demonstrate continued favorable trout habitat. Several miles of the stream habitat was restored and include easements for public fishing. GVC is still listed as 303d impaired by it is expected to be removed from the list soon to reflect the significantly improved water quality and habitat and sustained brown trout population. And Dane County Department of Land and Water Resources continue to work with area farmers to improve manure management practices. The best trout habitat is located in the lower reaches where enough spring flow sustains habitat and cold water temperatures. Hilsenhoff Biotic Index scores ranged from 2.91 (excellent water quality) to 5.15 (good water quality) during the period from 1994 through 2002.

Figure 5: Fish community changes in Gordon Creek

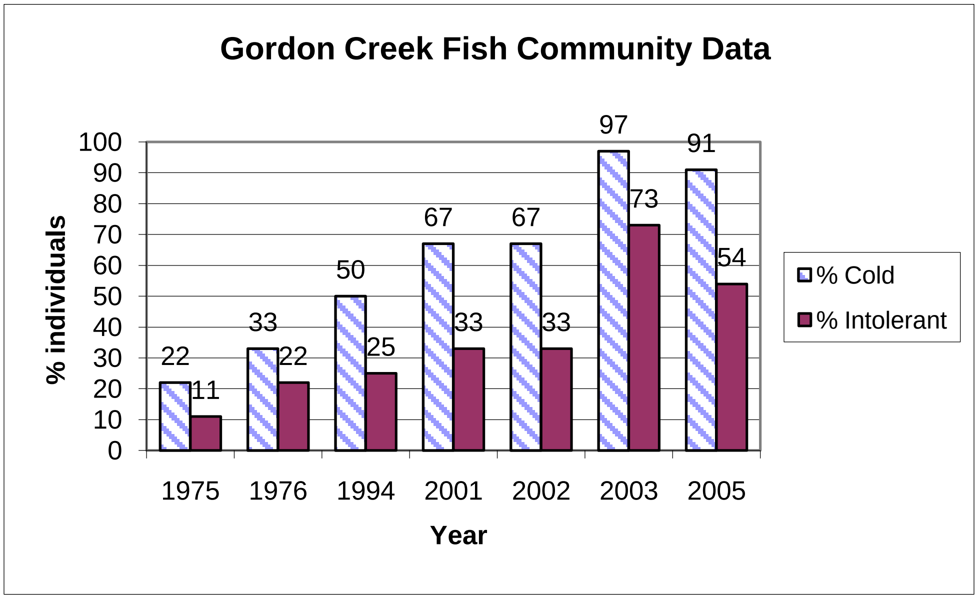


Figure 6: Changes in cold water IBI scores over time in Gordon Cr, German Valley Cr and Syftestad Cr

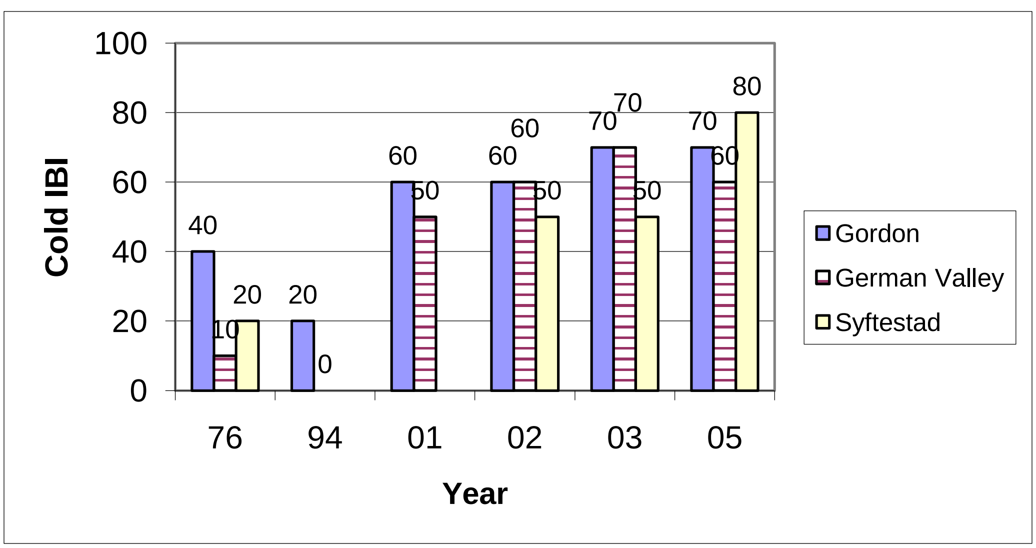
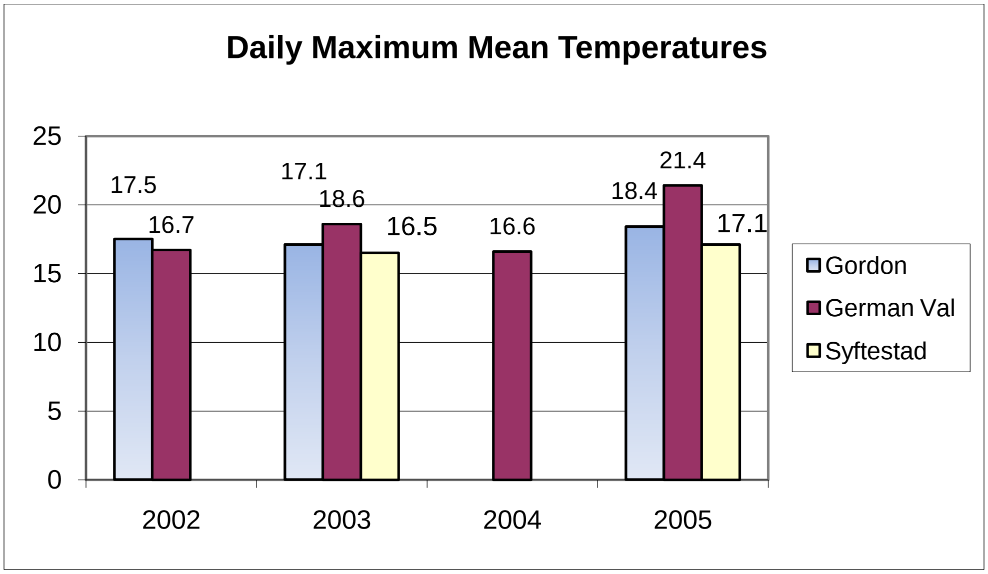


Figure 7: Summary of continuous water temperature data for Gordon Creek, German Valley Creek and Syftestad Creek.



Syftestad Creek

Syftestad Creek (also known as Daleyville Branch) is a small stream that arises in Section 25, Perry Township and flows south for about four miles to the confluence with Kittleson Valley Creek. Until recently, Syftestad Creek was considered a degraded forage fish stream due to habitat problems and polluted runoff in the watershed. It was removed from the 303d list in 2006 to reflect recent data that revealed conditions favorable for trout and cold water communities. Syftestad Creek supported 13 species of fish in the 1970s, including the State Special Concern redside dace. The rare fish disappeared from the stream along with most of the other species that do not thrive in sustained cold water habitats. Figures 6 and 7 display cold water IBI changes over time and continuous data logger water temperature summaries. Fish species richness ultimately declined while cold water IBI scores improved; a consistent pattern among MRPHA streams. Also consistent with the other trout streams in the area, HBI values reflected very good water quality in Syftestad Creek. On October 2, 2010, Underwater Habitat Investigations LLC performed a stream shocking demonstration for the Southern Wisconsin Chapter of Trout Unlimited. The survey revealed healthy brook trout and brown trout populations and the stream had a coldwater IBI score of 90 or “excellent” integrity rating.

Kittleson Valley Creek

Kittleson Valley Creek arises in Section 25 of Perry Township and flows west to the confluence with Gordon Creek in Iowa County. The stream has been a classified trout stream for decades but had been plagued with severe bank erosion and livestock grazing. Kittleson Valley Creek improved along with other MRPHA streams more recently. In 2009 WDNR baseline fish shocking surveys revealed that parts of Kiittleson Valley Creek supported typical trout stream fish species; primarily brown trout and mottled sculpin. IBI scores ranged from 30 to 70 from 2006-08 with a mean score of 57 (N=6). A 2008 HBI sample indicated “excellent” water quality with a score of 3.19. Kittleson Valley Creek and tributaries Pleasant Valley Creek and Lee Creek, are part of a pilot study known as the Wisconsin Buffer Initiative. The concept is based on targeted croplands and pastures that likely contribute the largest amounts of nutrients and sediment to the streams. The USGS operates a gaging station at CTH H as part of the Wisconsin Buffer Initiative. In 2007, the monitoring data demonstrated how a single storm event can affect water quality. Approximately six inches of rain fell on August 5th and contributed approximately 10% of the annual phosphorus load (1,170 lbs.) and approximately 14% of the annual sediment load (291 tons) in Kittleson Valley Creek. Flow rates typically average around 16 cfs at that location but peaked at 164 cfs during the late summer storm (USGS 2008).

Pleasant Valley Creek

Pleasant Valley Creek is a small stream that arises in Section 3 of Perry Township and flows south for about four miles to the confluence with Kittleson Valley Creek. Pleasant Valley Creek is listed as 303d impaired and is a key focus of the Wisconsin Buffer Initiative. HBI scores from macroinvertebrates collected in 2003-04 indicated "fair to fairly poor" water quality and ranged from 5.97 to 7.46. More recent biological indicators suggested that the stream likely improved with cold water IBI scores ranging from 30 (fair) to 70 (good)(mean =50, n =11). The dominant species were brown trout and mottled sculpin. Six flow rates, measured in 2008, averaged less than 0.5 cubic feet per section approximately one mile above the confluence with Kittleson Valley Creek.

Lee Creek (York Valley)

Lee Creek originates in Green County and flows northward to Kittleson Valley Creek. The small trout stream displays "fair" coldwater habitat (IBI=30) near Tyrand Road but improves to "good" (IBI=60,70) trout stream habitat from Lee Valley Road to the confluence with Kittleson Valley. An HBI macroinvertebrate sample (1.46) collected in 2008 indicated "excellent" water quality.

