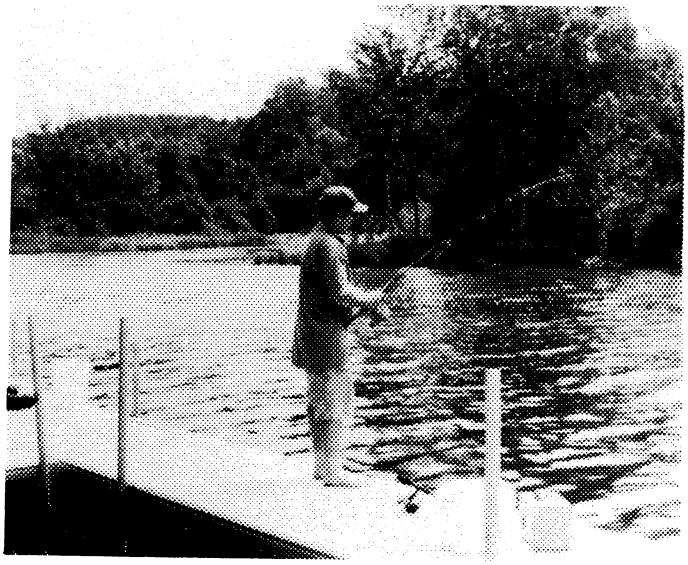
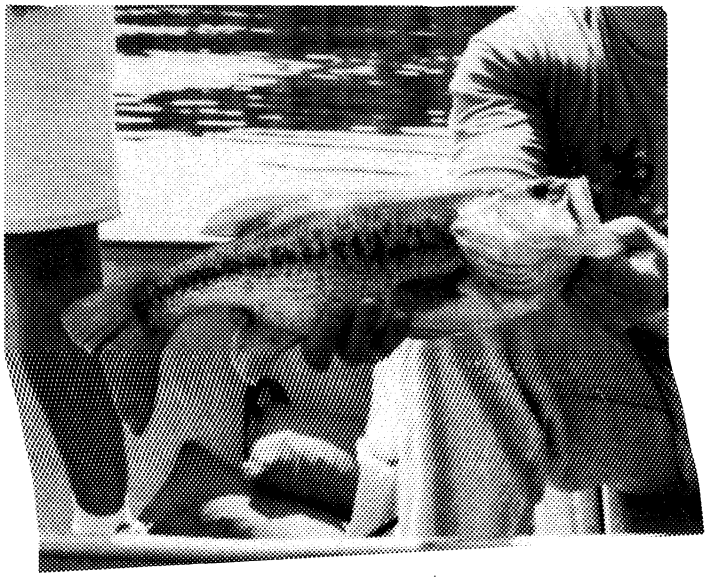




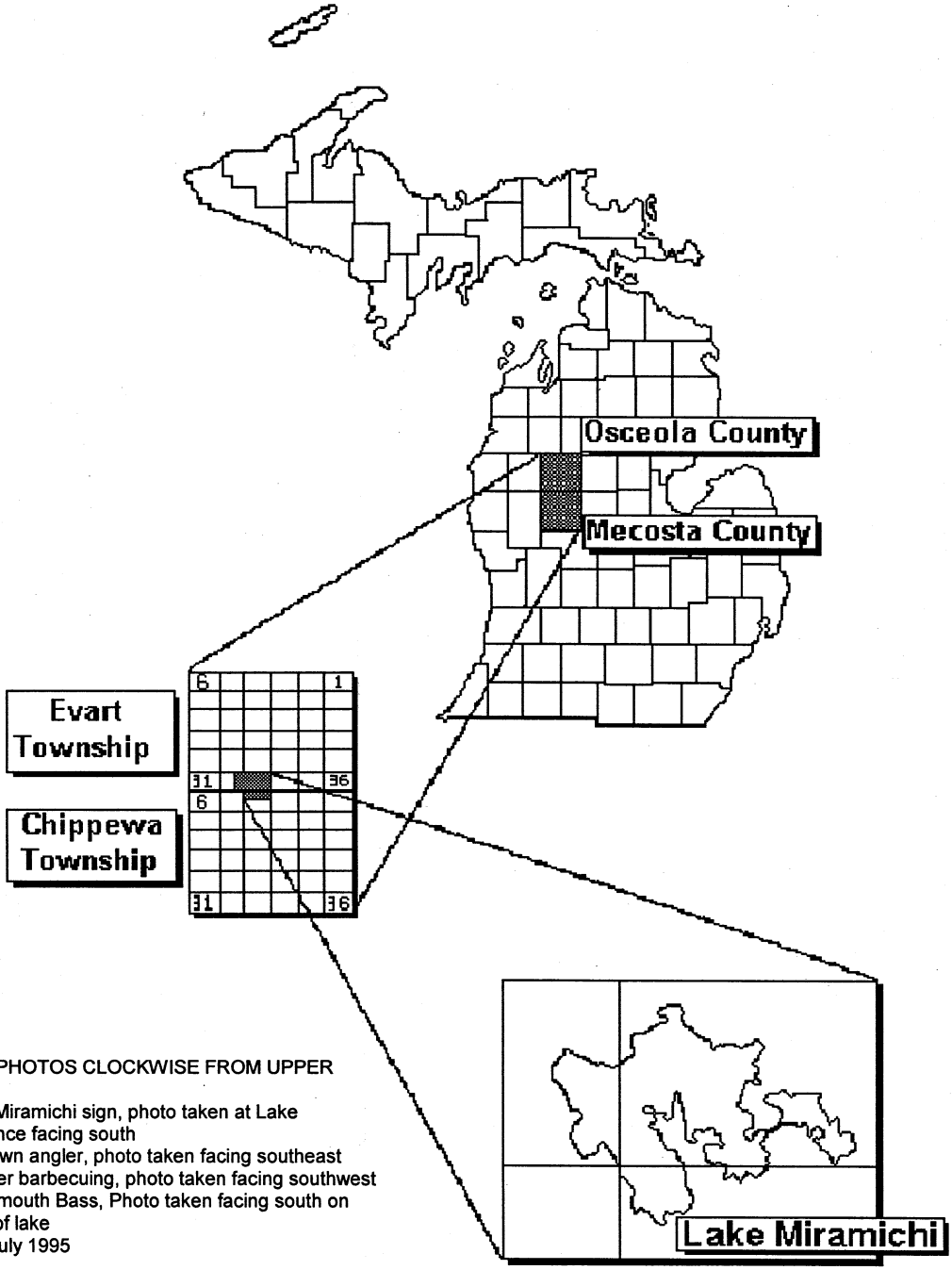
LAKE MIRAMICHI COMMUNITY & ENVIRONMENTAL ASSESSMENT SUMMER 1995

ENVIRONMENTAL MANAGEMENT STUDIES CENTER
FERRIS STATE UNIVERSITY
BIG RAPIDS, MICHIGAN





1995 Lake Miramichi Study Area



COVER PAGE PHOTOS CLOCKWISE FROM UPPER LEFT:
-Photo of Lake Miramichi sign, photo taken at Lake Miramichi entrance facing south
-Photo of unknown angler, photo taken facing southeast
-LMPOA member barbecuing, photo taken facing southwest
-Photo of Largemouth Bass, Photo taken facing south on northwest side of lake
-Photos taken July 1995

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All Lake Miramichi residents whose time and cooperation made this study possible.

