Betsie Lake

Benzie County (T26N, R16W, Section 27)
Betsie River Watershed; last surveyed 2008

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Environment

Betsie Lake is 289 acres in size and is located between the villages of Elberta and Frankfort in Benzie County, Michigan, in the northwestern Lower Peninsula. Betsie Lake is the drowned river mouth of the Betsie River, which flows into the southeastern end of the lake and drains out into Lake Michigan at the western end. The total drainage area for Betsie Lake is 244.6 square miles, including 2.6 square miles from the immediate drainage and minor tributaries (Grant 1978). The land encompassed by the Betsie Lake watershed is primarily deciduous forest or mixed deciduous/ coniferous forest, with minimal development. The maximum depth of the lake is 34 feet, though approximately 80% of the lake is less than 10 feet deep. The western end of the basin was frequently dredged while the Ann Arbor Railroad Car Ferries were in operation (Grant 1978), and is currently dredged on a 5 to 10 year cycle to maintain navigation (U.S. Army Corp of Engineers 2009). The Village of Frankfort occupies most of the north shore of the lake, which is moderately developed with marinas, or armored with rocks and steel seawall. On the south shore of Betsie Lake is the village of Elberta, which is lightly developed with marinas, or public parks and green space armored with rocks or steel seawall. The southeastern shoreline is mostly undeveloped marshy lowland, with a few private residences.

Historically, the land adjacent to Betsie Lake has been utilized by various industries. In the late 1800's the Frankfort Iron Works operated a blast furnace and railroad lines along the Elberta shoreline, which were sold to the Ann Arbor Railroad near the turn of the century (Blacklock 1975). Grain elevators, a petroleum facility, and coal docks were constructed, and car ferries operated along the lake until the Ann Arbor Railroad operations ceased in approximately 1982. During this time, oil spills on the lake were common (Grant 1978). Logging operations and sawmills operated on the Frankfort and Elberta shores from the time the harbor was opened in 1867 until 1905 (Blacklock 1975). Today, and going back as far as the early 1900's, frozen food packing companies, marine engineering firms and shipyards, manufacturing plants, and fruit processing plants have operated on the Frankfort side of the lake.

There is one citizen-based group that is active on Betsie Lake, the Friends of Betsie Bay (FOBB). The FOBB was established in 1998 (Fred Stransky, personal communication). Since then, they have initiated a water quality monitoring program for Betsie Lake (in cooperation with the Benzie Conservation District), as well as drafting of a management plan for the watershed. The FOBB are strong advocates of area land uses that promote a community in harmony with the natural environment of Betsie Lake.

Public boat ramps are available on Betsie Lake at the Frankfort municipal boat launch on the north side of the lake, or the Elberta Marina in the southeastern corner of the lake. The are also seven marinas on the lake, six private and one municipal, that provide dockage to transient Lake Michigan or Betsie Lake boaters. Public fishing piers are located at the Frankfort Green Space and the Elberta Waterfront Park.

History

The first documented biological survey of Betsie Lake was conducted by the Water Quality Division of the Michigan Department of Conservation in 1966. This survey was initiated following complaints from local residents about poor water quality throughout the lake. The goal of this survey was to determine what type of effects local point source waste discharges were having on the macroinvertebrate community and physical appearance of the lake (Bryant and Seeburger 1966). Bottom dwelling macroinvertebrates were collected in single dredge hauls using a Ponar dredge, then sieved and fixed with formalin (Bryant and Seeburger 1966). Twenty-seven samples were collected in six regions of the lake, and each species collected in the sample was assigned a tolerance level (intolerant, facultative, and tolerant) based upon their ability to survive in poor environmental conditions (Bryant and Seeburger 1966). Many of these sampling sites were located near four known point source waste water discharges. In all of these stations, tolerant bloodworms and sludgeworms were the predominant organisms collected, indicating poor water quality conditions (Bryant and Seeburger 1966).