Table 3: Fish and Aquatic Life Designations

Waterbody	2000 Impervious Cover	Planned Impervious Cover	Use	Use Potentiial	Codified Use
Gordon Cr.	5.11%	5.46%	Cold		ERW
German Valley Br.	4.33%	4.48%	Cold		303(d)
Jeglum Valley Br.	2.94%	2.94%	Cold		
Kittleson Valley Cr.	3.38%	3.38%	Cold		
Pleasant Valley Br.	3.62%	3.62%	wwff	Cold	303(d)
Syftestad Cr.	3.47%	3.47%	Cold		
York Valley Cr. (Lee Cr.)	3.07%	3.07%	Cold		

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Lower Wisconsin River Basin

The Dane County portion of the Lower Wisconsin River Basin encompasses about 141,620 acres that include the Roxbury Creek Watershed, Black Earth Creek Watershed, a portion of the Mill-Blue Mounds Creek Watershed and a portion of the Lake Wisconsin Watershed. This part of the county holds a wealth of water resources and diverse aquatic habitats that span both glaciated and Driftless Area landscapes. Water resources in the Dane County portion of the basin include upland Driftless Area trout streams, agricultural ditched streams, a regionally popular trout stream – Black Earth Creek, seepage lakes, impoundments and cut-off channel oxbow lakes that are part of a biologically diverse and recreationally important large river system known as the Lower Wisconsin State Riverway. Land uses for the four watersheds appear in Tables 4-7.

Lower Wisconsin State Riverway

While the longest river in the state finds its origin in Lac Vieux Desert, some 338 miles upstream in Vilas County, the Lower Wisconsin State Riverway remains one of the most biologically diverse large river systems remaining in the United States (Marshall and Lyons 2008). In 1989, Act 31 established the Lower Wisconsin State Riverway to protect the scenic beauty and natural character of the 92 mile Lower Wisconsin River from Prairie du Sac to the confluence with the Mississippi River. This unique public-private partnership was established as an alternative to the proposed federal Wild and Scenic Rivers Act designation that was publicly controversial (Matthews 2009). That same year, DNR staff recommended Outstanding Resource Water (ORW) designation for the Lower Wisconsin River to reflect the high biodiversity (including 98 species of fish, rare aquatic insects, diverse and rare mussel beds, and herptiles), tremendous sport fisheries and recreation use by over 400,000 visitors a year. The alternative designation of Exceptional Resource Water (ERW) was ultimately adopted in Wisconsin Administrative Code NR 102.

2009 marked the 20 Year Anniversary of the Lower Wisconsin State Riverway. Coinciding with the anniversary, an educational poster was designed by Flying Fish Graphics and was sponsored by numerous partners (including Dane County) to celebrate the tremendous biodiversity of the river. The high biodiversity reflects the braided river channel system with diverse habitats within a floodplain that is unimpeded by dams. The Lower Wisconsin River was also spared the severe water quality problems that plagued the upper reaches prior to the Clean Water Act, due to the long distances from the industrial and municipal wastewater point sources. Nonetheless, the Lower Wisconsin River was somewhat degraded by the pulp and paper mill industry throughout the 1970s as organoleptic compounds tainted fish flesh and rafts of foam floated downstream from the Prairie du Sac dam (WDNR Draft LWSRW Fisheries Plan). By the early 1980s, the Lower Wisconsin River benefitted from the implementation of the Clean Water Act as organic loading from pulp and paper mills and other point sources had declined by 95%. Coinciding with reduced point source pollution, land uses within the surrounding Driftless Area improved along with increased tributary and upland groundwater flows to the floodplain (Marshall 2009).

The Dane County reach of the Lower Wisconsin River is about 14 miles long. Some of the most environmentally sensitive habitats and aquatic life forms are found within the Dane County portion of the State Riverway including the reach below the Prairie du Sac Dam and floodplain lakes. The dam functions as a migration barrier and numerous rare fish and mussels are found within this reach of river including State Endangered crystal darter, State Threatened blue sucker, State Threatened paddlefish, State Endangered shoal chub, State Threatened pistolgrip mussel and State Endangered Higgin's Eye mussel. The endangered resources within this reach of river are often exposed to low dissolved oxygen levels due to organic loading from hypereutrophic Lake Wisconsin (Marshall and Unmuth 2004).

Cutoff channel oxbow lakes are found in several locations in the Dane County reach. Floodplain lakes have been the least surveyed and understood waterbodies in the state and their invaluable ecological functions had been largely overlooked for decades. A 2009-10 small-scale lakes planning grant survey of Dane County floodplain lakes helped bridge the information gap (Marshall and Jopke 2010). The surveys demonstrated that the floodplain habitats support rare fish species such as the State Threatened starhead topminnow, State Special Concern pirate perch, State Special Concern lake chubsucker and State Special Concern mud darter. The late George Becker (1983) described the starhead topminnow as imperiled and recommended that the state establish a “topminnow sanctuary” for the rare fish. However, the recent surveys of the State Riverway demonstrated that the starhead topminnow is much more abundant than previously thought and the State Riverway may actually function as the sanctuary that Dr. Becker had envisioned. Until recently the starhead topminnow was listed as State Endangered. However, the rare topminnow was changed to State Threatened to reflect the relative abundance found along the State Riverway.

Habitats surveyed included cutoff channel oxbows, creek bottoms, side channels that are intermittently cutoff from river flow and beaver ponds. These floodplain lake habitats are often sustained by upland groundwater flow and are vulnerable to groundwater contamination and runoff pollution (Marshall and Jopke 2010). In Sauk County, very low dissolved oxygen levels coincided with high river stages when nutrient rich alluvial groundwater reduces the flow of upland groundwater. The entire Lower Wisconsin State Riverway floodplain is vulnerable to groundwater pollution and recent research had demonstrated that fish and aquatic life are no less susceptible to high nitrates as human infants (Camargo et al. 2005). The long term trend of increased Driftless Area baseflows and higher groundwater levels may have improved the habitat for starhead topminnows; potential reasons for their population increase.

Recommendations from the Dane County small-scale lake planning grant study:

(1) Dane County should work with the Lower Wisconsin State Riverway Board and Department of Natural Resources to reevaluate existing State Riverway boundaries. Environmentally sensitive floodplain lakes would benefit expanded buffer zones to protect both upland groundwater and reduce surface runoff pollution.

(2) Given the environmental sensitivity and important ecological functions of the floodplain lakes, the Department of Natural Resources should classify these waterbodies as Outstanding Resource Waters (ORW).

(3) The pre-1994 State Stewardship fund for the Lower Wisconsin State Riverway should be restored.

(4) Future research should focus on a few floodplain lakes over a wide range of river stages and flows. Upland groundwater and alluvial groundwater inputs will likely fluctuate, along with floodplain lakes water quality, over a range of river stages. More detailed biological inventories are also needed.

(5) Consider restoring the lower reaches of Dunlap Creek and Marsh Creek to characteristics and habitat of natural floodplain creek bottoms.

Black Earth Creek Watershed

The Black Earth Creek Watershed encompasses 66,326 acres in Dane County including 75 miles of streams and 22 miles of classified trout habitat. The upper reaches of Black Earth Creek and Halfway Prairie Creek drain glaciated landscapes. Otherwise, streams in the southern border of the watershed benefit from the Driftless Area geology as groundwater discharges sustain cold and cool water fish populations and reduce water quality problems linked to intensive agriculture and urbanization. Land uses in the watershed have limited the potential ecological integrity of most streams in this watershed. Previous studies had identified water quality problems due to cropland erosion, channel ditching, barnyard runoff, construction site erosion and increased impervious surfaces; the latter two reflecting development pressures (Dane County State of the Waters Report 2008). Most of the streams in the watershed are classified as Rural except for the lower reach of Brewery Creek in Cross Plains and Black Earth Creek from Middleton downstream below Cross Plains where the classifications are Developing Waters.

Table 4: Black Earth Creek Watershed Characteristics

Resource Characteristics	In Acres
Hydric soils	4,865
Wetlands	1,511
Agriculture	30,959
Commercial	101
Institutional/Governmental	170
Industrial	492
Open Water	280
Vacant Land or Under Construction	7,523
Outdoor Recreation	773
Residential	2,614
Transportation, utilities etc.	2,537
Woodland	20,876
Total Watershed Area	67,383
Dane County Portion	66,326

Dane County State of the Waters Report

Black Earth Creek

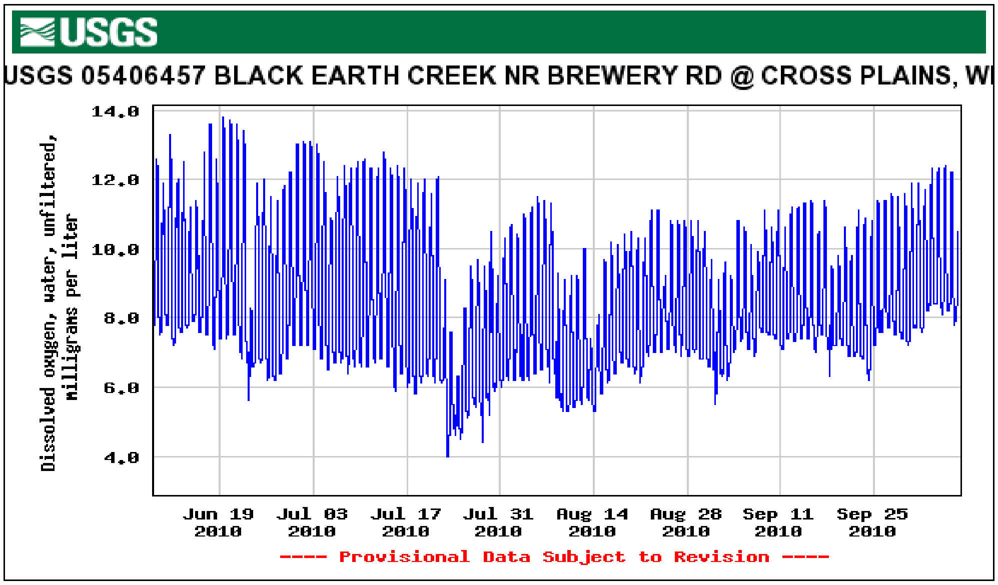
Black Earth Creek arises from the terminal moraine west of Middleton and flows about 27 miles to the confluence with Blue Mounds Creek. Most of the watershed is dominated by thick deposits of glacial outwash and alluvium, materials that form an excellent aquifer for sustained stream flow (DCRPC 1992). Black Earth Creek is a regionally popular trout stream and trout enthusiasts had rated it one of the top 100 trout streams in the nation. The sustainable habitat for a productive brown trout fishery reflects springflows that originate as wooded hillslope groundwater recharge areas with additional groundwater flow originating in the Sugar River Watershed (Potter et al. 1995). Under NR 102, Black Earth Creek is designated Outstanding Resource Water (ORW) from the headwaters downstream to the Village of Cross Plains wastewater treatment plant. This designation reflects the well established Class 1 trout fishery when the anti-degradation rule (NR 207) was adopted in 1989.

