

# **Minnow and Small Fish Assemblages Of Pewaukee Lake, Wisconsin**

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Prepared by

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## INTRODUCTION

Pewaukee Lake is a 2,493 acre glacial lake located in Waukesha County, Wisconsin. It is an extremely important part of the natural resource base of the City and Village of Pewaukee, and the Town of Delafield. The lake's basin was originally created by the blocking of a pre-glacial erosion valley with glacial material. This resulted in the impoundment of runoff and a reversal of the prevailing drainage pattern (SEWRPC 2003).

One unique aspect of the lake is that it is divided into two distinct, but very different basins. The West Basin has a 45 foot maximum depth, and is characterized by its steep sloping gradient. Previously known as Snail Lake, this basin was the original lake before settlers moved into this area. The East Basin, on the other hand, is quite shallow with a maximum depth of about 10 feet. Until 1838, this basin was a marsh with water levels ranging only from 0.5 to 1.0 foot (SEWRPC 2003). The outlet running from this marsh was later dammed, raising the water level to its current depth. The entire lake, including both basins, has a mean depth of about 15 feet. Approximately 15 percent of the lake is less than 5 feet deep, 63 percent is from 5-20 feet deep, and 22 percent of the lake is over 20 feet deep (SEWRPC 2003).

Pewaukee Lake's major axis lies from the Northwest to the Southeast, covering a maximum length of 4.5 miles and a maximum width of 1.4 miles. The circumference of Pewaukee Lake measures 12.8 miles. A watershed area drains 24.5 square miles of surrounding land directly into the lake. Pewaukee Lake is classified as a natural drainage or through flow lake, which indicates that it contains both an inflow of water into the lake, as well as a determined outflow. Zion Creek, Audley Creek, Cocoa Creek, and one unnamed tributary, commonly called Meadow Brook, are responsible for a large percentage of the water influx entering into Pewaukee Lake. On the other hand, Pewaukee River is the main outflow that drains the lake. Pewaukee Lake's water level is determined mainly by the dam located on this major outlet.

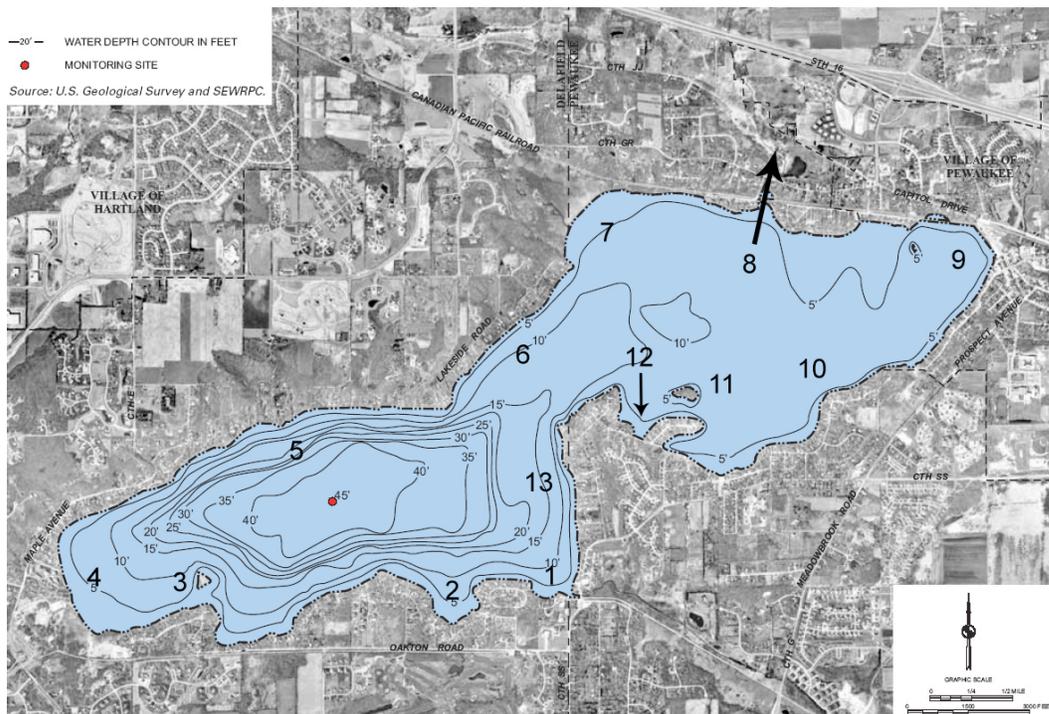
Pewaukee Lake is home to a diverse population of aquatic biota. Aquatic vegetation is quite abundant in the lake including emergent and submersed plants (macrophytes) as well as microscopic algae (phytoplankton). The lake supports an extensive sport fishery with a forage base of minnows and other small fish species (SEWRPC 2003). This study focused on the minnow and small fish assemblage of Pewaukee Lake. Comparisons to historical sampling are made in an effort to determine the status of this segment of the fishery.