EXECUTIVE SUMMARY

During the summer, 1995, the Environmental Management Studies Center at Ferris State University conducted an environmental and community assessment of the Lake Miramichi Subdivision. Lake Miramichi, a man-made lake in the Muskegon River Watershed, is located in both Mecosta and Osceola Counties, Michigan. It is approximately four miles south of Evart and twenty-five miles northeast of Big Rapids.

The study area was composed of Lake Miramichi, Little Lake Miramichi, and the surrounding subdivision. Research groups including Natural History, Physiography and Land Use, Socioeconomics and Transportation, Water Quality, and a resident survey were used to assess the area. Each research group collected data through the use of field observations, resident surveys, library research, personal interviews, photography, field sampling, and laboratory analysis.

A community survey of 52 owners of undeveloped lots and 61 homeowners was conducted which reflected the thoughts and feelings of the property owners. The survey results were used by the large study groups to help interpret collected data. From different aspects of this study, conclusions and recommendations were drawn by each group suggesting maintenance and improvement options for the Lake Miramichi Subdivision.

The overall water quality of the lakes are within state standards with only a few areas of concern. Site 1, located at the beach, contains high phosphorus levels which could promote accelerated aquatic plant growth. This can be the result of human waste in the swimming area. High amounts of fecal contamination were found at sites 2 and 3 and indicates possible health hazards. It is recommended to limit animal fecal waste and to conduct further analysis on the water.

Lake Miramichi and Little Lake Miramichi are warm-water mesotrophic lakes that contain a wide variety of plant and animal species. The ecological condition of the lakes appear to be stable. However, some problems do exist. Researchers concluded mechanical weed harvesting should be continued to decrease nutrient levels in the lakes. The use of fertilizer and trash burning should continue to be discouraged.

The area is used primarily for recreation. No commercial development is desired by the property owners at this time. It is recommended that the property owners become more active in the Lake Miramichi Property Owners Association (LMPOA). An increase in dues may be considered to improve areas of concern to Lake Miramichi residents. The LMPOA is considering the possibility of village incorporation, but the survey indicates that until the property owners are better informed about the process, village incorporation is not recommended.

It was found that the outlet of Lake Miramichi flows even though the water level in the lake was below the top of the overflow boards. The cement discharge structure should be examined for leaks. The small stream sediment trap appears to be full. To prevent further sediment build-up in the lake, the traps should be inspected and dredged on a routine basis. Installation of additional traps should be considered.

Because some areas are comprised of clay soils, percolation rates in some lots are poor, resulting in a number of lots that cannot be developed unless a sewage system is installed in the subdivision.

Lake Miramichi has excellent overall water quality and the LMPOA should be commended on its efforts in maintaining and improving the quality of the Lakes.

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INTRODUCTION

During the summer, 1995, the Environmental Management Studies Center at Ferris State University, conducted an environmental and community assessment of the Lake Miramichi Subdivision. This study benefited both the Industrial and Environmental Health Management students and the residents of the Lake Miramichi area. The study of Lake Miramichi gave the students valuable field experience and provided the Lake Miramichi community useful information on how to successfully manage their lake and community environment. Data were collected through the use of field observations, resident surveys, library research, personal interviews, photography, field sampling, and laboratory analysis.

Students of the Environmental Management Studies Center were divided into five groups. Each group developed its own report that was condensed and edited into this document. These detailed reports provide information on the following subjects: Physiography and Land Use, Socioeconomics and Transportation, Water Quality, Natural History, and the findings of the resident survey. The completed group reports are on file for review at the Ferris State University Environmental Management Studies Center, Big Rapids, Michigan.

Lake Miramichi is identified as a man-made lake in the Muskegon River Watershed. It is located in the N1/2 of the N1/2 of section 4, and the NE1/4 of the NE1/4 of section 5, Chippewa Township, T 16 N, R 8 W, Mecosta County and the E1/2 of the E1/2 section 32, and all of section 33, Evart Township, T 17 N, R 8 W, Osceola County. It is composed of two lakes, which are divided by a dam. It is approximately four miles south of Evart, and twenty-five miles northeast of Big Rapids.

HISTORY OF LAKE MIRAMICHI

Lake Miramichi, Little Lake Miramichi, Chippewa Township, Evart Township, and the City of Evart were originally inhabited by the Chippewa Indians before the area was settled by Europeans. They shared this area with the Ottawa tribes to the north, and the Mascoutens, Potawatomi, and Miami tribes to the south. In fact, Mecosta County was named after Chief Mecosta of the Chippewa tribe, Osceola County was named after Chief Osceola of the Seminole tribe, and Chippewa Township was named to honor the Chippewa Indians. The Native Americans in this area mainly spoke Algonquin, which was the common language used by the local tribes. Lake Miramichi is assumed to be an Algonquin term for "Land of cool blue water". The Europeans originally acquired this land from the Native Americans through two treaties; The Treaty of Saginaw of 1819 and The Treaty of Washington of 1836 (10).



Figure 1 Main entrance to Lake Miramichi Subdivision. Photo taken facing west. June 21,1995

In 1962, Hugh Adams, Newell Donley, Stanley Marsh, and Fay Zeller started the Lake Miramichi project by purchasing 680 acres including: Upper Big Stone Lake, Lake of the Woods, and Lake of the Fields. A 1,700 foot long dam was constructed at the northwestern end of the lake system. This dam raised the water level 18 feet, thereby creating the 205 acre lake that presently exists as Lake Miramichi. The project was completed in 1964 and later sold to the American Realty Service Corporation of Memphis, Tennessee, on June 23, 1966. An additional 273 acres were purchased by the corporation, increasing the total project area to 953 acres.

In 1966, a small dam was constructed at the southeastern end of Lake Miramichi, creating a 25 acre lake known as Little Lake Miramichi. This project was completed in 1967 (30). The subdivision development was then platted into 1,116 lots, currently containing 135 homes (Figure 1) (36). Forty-eight of these homes are occupied year round, 46 are occupied seasonally, and 41 are occupied at variable times throughout the year. There are 221 residents that own or rent these homes. Of the 221 residents, 108 live in the subdivision year round, 91 use their property on weekends and holidays, and 22 are seasonal residents (28). Use of the two lakes is restricted to only subdivision land owners and guests. Public access is strictly prohibited and enforced.

Membership dues are the main source of revenue to the Lake Miramichi Property Owners Association (LMPOA). Currently, people who own a home on their lot(s) pay $75.00 per year per lot, and owners of vacant lots pay $50.00 per year per lot (28).

RESIDENT SURVEY

Methodology

A statistically valid random sample survey was designed in keeping with personnel time and budget constraints. From a list supplied by the LMPOA, 133 Lake Miramichi homeowners and 120 owners of undeveloped lots were contacted. The residents were surveyed by face to face interviews and drop off questionnaires, while owners of vacant lots were contacted by mail.

Fifty-two mail surveys were received representing 46.0% of the respondents. Sixty-one (54.0%) of the 133 homeowners completed surveys. To conduct the survey, a plat map was obtained and the subdivision was divided into four areas, each containing an equal number of homes. Each area was given to one of the large study groups whose responsibility was to survey all the residents in their area.