The best trout habitat extends from just above Cross Plains downstream to the Village of Black Earth. The upper reaches of the ORW designation near Middleton support mixed stenothermal cold and eurythermal warm populations of fish; likely reflecting channel modifications and altered hydrology. Below the Village of Black Earth to the confluence with Blue Mounds Creek, Black Earth Creek again supports mixed populations of stenothermal cold and eurythermal warm fish. While Black Earth Creek supports high densities of wild brown trout, coldwater IBI scores from 2001-08 indicate "fair" environmental conditions with a mean score of 42.5 (range from 20 to 70, n=18). Below the Village of Black Earth, coldwater IBI scores (20) indicate "poor" conditions and reflect the mixed stenothermal – eurythermal fish populations. Below the confluence with Blue Mounds Creek and within the Lower Wisconsin State Riverway, rare fish species such as State Threatened starhead topminnow, State Special Concern mud darter, State Special Concern pirate perch and State Special Concern weed shiner thrive within the floodplain habitats.

While the popularity of the Black Earth Creek reflects a relatively long history for producing abundant brown trout, Black Earth Creek is threatened by more environmental problems than other high quality Dane County trout streams within the Driftless Area. Environmental problems that threaten Black Earth Creek include agricultural ditching, the Refuse Hideaway Landfill USEPA Superfund Site, gravel mining thermal discharges, cropland runoff, two municipal wastewater treatment plants, manure runoff and expanding urbanization. The Black Earth Creek Priority Watershed Project (1989-2001) addressed many of these issues with partial success, including Best Management Practices (BMPs) that exceeded pollution reduction goals (Dane County State of the Basin Report 2008). Restoration efforts did not end with the Priority Watershed Project as continued habitat improvement and water pollution control activities reflect ongoing federal programs such as the Conservation Reserve Program (CRP), Wetland Reserve and nutrient management. In spite of these successes, however, frequent dissolved oxygen criterion violations, periodic fish kills, expanding development and impervious surfaces continue to pose long term threats to the stream.

The United States Geological Surveys (USGS) maintains "Realtime" water quality monitoring stations along Black Earth Creek at Cross Plains, South Valley Road and Village of Black Earth. Dissolved oxygen levels frequently drop below trout stream criterion limit of 6 mg/l at all three stations and these violations typically occur during storm events when specific conductance levels are lower (reflecting soft rain water inputs) and when creek levels rise (Figures 8 and 9). Chronic low dissolved oxygen in the stream had been previously well documented (Walker et al. 2001). In addition to the frequent low dissolved oxygen levels, fish kills occasionally occur and sometimes result in significant trout mortality. In June of 2001, a storm related fish kill reduced trout densities from 64% to 86% west of Cross Plains (WDNR 2001). The specific cause(s) that occurred during the June 5 inch storm event is still unknown. However, WDNR reported potential sources including manure management; WPDES permitted factory dairy farms, urban runoff and tile drains from former wetlands (now cropped) that could potentially discharge pesticides, crop oils and commercial fertilizers to the stream. It is unknown whether the fish kill was the result of a single factor or cumulative effect from many sources. The impacts of the fish kill on trout populations appeared to be relatively short-lived. Electroshocking survey results from 2002 and 2003 demonstrated that the wild brown trout are resilient in Black Earth Creek. Both sizes and densities in the creek west of Cross Plains were found at levels that preceded the 2001 fish kill (WDNR Waters File 2003). Macroinvertebrates sampling immediately after the fish kill revealed no measureable impact of the pollution.

Figure 8: 2010 dissolved oxygen and specific conductance data from the Cross Plains Realtime Monitoring Site (USGS)



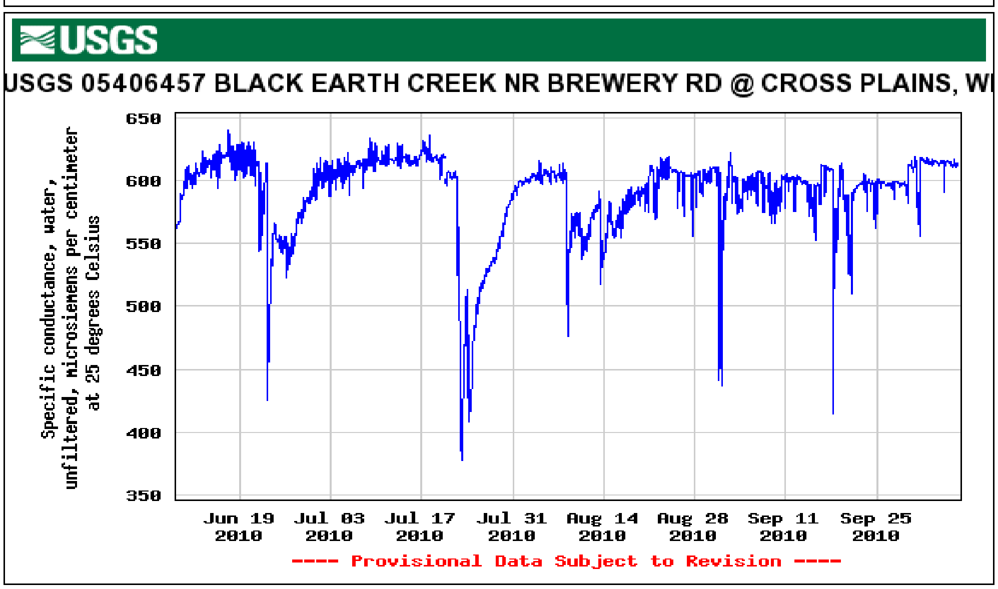
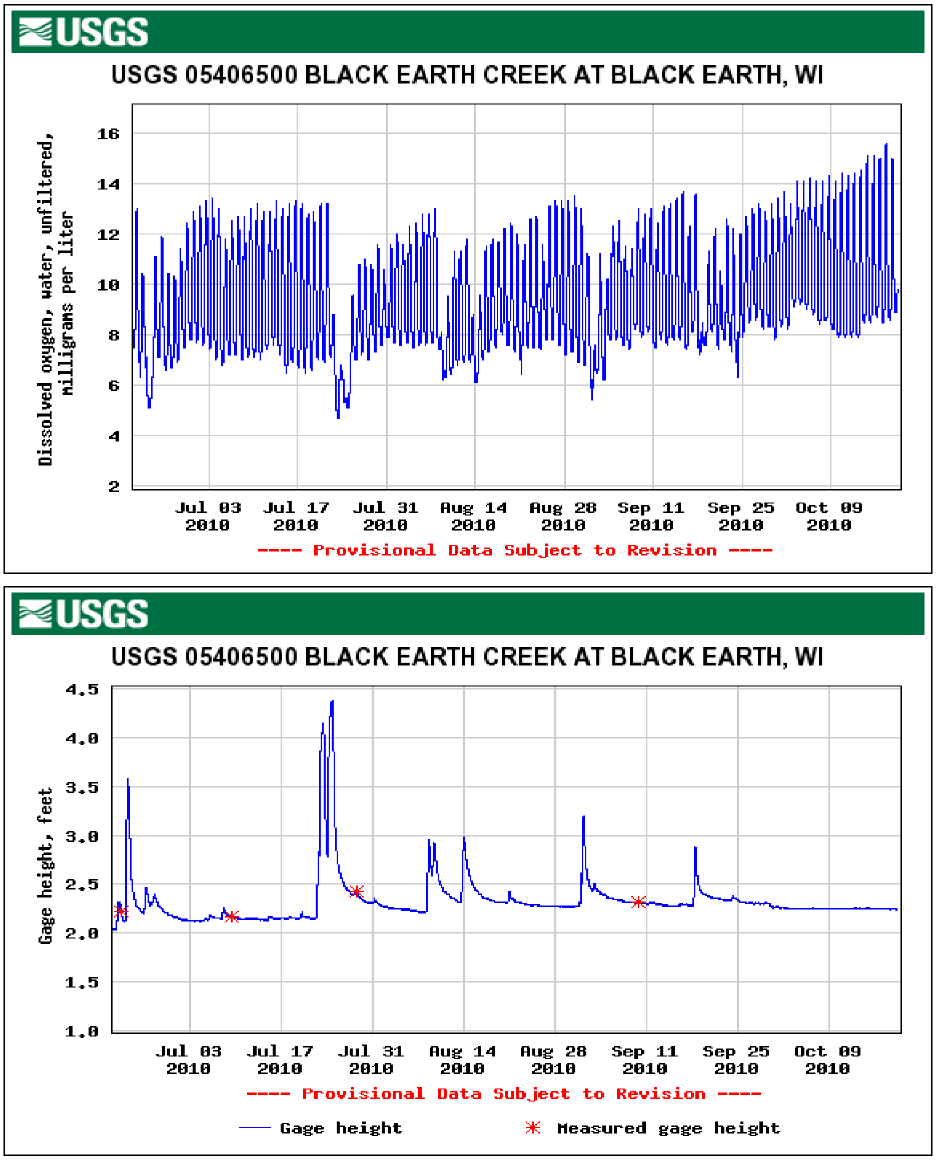


Figure 9: 2010 dissolved oxygen and gage height from the Black Earth Realtime Monitoring Site (USGS)

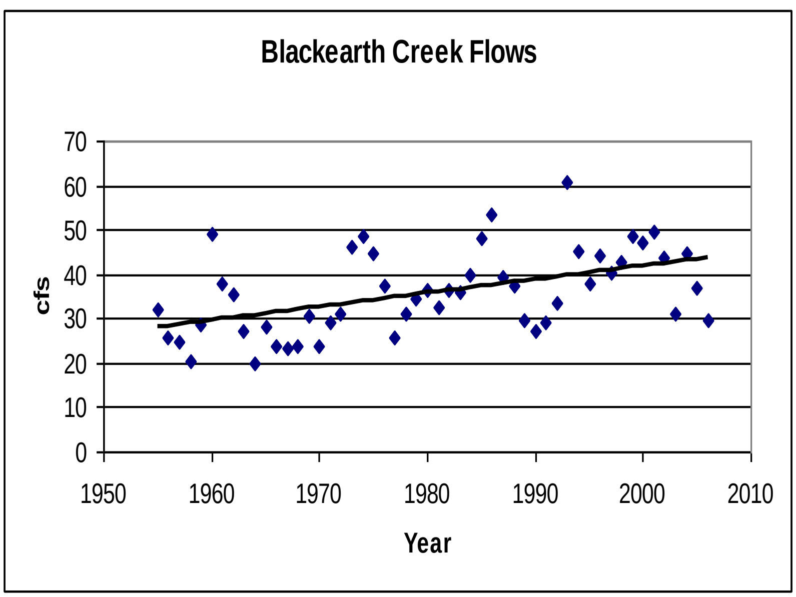


Additional information gleaned from the USGS monitoring station in Black Earth revealed that Black Earth Creek flow has been gradually increasing (Figure 10 – Krohelski et al. 2002). This trend is consistent with other Driftless Area streams where long term base flow rates had increased and may reflect conservation efforts (Gebert and Krug 1996, Juckem et al. 2008).

