Near Shore Fishes of Green Lake

Iowa darter collected on Green Lake 2015

Green Lake Sanitary District

Dave Marshall, Mark Sesing, Tim Larson, Dave Bartz, Scott Bunde, Charlie Marks

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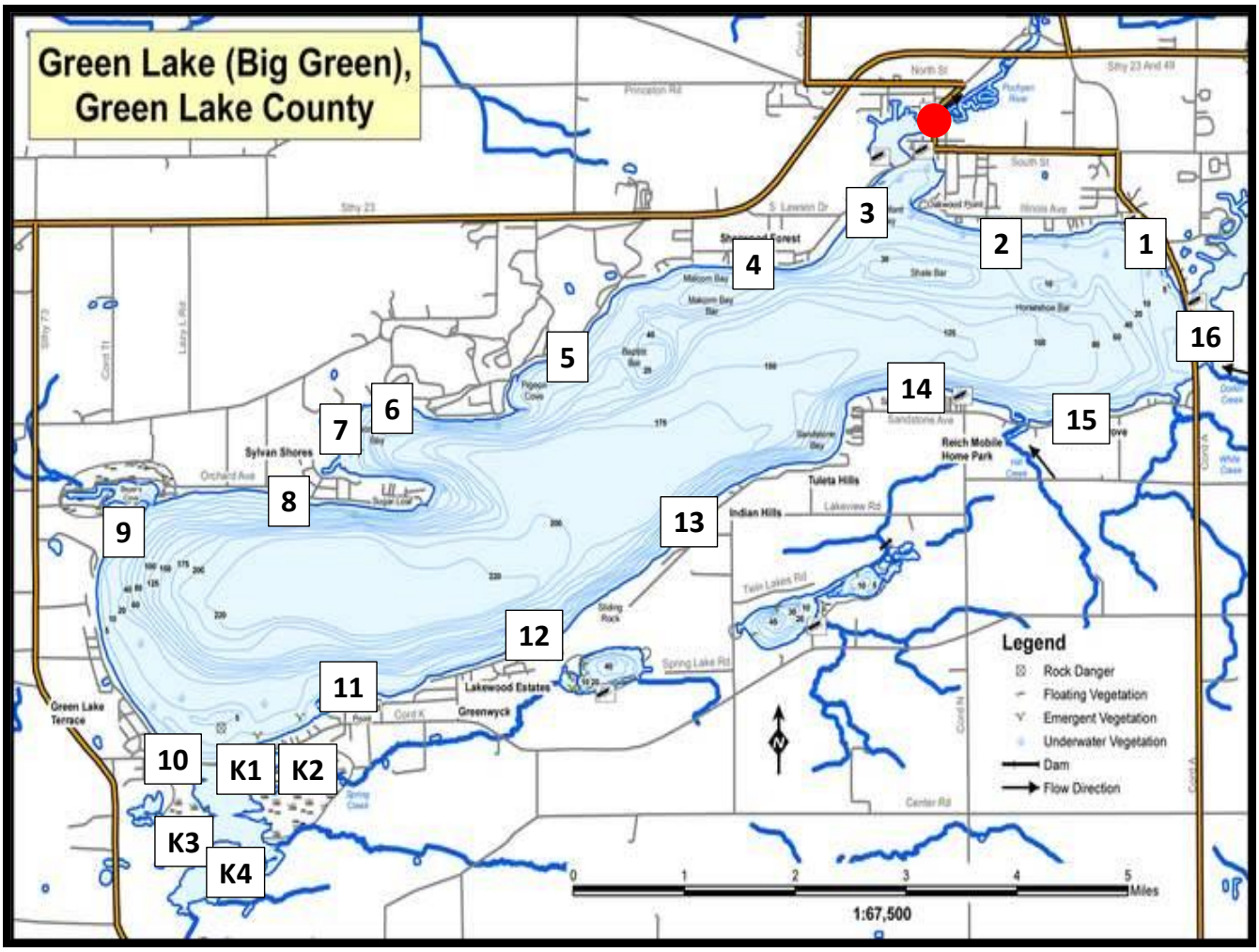
Summary

Limnologists typically focus on traditional trophic status indicators (i.e., TSI Secchi water clarity, TSI phosphorus and TSI chlorophyll), macrophyte surveys, plankton analysis, and sportfish inventories when assessing the environmental conditions in lakes. Important ecosystem indicators such as nearshore and nongame fish diversity are often overlooked. Some nearshore fish species are very sensitive to environmental degradation, and have been described as "canaries in the coal mine." These fish provide important food chain linkages and population declines can reveal ecosystem stresses that traditional lake monitoring will overlook. Nongame fish species are rarely surveyed since they offer no perceived economic benefit compared to more familiar gamefish populations. Nearshore fish surveys are also useful since immature stages of more popular sportfish are also collected and yield information on recruitment.

Periodic inventories of these biological indicators are useful in assessing individual population status, community diversity, and overall ecosystem stability. The survey conducted in 2015 represents the first comprehensive nearshore inventory of nongame fish species and associated immature sportfish in Green Lake. The following map identifies 16 nearshore fish sampling sites around Big Green Lake while K1 - K4 were sites sampled on the CTH K estuary. The red circle represents a survey that was completed in 1928. Wisconsin DNR had also conducted numerous fish population surveys on Green Lake, but these surveys focused on sportfish using either boom shockers or fyke nets that were designed to sample larger bodied fish. Results of these surveys revealed several large bodied fish species, including cold water species that inhabit deep water.