In 1972 the U.S Environmental Protection Agency surveyed Betsie Lake in conjunction with the National Eutrophication Survey, and at this time sampling results showed the lake to be eutrophic (U.S. EPA 1975). Samples from various water depths were collected at a single fixed location three times from June to November (U.S. EPA 1975). Water chemistry, phytoplankton, and chlorophyll a data was collected during each sampling period. Collectively, the villages of Frankfort and Elberta were found to contribute 48% of the total phosphorous load while the Betsie River contributed 52% of the total phosphorous load (U.S. EPA 1975). Based on these results, the U.S. Environmental Protection Agency (1975) recommended that point source phosphorous inputs to the lake be reduced to the lowest practical levels.

The Water Quality Division sampled the macroinvertebrate community, as well as sediment chemistry, in Betsie Lake during July of 1975. Macroinvertebrate dredge sampling was replicated at twenty-one of the original 1966 sampling locations in six regions of the lake. As observed in the 1966 survey, two tolerant species of aquatic oligochates dominated the samples (Grant 1978) despite the fact that one of the point source waste water discharges had ceased operations and another had lowered its discharge rate since the 1966 survey. Therefore, the residual wastes in the lake continued to affect the water quality of the lake (Grant 1978). While the lake was still considered to have low water quality, some improvements such as an increase in the numbers of oligochates and the increased presence of mayflies were noted in this survey (Grant 1978). Sediment samples were also collected at four of the sampling locations using a Ponar dredge (Grant 1978). Heavy metals were analyzed using atomic absorption followed by nitric acid digestion, while chlorinated hydrocarbons were analyzed using gas chromatography (Grant 1978). Copper, zinc, lead, and chromium levels were all considered to be slightly elevated compaired to U.S. EPA standards, while polychlorinated biphenyls (PCB's) and chlorinated hydrocarbon levels were low enough to be below the limits of analytical sensitivity (Grant 1978).

In 2007, the Friends of Betsie Bay, in cooperation with the Benzie Conservation District, conducted water quality assessments in the lake. A Hydrolab was used to collect information regarding pH, dissolved oxygen levels, and temperatures, and phosphorous, chlorophyll a, and Escherichia coli (E.

coli) levels were also testing using collected water samples (Benzie Conservation District 2009). The 2007 data showed that the overall water quality in Betsie Bay is good, and has improved over the original 1972 U.S. Environmental Protection Agency study (U.S. EPA 1975). Secchi disk readings have improved from an average of 2 to 4.5 feet in 1972, to 5 to 7 feet in 2007. This increase in visibility may be attributed to improving water quality, as well as the presence of zebra mussels inside the lake. Chlorophyll a levels were higher in 2007, and increased water clarity noted in the Secchi disk readings supports this. Phosphorous levels determined in 2007 are very similar to those from 1972. E.coli levels were very low in the lake and surrounding areas and pH and dissolved oxygen levels have remained very stable over time.

Fish have been stocked into Betsie Lake by the State of Michigan for many years. The U.S. Coast Guard Station on Betsie Lake has been used as a stocking location for lake run brown trout and rainbow trout (steelhead). From 1972 to 2009, MDNR Fisheries Division has annually planted from 8,400 to 44,300 spring yearling brown trout (Table 1). Fall fingerling brown trout were also added at a rate of 11,500 to 57,000 annually from 1983 to 1989 (Table 1). In the years 1981-1985, Michigan strain winter run steelhead were planted at a rate of 13,000 to 23,359, and in 1986-1987 from 20,001 to 22,060 summer run steelhead were stocked (Table 1). In 1988 the Orsini Fish Hatchery began operating upstream on the Betsie River producing winter run steelhead, and the stocking of steelhead ceased in the lake.

The MDNR Fisheries Division Master Angler program has had six entries from Betsie Lake since 1996. These entries include one rock bass, one northern pike, one brown trout, one Chinook salmon, and two common carp.

Current Status

The first comprehensive fisheries survey conducted on Betsie Lake occurred in May of 2008. This was a discretionary survey conducted using Status and Trends protocols (Kevin Wehrly, Institute for Fisheries Research, Ann Arbor; unpublished data). Net sampling occurred from May 5 through May 8, and included the use of one large-mesh fyke net (3 net-nights), one inland gill net (1 net-night), two experimental gill nets (4 net-nights), and three trap nets (9 net-nights). The survey plan also called for an electrofishing effort, but budgetary issues prevented this effort from being completed. The intent of the survey was to determine the current status of all fish populations in the lake.