## METHODS

Minnow species were sampled at 13 locations on Pewaukee Lake and Cocoa Creek in Waukesha County, Wisconsin (Table 1, Figure 1). Sampling occurred July through October, 2006. All sampling was conducted within 30 feet of shore with the exception of station 8 which was in Cocoa Creek, a tributary to the lake.

**Table 1.** Sampling locations with identification name, and Global Positioning System (GPS) coordinates used in Pewaukee Lake minnow study, 2006.

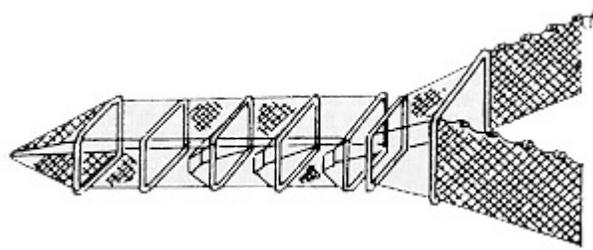
Location	North	West
1. Yacht Club Shoreline	43° 03.763	88° 18.417
2. South Central shore on West Side	43° 03.603	88° 18.875
3. Southwest Side of West Island	43° 03.723	88° 20.287
4. West End of Lake	43° 04.093	88° 20.029
5. North Shore of Deepest Point of Lake	43° 04.335	88° 19.787
6. North Shore Across From Rocky Point	43° 04.641	88° 18.589
7. Taylor's Bay	43° 05.125	88° 18.155
8. Cocoa Creek	43° 05.616	88° 17.149
9. Public Beach East End	43° 05.020	88° 15.951
10. South Central Shore on East Side	43° 04.590	88° 16.281
11. Middle Island	43° 04.475	88° 12.481
12. Starky's Bay	43° 04.306	88° 17.830
13. South of Rocky Point	43° 04.140	88° 18.246



**Figure 1.** Pewaukee Lake, Waukesha County, Wisconsin sampling locations during July through October 2006 (SEWRPC 2003).

Several methods were used to capture minnows for this study. Fish were collected using a modified Fyke net, commercial funnel minnow traps, and a 30-foot bag seine. A backpack electroshocker was used in Cocoa Creek.

The Fyke net (Figure 2) was comprised of a rectangular trap with two large wings offset on 45 degree angles in either direction to the axis of the main body. These wings help to guide the fish into the main part of the trap where two sets of slit doors allowed easy entrance into the trap, but difficult passage out. The Fyke net was made of fine mesh netting ensuring that small specimens could not escape. This net was only used at location 1. The trap was placed in 2-3 feet of water in sparse vegetation on a predominately sand-silt substrate. The trap was staked in and secured so that the top of the wings and body were even with the water level and the bottom was resting on the lake floor. To ensure that other fish larger than minnows did not get entangled in the Fyke net, a large protective screen made of chicken wire was secured in front of the trap. The Fyke net was baited with Nabisco Premium Saltine crackers and was left unattended for 24-48 hours. When specimens were obtained in the trap, a simple drawstring pull at the rear of the net allowed specimen recovery.