The Green Lake Sanitary District funded the study. A small scale grant was applied for but was unsuccessful.



Nineteen species of fish were collected in 2015 using both ¼ inch mesh bag seine and towed DC electroshocking gear at the 20 sites. Two species, fantail darter and mottled sculpin, had not been previously reported in the WDNR Fish Mapping Application database. WDNR had previously reported 21 species total based on 12 separate boom shocking, gill netting and fyke netting surveys conducted from 1957 through 2012. Nineteen species were identified in 1928 but this site was located near the dam and some of the species were more typical of lotic (stream) environments. The 1928 and 2015 surveys are the only records for central mudminnow and Iowa darter. Future nearshore fish surveys are warranted to better assess the status and potential trends in nearshore fish populations. Collectively, surveys conducted since 1928 revealed 40 fish species in this classic two-story fisheries lake.

Description of problem to be addressed by project:

1) Baseline Monitoring for CTH K Marsh Restoration - At Green Lake, tributary estuary areas are critical for supporting water quality, fish, and wildlife. CTH K estuary lying in the southwest quadrant of the lake is a degraded 270 acre shallow water marsh tributary to Green Lake. The estuary is degraded due to benthivorous fish (primarily carp), elevated water levels, and poor incoming water quality. At present, various strategies are underway to restore the marsh functions. With one important aspect of the restoration being the fishery, evaluation of the restoration outcomes will be important and allow for continued support and/or defining management priorities. Four index sites are being proposed for the K estuary serving to establish a baseline characterization of the near shore fishery.

2) Baseline monitoring of near shore "Fish Sticks" habitat enhancements. The installation of woody habitat near shore is anticipated to improve local fish habitat complexity leading to improved species diversity and abundance. This project is a "pilot" demonstration and its success will enable further public support for its continued installation. Typical losses of near shore woody structure (trees, brush, branches) due to development on WI lakes, Green Lake included, has resulted in simplification of physical macro and micro habitat resulting in biodiversity declines. Diverse ecosystems are more resilient to stress and are more likely to withstand negative external influence. The influence of resilient near shore fish populations ensures greater stability in the sport fishery. Four sites, Hammers Trail, Norwegian bay, Pools Hill, and Sunnyside will be appraised. These are all Healthy Lakes Project sites targeting woody structure quality. Because 2 of the sites (Pools Hill, Sunnyside) are within the Silver Creek inlet, the appraisal will also provide limited baseline data for the inlet.

3) Baseline Monitoring for Green Lake - Little is known of nearshore fish populations on the main basin of Green Lake. This group is represented by the minnows and other small forage species. Emerald Shiners for example have been reported as a declining forage species at Green Lake (Bartz,D). Although this could be problematic, evidence (i.e. data) is lacking. Nearshore fish populations can be diverse and represented by Endangered, Threatened, Special Concern and other intolerant groups. Periodic inventories of nearshore will indicate ecosystem health.

While Green Lake and its watershed likely support State endangered/threatened fish species, baseline populations remain unknown. 15 index sites are proposed for the main lake, 2 of those also being “fish sticks” sites.

Methods

The 2015 survey was specifically designed to sample nearshore nongame fishes and juvenile gamefish. It was not designed as a tool for evaluating the growth rates and size distributions of gamefish populations that require boom shocking and fyke netting gear. Instead, a towed DC electro-shocker barge and a 30 foot ¼” mesh seine were used as part of the 2015 nearshore survey to sample 20 sites (cover map). Latitude and longitude locations were recorded at the start and end of each electroshocking sites. Electroshocking distances at each site were approximately 100 yards long, determined with the trip odometer function of a handheld Garmin GPSmap 76. Seining was conducted perpendicular to shore at the start point of each electroshocking site. Three pulls, when possible, were completed within the site width starting in 4 feet depths (approximate) and pulling the seine shoreward. The actual distance from 4 ft. depths to the shoreline is dependent on site bathymetry. Seining catches fish in deeper water (up to waist deep). The combination of gear types was chosen to more effectively sample the different niches, behaviors and habitat preferences of diverse fish populations.

The seining was completed using ¼ inch mesh. This allows for capture of smaller fish typically occupying the near shore zone. Seining was conducted further off shore Vs electroshocking starting at 4 ft. depths with nets taken to shore for fish handling

The electrofishing is more effective at sampling habitats such as boulders, woody debris and artificial structures.

Electroshocking close to shore – A 12 Volt DC unit in combination with hand held electrode allows for access into smaller interstitial spaces where many non-game fish seek cover in addition to juvenile game fish like bass

Seining was completed on June 23, July 7, and Aug 6 , 2015, electroshocking on June 23 and 24, 2015.