During the survey, a total of 708 fish by number representing 22 species were caught (Table 2). Rock bass, white sucker, and yellow perch comprised the largest portion of the catch. A total of 292 rock bass made up 41% of the total catch, ranging in size from 4 to 10 inches. White suckers represented 43% of the catch by weight with 124 individuals ranging in size from 12 to 23 inches. Fifty-four yellow perch from 5 to 11 inches were caught, with 52% exceeding nine inches in length. Brown bullhead, bowfin, and gizzard shad were also observed.

Game fish caught included northern pike, smallmouth bass, largemouth bass, and walleye (Table 2). A total of 33 northern pike were caught ranging from 15 to 31 inches, and comprised 12% of the weight by catch. In addition, five walleye were also caught, ranging in size from 19 to 26 inches. The presence of walleye in Betsie Lake was not surprising, as anglers have reported catching them in the past. Walleye were stocked up river in the Homestead Pond in 1966, and anglers reported good catches

of walleye in the Betsie River from 1973 to 1976. This return of fish may have been the result of the planted walleye leaving the pond while the dam was being removed in 1973 and 1974, then returning to spawn. There has been no documented evidence of a spawning run of walleye in the Betsie River before or since this planting. According to Hanchin et al. (2007), adult walleye tagged in the Muskegon River during spawning were subsequently recaptured at many different locations around Lake Michigan, including other drowned rivermouth lakes. Therefore, since no walleye are stocked in the Betsie River system or Betsie Lake, it is likely that the walleye in Betsie Lake are migrants from other systems, potentially from the Herring Lakes, Portage Lake, or Platte Lake. Although only five walleye were caught in this survey, they were all growing at rates well above the state of Michigan average length at age. They were likely post-spawn adult walleye that had spawned elsewhere and were taking advantage of the diverse forage opportunities in Betsie Lake.

Most species caught showed above average growth (Table 3). Age -2,-3,-4, and-5 northern pike were growing well at 1.6 inches above the state of Michigan average length at age. Smallmouth bass (Ages 4 and 5) were also growing well at 1.3 inches about the state of Michigan average length at age. Rock bass (Ages 3, 4, 6, and 7) also slightly exceeded state average lengths at age at 0.6 inches. Not enough (less than five) black crappie, largemouth bass, steelhead, or walleye were collected from any one inch class to make statistical inferences about their age and growth.

At certain times of the year, Betsie Lake receives considerable fishing pressure. In the spring, Betsie Lake is very popular with anglers trolling for brown trout and steelhead as they migrate in and out of the lake from Lake Michigan. Pier fishing and shore fishing along the Elberta shoreline for steelhead is also popular. Additionally, Chinook and coho salmon provide Betsie Lake anglers with excellent trolling, shore, and pier fishing opportunities from August through October as they stage in Betsie Lake, prior to heading upstream into the Betsie River. Though currently undocumented, angling for these migratory species likely accounts for the majority of the fishing pressure that occurs on Betsie Lake. In the summer, Betsie Lake receives some fishing pressure from anglers seeking smallmouth bass and northern pike. Some ice fishing also takes place on Betsie Lake, with steelhead, northern pike and yellow perch being the most sought-after species in the winter.

Analysis and Discussion

The 2008 MDNR fisheries survey showed that Betsie Lake has a generally healthy fish community, and that the species composition of the lake is similar to that found in other drowned river mouth lakes, including Manistee and Pere Marquette Lakes (MDNR Fisheries Division, unpublished data). Game fish captured included smallmouth bass, northern pike, and walleye. Smallmouth bass were also represented by eight year classes (Ages 3 through 10) and were growing well. The northern pike population appears to be healthy, as evident by the five year classes captured and above average growth rates exhibited.

Additional gamefish species that were captured in low numbers in the 2008 survey included rainbow trout (likely steelhead migrating to and from the Betsie River), brown trout, and menominee whitefish. Largemouth bass were notably absent from the 2008 survey. It is likely that they are present in Betsie Lake, at least in low numbers.