The questions selected for the survey were submitted by group members of Natural History, Water Quality, Socioeconomics and Transportation, and Physiography and Land Use.

Survey Results

Question 1: If you have a house on Lake Miramichi do you:

1) Own your house	64	(98.5%)
2) Rent/Lease	1	(1.5%)
3) No response	48	

Question 2: How many individuals usually occupy the residence?

1) Two or less people	47	(73.4%)
2) Three to five people	16	(25.0%)
3) More than six people	1	(1.6%)
4) No response	49	

Question 3: How many lots do you own at Lake Miramichi?

1) One to two lots	93	(85.3%)
2) Three to five lots	15	(13.8 %)
3) More than ten lots	1	(0.9%)
4) Six to ten lots	0	(0.0%)
5) Made no response	4	

Question 4: Check the response that most closely describes the usage of your lot at Lake Miramichi? (If yes to choice #1, skip to question #8)

1) Do not use property	38	(35.5%)
2) Permanent residence	38	(35.5%)
3) Vac./holiday/weekend	19	(17.8%)
4) Seasonal residence	11	(10.3%)
5) Hunting	1	(.9%)
6) Fishing	0	(0.0%)
7) Made no response	6	

Question 5: If you are a part time resident, what are your plans for your home?

1) Permanent residence	15	(37.5%)
2) Weekend/holiday/rec.	11	(27.5%)
3) Seasonal residence	7	(17.5%)
4) Sell	5	(12.5%)
5) Undecided	2	(5.0%)
6) No response	73	

Question 6: If you checked seasonal or recreation/holiday/weekend in the previous question, which of the following months do you frequent the lake?

1) July-September	29	(42.6%)
2) April-June	25	(36.8%)
3) October-December	8	(11.8%)
4) January-March	6	(8.8%)
5) No response	82	

Question 7: If you are a part time resident, how many times a year do you or your family members travel to Lake Miramichi?

1) Other	10	(34.5%)
2) Three to four times/year	8	(27.6%)
3) Five to six times/year	6	(20.7%)
4) Less than twice/year	5	(17.2%)
5) No response	84	

Question 8: If you own vacant lot(s) now, do you plan to build on your lot(s) in the future?

1) No	59	(64.1%)
2) Undecided	16	(17.4%)
3) Not applicable	14	(15.2%)
4) Yes	3	(3.3%)
5) No response	21	

Question 9: If you are a permanent or seasonal resident to which town do you most frequently travel?

1) Evart	59	(83.1%)
2) Big Rapids	7	(9.9%)
3) Reed City	2	(2.8%)
4) Other	2	(2.8%)
5) Barryton	1	(1.4%)
6) No response	42	

Question 10: How often do you travel to the above mentioned town on average?

1) < than two times/week	27	(40.3%)
2) 3 to 4 times/week	26	(38.8%)
3) 5 to 6 times/week	10	(14.9%)
4) Other	4	(6.0%)
5) No response	46	

Question 11: In your opinion, how do the roads of Lake Miramichi Subdivision compare to gravel roads maintained by the county?

1) Same as county roads	36	(35.3%)
2) Better than...	24	(23.5%)
3) Worse than...	22	(21.6%)
4) No opinion	20	(19.6%)
5) No response	11	

Question 12: Do you feel that the gravel roads of Lake Miramichi should be paved?

1) No	46	(43.8%)
2) Yes	35	(33.3%)
3) No opinion	24	(22.9%)
4) No response	8	

Question 13: If yes, are you willing to accept an increase in dues to cover the cost?

1) No	47	(58.0%)
2) Yes	17	(21.0%)
3) Depends on increase	13	(16.0%)
4) Undecided	4	(4.9%)
5) No response	32	

Question 14: Place a check by each of the following public services if you are satisfied with the quality of the services they provide.

1) Postal services	48	(26.8%)
2) EMS (ambulance)	34	(19.0%)
3) Police	29	(16.2%)
4) Lake security	28	(15.6%)
5) Fire Dept.	27	(15.1%)
6) School busing	13	(7.3%)
7) No response	52	

Question 15: Currently, do you feel there is a problem with the general public gaining access to Lake Miramichi?

1) Yes	42	(40.4%)
2) No	34	(32.7%)
3) Undecided	28	(26.9%)
4) No response	9	

Question 16: Considering the services provided by the LMPOA, do you feel that the dues should:

1) Remain at current level	53	(50.5%)
2) Increase in amount	36	(34.3%)
3) Decrease in amount	16	(15.2%)
4) No response	8	

Question 17: Rate your feelings on the following statement: Homeowners should pay higher Lake Association dues than vacant lot owners.

1) Strongly agree	46	(42.2%)
2) Agree	36	(33.0%)
3) Neutral	9	(8.3%)
4) Disagree	8	(7.3%)
5) Strongly disagree	7	(6.4%)
6) No opinion	3	(2.8%)
7) No response	4	

Question 18: Are you in favor of Lake Miramichi being incorporated as a village?

1) Undecided	45	(41.3%)
2) No	43	(39.4%)
3) Yes	21	(19.3%)
4) No response	4	

Question 19: Are you registered to vote in either Evart or Chippewa Township?

1) Neither	60	(57.7%)
2) Evart	38	(36.5%)
3) Chippewa	6	(5.8%)
4) No response	9	

Question 20: What is the current property tax on your Lake Miramichi property? (estimate if necessary)

Lowest tax:	$9.50
Highest tax:	$ 7000.00
Average tax:	$577.60
Median tax:	$431.48

Question 21: Are you concerned about excessive growth of vegetation (weeds) in Lake Miramichi?

1) Yes	66	(63.5%)
2) No	20	(19.2%)
3) Undecided	18	(17.3%)
4) No response	9	

Question 22: In your opinion, which method of weed control is most effective for controlling the lake vegetation?

1) Mechanical harvesting	63	(75.9%)
2) Chemical	17	(20.5%)
3) Other	3	(3.6%)
4) No response	30	

Question 23: Have you noticed a significant increase/decrease in fish species? After each choice please specify which species have increased/decreased.

1) No noticeable change	49	(64.5%)
2) Increase	7	(9.2%)
-- Perch	5	(71.4%)
-- Bluegill	2	(28.6%)
-- Bass	3	(42.9%)
-- Pike	2	(28.6%)
3) Decrease	20	(26.3%)
-- Perch	3	(15.0%)
-- Bluegill	3	(15.0%)
-- Bass	2	(10.0%)
-- Pike	6	(30.0%)
-- Speck	2	(10.0%)
-- Dogfish	1	(5%)
-- Restock all species	3	(15.0%)

Question 24: Have you observed a change in the size of fish from Lake Miramichi? After each choice please specify which species.

1) No noticeable change	48	(64.9%)
2) Smaller	23	(31.1%
--Perch	3	(14.3%)
--Bluegill	4	(19.0%)
--Bass	9	(42.9%)
--Pike	4	(19.0%)
--All	1	(14.8%)
3) Larger	3	(4.1%)
--Perch	2	(66.6%)
--Bluegill	2	(66.6%)
4) No response	41	

Question 25: If your lot borders on the lake has any erosion taken place? (If no skip to #27)

1) Yes	20	(46.5%)
2) No	19	(44.2%)
3) Unsure	4	(9.3%)
4) No response	70	

Question 26: If erosion has taken place have you taken any precautionary measures to reduce the erosion?