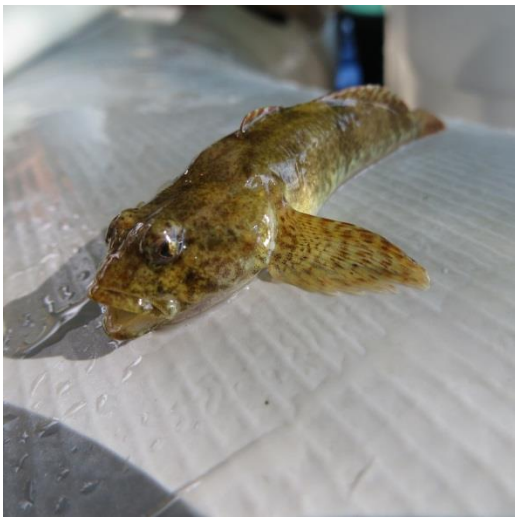
General habitat features were noted for each site (see appendix). The primary habitat features were summarized as rock, submersed aquatic plants, emergent aquatic plants and woody structure. Dissolved oxygen and temperature were measured at each site using a YSI DO meter. Specific conductance was measured with an Extech ExStik II. The WDNR Fish Mapping Application database (2015) was used to access the historic Green Lake fish database for comparisons with the 2015 nearshore survey.

Sites 1 thru 15 represent nearshore fish populations around the shore perimeter of Green Lake. Sites 6 and 7 doubled as controls for planned fish sticks installations. Site 16 was sampled to look at nearshore fish in the Silver Creek estuary. Sites K1 thru K4 were sampled to characterize nearshore fish populations in the County K estuary and serve as baseline pre-restoration evaluation sites.

Results

Tables 1 and 2 display the species collected in 2015, separated for towed electroshocking and small mesh seining. Eighteen species were collected with the towed DC electroshocker and 12 species using the seine. Collectively 19 species were found utilizing shocker and seine.

Species collected at the highest frequency using electroshocking gear were bluegill (90% frequency of occurrence), rock bass (65%), yellow bullhead (40%), yellow perch (35%) and mimic shiner (35%). This study documents the Iowa darter and central mudminnow in 2015 but these species had not been reported in the lake since 1928. Fantail darters and mottled sculpin were documented and these species had not been reported previously in the WDNR Fish Mapping Application Database (2015). The Iowa darter and mottled sculpin are classified as environmentally Intolerant (sensitive) and are considered to be vulnerable to environmental changes/degradation. The Iowa Darter and the “Miller’s Thumb” sculpin (mottled) serve as intermediate hosts for specific clam (mussel) species (Becker, G. Fishes of Wisconsin).



A mottled sculpin – Known as an indicator of trout waters, the sculpin has several common names one of which is “miller’s thumb”, derived from the condition of a flattened millers thumb after being caught between mill stones (G. C. Becker, Fishes of WI) . The sculpin is associated with colder water, especially in trout streams, but is also found in lakes with rock/cobble shores and good water quality. The sculpin is a species analogous to the coal mine canary.

With the exception of the K and Silver Creek estuaries, the principal habitat sampled with the electroshocking gear was in the form of large glacial boulders and associated cobble/ gravel and sand. The large crevices and interstitial spaces provide abundant habitats but we collected fewer fish than expected. The rock was generally covered with green (Chlorophyta) filamentous algae later identified as Cladophora. Supersaturated dissolved oxygen levels (105 – 198 %) were found at all sites around Green Lake and reflected photosynthetic activity of the dense filamentous algal growths. Specific conductance levels averaged 477 uS/cm (range 457 – 501). At Site 16 (Silver Creek estuary), dense floating leaf and submersed aquatic vegetation resulted in significant photosynthetic effect with dissolved oxygen saturation at 250%.

The large boulders rendered seining less effective. As a result, fewer species were collected using this gear. However, bluntnose minnows were collected at Site 7 with the seine and none were found using the towed DC electroshocker. Species collected at the highest frequency using the small mesh seine were largemouth bass (47%), yellow perch (47%), bluegills (40%), and smallmouth bass (27%).

Contrasted with the clear water in Green Lake, the County K estuary was very turbid due in part to a Cyanobacteria bloom (aka blue-green algae) and suspended sediment. The dissolved oxygen saturation began at 67% at 9 am and increased to 141 % by late morning. Only one intolerant species (smallmouth bass) was found in the K estuary . Degraded conditions were linked to Cyanobacteria blooms and carp disturbances. The estuary did provide habitat for

quality size bluegills and channel catfish however indicating the potential for fishery development. Reviewing the estimated overall habitat, sites scoring low (1) averaged 3.6 species per site and sites scoring medium (2) averaged 5.1 species per site using electroshocking gear. Only one site was estimated to display high (3) habitat value. This appraisal was not applied to seining since the habitat scores were based on visual nearshore conditions and seining occurred offshore.

Table 1: Green Lake Fish Collected with DC Towed Electroshocking Barge

Common Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**K1**	**K2**	**K3**	**K4**
Central mudminnow							1													1
Common carp																	5	2	17	9
Golden shiner																		2		
Fathead minnow																	4	3	29	5
Mimic shiner*	1			12		2		100			100	100	100							
White sucker							1													
Yellow bullhead	2					4	4				3						3	1	2	3
Channel catfish																	2		11	6
Bluegill		1	1	3	2	20		12		10		1	1		1	1	15	35	4	6
Pumpkinseed																2				
Largemouth bass									1			1		2	2				2	
Smallmouth bass		1						4									1			
Rock bass	3	7	10	21	42	15	4	23			26	1	6	4	12					
Yellow perch			2	2					1			11	1	1		3				
Iowa darter	4	1										2	1	1						
Fantail darter													3	2						
Mottled sculpin					1			1					1							
White bass											1									

* Mimic shiners exceeded 100 at four sites.