**Figure 2.** Diagram of a general Fyke net. Model actually used consisted of two chambers.

The second method employed was the use of funnel minnow traps (Figure 3). The structure of a funnel minnow trap is quite simple. It has a cylindrical shape and is made of a fine labyrinth of wire. With two funnels facing inward, it exploits the same principle as fyke nets, but on a smaller scale. Access to the specimens can be attained through the hinge, which opens the trap into two parts. These traps were set at sites 1,4,7, and 10. All of the traps were placed in 2-5 feet of water near or in vegetation on the bottom of the lake. A large weight was attached to each funnel minnow trap to ensure a stationary position as it rested on the bottom. A small buoy marked the location of each trap. All of the traps were left for at least 48 hours and were baited with Nabisco Premium saltine crackers. The funnel minnow trap and Fyke net were used during September and early October.



**Figure 3.** Funnel minnow trap.

The third method involved the use of a 30 x 5 foot bag seine with ½ inch mesh (Figure 4). This net was pulled parallel to shore for approximately 300 feet at all locations except Cocoa Creek. Fish were removed from the net, identified and measured on location. Some individuals were preserved and returned to the lab for verification of identification. Identifications were made based on keys developed by Becker (1983) as well as Eddy and Underhill (1978). Seining was done during the last week of July.



Figure 4: Bag seine

A backpack electroshocker was used to collect fish in Cocoa Creek. Unlike the traps which are passive capture techniques, electroshocking is a highly active capture technique. Shocking was done on in late September and covered approximately 500 yards of the stream beginning at Highway JJ and moving upstream (Figure 5).



Figure 5: Electroshocking on Cocoa Creek, Waukesha County Wisconsin

## RESULTS

A total of 1,096 fish were collected from July through October 2006 (Table 3). Bluntnose minnow was the most abundant species. The southeast shore of Pewaukee Lake (location 10) provided the largest number of minnows and small fish (Table 4). Bluntnose minnow and spottail shiner were the only two species collected at this location. The north shore across from Rocky Point (location 6) produced the fewest fish, with one bluntnose minnow being the only specimen.

**Table 3.** Total number, percent, and length of fish collected in Pewaukee Lake and Cocoa Creek during July – October, 2006.

Common Name	Scientific Name	Number Caught	% of Total Collected	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)
Black Crappie	<i>Pomoxis annularis</i>	26	2.4	70	89.6	115
Bluegill	<i>Lepomis macrochirus</i>	254	23.2	25	87.5	203
Bluegill / Pumpkinseed Hybrid	<i>Lepomis macrochirus / Lepomis gibbosus</i>	1	0.1	145		145
Bluntnose Minnow	<i>Pimephales notatus</i>	280	25.6	35	60.8	120
Brook Silverside	<i>Labidesthes sicculus</i>	162	14.8	12	45.5	100
Brown Bullhead	<i>Ameiurus nebulosus</i>	1	0.1	26	26.0	26
Central Mudminnow	<i>Umbra limi</i>	2	0.2	48	75.5	103
Golden Shiner	<i>Notemigonus crysoleucas</i>	4	0.4	130	151.0	189
Johnny Darter	<i>Etheostoma nigrum</i>	1	0.1	51	51.0	51
Largemouth Bass	<i>Micropterus salmoides</i>	46	4.2	38	90.7	300
Longnose Gar	<i>Lepisosteus osseus</i>	1	0.1	222	222.0	222
Pumpkinseed	<i>Lepomis gibbosus</i>	121	11.0	55	85.4	191
Rock Bass	<i>Ambloplites rupestris</i>	4	0.4	87	143.0	191
Sheepshead	<i>Archosargus probatocephalus</i>	1	0.1	325	325.0	325
Smallmouth Bass	<i>Micropterus dolomieu</i>	27	2.5	42	93.1	145
Spottail Shiner	<i>Notropis hudsonius</i>	94	8.6	40	60.9	77
Yellow Bullhead	<i>Ameiurus natalis</i>	2	0.2	27	27.0	27
Yellow Perch	<i>Perca flavescens</i>	69	6.3	32	107.3	155
Total Number of Fish		1096		12	104.80	325