1) Rock or stone	15	(60.0%)
2) Sea wall	4	(16.0%)
3) Vegetation	3	(12.0%)
4) Other	3	(12.0%)
5) No response	94	

Question 27: Do you use fertilizer/herbicide/insecticide (i.e. Weed-N-Feed, Miracle Gro, etc.) on your property? (If no, go to question #29)

1) Do not use	60	(72.3%)
2) Fertilizer	15	(18.1%)
3) Insecticide	7	(8.4%)
4) Herbicide	1	(1.2%)
5) No response	33	

Question 28: Please indicate how often you use each of these products on a yearly basis.

1) Fertilizer	14	(73.7%)
--once/year	3	(20.0%)
--twice/year	7	(46.7%)
--four times/year	1	(6.7%)
2) Insecticides	5	(26.3%)
--once/year	2	(28.6%)
--2 to 3 times/year	1	(14.3%)
--small amounts	1	(14.3%)
3) Herbicides	0	(0.0%)
4) No response	95	

Question 29: Do you consider any of the following to be nuisance animals on your Lake Miramichi property?

1) Flying insects	28	(22.0%)
2) Birds(Geese, ducks)	21	(16.5%)
3) Muskrats	21	(16.5%)
4) Raccoons	21	(16.5%)
5) Beavers	10	(7.9%)
6) Other	9	(7.1%)
--skunks	1	(4.3%)
--squirrels	2	(8.7%)
--deer	2	(8.7%)
--ground moles	9	(39.1%)
--bats	1	(4.3%)
--woodpeckers	1	(4.3%)
--chipmunks	1	(4.3%)
--rabbits	1	(4.3%)
--snakes	2	(8.7%)
--ants	1	(4.3%)
--spiders	1	(4.3%)
7) Mice and rats	6	(4.7%)
8) Opossums	6	(4.7%)
9) Woodchucks	5	(3.9%)
10) No response	61	

Question 30: Have you ever experienced flooding or ponding (standing water) on your Lake Miramichi property? (if no skip to #32)

1) Yes	68	(82.9%)
2) No	8	(9.8%)
3) Unsure	6	(7.3%)
4) Made no response	31	

Question 31: If you answered yes to the previous question, during what time of the year does this flooding/ponding occur?

1) April-June	5	(50.0%)
2) July-September	3	(30.0%)
3) January-March	2	(20.0%)
4) October-December	0	(0.0%)
5) Made no response	105	

Question 32: Have you observed any of the following in your Lake Miramichi drinking water?

1) No noticeable change	52	(77.6%)
2) Sediments	7	(10.4%)
3) Odor	4	(6.0%)
4) Undesirable taste	2	(3.0%)
5) Color	1	(1.5%)
6) Other	1	(1.5%)
7) Made no response	48	

Question 33: Have you noticed any trend in the Lake Miramichi water clarity?

1) Unchanged	50	(64.1%)
2) Better (clearer)	26	(33.3%)
3) Worse (cloudier)	2	(2.6%)
4) Made no response	35	

Question 34: Do you know of anything in the Lake Miramichi area that may be a threat to the quality of the water in Lake Miramichi?

1) Runoff/Contamination	6	(35.3%)
2) Possible septic leaks	4	(23.5%)
3) Geese	2	(11.8%)
4) Runoff into lake	2	(11.8%)
5) More sediment traps	2	(11.8%)
6) Muskrats	1	(5.9%)

Question 35: Summary of number of days per week participating in the following activities.

Score (%)

#of days	Swimming	Boating	Water skiing	Summer Fishing	Winter Fishing
1	9(34.6)	4(11.1)	2(14.3)	12(30.0)	6(19.4)
2	8(30.8)	13(36.1)	5(35.7)	11(27.5)	9(29.0)
3	5(19.2)	4(11.1)	1(7.1)	2(5.0)	2(3.2)
4	1(3.8)	5(13.9)	0	6(15.0)	1(3.2)
5	0	5(13.9)	0	2(5.0)	1(3.2)
6	0	0	0	0	0
7	0	1(2.8)	0	1(2.5)	1(3.2)

Question 36: Do you believe there are conflicts between anglers, power boats, jet skis, and lake front homeowners?

1) Yes	38	(39.6%)
2) No opinion	38	(39.6%)
3) No	20	(20.8%)
4) No response	17	

Question 37: If you feel there are conflicts, please elaborate on what you feel some of these are.

1) Boats too large for lake	10	(26.3%)
2) Boats interfere with anglers	8	(21.1%)
3) Boats drive too fast	3	(7.9%)
4) Boats get too close to docks	1	(2.6%)
5) Limited to fishing boats	1	(2.6%)
6) Boats should stay 100' from dock	1	(2.6%)

Question 38: What is your current method(s) of household solid waste disposal?

1) Private hauler	38	(44.7%)
2) Transfer station/landfill	16	(18.8%)
3) Recycle	13	(15.3%)
4) Take home to permanent residence	12	(14.1%)
5) Burn	5	(5.9%)
6) Other	1	(1.2%)
7) No response	42	

Question 39: What method of disposal do you use for yard waste? (i.e. grass clipping, leaves, branches, etc.)

1) Burn	30	(35.7%)
2) Compost	26	(31.0%)
3) Discard on vacant lot	16	(19.0%)
4) Private hauler	6	(7.1%)
5) Other	5	(6.0%)
6) Landfill/Transfer station	1	(1.2%)
7) No response	46	

Question 40: In regards to development in and around Lake Miramichi, which of the following would you like to see more of:

1) No development	45	(44.1%)
2) Recreation	24	(23.5%)
3) Tourism	11	(10.8%)
4) Commercial	11	(10.8%)
5) Industry	7	(6.9%)
6) Agriculture	4	(3.9%)
7) No response	27	

Question 41: What is your annual income? (optional)

1) Over $50,000	26	(32.9%)
2) Under $20,00	22	(27.8%)
3) $20,000-29,999	13	(16.5%)
4) $30,000-39,999	9	(11.4%)
5) $40,000-49,999	9	(11.4%)
6) No response	34	

Question 42: What age category do you belong to? (optional)

1) Over 60	60	(56.1%)
2) 50-59 years	23	(21.5%)
3) 40-49 years	14	(13.1%)
4) 30-39 years	8	(7.5%)
5) 18-29 years	2	(1.9%)
6) No response	34	

Question 43: What is your current employment status?

1) Retired	63	(57.8%)
2) Full time	39	(35.8%)
3) Part time	6	(5.5%)
4) Unemployed	1	(0.9%)
5) No response	4	

Question 44: Would you be in favor of switching to a private individual well system versus the current community water supply?