Table 2: Green Lake Fish Collected with a 30 foot Seine *

Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	K1	K2	K3	K4
Central mudminnow																				
Common carp							3												1	
Golden shiner																				
Fathead minnow																	2	2	5	
Mimic shiner				3		2														
White sucker																				
Yellow bullhead																				
Channel catfish																			4	
Bluegill			1		3	4				2							3		1	
Pumpkinseed																	2			
Largemouth bass	2						1		25	72	17	1							1	
Smallmouth bass											4	1	2	9						
Rock bass				1				1												
Yellow perch	3	1	5			162	2		69	1										
Iowa darter		1																		
Fantail darter																				
Mottled sculpin																				
White bass																				
Bluntnose minnow							30													

*The data above is based on three hauls per site (two hauls at Site K3 and no hauls at Site 16 due to unfavorable conditions) large boulders rendered seine hauls less effective at Sites 5 and 15.

Discussion

Based on the new species documented as part of this project, 40 fish species have been reported in Green Lake since 1928. Table 3 contains the updated Green Lake fish species list along with the environmental indicator category; I = Intolerant to environmental degradation, M = Medium tolerance to environmental degradation and T = Tolerant of environmental degradation (Lyons 2012). Six species listed are Intolerant, 18 species are Medium tolerance to degradation, and 9 species are Tolerant of environmental degradation. Seven species have not been assigned a tolerance category that is otherwise used for stream classifications. The ratio of intolerant to more tolerant species can be a useful metric in future surveys.

The 2015 nearshore fish survey did not target large bodied or cold water species. WDNR had surveyed these populations extensively from 1957 to 2012 (Table 4).

A mix of lotic and lentic fish was reported as part of a 1928 survey near the dam. It is unclear, however, if the site was located below the dam, above the dam or both. Some of the fish caught as part of the 1928 survey are not typically found in lakes (redhorses, stonerollers, pearl dace, creek chub, western blacknose dace and Southern redbelly dace). However, some of the species such as johnny darter, logperch, blackchin shiner, and bluntnose minnow are often found in lakes. Three of these four fish species were not found in 2015 (the exception being the bluntnose). The blackchin shiner is considered one of the "canaries in the coalmine" fish that has declined across its range (Gaumitz 2005, Lyons et al. 2000). The blackchin shiner has a strong affinity for aquatic plants and its decline often coincides with other environmentally sensitive nearshore species in Wisconsin due to loss of habitat, including aquatic vegetation, and/or water quality degradation (Marshall and Lyons 2008).

On a quantitative level the 2015 survey documented relatively low to moderate numbers of fish in near shore areas (based on experience). It remains unclear why there was only modest numbers of nearshore fish around Green Lake. Productivity in the lake does not appear to be low based on trophic parameters. However, dense filamentous algal growth in association with zebra mussel nutrient excretion is possible limiting factors. In the Great Lakes zebra mussels and quagga mussels have colonized extensive areas of lake substrate and associated dense

growths of *Cladophora glomerata* may be contributing to declines of some fish species. Synergistic interactions of zebra mussels and Cladophora have been reported in the Great Lakes that can affect both habitat and nutrient cycling (Oster 1980, Stankovich 2004). Zebra mussels are abundant in Green Lake and a filamentous algal sample collected from Green Lake during the nearshore fish survey was identified as *C. glomerata* (Garrison,P. WDNR).

Cladophora algae along the shoreline zone of Green Lake – the filamentous growth is suspected to be related to nutrient delivery from zebra mussels colonizing the lake substrate. Fish will be affected as habitat shifts from rooted plants and "clean" substrates to the condition shown here

Table 4 compares species found as part of the 1928 survey, 12 WDNR surveys from 1957 – 2012 and the 2015 survey. Results demonstrate that a variety of sampling methods are needed to assess fish populations ranging from sportfish to nongame species to invasive nonnative species such as common carp. Periodic nearshore fish sampling will enhance our understanding of the lake ecosystem and potential indicators of environmental change.

Common carp is an ongoing problem in the County K estuary that reduces rooted aquatic plant growth with high turbidity and Cyanobacteria blooms. The nearshore survey revealed the presence of large bodied channel catfish and also quality catch size bluegills. As common carp control alternatives are evaluated, the presence of these important predators and carp predators could play an important role in suppressing the common carp population. All of the carp observed during the nearshore fish survey were adults and the lack of young of year may

reflect a combination of egg-eaters (bluegills), predators (channel catfish) and pheromones as cues to suppress spawning (Bajer and Sorensen 2010, Sorensen and Stacy 2003).