**Table 4.** Total numbers of minnows and small fish collected by location in Pewaukee Lake, Waukesha County during July through October, 2006

	Bluntnose Minnow	Brook Silverside	Central Mudminnow	Golden Shiner	Johnny Darter	Spottail Shiner	Total in Each Location
<b>Locations</b>							
1. Yacht Club Shoreline	2				1	1	4
2. South Central shore on west side	4	5				1	10
3. Southwest Side of West Island	8						8
4. Northwest Corner of Lake	6	26		2			34
5. North Shore of Deepest Point of Lake	3	6					9
6. North Shore Across From Rocky Point	1						1
7. Taylor's Bay	4	44					48
8. Cocoa Creek	12		2				14
9. Public Beach	41	9				12	62
10. Southeast Shore	190					80	270
11. Middle Island		55					55
12. Starky's Bay	8	2		2			12
13. South of Rocky Point	1	15					16
Total Number of Each Species	280	162	2	4	1	94	543

Twelve species of fish were collected that were not included in the minnow and small fish assemblage (Table 5). Bluegill were by far the most abundant followed by pumpkinseed sunfish. Location 10 had the most fish again, and location 6 remained the lowest.

**Table 5.** Total number of each fish species not included in the minnow/small fish assemblage collected by location in Pewaukee Lake, Waukesha County during July through October 2006.

	Black Crappie	Bluegill	Bluegill/ Pumpkinseed Hybrid	Brown Bullhead	Largemouth Bass	Longnose Gar	Pumpkinseed	Rock Bass	Sheepshead	Smallmouth Bass	Yellow Bullhead	Yellow Perch
Locations												
1. Yacht Club Shoreline	1	32			2		2	2	1			
2. South Central shore on west side		23			13		5	2				5
3. Southwest Side of West Island		8			4		17					27
4. Northwest Corner of Lake	3	26			7		14			7		8
5. North Shore of Deepest Point of Lake		3			1					2		2
6. North Shore Across From Rocky Point		1										
7. Taylor's Bay		15					2				1	
8. Cocoa Creek												
9. Public Beach		48			5		26			9		8
10. Southeast Shore		5		1	4		1			1	1	5
11. Middle Island		9	1		1		8			3		
12. Starky's Bay	22	65			7	1	37			5		9
13. South of Rocky Point		19			2		9					5
Total	26	254	1	1	46	1	121	4	1	27	2	69

## DISCUSSION

A comparison of minnow and small fish populations through the years can provide insight into the overall health of Pewaukee Lake. A change in the fish community can reflect long term trends in the quality of a lake's ecosystem (Jennings et al, 1998; Niemela et al. 1998; Drake and Valley 2005). In an evaluation of fish species composition as a measure of the biotic integrity of lakes, Jennings et al. (1999) recommended intolerant species and habitat specialists as good indicators of lake quality. They also recommended that indicators of biotic integrity should be collected using similar methods. Sampling procedures for this study were designed to be similar to those used in previous years so that comparisons could be made. Due to lack of specific information regarding sampling area, total effort may not have been equivalent between years. During 2006 sampling, all locations in the near shore areas of the lake that could accommodate seining were sampled. Previous year's data were gleaned from Wisconsin Department of Natural Resources fisheries data files.