Even though the Priority Watershed Project ended in 2001, the numerous partners continue to seek management strategies to protect and improve the popular trout stream. The “Black Earth Creek Resource Area Plan”, prepared by Kakuska (2003) with input from a diverse steering committee, recommended 10 specific actions that will protect the trout stream and associated natural resources within the Black Earth Creek Valley:

1. Protect/promote cost-share funding and other incentives to acquire lands or property rights for priority areas identified in the Resource Area Plan.
2. Encourage/promote participation in the farmland preservation programs offered by various public and private groups, such as the American Farmland Trust, Pheasants Forever, etc.
3. Protect upland wooded areas, especially steep slopes to prevent soil erosion, promote infiltration, provide wildlife habitat, resource connectivity and scenic beauty, such as through easements along ridgelines and hilltops.
4. Promote trail linkages between various sites and across jurisdictional boundaries, such as a trail along the length of the creek corridor between Middleton and Mazomanie, connecting with the Ice Age Trail as well as neighboring communities.
5. Use public access areas as stepping stones connected with and along the trail to enhance outdoor recreation and educational opportunities, including exhibits and displays.
6. Restore glacial Mud Lake west of the Middleton business park as a controlled surface and groundwater facility to help protect Black Earth Creek.
7. Promote infiltration practices as a means of protecting groundwater discharge to Black Earth Creek (e.g., grass swales, retention areas, and rain gardens; rooftop storage/runoff directed to lawns and other more pervious areas instead of driveways, parking lots and streets).
8. Incorporate natural resource elements as specific conservation design features.
9. Provide advice to farmers, developers and homeowners on opportunities they can take to help protect Black Earth Creek.
10. Investigate the feasibility of pumping more water from municipal wells located closer to the Yahara Lakes (Middleton and Madison).

Figure 10: Black Earth Creek Mean Annual Stream Flow Trend (R^2=0.71)



Brewery Creek (Enchanted Valley Creek, Dry Run Creek)

Brewery Creek is a small tributary of Black Earth Creek that enters from the north. The stream is 6.1 miles long and drains a 10.5 sq. mile watershed. Brewery Creek had a long history of water quality degradation and parts of the stream had been ditched (DCRPC 1992). Dissolved oxygen had dropped to 0 mg/l during a storm event in 1990. A recent study revealed improved conditions in Brewery Creek and demonstrated that staged subdivision development with stormwater management and erosion controls can minimize impacts to a receiving stream during the construction phase (Selbig et al. 2004). As part of that study biological indicators indicated that the stream had improved from a watershed perspective and it now supports a numerous brown trout that migrate upstream from Black Earth Creek. In the 1980s, manure management problems had eliminated environmentally intolerant macroinvertebrate populations in Brewery Creek. But from 1985 HBI values as high as 7.6 (= poor w. q.) declined to values less than 5 (= good w. q.) from 1995 through 2002 (R^2=0.58). The stream improvements may have reflected best management practices completed as part of the Priority Watershed Project and more general water quality and land use trends that had been occurring within the Driftless Area (Gebert and Krug 1996, Juckem et al. 2008).

While HBI values indicated good water quality in the stream, fish community data indicated that Brewery Creek is “poor” trout habitat. From 1999 through 2003, the fish community was dominated by tolerant species such as creekchubs, fathead minnows, golden shiners, white suckers, yellow bullhead and green sunfish. However, the common occurrence of brown trout in the small creek is a significant improvement compared to no trout and 100% tolerant fish that were previously found in the stream during the 1980s.

The improved fish and macroinvertebrate communities in the stream appear to contradict another study. Graczyk et al. (2003) demonstrated that pre and post Priority Watershed Project storm related sediment and nutrient loads were not significantly different at the 0.05 probability level. This information suggests that perhaps the biological improvements may reflect changes in hydrology such as increased baseflows that Black Earth Creek and other Driftless Area streams have displayed. Increased baseflows related to higher groundwater discharge may provide more hospitable conditions for fish and aquatic life. The maximum daily mean temperatures recorded from 2000-02 in Brewery Creek now indicate coldwater or trout habitat and reflect groundwater inputs. Since Brewery Creek is an important tributary to Black Earth Creek, it is designated a “Priority Stream” in the Dane County Open Space Plan for land acquisition and streambank protection.

Garfoot Creek

Garfoot Creek is a 3.8 mile long tributary that enters Black Earth Creek from the south, approximately 0.5 miles upstream of Salmo Pond. It has a relatively high gradient of 32 ft/mile. Garfoot is classified as a Class II trout stream and is designated Exceptional Resource Water (ERW). As part of the Black Earth Creek Priority Watershed Project, event monitoring indicated significant BOD, sediment and nutrient loading in the stream (DCRPC 1992). More recently, Graczyk et al. (2003) determined that levels of ammonia nitrogen during storm events was statistically lower following completion of best management practices (BMPs) in the watershed. Levels of phosphorus and suspended sediment were not statistically different before or after implementation of BMPs. Recent WDNR baseline electroshocking surveys indicated that Garfoot Creek displays the best trout habitat in the entire watershed. From 2001-03, coldwater IBI scores ranged from 20 to 90 with a means score of 67 (n=7) or “good” trout habitat. An experimental brook trout stocking effort is underway to determine if this environmentally sensitive native Salmonid can thrive in the stream. The stream in under consideration for Class I management.

Vermont Creek

Vermont Creek arises in Section 25 of Vermont Township and flows six miles north to the confluence with Black Earth Creek in the Village of Black Earth. The creek flows through a relatively broad valley floodplain and most of the channel had been ditched and straightened. Also, some of the springheads had been impounded. As a result, it displays marginal Class III trout habitat and was added to the 303d list of impaired waters in 2004. Recent habitat restoration efforts, involving Dane County Department of Land and Water Resources, Southern Wisconsin Chapter Trout Unlimited, WDNR and Natural Heritage Land Trust, have focused on box elder removal, channel sloping, cattle fencing and installation of instream habitat structures. The partners anticipate improved trout production and recruitment in the stream. WDNR baseline coldwater IBI scores (range 10 - 50, mean = 27, n = 12) reflect the degraded habitat in the stream. Future WDNR electroshocking surveys will document effectiveness of the habitat restorations.

Halfway Prairie Creek

The headwater of Halfway Prairie Creek is located at the outlet of hypereutrophic Indian Lake. The stream flows 11 miles before entering Black Earth Creek in the Village of Mazomanie. Most of the stream channel had been ditched with minimal riparian buffers. As a result, the stream displays very poor habitat and supports predominantly an environmentally tolerant fisheries. While a few brown trout occasionally found in the stream, WDNR baseline electroshocking surveys(2006) demonstrated very poor coldwater IBI scores (range 0 - 20, mean = 8.3, n = 6) and reflected the degraded habitat. The stream had been identified for potential trout management if buffers are expanded and habitat improved. 2006 HBI scores (mean = 4.1, n = 4) reflected “very good” water quality and influence of groundwater inputs.

Wendt Creek (Spring Brook)

Wendt Creek arises from wetlands in Sections 17 and 18 in the Town of Berry. The stream flows six miles to the confluence with Halfway Prairie Creek in Section 16 in the Town of Mazomanie. Wendt Creek had a brief history of trout management in the early 1950s but agricultural channel ditching and water quality problems rendered these efforts unsuccessful. The stream is now listed as 303d impaired but may have potential for trout management if buffers are expanded and habitat improved. Poor coldwater IBI scores (range 10 - 20, mean = 14.3, n = 7) from electroshocking surveys performed in 2003 and 2006 reflect fish populations dominated by environmentally tolerant and other eurythermal species. Consistent with Halfway Prairie Creek, macroinvertebrate collections from 2006 indicated “good” water quality with HBI scores ranging from 4.3 - 5.5 (mean = 4.6, n = 5).

Indian Lake

Indian Lake is a 27 ha (66 acres) shallow kettle lake that is maintained by groundwater and surface runoff. The entire lake is surrounded by the county park and recreational uses include fishing, bird watching, canoeing and other types of boating that do not involve gas engines. The lake is primarily managed for largemouth bass and panfish. An aeration system is frequently used during late winter months to avoid anoxia and fish winterkill conditions. The small lake had a long history of severe bluegreen algal blooms. During the early 1980's, WDNR Bureau of Research conducted an experiment to determine if adding nitrogen to the lake would trigger a shift from nitrogen fixing Cyanobacteria species to non-bloom species (Lathrop 1988). The findings indicated that nitrogen applications were not effective due to short-term responses and other complicating factors. Since then, bluegreen algal blooms in the lake have declined as a response to sustained dense aquatic plant growths and perhaps other factors.

Consistent with the hydrology of Fish and Crystal lakes, Indian Lake water levels have increased over time. The maximum recorded depth during the 1970s was 6 feet (Day et al. 1985). In 2006, the maximum water depth had increased to 8.5 feet. The water levels in all three lakes may reflect increased regional groundwater recharge associated with agricultural conservation land use practices (Gebert and Krug 1996). The lake area also expanded significantly.

More recently, EWM and coontail had become established in the lake and apparently suppress phytoplankton blooms. Harvesting the dense beds had become the primary management focus in the shallow lake. Dane County has been operating mechanical harvesters to create navigation channels for non-motorized boating access in the lake. These efforts also have potential to improve predator prey interactions (Marshall 2007). Lake volunteer secchi measurements (SWIMS database) taken from 2007-09 ranged from 0.5 meters to 1.7 meters (mean Trophic State Index Value 56 = eutrophic). Longer term secchi trends indicated improved water clarity and likely reflect increased macrophytes densities in the lake (Figure 12).

Fish species richness has been limited by periodic winterkills in the past. Species identified in the past surveys include fathead minnows (*Pimephales promelas*), bluntnose minnow (*Pimephales notatus*), white suckers (*Catostomus commersoni*), black bullhead (*Ameiurus melas*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*) (Lathrop 1988, Day et al. 1985). Following winterkills, bullhead populations periodically exploded and exacerbated turbidity and internal phosphorus loading in the lake. This occurred when dense bullhead populations disturbed bottom sediments when feeding. Currently, bluegill and largemouth bass populations are sustained by late winter aeration while harvesting improves the habitat.