Recommendations

1) Re-survey all Near Shore lake sites in 2020
2) Re-survey Near Shore K estuary and "fish stick" sites (post- restoration) in 2020 or sooner. Timing of restoration must be considered in scheduling.
3) Ensure the inclusion of Near Shore data into appropriate WI DNR and partners data bases
4) Study the linkage between Cladophora abundance and Zebra Mussels. Literature reviews, in situ evaluations, and water quality appraisals could be included.
5) Continue to improve the flow of information to the public regarding the relationship of zebra mussels and filamentous (Cladophora) algae. Improved understanding of the zebra mussel/filamentous algae link can foster realistic expectations for property owners and users.
6) Complete appraisals of zebra mussel distribution within the main lake basin
7) Complete appraisals of Cladophora distribution within the main lake basin

Table 3: Updated Green Lake Fish Species List with Environmental Indications

Common Name	***Scientific Name***	**Envir. Tolerance**
Bowfin	*Amia calva*	M
Longnose gar	*Lepisosteus osseus*	M
Lake trout	*Salvelinus namaycush*	
Brook trout	*Salvelinus fontilalis*	I
Brown trout	*Salmo trutta*	M
Rainbow trout	*Oncorhynchus mykiss*	M
Cisco	*Coregonus artedi*	
Whitefish	*Prosopium*	
Central mudminnow	*Umbra limi*	T
Northern pike	*Esox lucius*	M
Muskellunge	*Esox masquinongy*	
Common carp	*Cyprinus carpio*	T
Golden shiner	*Notemigonus crysoleucus*	T
Fathead minnow	*Pimephales promelas*	T

Cont. on next page		
Common Name	***Scientific Name***	**Envir. Tolerance**
Bluntnose minnow	*Pimephales notatus*	T
Blackchin shiner	*Notropis heterodon*	I
Mimic shiner	*Notropis volucellus*	M
Creekchub	*Semotilus atromaculatus*	T
Pearle dace	*Margariscus margarita*	M
Southern redbelly dace	*Phoxinus erythrogaster*	M
W. blacknose dace	*Rhinichthys obtusus*	T
Stonerollers	*Campostoma spp.*	
White sucker	*Catostomus commersoni*	T
Redhorses	*Moxostoma spp.*	
Yellow bullhead	*Ameiurus natalis*	T
Channel catfish	*Ictalurus punctatus*	M
Bluegill	*Lepomis macrochirus*	M
Pumpkinseed	*Lepomis gibbosus*	M
Largemouth bass	*Micropterus salmoides*	M
Smallmouth bass	*Micropterus dolomeiu*	I
Rock bass	*Ambloplites rupestris*	I
Black crappie	*Pomoxis nigromaculatus*	M
White bass	*Morone chrysops*	
Yellow perch	*Perca flavescens*	M
Iowa darter	*Etheostoma exile*	I
Fantail darter	*Etheostoma flabellare*	M
Johnny darter	*Etheostoma nigrum*	M
Logperch	*Percina caprodes*	M
Walleye	*Sander vitreus*	M
Mottled sculpin	*Cottus bairdii*	I
I = Intolerant, M = Medium Tolerance, T = Tolerant		

Table 4: Green Lake Fish Species List Based on Different Sampling Methods and Periods.

Common Name	**1928**	**WDNR***	**2015**
Bowfin		X	
Longnose gar		X	
Lake trout		X	
Brook trout		X	
Brown trout		X	
Rainbow trout		X	
Cisco		X	

(cont.)			
Common Name	**1928**	**WDNR***	**2015**
Central mudminnow	X		X
Whitefish		X	
Northern pike	X	X	
Muskellunge		X	
Common carp	X	X	X
Golden shiner		**	X
Fathead minnow		**	X
Bluntnose minnow	X		X
Blackchin shiner	X		
Mimic shiner		**	X
Creekchub	X		
Pearle dace	X		
Southern redbelly dace	X		
W. blacknose dace	X		
Stonerollers	X		
White sucker	X	X	X
Redhorses	X		
Yellow bullhead		**	X
Channel catfish		X	X
Bluegill		X	X
Pumpkinseed	X	X	X
Largemouth bass	X	X	X
Smallmouth bass		X	X
Rock bass		X	X
Black crappie	X	X	
White bass		X	X
Yellow perch	X	X	X
Iowa darter	X		X
Fantail darter			X
Johnny darter	X		
Logperch	X		
Walleye		X	
Mottled sculpin			X
Total spp.	19	21	19

* includes 12 surveys during the period 1947-2012

** Species identification unconfirmed

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Appendix

Six nongame species representing three different families; Minnow Family, Mudminnow Family and Sculpin Family

Fathead minnow

Mimic shiner

Bluntnose minnow

Blackchin shiner

Mottled sculpin

Central mudminnow

Appendix (cont.)

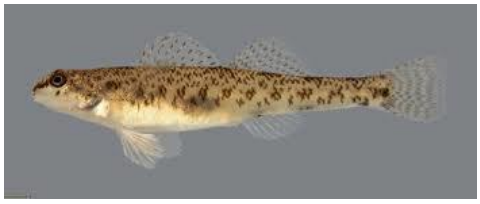
Five Perch Family members documented in Green Lake over the years

Logperch

Yellow perch

Iowa darter

Fantail darter



Johnny darter

Appendix (cont.)