Over the 1960/61 sampling period 29 fish species were collected in seines and 18 fish species were collected during the summer of 2006 (Table 6). Species that were collected in 1960/61 but not in 2006 (Table 7) included blackchin shiner, blacknose shiner, and pugnose

shiner all of which are listed as intolerant species (Jennings et al. 1999). The pugnose shiner is intolerant of turbid waters and is listed as a threatened species in Wisconsin due to its decline in many watersheds (Becker 1983, WDNR 1997). Given the often turbid conditions in Pewaukee Lake it is possible this species is no longer present in the lake. The blackchin shiner was common in Wisconsin, but its numbers have been decreasing in lakes that have become more turbid (Becker 1983). Although blacknose shiner is abundant in some areas of Wisconsin, it has also declined in areas where water quality has declined (Becker 1983). The bigmouth shiner, which was also collected in 1960/61 but not in 2006, is most common in the flowing waters of Wisconsin (Becker 1983) and therefore may be somewhat rare in lakes. Emerald shiner, another minnow species that did not reoccur in the 2006 sampling, are common in Wisconsin lakes but are often not vulnerable to capture in seines due to their preference for open waters. Only four fish species were collected in the 2006 seining that were not collected in 1960/61 (Table 8). Only one of these fishes, the central mudminnow, is part of the minnow/small fish assemblage. This fish which is often found in quiet waters with dense vegetation (Becker 1983) was not collected in the lake proper but in Cocoa Creek, a tributary to Pewaukee Lake.

Other members of the minnow and small fish assemblage that did occur in both the 1960/61 sampling and 2006 sampling are either listed as tolerant species or not considered either tolerant or intolerant. The one exception to this is the spottail shiner which occurred in fairly high numbers along the southeast shore of the lake in the 2006 seine net collections (Table 4). Even though this fish is listed as intolerant it is very common. Its most abundant inland distribution is in the Wisconsin River, Rock River and Fox/Wolf River systems (Becker 1983). Pewaukee Lake is part of the Fox River watershed and therefore lies within the region of greatest abundance for the spottail shiner.

Table 6: Number and percent composition and index of diversity of fish collected in seines in Pewaukee Lake, Waukesha County during the summer of 1960, 1961, and 2006.

Common Name	Species	Tolerance (I = intolerant, T = tolerant)	1960		1961		2006	
			Number	Percent	Number	Percent	Number	Percent
Banded Killfish	<i>Fundulus diaphanus</i>		53	2.18	4	0.10		
Bigmouth Shiner	<i>Notropis dorsalis</i>				1	0.02		
Black Crappie	<i>Pomoxis annularis</i>		4	0.16	531	12.82	26	2.37
Blackchin Shiner	<i>Notropis heterodon</i>	I	34	1.40	8	0.19		
Blacknose Shiner	<i>Notropis heterolepis</i>	I	3	0.12	35	0.85		
Bluegill	<i>Lepomis macrochirus</i>		659	27.12	574	13.86	254	23.18
Bluegill / Pumpkinseed Hybrid	<i>Lepomis macrochirus x Lepomis gibbosus</i>						1	0.09
Bluntnose Minnow	<i>Pimephales notatus</i>	T	1009	41.52	432	10.43	280	25.55
Brook Silverside	<i>Labidesthes sicculus</i>		120	4.94	928	22.41	162	14.78
Brown Bullhead	<i>Ameiurus nebulosus</i>						1	0.09
Common Carp	<i>Cyprinus Carpio</i>	T	13	0.53				
Common Shiner	<i>Luxilus cornutus</i>				8	0.19		
Central Mudminnow	<i>Umbra limi</i>	T					2	0.18
Emerald Shiner	<i>Notropis atherinoides</i>		1	0.04	13	0.31		
Golden Shiner	<i>Notemigonus crysoleucas</i>	T			11	0.27	4	0.36
Grass Pickerel	<i>Esox americanus</i>		1	0.04				
Green Sunfish	<i>Lepomis cyanellus</i>	T	4	0.16				
Johnny Darter	<i>Etheostoma nigrum</i>		20	0.82	43	1.04	1	0.09
Lake Chubsucker	<i>Erimyzon sucetta</i>				2	0.05		
Largemouth Bass	<i>Micropterus salmoides</i>		111	4.57	28	0.68	46	4.20
Longnose Gar	<i>Lepisosteus osseus</i>				4	0.10	1	0.09
Northern Pike	<i>Esox lucius</i>				1	0.02		
Pugnose Shiner	<i>Opsopoeodus emiliae</i>	I			2	0.05		
Pumpkinseed	<i>Lepomis gibbosus</i>		75	3.09	84	2.03	121	11.04
Rock Bass	<i>Ambloplites rupestris</i>	I			2	0.05	4	0.36
Sheepshead	<i>Aplodinotus grunniens</i>				1	0.02	1	0.09
Smallmouth Bass	<i>Micropterus dolomieu</i>	I					27	2.46
Spottail Shiner	<i>Notropis hudsonius</i>	I			39	0.94	94	8.58
Tadpole Madtom	<i>Noturus gyrinus</i>		2	0.08				
Walleye	<i>Stizostedion vitreum</i>				3	0.07		
White Sucker	<i>Catostomus commersoni</i>	T			1	0.02		
Yellow Bullhead	<i>Ameiurus natalis</i>	T	2	0.08			2	0.18
Yellow Perch	<i>Perca flavescens</i>		319	13.13	1386	33.47	69	6.30
Total Number			2430		4141		1096	
Number of Species			17		24		18	