With the exception of rock bass and yellow perch, Betsie Lake does not have strong panfish populations. Rock bass were the most numerous species found in the survey, with 292 individuals representing eight year classes (Ages 2 through 9). Yellow perch were also well-represented in the survey, with most fish larger than seven inches in length. It is likely that the yellow perch population of Betsie Lake is heavily influenced by the yellow perch population of Lake Michigan, as there is likely movement of yellow perch back and forth between Betsie Lake and Lake Michigan particularly when spawning (Schnieder at al. 2007). One black crappie was also captured in the survey. The lack of other panfish species, including bluegill and pumpkinseed sunfish in the catch was somewhat surprising. While Betsie Lake is not known for its bluegill or pumpkinseed sunfish fishing, it is likely that both species are present, at least in low numbers.

Other fish collected in the 2008 Betsie Lake survey in significant numbers included bowfin, brown bullhead, white sucker, gizzard shad, and two species of redhorse. Gizzard shad represented 4.8% of the total catch by number with 34 individuals. While gizzard shad potentially provide an excellent forage base for bass, northern pike, and walleye, they also have been known to compete heavily with juvenile largemouth and bluegill (Aday et al. 2003). Juvenile brown bullhead, white sucker, and redhorse also provide forage for smallmouth bass, largemouth bass, and northern pike, but as adults they may have negative impacts on more desirable species like walleye or yellow perch, as they compete with panfish and juvenile game fish for forage (Hayes 1990). These three species comprised 22% of the total species caught by number. Very low numbers of longnose gar, burbot, alewife, sea lamprey, and common carp were also collected.

Management Direction

Another fisheries survey of Betsie Lake should be conducted within the next five years. In the next fisheries survey, electrofishing and seining should be conducted along with trap and gill nets in order to obtain a more representative sample of fish. Electrofishing is less species-specific than netting and has the potential to collect more data on bass, panfish, and salmonids, while seining will provide better insight into the minnow and juvenile game fish populations in the lake. Both of these techniques will allow for the sampling of shallower, more diverse near-shore areas that may have been missed in the 2008 survey.

The overall goal for Betsie Lake is to maintain a stable and sustainable fisheries community. Movement of fish such as walleye, whitefish, and gizzard shad from Lake Michigan provides for increased species diversity and angling opportunity, as does the migratory movements of salmonids such as steelhead, brown trout, coho salmon, and Chinook salmon. Species such as rock bass, smallmouth bass, yellow perch, northern pike, white sucker, and redhorse that are native to the lake should continue to thrive. Currently, none of these species are stocked by the MDNR Fisheries Division, and they appear to be reproducing well on their own.

One of the goals for Betsie Lake should be to sustain the salmonid fishery in Betsie Lake and in the Lake Michigan waters of the Frankfort area. In particular, the stocking of brown trout into Betsie Lake should be continued at the current rates of 15,000 to 20,000 fish annually. These stocking rates are necessary in order to sustain the current fishery, and will allow Betsie Lake to continue to be one of the better brown trout fisheries along the Lake Michigan shoreline. The Betsie River is also stocked with

yearling steelhead, and in some years supports high levels of steelhead natural reproduction. No Chinook or coho salmon are stocked in the Betsie River, so the salmon fisheries of the Betsie River and Betsie Lake are entirely dependent on natural reproduction and migration. The steelhead and salmon pass through Betsie Lake as smolts on their way downstream to Lake Michigan, and return through Betsie Lake as adults on their way upstream to spawn. Good water quality in both the Betsie River system and Betsie Lake is necessary to ensure optimal spawning habitat, improve survival rates of natural and stocked fish, and to encourage fish to return to the system to reproduce. Therefore, maintaining and improving water quality in the Betsie River and in Betsie Lake should be one of the highest priorities for the Betsie River watershed.

Another goal for Betsie Lake should be the conservation of the remaining undeveloped riparian areas, in particular those containing wetlands. Riparian areas along the lake should be protected, as these areas are important to fish community health and continued improvement of the lake's water quality. A large percentage of the lake's shoreline is heavily armored with rocks, docks, or steel seawall, so the protection of any remaining natural riparian areas near the southeastern end of the lake and the mouth of the Betsie River should continue to be a priority. Also, marina development on Betsie Lake should be completed with the Betsie Lake sport fishery in mind. Betsie Lake is less than 300 acres in size, so new marina development potentially could take place on canals dredged inland instead of on the limited open water of Betsie Lake itself.