Table 5: Nearshore Fish Survey Site Descriptions

	6/23/2015	6/23/2015	6/23/2015	6/23/2015	6/24/2015	6/24/2015	6/24/2015
	1	2	3	4	5	6	7
Start Lat	43.8293	43.8345	43.83944	43.83143	43.82327	43.81617	43.81311
Start Long	88.92982	88.94894	88.969	88.98347	89.00523	89.03363	89.03717
End Lat	43.82962	43.83467	43.83846	43.83117	43.82308	43.81595	43.8129
End Long	88.92953	88.95029	88.96962	88.98448	89.00607	89.03442	89.03767
Start Time	14:30		15:45	16:15	8:38	9:15	9:40
End Time	14:40		16:00	16:40	8:50	9:25	9:49
Pics	447, 448	449		453	454, 456	479	487, 488
Bedrock%							
Boulder%	10	30	30	30	50		
Cobble%	10	30	30	30	30		
Gravel%	30	30	30	30	10	10	
Sand%	40	10	10	10	10	80	90
Silt/Marl%	10					10	19
Clay%							
Temp C	26.2	22.8	22.3	21.6	20.5	20.4	22
D.O. mg/l	15.6	15	15.9	13	10.4	9.26	12.4
% Sat.	198	179	193	151	118	105	145
Sp Cond	501	466	465	471	490	485	480
Clarity	Clear	Clear	Clear	Clear	Clear	Clear	Clear

Appendix (cont.)- Nearshore Fish Survey Site Descriptions

	6/24/2015	6/24/2015	6/24/2015	6/24/2015	6/24/2015	6/24/2015	6/24/2015
	8	9	10	11	12	13	14
Start Lat	43.80412	43.80115	43.78522	43.78538	43.79122	43.80698	43.81745
Start Long	89.03518	89.06695	89.06587	89.03845	89.00935	88.98803	88.96995
End Lat	43.80503	43.8009	43.78498	43.7856	43.79192	43.80725	43.8179
End Long	89.03645	89.06737	89.06527	89.03755	89.00835	88.98703	88.96873
Start Time	10:10	10:50	11:10	12:35	13:07	13:40	14:07
End Time	10:22	10:55	11:20	12:45	13:15	13:50	14:22
Pics	502 - 505	511-514	516-522	523, 524	525-531	538-545	549-556
Bedrock%							
Boulder%	20			10	20	20	20
Cobble%	50			40	40	30	40
Gravel%	30			40	30	40	40
Sand%			90	10	10	10	
Silt/Marl%			10				
Clay%							
Temp C	21.6	22	23.1	23.8	23.7	23.7	23.7
D.O. mg/l	9.7	10.8	12.8	10.4	8.8	9.8	10.2
% Sat.	114	125			107	120	124
Sp Cond	470	457	462	465	483	485	485
	Clear	Clear	Clear	Clear	Clear	Clear	Clear

Appendix (cont.)- Nearshore Fish Survey Site Descriptions

	6/24/2015	6/24/2015	6/23/2015	6/23/2015	6/23/2015	6/23/2015
	15	16	K1	K2	K3	K4
Start Lat	43.81693		43.7764	43.77744	43.76833	43.7666
Start Long	88.93388		89.05363	89.0508	89.05365	89.05214
End Lat	43.81753	43.83012	43.77675	43.77719	43.76856	43.76624
End Long	88.93267	88.91965	89.055	89.0518	89.05246	89.05309
Start Time	14:35	15:08	9:00	9:55	10:40	11:25
End Time	14:49	15:18	9:12	10:05	10:55	11:35
Pics	557, 558	561-572	429	430		
Bedrock%	10					
Boulder%	30				10	10
Cobble%	30		25	10		20
Gravel%	30		25	30		10
Sand%		50	10	10	20	10
Silt/Marl%		50	35	30	50	30
Clay%			5	20	20	20
Temp C	24.4	29	22.3	23.1	23.7	23.4
D.O. mg/l	12.3	16	7	5.6	11.7	10.5
% Sat.	154	250	82	67	141	126
Sp Cond	496	654	446	452	397	421
	Clear	Stained	Turbid	Turbid	Turbid	Turbid

Appendix (cont.)

Baseline Characterization of Near Shore Fishery at Green Lake, Including Lake Shore Sites and Sites Designated for Restoration Actions

Description of problem to be addressed by project:

1) Baseline Monitoring for CTH K Marsh Restoration - At Green Lake, tributary marsh areas are critical for supporting water quality, fish, and wildlife. CTH K marsh (aka County Park marsh) lying in the southwest quadrant of the lake, is a degraded 400 acre shallow water marsh tributary to Green Lake. The marsh is degraded due to benthivorous fish (primarily carp), elevated water levels, and poor incoming water quality. At present, various strategies are underway to restore the marsh functions. With one important aspect of the restoration being the fishery, evaluation of the restoration outcomes will be important and allow for continued support and/or defining management priorities. While many evaluation projects focus on traditional eutrophication indicators (Phosphorus, Chl a, Sechhi) and aquatic plants, other ecological indicators i.e. near shore fish are often overlooked. Four index sites are being proposed for the K marsh serving to establish a baseline characterization of the near shore fishery.

2) Baseline monitoring of near shore "Fish Sticks" habitat enhancements. The installation of woody habitat near shore is anticipated to improve local fish habitat complexity leading to improved species diversity and abundance. This project is a "pilot" demonstration and indicating its success will enable further public support for its continued installation. Typical losses of near shore woody structure (trees, brush, branches) due to development on WI lakes, Green Lake included, has resulted in simplification of physical macro and micro habitat resulting in biodiversity declines. Biodiverse systems are more resilient to stress and are more likely to withstand negative external influence. The influence of resilient near shore fish populations ensures greater stability in the sport fishery. Four sites, Hammers Trail, Norwegian bay, Pools Hill, and Sunnyside will be appraised. These are all Healthy Lakes Project sites targeting woody structure quality. Because 2 of the sites (Pools Hill, Sunnyside) are within the Silver Creek inlet, the appraisal will also provide limited baseline data for the inlet.