1) Yes	40	(38.8%)
2) Undecided	35	(34.0%)
3) No	28	(27.2%)
4) No response	10	

General Comments:

More security checking boats	2	(4.3%)
Too large of items in dumpsters	1	(2.2%)
Need more volunteers	3	(6.5%)
Better snow and ice removal	1	(2.2%)
Water bill is too high	22	(47.8%)
More capable board members	3	(6.5%)
Clean up main entrance	1	(2.2%)
Send report to Evart for action	1	(2.2%)
Better roads	3	(6.5%)
Light around park and beach area	1	(2.2%)
Finish paving between 80th & 90th	1	(2.2%)
No hunting or firearms	3	(6.5%)
Maintenance of dam area	2	(4.3%)
Only one main entrance	1	(2.2%)
Difficult to resell property	3	(6.5%)
No motorcycles on campgrounds	1	(2.2%)

Total comments received--46

Survey Interpretation

Of the 253 surveys distributed, 113 lake area residents and property owners responded, this represents the overall opinion of 48.6% of those surveyed, and approximately 20% of the total ownership. Although only 20% of the total population was included in the survey, a 95% confidence level was used in construction of the survey. In determining the number of participants needed for the results to be statistically significant, the survey population had to be greater than 230. This survey population was 253 which means that the results are statistically significant. (i.e. this confidence level insures that the survey results will accurately reflect the opinions of the property owners)(13).

Most residents of Lake Miramichi own their homes (98.5%). Three-quarters of these homeowners own one to two lots. One-third of the respondents consider Lake Miramichi their permanent residence, while the other 2/3 use the lake seasonally, for vacations, and for other recreational uses such as fishing and hunting.

Over half of the respondents are retired, which is supported by the finding that 56.1% of respondents are over the age of 60 and 75% of the households that have two or less occupants. Since such a small number of residents under the age of 39 (9.4%) responded, it was difficult to make an accurate analysis between age groups at Lake Miramichi.

The majority of respondents (86%) who would like to see the roads paved were homeowners (Figure 2). Those who answered no were evenly split between homeowners and vacant lot owners. Over 75% of the vacant lot owner respondents had no opinion. Since these owners do not reside at, and infrequently visit Lake Miramichi, they do not see the benefits of paving the roads. Even so, only 17 respondents said they would accept an increase in dues to pay for paved roads. This was a difficult question to assess because it was a "skip" question and should have only been answered by the 35 people who checked yes on question 12 (Should gravel roads of Lake Miramichi be paved?). In fact, question 13 (If yes, are you willing to accept an increase in dues to cover costs?) was answered by 81 people. According to these 81 people, 58.0% are not willing to have an increase in dues for paved roads. This may indicate that the majority of homeowners and vacant lot owners do not feel it is necessary to have paved roads.

According to the LMPOA rules and regulations handbook, property owners of Lake Miramichi are prohibited from using fertilizers. Surprisingly, 18.1% of the respondents stated that they use fertilizer. The LMPOA should enforce rules and regulations more strictly.

Both homeowners and vacant lot owners feel that homeowners should pay higher dues than vacant lot owners. Possibly, homeowners are willing to pay more dues because they see year round community benefits. According to survey comments, vacant lot owners feel they should not pay for benefits they are not there to receive (Figure 3).

The majority of respondents (41.3%) are undecided on the village incorporation issue (Figure 3). This may be due to the lack of general

information on the ramifications involved with becoming a village. A slightly lower percentage was opposed to village incorporation (39.4%). A fear of losing the current private status of the community may be an explanation.

Many citizens (44%) agree that there should be no development of any kind around Lake Miramichi (Figure 2). From comments received, the population is enthusiastic about home construction, but unfavorable to commercial development. This indicates that many residents are satisfied with the environment as it currently exists.

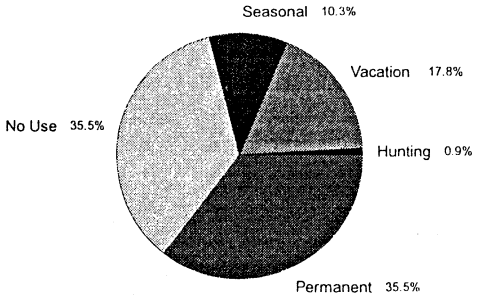
The survey showed a majority of citizens either want a private well system or are undecided on what they want (Figure 3). Because only one-quarter said they are happy with the current community water supply and 75% expressed dissatisfaction with the community water supply, it may indicate that the LMPOA should assess the current water system. The largest complaint expressed from the comment section of the survey was the high price of the water availability charge. Vacant lot owners complain that they are being charged the fee despite the fact that they do not use the water. Figure 19 shows a cost comparison between the water rates at Lake Miramichi and other local areas. This comparison may be taken into account if the LMPOA decides to assess the current water system.

Many mail respondents felt they were not able to accurately answer the survey because they no longer visit Lake Miramichi and could not provide an opinion of the current conditions of the lake.

Figure 2 Pie chart results for selected survey questions.

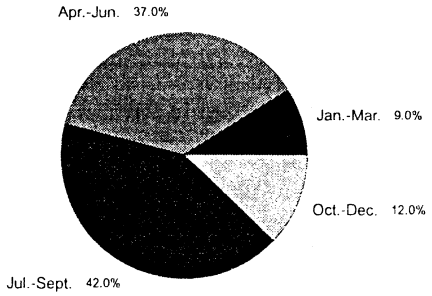
Question #4

Check the response that most closely describes the usage of your lots at Lake Miramichi



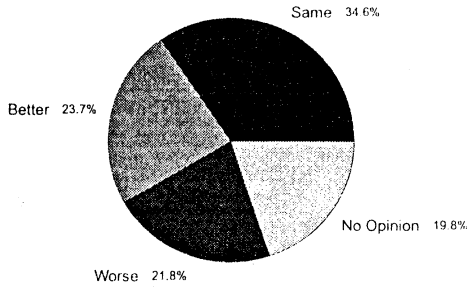
Question #6

Which of the following months do you frequent the lake?



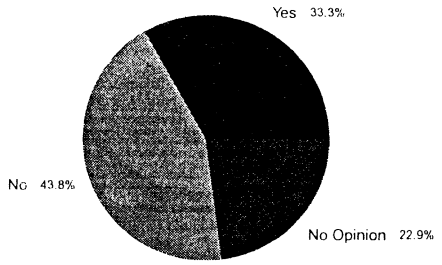
Question #11

In your opinion how do the roads of Lake Miramichi subdivision compare to gravel roads maintained by the county?



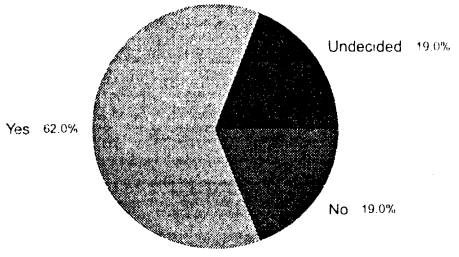
Question #12

Do you feel the gravel roads of Lake Miramichi should be paved?



Question #21

Are you concerned about excessive growth of vegetation (weeds) in Lake Miramichi?



Question #27

Do you use fertilizer/herbicide/insecticide on your property?