Table 7: Fish species collected in seines 1960/61 but not collected in 2006.

Common Name	Species	Tolerance (I = intolerant, T = tolerant)
Banded Killfish	<i>Fundulus diaphanus</i>	
Bigmouth Shiner	<i>Notropis dorsalis</i>	
Blackchin Shiner	<i>Notropis heterodon</i>	I
Blacknose Shiner	<i>Notropis heterolepis</i>	I
Common Carp	<i>Cyprinus Carpio</i>	T
Common Shiner	<i>Luxilus cornutus</i>	
Emerald Shiner	<i>Notropis atherinoides</i>	
Grass Pickerel	<i>Esox americanus</i>	
Green Sunfish	<i>Lepomis cyanellus</i>	T
Lake Chubsucker	<i>Erimyzon sucetta</i>	
Northern Pike	<i>Esox lucius</i>	
Pugnose Shiner	<i>Opsopoeodus emiliae</i>	I
Tadpole Madtom	<i>Noturus gyrinus</i>	
Walleye	<i>Stizostedion vitreum</i>	
White Sucker	<i>Catostomus commersoni</i>	T

Table 8: Fish species collected in seines in 2006 but not collected in 1960/61.

Common Name	Species	Tolerance (I = intolerant, T = tolerant)
Bluegill / Pumpkinseed Hybrid	<i>Lepomis macrochirus x Lepomis gibbosus</i>	
Brown Bullhead	<i>Ameiurus nebulosus</i>	
Central Mudminnow	<i>Umbra limi</i>	T
Smallmouth Bass	<i>Micropterus dolomieu</i>	I

The apparent decline in minnow and small fish species noted in this comparative study is not a definitive indication of declining overall quality of Pewaukee Lake. The sampling in the 1960's represents two summers of sampling while this study included only one. This information however is one more contribution to an overall understanding of the condition of Pewaukee Lake's ecosystem. Studies of the diversity, composition, and distribution of zooplankton, macroinvertebrates and aquatic plants as well as the general fish population have also been completed (Beyler and Gospodarek 2000, SEWRPC 2003, Schmolt and Anderson 2001, Iwen and Anderson 2005, Koch and Anderson. 2003) and have tracked a progression of changes in the lake from the 1960's. The diversity of aquatic plant communities has increased while total phosphorus levels have decreased. The lake hovers between mesotrophic and eutrophic conditions but maintains a vibrant sport fish population. Certainly a decline in minnow diversity would be cause for concern; therefore a more extensive effort with larger seine nets will be carried out during the summer of 2007 in an attempt to more effectively assess the lakes minnow populations.

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