3) Baseline Monitoring for Green Lake - Little is known of nearshore fish populations on the main basin of Green Lake. This group is represented by the minnows and other small forage species. Emerald Shiners for example have been reported as a declining forage species at Green Lake (Bartz,D). Although this could be problematic, evidence (i.e. data) is lacking. Assuming the Emerald Shiner is declining (due to various causes) , their sensitivity to environmental conditions is analogous to the canary in the coal

mine. These sensitive fish populations provide important ecological linkages that may reveal lake ecosystem stresses before traditional trophic parameters (phosphorus, clarity, and chlorophyll) reveal water quality problems. Nearshore fish populations can be diverse and represented by Endangered, Threatened, Special Concern and other intolerant groups. Periodic inventories of nearshore fish populations are needed to assess species richness, status of environmentally sensitive species and reflect ecosystem health. While Green Lake and its watershed likely support State endangered/threatened fish species, baseline populations remain unknown. 15 index sites are proposed for the main lake, 2 of those also being "fish sticks" sites.

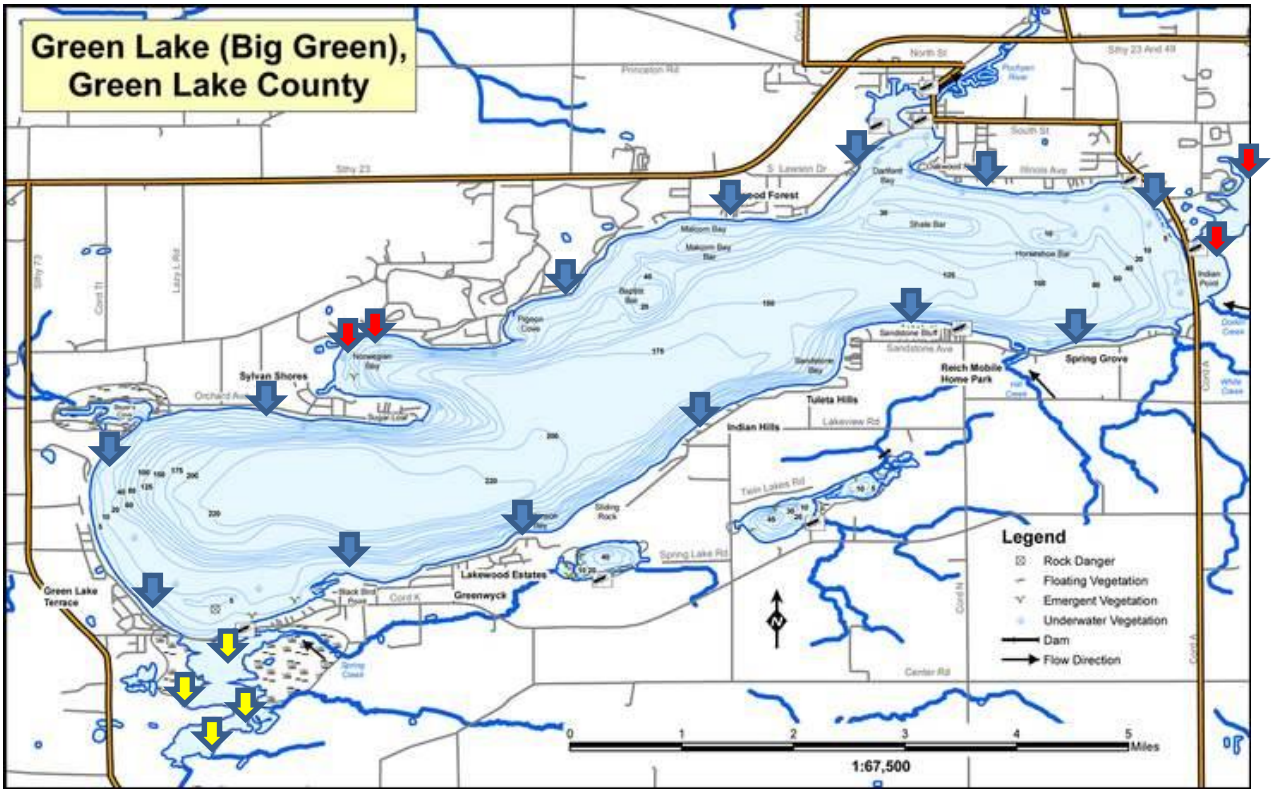
Project goals and objectives: Evaluate the status of nearshore fish populations including species richness, environmentally sensitive species and presence/absence of NHI species. Evaluate factors that may be affecting species diversity, rare and endangered species and the overall ecological balance in the lake. Review existing information on species status. Establish baseline fishery population characteristics prior to restoration (fish sticks and K marsh only). Post restoration monitoring would be completed in 2016 or beyond and is not included in this proposal. This proposal includes pre-restoration work only.