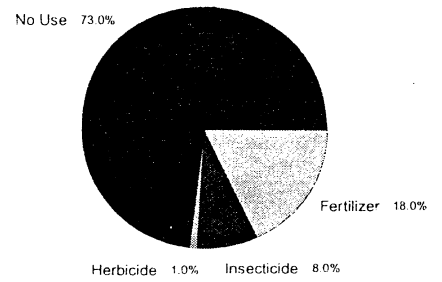
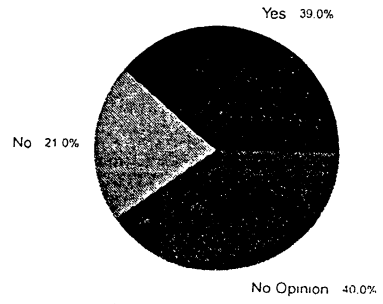


Figure 2 cont.

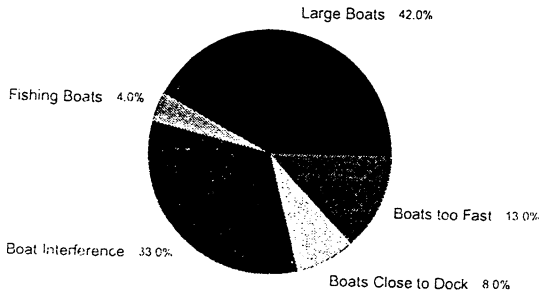
Question #36

Do you believe there are conflicts between fishermen, power boats, jet skis, and home owners?



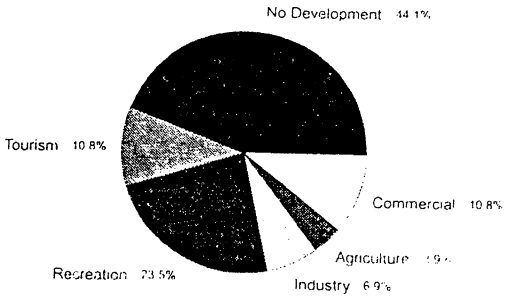
Question #37

Elaboration of conflicts on Lake Miramichi.



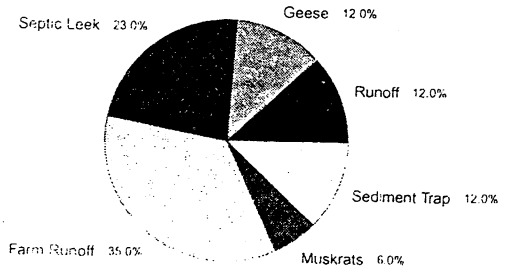
Question #40

Which of the following would you like to see more of?



Question #34

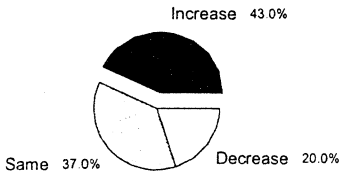
Do you know of anything in the Lake Miramichi area that may be threatening the water quality?



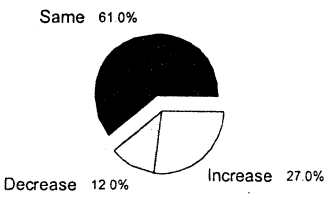
Question # 16

Should Lake Miramichi Property owners dues...

Mail



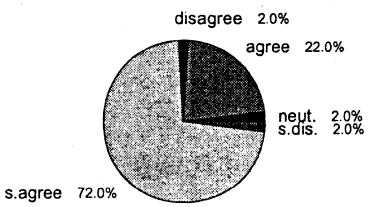
Face



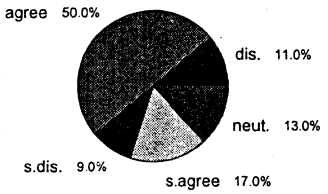
Question # 17

Should home owners pay higher lake association dues than vacant lot owners?

Mail



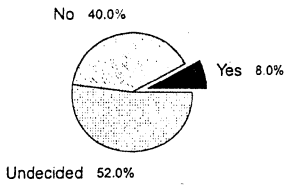
Face



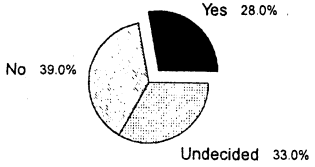
Question # 18

Are you in favor of Lake Miramichi being incorporated as a village?

Mail



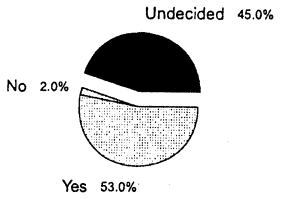
Face



Question #44

Are you in favor of switching to a private individual well?

Mail



Face

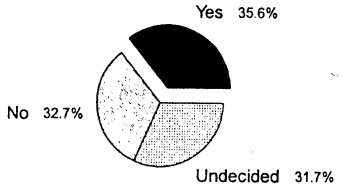


Figure 3 Pie chart of comparisons of face to face surveys and mail surveys.

PHYSIOGRAPHY AND LAND USE

Geological History

Lake Miramichi is located near the center of the area known geologically as the Michigan Basin. The geological history of the basin is divided into four Eras: Precambrian, Paleozoic, Mesozoic, and Cenozoic (the current Era).

The Michigan Basin rests upon a floor or "basement" of very ancient Precambrian granite bedrock, which was covered by six great seas during the Paleozoic Era. Throughout a 380 million year period, these seas deposited sediments which forced the earth's crust to sag downward forming a bowl shaped basin (5). Forty million years after the end of the Paleozoic Era, the "red beds" were created. These "red beds" were formed in the late Jurassic period during the Mesozoic Era and consist mainly of sandstone, shale and clay with minor beds of limestone and gypsum. The Jurassic "red beds" vary in thickness up to 400 feet (5).

The Lake Miramichi area was formed by glaciation in the Pleistocene Epoch of the Cenozoic Era, known as the Ice Age. The glaciers of the Ice Age left layers of clays, sands, glacial till, and glacial outwash over the "red beds". Glacial outwash is composed of particles which were moved by flowing glacial melt water and deposited. Flowing water tends to sort these particles by size. Sizes range from fine silt to large boulders. Glacial till is similar to glacial outwash, but its sediments were moved by ice rather than water (4).

The final advance of the last glacier, the Wisconsin glacier, formed end moraines, which are masses of glacial debris laid down at the end of a glacier, forming hills and ridges (5). The Wisconsin glacier also dredged depressions into the earth, leaving ice deposits that subsequently melted. This dredging and melting formed three natural lakes. These were subsequently inundated when a dam was constructed to create Lake Miramichi. Sediments from these glaciers were also deposited to form the soil that is currently present.

Methodology

To find the position of the points where the depth of the lake was measured, a Total Station was set up at five different locations around the lake. These include the marina, the outlet of the lake, next to the beach access site, lot number 21 (located in the southeastern shoreline) and lot number 359 (located on the north shoreline of the lake). A Total Station is an electronic theodolite combined with a Electronic Distance Measurement (EDM) instrument (Figure 4). An electronic theodolite is an instrument that takes a reading by transmitting a microwave pulse which is returned by a reflector. This instrument can compute and record vertical and horizontal angles, slope distances, horizontal distances, and height differences (6).



Figure 4 Total Station and observer facing southwest. Photo taken facing southeast from the LMPOA beach area. June 20, 1995.