A point intercept aquatic plant survey was performed on the lake in 2006 and that information was used to prepare an aquatic plant management plan for the lake (Marshall 2007). The goals for managing Indian Lake macrophytes are to (1) improve non-motorized boat access within dense coontail, Eurasian watermilfoil and curly-leaf pondweed beds, (2) sustain lake-wide aquatic plant beds in desirable densities to prevent bluegreen algal blooms that had historically occurred (3) manage aquatic plants to enhance the largemouth bass and bluegill fisheries and (4) enhance native floating-leaf plant populations.

Figure 11: Mean coldwater IBI scores for Black Earth Creek Watershed streams

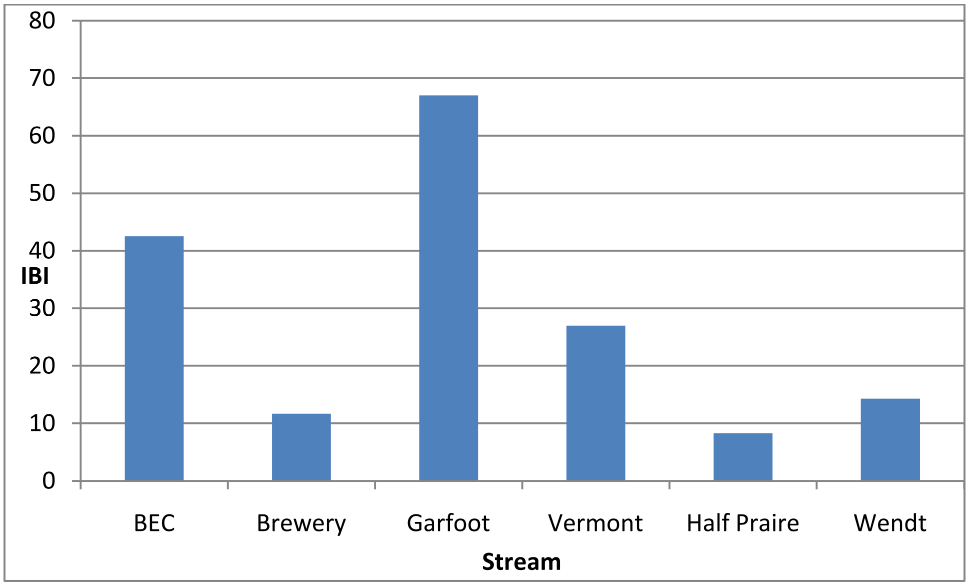


Figure 12: Water clarity trend in Indian Lake

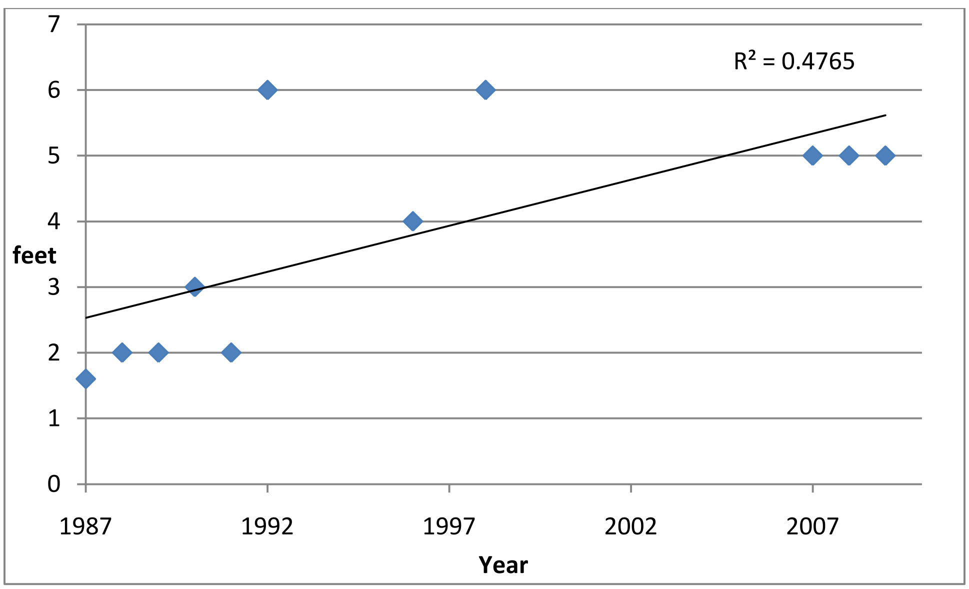


Table 5: Fish and Aquatic Life Designations

Waterbody	2000 Impervious Cover	Planned Impervious Cover	Use	Use Potentiial	Codified Use
Black Earth Cr. (Lower)	5.19%	5.83%	Cold	Cold	
Black Earth Cr. (Middle)	5.68%	6.47%	Cold		
Black Earth Cr. (Upper)	7.06%	8.53%	Cold		ORW
Brewer Cr.	6.24%	7.42%	wwff	Cold	
Garfoot Cr.	2.99%	2.99%	Cold	Class 1 trout	ERW
Vermont Cr.	3.57%	3.9%	Cold	Class 11 trout	303d
Halfway Prairie Cr.	3.99%	4.07%	wwff	Cold	303d
Wendt Cr.	3.32%	3.32%	wwff	Cold	303d

Mill and Blue Mounds Creeks Watershed

The Dane Count y portion of the Mill and Blue Mounds Creeks Watershed encompasses 22,851 acres of predominantly Driftless Area broad-leaf deciduous forest and agriculture. The percentage of agriculture is relatively low compared to many Driftless Area watersheds. Of concern are the relatively high urban growth rates in the Village of Mt. Horeb and Village of Blue Mounds with associated impacts of construction erosion and impervious surfaces runoff. Other concerns have included overtopping manure storage pits near streams and polluted runoff. More detailed resource characteristics appear in Table 6. The streams in this watershed typically display good trout habitat based on resident fish communities.

Table 6: Mill and Blue Mounds Creeks Watershed

Resource Characteristics	**In Acres**
Hydric soils	829
Wetlands	507
Agriculture	7,145
Commercial	31
Institutional/Governmental	21
Industrial	43
Open Water	8
Vacant Land or Under Construction	3,309
Outdoor Recreation	481
Residential	512
Transportation, utilities etc.	665
Woodland	10,594
Total Watershed Area	119,615
Dane County Portion	22,851

Dane County State of the Waters Report

Moen Creek

Moen Creek originates in Section 2 of Blue Mounds Township and flows northeast about two miles to the confluence with Elvers Creek. The headwaters are impounded to form Stewart Lake. A recent study of the creek near the dam determined that thermal impacts from the lake are minimal and did not alter the coldwater fish community (Dane County Dept. of Land and Water Resources 2006). Recent biological monitoring data indicate that the stream is supporting its Class II trout fishery with a coldwater IBI score of 40 (= fair) and HBI value of 4 (= very good water quality). The gradient is very steep at 103 ft/mile with a discharge of approximately 4 cfs near the confluence with Elvers Creek (Dane County Dept. of Land and Water Resources 2006).

Elvers Creek

Elvers Creek arises in Section 11 of Blue Mounds Township and flows north eight miles to the confluence with Ryan Creek. WDNR manages about 105 acres of public fishing grounds along the classified trout stream that is also designated ERW under Wisconsin Administrative Code NR 102. Portions of the lower stream reach had been ditched and is considered marginal Class III trout habitat. Polluted runoff from farmlands is also considered a problem limiting full potential of the stream. WDNR biologists recommended the stream for polluted runoff abatement efforts since the stream has potential for Class I trout management (Lower Wisconsin River State of the Basin Report). WDNR electrofishing surveys conducted from 2002 to 2008 had demonstrated favorable trout habitat in the stream with coldwater IBI scores ranging from 50 to 70 (mean = 58.3, n = 6).

Bohn Creek

Bohn Creek arises in Section 9 of Blue Mounds Township and flows north three miles to the confluence with Elvers Creek in Vermont Township. The lower part of the creek is managed as a Class II trout stream and it is also designated ERW under Wisconsin Administrative Code NR 102. The portion of Bohn Creek above the confluence with Little Norway Creek is considered marginal trout habitat. WDNR electroshocking surveys performed in 2002 and 2205 along the lower reaches of the stream revealed “excellent” trout habitat with a mean coldwater IBI score of 93 (n = 3). The very high scores reflected in part the presence of native brook trout in the creek.

Little Norway Creek

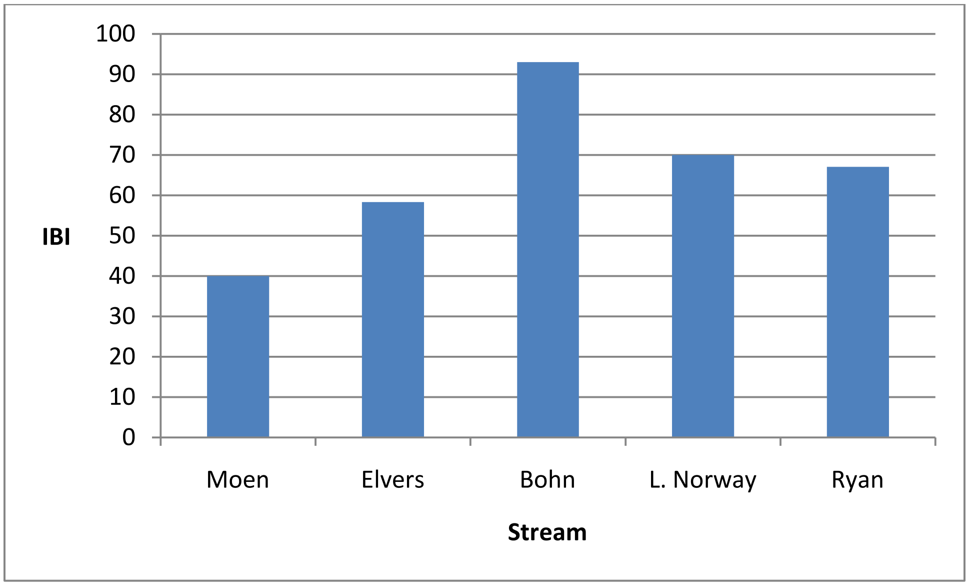
Little Norway Creek is a small tributary to Bohn Creek and arises in Section 4 of Blue Mounds Township. The creek is very steep with an elevation change of 92 feet/mile. While the small creek is not currently managed, a WDNR electroshocking survey performed in 2008 revealed good trout habitat with a coldwater IBI score of 70.