References

Aday, D.D., R.J.H. Hoxmeier, and D.H. Wahl. 2003. Direct and indirect effects of gizzard shad on bluegill growth and population size structure. Transactions of the American Fisheries Society 132: 47-56.

Benzie Conservation District. 2009. [Online]. http://www.benziecd.org/betsiebay.html. [November 30, 2009].

Blacklock, A.B. 1975. Blacklock's history of Elberta. J.B. Publications. Manistee, Michigan.

Bryant, W.C. and D.J. Seeburger. 1966. A biological survey of Lake Betsie, Benzie County, Michigan, November 14-16, 1966. Michigan Water Resources Comission Report.

Grant, J. 1978. Biological survey of Betsie Lake 1975. Water Quality Division, Department of Natural Resources Publication 4833-5146.

Hanchin, P. A., R. P. O'Neal, R. D. Clark, Jr., and R. N. Lockwood. 2007. The walleye population and fishery of the Muskegon Lake System, Muskegon and Newaygo counties, Michigan, in 2002. Michigan Department of Natural Resources, Fisheries Special Report 40, Ann Arbor.

Hayes, D. B. 1990. Competition between white sucker (Catostomus commersoni) and yellow perch (Perca flavescens): results of a whole lake manipulation. Michigan Department of Natural Resources, Fisheries Research Report 1972, Ann Arbor.

Schneider, J. C., R. P. O'Neal, and R. D. Clark, Jr. 2007. Ecology, management, and status of

walleye, sauger, and yellow perch in Michigan. Michigan Department of Natural Resources, Fisheries Special Report 41, Ann Arbor.

U.S. Environmental Protection Agency. 1975. Report on Betsie Lake, Benzie County, Michigan. EPA Region V., Working Paper 185.

U.S. Army Corps of Engineers. 2009. [Online]. http://www.lre.usace.army.mil/greatlakes/navigation/great_lakes_harbors_information/index.cfm. [November 13, 2009].

Table 1. Michigan DNR fish plantings in Betsie Lake 1972-2009

Year	Species and Strain/Type	Number
1971	Rainbow trout (*Michigan)*	10,000
1972	Brown trout (Fall fingerlings)	35,000
1973	Brown trout (Spring yearlings)	20,000
1974	Brown trout (Spring yearlings)	44,300
1975	Brown trout (Spring yearlings)	10,000
1976	Brown trout (Spring yearlings)	19,621
	Rainbow trout *(Michigan)*	17,086
1977	Brown trout (Spring yearlings)	20,000
1978	Brown trout (Spring yearlings)	25,038
1979	Brown trout (Spring yearlings)	10,000
1980	Rainbow trout *(Michigan)*	20,000
1981	Brown trout *(Harrietta)*	8,400
	Rainbow trout *(Michigan)*	20,004
1982	Brown trout *(Harrietta)*	20,000
	Rainbow trout *(Michigan)*	15,000
1983	Brown trout *(Harrietta)*	10,000
	Brown trout (Fall fingerlings)	20,000
	Rainbow trout *(Michigan)*	23,359
1984	Brown trout *(Harrietta)*	15,000
	Brown trout (Fall fingerlings)	17,000
	Rainbow trout *(Michigan)*	15,000
1985	Brown trout *(Wild Rose)*	11,300
	Brown trout (Fall fingerlings)	20,000
	Rainbow trout *(Michigan)*	13,000
1986	Brown trout *(Wild Rose)*	15,000
	Brown trout (Fall fingerlings)	20,000
	Rainbow trout *(Skamania)*	20,001
1987	Brown trout *(Soda Lake)*	14,900
	Brown trout (Fall fingerlings)	11,500
	Rainbow trout *(Skamania)*	17,500
	Rainbow trout *(Shasta)*	4,560
1988	Brown trout *(Plymouth rock)*	15,000
	Rainbow trout *(Skamania)*	15,000
1989	Brown trout *(Plymouth rock)*	15,000
	Brown trout (Fall fingerlings)	57,000
1990	Brown trout *(Soda Lake)*	14,998
1991	Brown trout *(Plymouth rock)*	15,738
1992	Brown trout *(Wild Rose)*	14,700
1993	Brown trout *(Wild Rose)*	14,900
1994	Brown trout *(Wild Rose)*	15,000
1995	Brown trout *(Wild Rose)*	14,900
1996	Brown trout *(Wild Rose)*	13,500
1997	Brown trout *(Wild Rose)*	14,170
1998	Brown trout *(Wild Rose)*	14,500
1999	Brown trout *(Seeforellen)*	15,000