Methods and activities: Near shore fish population sampling will include small mesh seining, towed DC electro-shocker, minnow traps and small mesh dip netting. The combination of sampling gear is needed to effectively sample the different habitats and behaviors of diverse fish populations. All specimens will be immediately released after field identification and enumeration except when immature specimens require further review. The fish surveys are designed to sample populations of nongame species and juvenile stages of sport fish. This type of survey *will not* evaluate the growth rates, size distribution or population densities of sport fish populations. 21 sites collectively will be evaluated in the K marsh (4), lake basin (13) and fish sticks (4) locales.

Review files information from WDNR, Green Lake Sanitary District and other potential repositories.

A variety of sampling sites will be identified for sampling along the lake shoreline and tributaries. Additional information collected will include GPS coordinates, estimating habitat types: Woody debris, aquatic vegetation and rock (High=3, Medium=2, Low=1, Absent=0). Water temperature and dissolved oxygen data will be collected with a YSI Model 52 meter. Specific conductance and pH data will be measured with a YSI Model 63 meter. The map below indicates the 4 "fish stick" project sites in red (from Reas,2015)

Fish Stick project sites are indicated in red. A total of 4 fish stick sites are proposed. (Reas,L & Marks,C)



Arrows indicate survey stations on main lake body and tributaries. (Blue-Lake/Yellow-K marsh/Red-Fish Sticks) The lake sites are approximate, subject to change.

Description of project deliverables: Updated nearshore fish community database, analysis comparing with previous surveys results, assessment of potential or likely environmental factors contributing to status of nearshore fish populations, intolerant species and NHI species. **A final report will be prepared.**

Description of data to be collected: List of species collected and identified, environmental conditions including summary of site habitat conditions, vertical d. o., temperature, pH and specific conductance.

Description of existing and proposed partnerships: Green Lake Sanitary District, Wisconsin DNR Bureau of Endangered Resources, WI Lakes Partnership, WI DNR Fish Management, Green Lake Association, and local consulting contractors.

Discussion of role of project in planning and/or management of lake: This information is critical for a comprehensive analysis and planning perspective and assists WDNR Endangered Resources and all management partners in analysis of the state of Species of Greatest Conservation Need, Critical Habitat Designations and recommendations for shoreline habitat management. Sites designated for evaluation (4 in K Marsh, 4 fish stick) are proposed to determine efficacy (did it work?) of corresponding restoration actions however *post installation monitoring will not be completed under this proposal* as the restoration progress timeline is not established.

Timetable for implementation of key activities: Identify survey sites, review existing database and submit inquiries data inquiries to partners as needed (May 2015). Conduct nearshore fish population surveys including small mesh seining, minnow traps, dip netting and towed DC electroshocking in June and August 2015. Complete data analysis and prepare final report by December 31, 2015. Further site evaluation will be necessary post 2015 (2016, 2017) and will be dependent upon fish stick and K marsh restoration progress timelines.

Plan for sharing project results: Fact sheets will be prepared for partner and media distribution.

Additional information:

One team will complete the field activities w/ multiple boats surveying together simultaneously conducting 1) seining with nets and 2) electrical shocking gear

1) Seine team /Bartz, Tech , and one more desired. Costs absorbed as routine operation
2) Shocker team/Marshall, Sesing, Larson.
   5 field members minimum…6-7 more ideal.

DNR will supply one boat and D. Marshall will supply one boat (alternates- Sesing, GLSD, T. Larson)

<u>Costs</u>
2 day event $2,700 (includes 2 persons w/travel,equipment,gear,report prep)
3 day event $3,900 (includes 2 persons w/travel,equipment,gear,report prep)

Appendix (cont.)

Nearshore Fish Collection Datasheet - Front

DATE:

Waterbody: _____ **County:** _____ **WBIC:** _____

Location description: _____

_____

Start:
Latitude (dd.dddd): _____._____ **N** **Longitude (dd.dddd):** _____._____**W**

Finish:
Latitude (dd.dddd): _____._____ **N** **Longitude (dd.dddd):** _____._____**W**

Fish sampling gear: Seine ____ **Shocker** _____ **Dip net** ___

Crew: _____

Comments: _____

SITE HABITAT

SUBSTRATE (nearest 5% within area sampled):
Bedrock: ____ **Boulder:** ____ **Cobble:** ____ **Gravel:** ____ **Sand:** ____ **Silt/Marl:** ____ **Clay:** ____
Other: ____ **(Specify:** _____**)**

AQUATIC VEGETATION (Within area; circle one: H=High, M=Moderate, L=Low, A=Absent):
Macrophytes-Submerged: H M L A M-Floating: H M L A M-Emergent: H M L A Algae: H M L A
Species observed:_____

COVER (Within area sampled; cover for an 8" fish; circle one: H=High, M=Moderate, L=Low, A=Absent):
Overall: H M L A Aquatic plants: H M L A Woody debris: H M L A Natural Rock: H M L A
Artificial structures: H M L A Number of piers/ artificial structures: _____**)**

Water temperature: _____ **C @** _____ **hrs Water Clarity (circle one): Clear Stained Sl. Turbid Turbid**

Dissolved oxygen:_____**mg/l pH**_____**su Sp. conductance**_____**uS/cm Transparency tube**_____**cm**

FISH CAUGHT

SPECIES	NUMBER	COMMENTS

Nearshore Fish Collection Datasheet - Back

FISH CAUGHT

SPECIES	NUMBER	COMMENTS
Total species	**Total number**	