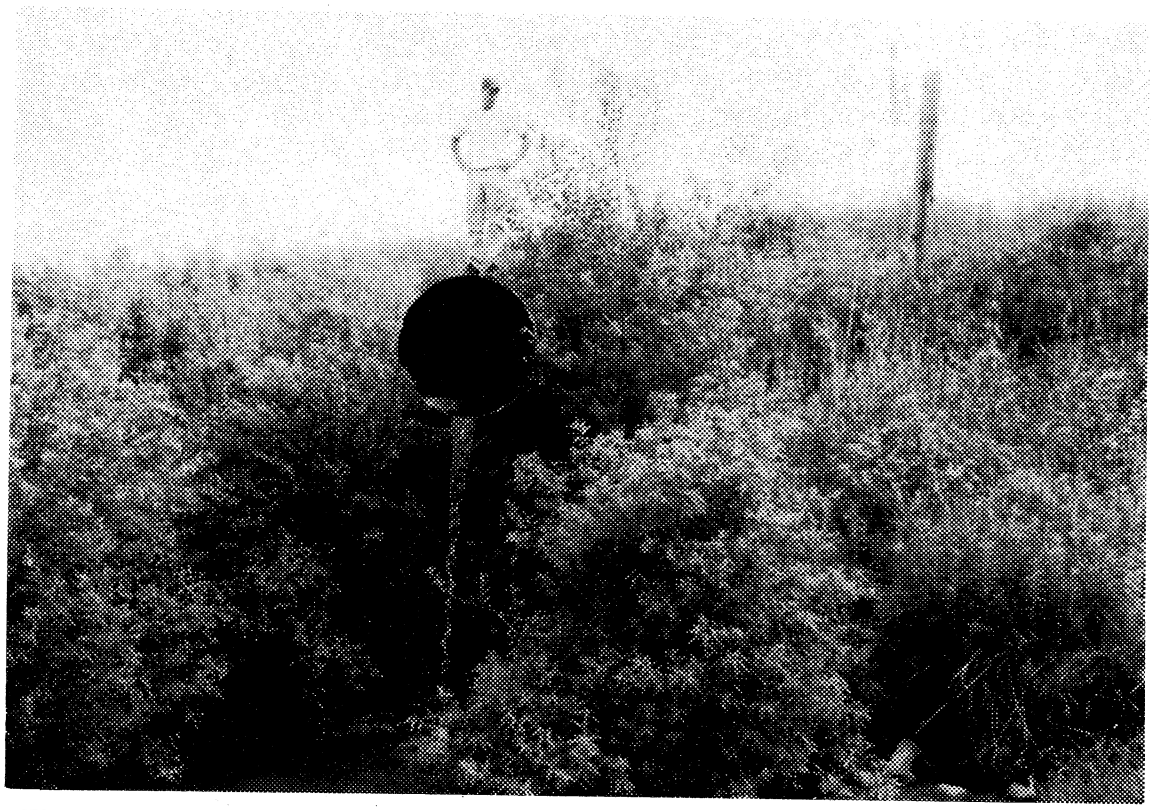


Figure 5 Forty-eight inch outlet pipe from Lake Miramichi overflow area. Photo taken facing southwest. June 29, 1995.

The Total Station recorded the horizontal angle and distance at each point the depth was to be measured. The depths were measured with a Echotrac SF-3000 depthfinder. This depthfinder was calibrated before it was used to insure the proper depth was being recorded. From the data collected, a bathymetric chart of the topography of Lake Miramichi's bottom was plotted (Figure 6).

Lake Level

Even though Lake Miramichi is a private lake, the water level is set by the Michigan Department of Natural Resources (MDNR). The level of the lake is controlled by a cement discharge structure surrounding the outlet of the lake (Figure 5). The LMPOA is responsible for maintaining the lake level within the MDNR limits. The LMPOA also maintains the lake level by keeping it within five to eight inches from the top of the cement discharge structure by using stop boards. There are three 4" x 6" boards and one 2" x 6" board at the cement outlet structure to control the lake level. If the water level is high, the stop boards can be removed to allow water outflow to increase. If the lake level is low, the boards are inserted to slow or stop the outflow (26).

Climate

The Great Lakes significantly affect Michigan's climate. Although weather in Michigan fluctuates daily, the overall seasonal patterns are moderated by the Great Lakes. Michigan's summers are cooler and winters are warmer than the harsh extremes found in states of equal latitude (2). During the first two weeks of the field study period, temperatures exceeded 90 degrees Fahrenheit, and there was no precipitation for the first two weeks. During the final week of the field study, the Lake Miramichi area received a large amount of precipitation followed by seasonal temperatures. This resulted in a dramatic increase in flow rates for the streams when they were measured on June 29.

Soils

The Lake Miramichi area consists of rolling hills and valleys with scattered hardwood forests. The soils vary from gravel to sand depending on how they settled after the glacial retreat (Figure 7).

Osceola County

#4 Isabella-McBride-Montcalm Associations:

These soils are well drained to moderately well drained loamy and sandy soils on undulating to hilly uplands. The Isabella soils have a loamy surface layer, a subsoil of sandy loam to heavy sandy clay loam, and underlying material that is sandy clay loam. McBride soils have the same kinds of material as the Isabella, but the surface layer and the material underlying the subsoil are sandy loam. Montcalm soils have a sandy surface layer, a sandy to loamy subsoil, and sandy underlying material. These soil associations are suitable for pasture, woods, and recreation (20).