Ryan Creek

Ryan Creek is a six mile long Class II trout fishery that is also designated ERW under Wisconsin Administrative Code NR 102. While problems in the creek have been linked to channel ditching and cattle grazing, coldwater IBI scores from WDNR electroshocking surveys (2002, 2003 and 2009) revealed good trout habitat (range 50 – 80, mean = 67, n = 6). Very good HBI scores

(1.975 and 2.875) were revealed from macroinvertebrate samples collected in 2003. The stream is ranked high for polluted runoff abatement funding.

Figure 13: Comparative coldwater IBI scores from Mill and Blue Mounds Creek Watershed



Stewart Lake

The Dane County Department of Land and Water Resources initiated a study of Stewart Lake in the spring of 2006 to assess the water quality conditions in the lake and determine if the management recommendations in a previous (1995) plan were still viable (Dane Co. Dept. Land and Water Resources 2006). Results indicated that excessive lake fertility continued to undermine ecological and recreational potential in the lake. The data suggest that most of the fertility problems were linked to sediment deposits, although sediment depths had not changed significantly over the past decade. These results indicated that the best management practices installed after 1995 had been effective at reducing additional sedimentation in the lake. Consistent with the 1995 lake management plan, dredging was recommended to prevent internal phosphorus loading from the lake sediments.

The 1992-93 lake study concluded that stormwater runoff was a major source of nutrients in the lake as well as internal phosphorus loading from bottom sediments. The combined nutrient sources resulted in heavy algal growths in the lake. In this study it was concluded that lake fertility was also linked to sediment nutrients. However, in 2006 the fertility produced excessive rooted aquatic plants instead of algae. Whereas chlorophyll-a concentrations were relatively high in 1992-93 and reflected typical eutrophic conditions, in 2006 dense growths of non-native curly-leaf pondweed (*Potamogeton crispus*), common waterweed (*Elodea canadensis*) and coontail (*Ceratophyllum demersum*) had apparently suppressed phytoplankton growth. As a result, chlorophyll concentrations were lower and water clarity was generally better in 2006 than in 1992 or 1993.

During both study periods, low dissolved oxygen near the bottom of the lake was prevalent, indicating poor habitat for trout and other sportfish. However, in 2006 low dissolved oxygen levels were more pronounced than in 1992 or 1993. Following the seasonal decline of very dense common waterweed, August and September dissolved oxygen levels were lower than the minimum water quality criterion concentration of 5 mg/l throughout the entire water column. The data suggested that the suppression of algal photosynthesis continued even as the rooted plants were decaying. The decomposition of the aquatic plants also contributed dissolved oxygen deficits. When the aquatic plants were growing in early June 2006, supersaturated dissolved oxygen levels were evident and reflected photosynthesis (Figure 14). Coinciding with low dissolved oxygen in late summer, Stewart Lake had unusually high conductivity readings. The high conductivity readings can be an indicator of high fertility, including nutrients that were likely released from the decaying plants and ultimately from the sediment. High conductivity can also reflect high chlorides found in wastewater or road salt.

The ecological effects of the dense rooted aquatic plants found in 2006 included undermining fish predator-prey relationships. Abundant very small bluegills were easily observed near the surface during the 2006 study, particularly when dissolved oxygen levels were low. The dense plant canopy likely created a refuge, resulting in large numbers of stunted panfish.

2006 lake cross sectional data indicated that the water depths had not decreased since 1993 and that the watershed best management strategies were working. No significant change in water depths indicated that there were no additional sediment sources. Sediment chemical analysis revealed that the material is relatively clean and would not pose an environmental problem for drawdown, dredging and disposal.

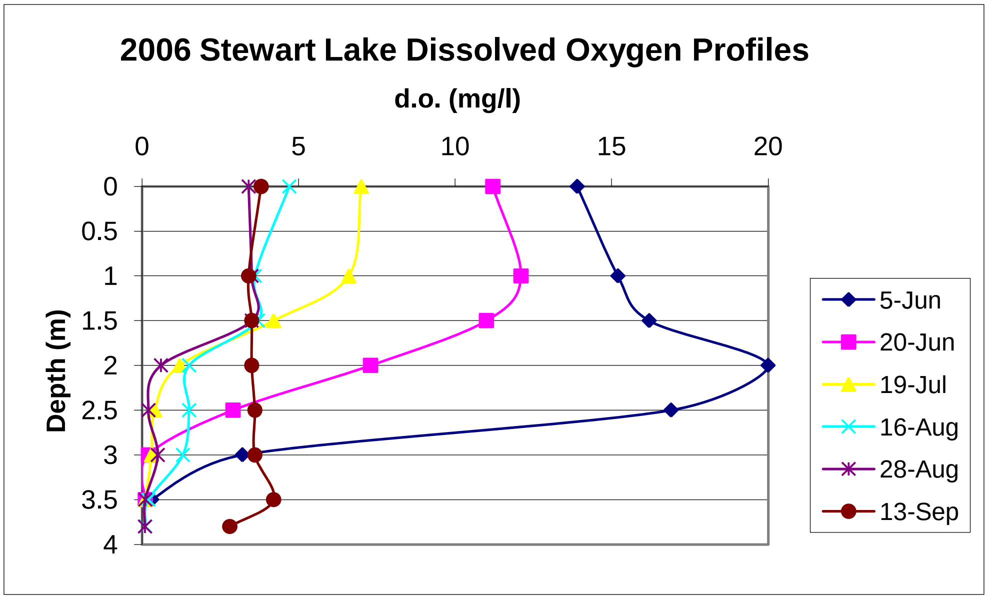
Water quality and thermal impacts of the lake were minimal below the dam. Groundwater flow to the stream rapidly increased below the dam and data loggers indicated water temperatures were typical of Driftless Area trout streams. The aquatic insect community reflected a healthy stream and fish populations were dominated by mottled sculpin (*Cottus bairdii*) and brown trout (*Salmo trutta*). Therefore, a restored lake was considered compatible with a healthy trout stream below the dam (Dane County Dept. of Land and Water Resources 2006).

In 2009, the lake was drained and sediments were allowed to compact before hydraulic dredging began. A total of 19,000 cubic yards were removed from the lake before it was refilled in 2010. Dane County Dept. of Land and Water Resources staff will monitor lake water quality responses to the restoration project, including potential for curly-leaf pondweed and Elodea growths that are common in Driftless Area impoundments.

Table 7: Fish and Aquatic Life Designations

Waterbody	2000 Impervious Cover	Planned Impervious Cover	Use	Use Potential	Codified Use
Bohn Creek	6.51%	6.51%	Cold	Cold	ERW
Elvers Creek (upper)	7.61%	8.84%	Cold	Class II	ERW
Elvers Creek	4.51%	4.72%	Cold	Class I	ERW
L. Norway Cr.	4.46%	4.46%	Cold		
Moen Creek	8.08%	9.39%	Cold		
Ryan Creek	3.75%	3.81%	Cold		ERW

Figure 15: 2006 dissolved oxygen profiles in Stewart Lake



Roxbury Creek Watershed

The Dane County portion of the Roxbury Creek Watershed encompasses 38,199 acres with agriculture the dominant land use. The principle water quality problems within this watershed are polluted runoff and channel ditching. Of concern to lake property owners is the long term trend of rising lake water in two seepage lakes; Fish Lake and Crystal Lake. The trend of rising lake levels coincides with increased baseflows in Driftless Area streams. Table 7 displays the watershed characteristics.

Table 7: Roxbury Creek Watershed

Resource Characteristics	In Acres
Hydric soils	7,197
Wetlands	3,717
Agriculture	18,816
Commercial	16
Institutional/Governmental	12
Industrial	164
Open Water	1,729
Vacant Land or Under Construction	4,259
Outdoor Recreation	339
Residential	842
Transportation, utilities etc.	1,090
Woodland	10,929
Total Watershed Area	45,553
Dane County Portion	38,199

Dunlap Creek (Dunlap Hollow Creek)

Dunlap Creek originates at the base of the terminal moraine in Section 33 of Roxbury Township. The stream flows about 10 miles to the confluence with the Wisconsin River. A wetland along the upper reaches of Dunlap Creek is composed of sedge meadows, fens, low prairies and shallow marshes (DCRPC 1992). The upper portion of Dunlap Creek is managed as a Class II trout stream and is designated ERW under Wisconsin Administrative Code NR 102. It was the focus of a small-scale priority watershed project in 1991 with BMPs designed to reduce gulley erosion. Between 1992 and 2003, coldwater IBI scores from electroshocking surveys in the upper reaches of Dunlap Creek ranged from 20 to 30 (mean = 24, n = 10) and revealed poor trout habitat. These results reflect sedimentation from cultivated fields and grazing (Dane County State of the Waters Report 2008).

Downstream of Hwy 78, extensive channel straightening and lack of buffers significantly reduces instream habitat until the stream enters the Lower Wisconsin State Riverway public lands. In 2010, an electroshocking survey, performed at the confluence with the Wisconsin River, revealed poor habitat in the stream. Typical floodplain fish were not found but instead species that reflect a degraded coldwater stream (Marshall and Jopke 2010). Recommendations from that study include restoring a meandered floodplain creek that should provide habitat for rare fish species found elsewhere along the Lower Wisconsin State Riverway. The existing ditched channel appears to inject cold water into the floodplain and may function as a thermal barrier to typical floodplain fish species. Brown trout should not be managed in the floodplain since the nonnative piscivore often threatens native and rare nongame fish species.

Marsh Creek (Marsh Valley Creek)

Marsh Creek arises in Section 4 of Mazomanie Township and flows 3.5 miles to the confluence with the Wisconsin River. The small low gradient stream had been ditched and lacks favorable fish habitat. Recently, Dane County purchased lands along Marsh Creek as part of the Walking Iron Park. The public acquisition offers potential for plugging lateral ditches and restored hydrology and habitat in the stream. Riparian and channel restorations could benefit a number of floodplain eurythermal fish species including the State Special Concern pirate perch that had been collected from the stream. Nonnative brown trout management is not recommended for the stream (Unmuth, personal communication).