Year	Species and Strain/Type	Number
2000	Brown trout *(Wild Rose)*	20,000
2001	Brown trout *(Wild Rose)*	15,800
2002	Brown trout *(Wild Rose)*	15,800
2003	Brown trout *(Wild Rose)*	15,500
2004	Brown trout *(Wild Rose)*	15,100
2005	Brown trout *(Wild Rose)*	16,000
2006	Brown trout *(Wild Rose)*	16,100
2007	Brown trout *(Wild Rose)*	13,800
2008	Brown trout (*Gilchrist Creek)*	16,000
2009	Brown trout (*Gilchrist Creek)*	20,000

Table 2. Number, weight, and length of fish collected from Betsie Lake with large mesh fyke nets, trap nets, inland gill nets, and experimental gill nets May 5-8, 2008.

Species	Number	Percent by number	Weight (lbs)	Percent by weight	Length Range (inches)	Average length
Alewife	4	1%	0.37	0%	6 to 8	6.5
Black crappie	1	0%	0.14	0%	6	6
Brown trout	1	0%	0.12	0%	6	6
Bowfin	31	4%	0	0%	14 to 28	23.7
Brown bullhead	41	6%	16.3	2%	6 to 12	8.6
Burbot	7	1%	5.6	1%	11 to 16	13.5
Common carp	1	0%	11.48	1%	29	29
White sucker	124	18%	350.02	43%	12 to 23	18.5
Gizzard shad	34	5%	47.93	6%	12 to18	15.2
Largemouth bass	2	0%	4.33	1%	15 to 16	15.5
Longnose gar	2	0%	3.09	0%	19 to 30	24.5
Northern pike	33	5%	99.54	12%	15 to 31	22.7
Rainbow trout	2	0%	4.22	1%	7 to 22	14.5
Rock bass	292	41%	71.86	9%	4 to 10	6.2
Round whitefish	1	0%	0.7	0%	13	13
Sea lamprey	1	0%	0.54	0%	19	19
Shorthead redhorse	13	2%	35.12	4%	18 to 23	20.5
Silver redhose	19	3%	44.73	6%	5 to 27	16.5
Smallmouth bass	38	5%	78.16	10%	9 to 20	15
Walleye	5	1%	19.38	2%	19 to 26	22
Mudpuppy	2	0%	0	0%	10 to 13	21.7
Yellow perch	54	8%	16.08	2%	5 to 11	8.1
Total	708	100%	809.71	100%		

Table 3. Average total weighted length (inches) at age and growth relative to the state average for fish sampled from Betsie Lake with large mesh fyke nets, trap nets, inland gill nets, and experimental gill nets May 5-8, 2008.

Species	Age I	II	III	IV	V	VI	VII	VIII	IX	X	Mean Growth Index
Black crappie	…	…	6.5 (1)	…	…	…	…	…	…	…	**
Largemouth bass	…	…	…	…	15.9 (1)	16.6 (1)	…	…	…	…	**
Northern pike	15.7 (1)	19.0 (5)	21.5 (16)	26.2 (16)	28.5 (5)	…	…	…	…	…	+ 1.6
Rock bass	…	4.3 (3)	6.0 (19)	7.0 (8)	7.6 (4)	8.1 (9)	8.7 (7)	9.7 (2)	9.00 (1)		+ 0.6
Smallmouth bass	…	…	11.5 (2)	13.9 (13)	15.7 (12)	17.4 (2)	17.3 (2)	11.6 (1)	18.6 (4)	20.2 (1)	+ 1.3
Walleye	…	…	…	21.5 (2)	23.7 (1)	23.0 (2)	…	…	…	…	**
Rainbow trout (steelhead)	…	…	22 (1)	…	…	…	…	…	…	…	**

** Mean growth index can only be calculated for age groups with five or more individuals.