Roxbury Creek (Blums Creek)

Roxbury Creek arises in Section 24 of Roxbury Township and flows eight miles west to the confluence with a Wisconsin River side channel oxbow. The primary land use along the creek is intensive agriculture and most of the headwaters had been ditched. The current stream classification is Limited Forage Fish from the headwaters downstream to Section 17. Downstream from that location the stream is classified Warm Water Forage Fish with a moderately diverse community that includes the State Special Concern pirate perch. In 2009, Roxbury Creek received emergency water pumping from hypereutrophic Crystal Lake. A survey that year demonstrated some degradation to the Wisconsin River slough near Roxbury Creek. Given the ecological importance of floodplain habitats to the Lower Wisconsin State Riverway, efforts to improve Roxbury Creek are recommended to protect the side channel and associated nongame fish (Unmuth, personal communication).

Fish Lake

Fish Lake (252 acres) is a moderately eutrophic lake located in the Town of Roxbury. The lake is relatively undeveloped with significant parklands adjoining the east and west shorelines. The public land acquisitions and the creation of Lusier County Park have been great additions to this unique deepwater seepage lake in southern Wisconsin. The acquisitions have also benefitted the water quality by reducing surface runoff pollution. Recreational uses include swimming, fishing and boating. There is a town ordinance prohibiting gasoline motors on the lake.

The Fish Lake watershed is approximately 1680 acres including the lake surface. The primary land use is agriculture. Top soils are fine silty loam and are nutrient rich from manure and fertilizer applications. Most of the watershed is rolling farmland with steep wooded hills. Just northwest of Fish Lake is Mud Lake (74 acres). Mud Lake was historically a northwest bay of Fish Lake that was mostly disconnected when Fish Lake Road was constructed. The bay is currently connected to Fish Lake via a culvert.

Major changes had occurred in Fish Lake over the last several decades including declining water quality and reduced native aquatic plant beds. Detailed information on Fish Lake can be found in a comprehensive lake management plan (Marshall et al. 1996) and in numerous research articles focusing on ecology of macrophytes and fish. The comprehensive lake management plan was based on a U.S. Environmental Protection Agency (USEPA) Clean Lakes Phase I Diagnostic and Feasibility Study and incorporated significant findings of the cooperative research effort known as the “Integrated Management of Macrophytes and Fish”.

Historically, Fish Lake had been classified mesotrophic based on chlorophyll-a, phosphorus, and Secchi (DCRPC 1979). During the 1970’s, the lake was considered to have the best water quality in the county however other indicators suggested gradual water quality decline. Hypolimnetic dissolved oxygen levels had been declining since the late 1950’s while poor survival of stocked rainbow trout (*Oncorhynchus mykiss*) ended any efforts to manage a two story fisheries by 1969 (DCRPC 1979). Cisco (*Coregonus artedii*) populations are native to the lake, and like trout, also require deep cool water habitat with sufficient dissolved oxygen. Over the past several decades, periodic cisco kills have been documented and coincided with low dissolved oxygen levels in the upper hypolimnion and thermocline.

Fish Lake historically supported diverse floating-leaf and submersed aquatic plant beds but significant declines in abundance had occurred. Native plant declines coincided with three long term changes in the lake: eutrophication, Eurasian water milfoil (EWM) invasion and rising water levels.

Approximately 60% of the Fish Lake watershed was agricultural, primarily in the forms of croplands and dairy farms. Even though the watershed to lake ratio is relatively low at 4.4:1, high phosphorus loading was documented during the 1990’s. The estimated annual phosphorus loading to the lake was 1690 lbs/year. Winter manure spreading and feedlots were identified as principal watershed sources of phosphorus and nitrogen at that time. More recently, the predicted phosphorus loading to the lake has declined and reflects a feedlot closure near Mud Lake and expanded parkland around both Fish and Mud lakes.

Within the last few decades, rising Trophic State Index (TSI) values indicated that Fish Lake had shifted from mesotrophic to moderate eutrophic condition. The long term water quality decline in the lake had been linked to watershed nutrient sources (Marshall et al. 1996). Evidence of declining water quality included reduced Secchi measurements, higher chlorophyll and higher hypolimnetic phosphorus and ammonia levels. In addition to increasing (TSI) values, littoral zone sediments also reflected nutrient enrichment. Shallow water sediment core sampling revealed very high levels of both phosphorus (1142 mg/kg) and ammonia (128 mg/kg). Sediment testing indicated that polluted runoff was deposited within littoral areas of the lake, particularly along the west shorelines adjacent to most of the agricultural runoff. Sediment fertility has been linked with EWM growth and phosphorus transport from the littoral zone (Smith and Barko 1990). Deep water sediment core sampling was also conducted and revealed significant water quality decline in recent years. Analyzing sediment cores is a way of determining a history of nutrient input into a lake. Upper portions of sediments reflected recent deposition.

While detailed lake and watershed monitoring studies were initiated in 1988 to address the declining water quality, lake users were generally more aware of the "dense weed beds" in the lake. Eurasian watermilfoil was first identified in 1967 and rapidly expanded throughout the 1980s. By 1991 dense growths of EWM covered 99 acres of the lake bottom area (Lillie 1996). During the EWM expansion period, numerous native species declined substantially as EWM established monotypic stands beyond one meter depth - a typical pattern of EWM invasions (Madsen et al. 1991). With the exception of coontail, the remaining native macrophytes occupied near-shore areas (Lillie 1996). The near-shore native plant beds can be more vulnerable to shoreline development and rapid water level decline.

In 1994, EWM declined by approximately 40% across the lake. The decline coincided with weevil damage (Lillie 2000, Creed 1998). Native weevils can reduce the viability of EWM by boring into the stems (Mazzei et al. 1999). Boring into the stem results in loss of plant buoyancy and the plant basically sinks. This either kills the plant directly or severely weakens the plant due to reduced photosynthesis. Coinciding with reduced macrophyte density that year, Secchi depths declined and chlorophyll-a concentrations increased. Higher chlorophyll levels may have reflected nutrient release from decaying EWM, reduced alleopathy or both. These conditions were temporary since EWM rebounded in 1996. The temporary EWM decline did not expand the distribution or abundance of native plants and may reflect sediment nutrient effects. The EWM decline and resurgence suggested that a lake-wide chemical eradication may not expand native plants and could result in severe Cyanobacteria blooms.

In addition to eutrophication and EWM expansion in Fish Lake, long-term rising water levels (Krohelski et al. 2002) was likely a third factor contributing to redistribution of native plants. As the water level rose, emergent and floating-leaf plants moved to newly submersed shorelines while EWM also migrated toward shore. The result had been a gradual shift of all plants, emergent, floating-leaf and submersed, toward the perimeter of the lake. In 2006, the management district began pumping water from the lake to reduce water levels. Many of the relatively scarce native species became desiccated as water levels rapidly dropped. More recently, the lake pumping had become a controversial issue given the uncertainty of pumping effectiveness and negative impacts of pumping hypereutrophic water to the Lower Wisconsin State Riverway. Impacts of the pumping in 2009 had included shoreline erosion of public land, loss of a diverse mussel bed that included State Threatened species and water quality degradation.

The EWM invasion had altered the habitat chemically in Fish Lake (Unmuth et al. 2000). Very low dissolved oxygen levels were found near the bottom of the beds. The effects of dense plant beds on predator-prey interactions had been reported as well (Engel 1987, Savino et al. 1992).

Local efforts to develop new methods for improving habitat within dense EWM beds began in 1989 (Marshall 1990). Scuba divers used manual cutting tools in Fish Lake to cut deeper growths of EWM at the sediment surface. The deep cutting technique held promise since the channels created by the SCUBA divers persisted for four years. Aerial photographs of the lake during this period clearly revealed where the channels were cut. Modest growths of curly-leaf pondweed and coontail had replaced EWM within the channels. Deep cutting to stress deeper EWM stands was ultimately tested by teams of researchers seeking management tools for improving EWM habitat and predator-prey interactions (Unmuth et al. 1999, Unmuth et al 1998, Olson et al. 1998, Trebitz et al 1997). The Dane County Public Works Department modified one of the county harvesters in order to conduct a series of deep cutting experiments in Fish Lake and in other lakes as well. While the mechanical channels did not persist as long as the manual cut channels, the results demonstrated increased growth rates for particular year classes of both bluegill and largemouth bass populations. "Cruising lanes" became available to largemouth bass. Predation on stunted bluegills occurred, followed with increased growth rates of specific year classes for both species.

Bluegill and largemouth bass comprise the dominant fisheries in the lake but numerous other species are found in the lake as well. Environmentally sensitive nongame species identified in Fish Lake include banded killifish (*Fundulus diaphanous*), blackchin shiner (*Notropis heterodon*) and blacknose shiner (*Notropis heterolepis*) and Iowa darter (*Etheostoma exile*). These species can typically be found in dense aquatic plant communities near shore (Becker 1983). The banded killifish is classified as State Special Concern and the other three species are classified as environmentally sensitive to degraded habitat (Lyons 1992). Abundant overhanging trees ring the lake and create another important habitat feature for fish populations and herptiles. In 2002, WDNR and Dane County Parks cooperated in a habitat improvement project along the Lussier Park shore. Large dead trees were pushed into the water and American lotus seed and nursery seedlings from Mud Lake were planted as well. The goal was to improve habitat for game fishes and intolerant nongame species that can be vulnerable to near-shore habitat loss. The current status of nongame fishes in the lake is unknown.

Fish Lake continues to be the focus of lake monitoring since it is part of the University of Wisconsin Center for Limnology Long Term Ecological Research (LTER) program. Figure 16 displays total phosphorus data and corresponding TSI (14.42 ln (ug/l) + 4.15) values from March 2006 to November 2009. The highly variable phosphorus levels reflect complex factors including lake morphology (deep seepage lake), dense Eurasian watermilfoil beds, seasonal variability, internal loading and agricultural runoff.

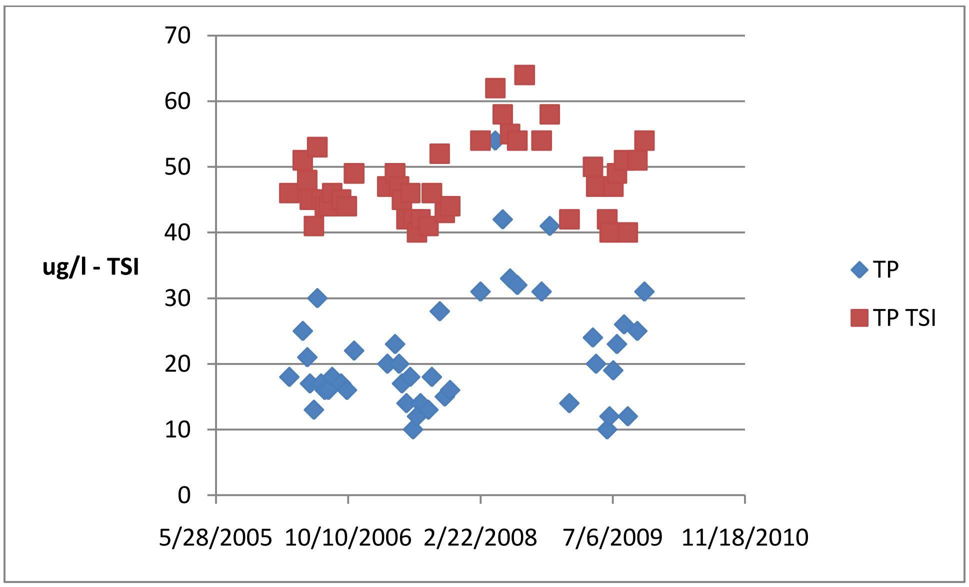
Point intercept macrophytes surveys were performed on Fish Lake in 2006-07 to gather information needed to prepare an aquatic plant management plan for the lake; a requirement of NR 109.04 (Marshall 2007). The recommendations listed in that plan include:

1. Consider longer term efforts to sustain boating lanes and improved fish habitat using methods such as deep cutting - harvesting. Methods could include modified large scale harvesting or manual cutting involving SCUBA.
2. Protect important habitat features including floating-leaf plant beds and coarse woody habitat. Residents should be discouraged from manually removing high values species such as watershield, floating-leaf pondweed and water lilies.
3. Recommend Sensitive Areas Designations to WDNR based on criteria established in Wisconsin Administrative Code NR 107 and other important ecological features. Sensitive Areas would

encompass plant beds with high value native species including watershield, floating-leaf pondweed and water lilies. Use of herbicides and large-scale mechanical harvesting is prohibited in these areas.

4. Encourage local land use planning and management to reduce nutrient runoff into the lake. (Watershed runoff had contributed to littoral zone sediments rich in nutrients, a factor contributing to high EWM growth in the lake. Potential sources of polluted runoff should be re-evaluated given reductions linked to surrounding park land acquisitions.)
5. Consider sampling nearshore fish populations, including blackchin shiner, blacknose shiner and banded killifish. These species may be affected by rapid habitat changes including rising water levels.

Figure 16: Recent surface total phosphorus trends in Fish Lake



Crystal Lake

Crystal Lake is a 525 acre shallow seepage lake located just 1,950 feet east of Fish Lake. Recreational uses include gasoline motorized boating, fishing, water skiing and swimming. In recent years, Crystal Lake has been a popular attraction for anglers due to the fast growing bluegill, crappie and largemouth bass populations. Additional recreational opportunities are located at a large commercial park located on the Columbia County side of the lake.

Unlike the relatively deep Fish Lake, Crystal Lake is shallow and it does not thermally stratify. Crystal Lake is classified as hypereutrophic due to high concentrations of Cyanobacteria. The WDNR lake database indicated that Secchi depth measurements have ranged from 1.5 feet (TSI = 72) to 2.8 feet (TSI = 63). The surrounding watershed is very similar to the Fish Lake watershed with agriculture the dominant land use. Likely sources of phosphorus to Crystal Lake include feedlots, crop fields and internal loading as the lake mixes throughout the summer. During the 1980s, WDNR conducted animal waste management (NR 243) investigations on several shoreline feedlots that were located on the Columbia County side of the lake.

Crystal Lake is hydraulically connected to Fish Lake by groundwater and rising water levels occurred in both lakes for decades (Krohelski et al. 2002). Maximum water depths were only 6 feet in the 1940s and increased to 9 feet by 1960. Frequent winter fish kills had been documented from the 1940s through the 1960s (DCRPC 1979). Aeration and frequent stocking were necessary to create recreational fishing during that period. When fish kills had occurred, bullheads were often the only survivors.

In recent years the trend of increasing water levels continued and the maximum water depth is now 14 feet. Consistent with the Fish Lake shoreline, trees had become inundated in past years and dead trees now line the perimeter of Crystal Lake. The dead trees are an important habitat feature for fish and herptile populations. Coinciding with the rising water levels, sustainable largemouth bass and panfish populations in the lake indicate that winterkills had diminished. In spite of continued hypereutrophic conditions, greater water volume has apparently increased the total oxygen mass within the lake. Water level declines in the future, perhaps linked to pumping, could reverse the trend of sustainable winter dissolved oxygen levels in the lake.

Dense growths of macrophytes had been reported decades ago including common waterweed (*Elodea canadensis*), sago pondweed (*Struckenia pectinatus*), duckweed (*Lemna*) and white water lily (*Nymphaea odorata*) (DCRPC 1979). There are no historical quantitative records on Cyanobacteria blooms or how the blooms might have affected the maximum rooting depths and distribution of macrophytes in Crystal Lake.

In recent years, EWM had become established in the lake and the formation of dense monotypic stands created recreational use problems. Management had included private herbicides applications around the two commercial mobile home parks in Columbia County while Dane County operated mechanical harvesters to provide boating access from the public boat ramp and elsewhere.

Fish populations had fluctuated over the years due to previous winterkills and also reflected restocking efforts. Bluegills (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*) and black bullhead (*Ameirus melas*) had been the most common species reported (DCRPC 1979). Other species reported from the lake include golden shiner (*Notemigonus crysoleucas*), fathead minnow (*Pimephales promelas*), pumpkinseed (*Lepomis gibbosus*) and orangespotted sunfish (*Lepomis humilis*). No environmentally intolerant fish species have been reported from the lake. Since about 1980, higher water levels have coincided with sustainable populations of largemouth bass, bluegill, black crappie (*Pomoxis nigromaculatus*), and to a lesser extent yellow perch (*Perca flavescens*). Panfish growth rates had been exceptionally fast compared with most Wisconsin lakes (Unmuth and Larson 1999). Cyanobacteria blooms and outbreaks of *Columnaris* bacteria are factors that periodically have negative impacts on the fisheries.

In 2006-07, point intercept macrophyte surveys were performed to collect information needed to prepare an aquatic plant management plan for the lake; a requirement under Wisconsin Administrative Code NR 109.24 (Marshall 2007). The surveys demonstrated that Eurasian watermilfoil was a minor component in an aquatic plant community already limited by heavy bluegreen algal blooms and poor water clarity. Recommendations from Crystal Lake aquatic management plan include:

1. Mechanical harvesting should be conducted during periods when EWM densities are high to improve boating access.
2. Modest levels of native macrophytes provide important fish habitat and should not be the focus of eradication efforts. These conditions may change and Eurasian watermilfoil could expand under different water level conditions, warranting management.
3. Recommend Sensitive Area designations to WDNR including bays supporting white water lily beds.
4. Protect coarse woody habitat around the lake for fish and herptile populations.
5. Encourage local land use planning and management to reduce nutrient loading into the lake. (Reducing bluegreen algal blooms could ultimately improve native plant growth in the lake.)
6. Consider coordinating the preparation of a comprehensive lake management plan with Columbia County.

Table 8: Fish and Aquatic Life Designations

Waterbody	2000 Impervious Cover	Planned Impervious Cover	Use	Use Potential	Codified Use
Dunlap Creek	3.43%	3.48%	Cold		ERW
Marsh Creek	5.42%	5.42%	wwff		
Roxbury Creek	4.26%	4.69%	lff/wwff		
Spring Creek *	4.33%	4.56%	Cold		ERW

*Lake Wisconsin Watershed

Lake Wisconsin Watershed

Dane County captures a small portion (14,244 acres) of the Lake Wisconsin Watershed that also occurs in Columbia and Sauk Counties. While Lake Wisconsin is the dominant feature of the watershed and falls outside of Dane County, it is a factor that affects the water quality of the Dane County portion of the Wisconsin River. Development is another issue of water quality concern since rapid growth rates have occurred in the Village of Dane and Lodi (Dane County State of the Waters Report 2008). Table 9 contains more detailed watershed characteristics.

Table 9: Lake Wisconsin Watershed

Resource Characteristics	In Acres
Hydric soils	876
Wetlands	698
Agriculture	9,541
Commercial	6
Institutional/Governmental	11
Industrial	23
Open Water	41
Vacant Land or Under Construction	1,118
Outdoor Recreation	9
Residential	321
Transportation, utilities etc.	461
Woodland	2,712
Total Watershed Area	137,695
Dane County Portion	14,244

Dane County State of the Waters Report

Spring Creek (Lodi Creek)

Spring Creek originates in the Town of Dane and flows north into Columbia County. It is a Class II trout stream and the Dane County portion is also designated ERW under Wisconsin Administrative Code NR 102. In Dane County, Spring Creek flows through Lodi Marsh, a State Natural Area. WDNR describes the Natural Area as: a large wetland complex with numerous springs and spring runs, southern sedge meadow, and cat-tail marsh. The large, mostly open wetland borders the headwaters and upper two miles of Spring Creek. Cattails, bulrushes, and sedges comprise most of the vegetation. Shrubs include pussy-willow, red-osier dogwood, and bog birch. On the south side of the marsh is a knob hill rising 240 feet from the marsh bottom. Its north slope supports a dry-mesic forest of red oak, sugar maple and basswood while a small dry prairie is located on the south slope. Along the base of the hill is an extensive seepage area with an abundance of skunk cabbage, marsh marigold, marsh fern, northern bedstraw, swamp loosestrife, spring-cress, wild iris, and mountain mint. Two large springs, one on each hill, provide a steady water flow. Of interest is the presence of 14 species of Papaipema moths, which are regarded as indicators of high-quality prairie and wetland habitat. In addition, many significant wetland-restricted moths are also found here. Breeding birds include great-blue heron, Sandhill crane, common snipe, willow and alder flycatcher, sedge wren, marsh wren, yellow warbler, blue-winged warbler, and a large number of red-winged blackbirds. Rare species include the silphium borer moth (*Papaipema silphii*), Newman's brocade (*Meropleon ambifuscum*), and ottoe skipper (*Hesperia ottoe*).

WDNR manages brook trout in the Dane County portion but the stream is difficult to survey within the extensive marsh. Beaver dams impound portions of the creek within the marsh. Most of the survey work had been completed in Columbia County and coldwater IBI scores range from 40 to 60 (mean = 52.5, n = 8) and reflect good trout habitat. The Friends of Scenic Lodi Valley had conducted River Planning Grant studies on the Columbia County portion of the creek over concern for polluted runoff from agriculture and impervious areas within Lodi.

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