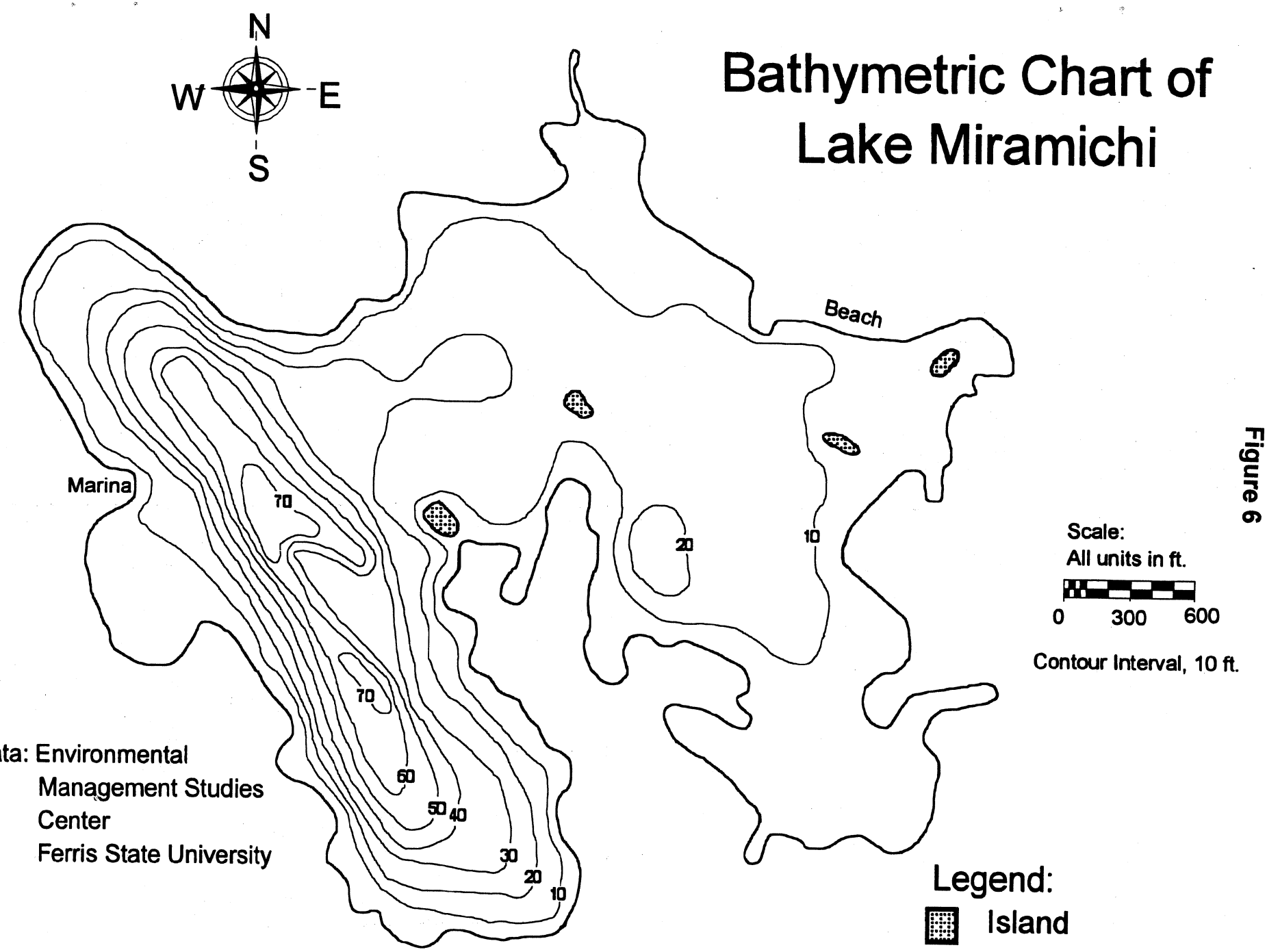

N
W
E
S
Bathymetric Chart of
Lake Miramichi
Beach
Marina
70
70
60
50
40
30
20
10
20
10
Scale:
All units in ft.
0
300
600
Contour Interval, 10 ft.
Data: Environmental
Management Studies
Center
Ferris State University
Legend:
Island
Source: United States Department of
the Interior Geological Survey

Figure 6

#2 Chelsea-Rubicon-Montcalm Associations:

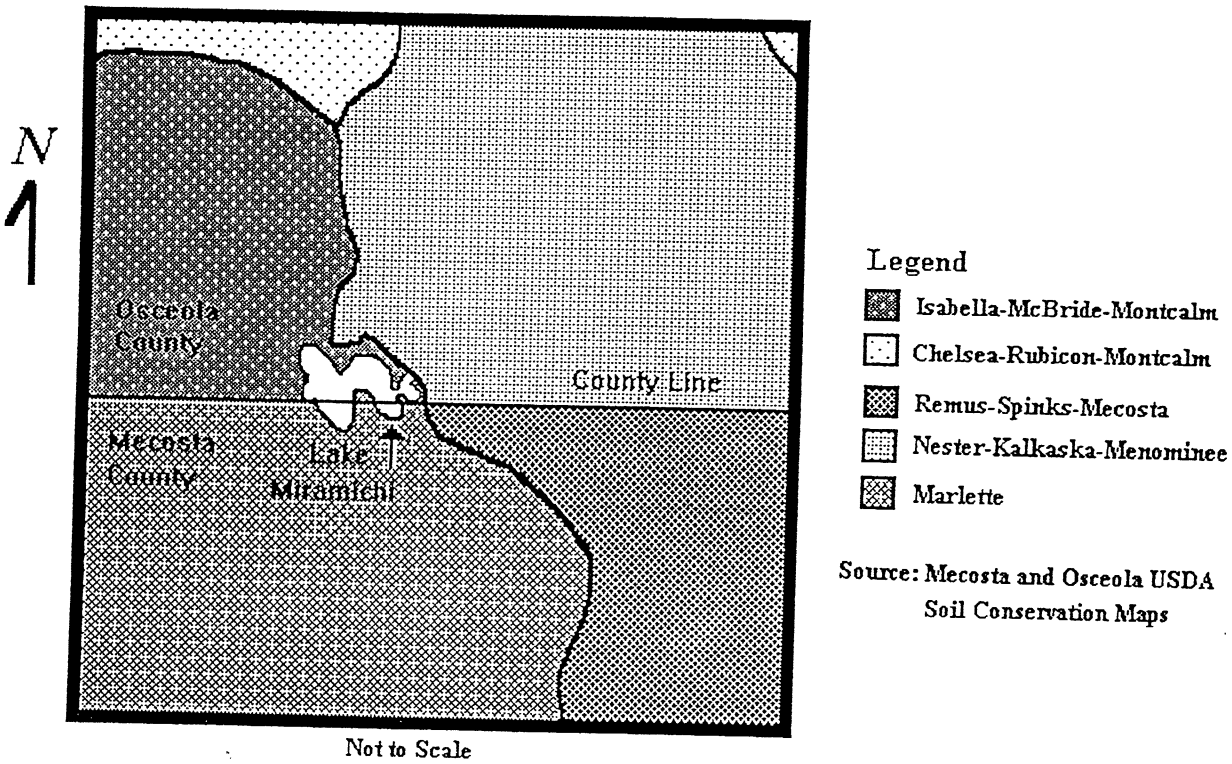
These soils are well drained to moderately well drained sandy soils in rolling to steep moraines. The Rubican soils are sandy throughout their profile. The Chelsea and Montcalm are also sandy but they have a slightly finer textured subsoil than the Rubicon. All three soils lie close together in a complex pattern. Most of this association is used for wood crops or as habitats for wildlife (20).

#6 Nester-Kalkaska-Menominee Associations:

These soils are well drained to moderately well drained loamy and sandy soils on undulating to hilly uplands. The Nester soils are formed in clay loam or silty clay loam material and well drained or moderately well drained. Kalkaska soils are the coarsest textured of the three and are well drained and formed in thick deposits of medium and coarse sands. Menominee soils have a layer of sand or loamy sand over loamy material. These soils are mainly used for crops and pasture land (20).

Figure 7

General Soils Map of Lake Miramichi Area



Mecosta County

#4 Marlette Associations:
These soils consists of undulating to rolling, moderately well drained to well drained, loamy soils formed in glacial till. The surface layer in this association contains dark brown sand, and is approximately eleven inches deep. The middle layer and bottom layer contain brown clay, and brown, mottled clay. These soils are suitable for woodlands (19).

#3 Remus-Spinks-Mecosta-Associations:
These soils consist of nearly level to rolling, well drained, loamy and sandy soils formed in glacial till or outwash deposits. The shallow surface layer of this association contains dark brown sand. The middle layer contains pale brown sand and the bottom layer contains brown sandy clay. These soils are well suited for cropland, woodland, and pasture (19).

Generally, these soil associations are well suited for building site development and septic tank absorption fields with the exceptions of the Marlette association and the Mecosta association. These two types are poorly suited for building site development and septic tank absorption fields. The major limitation is the slow permeability of the clay soils. Soils not containing clay exhibit poor filtering of contaminants and nutrients.

Surface Water

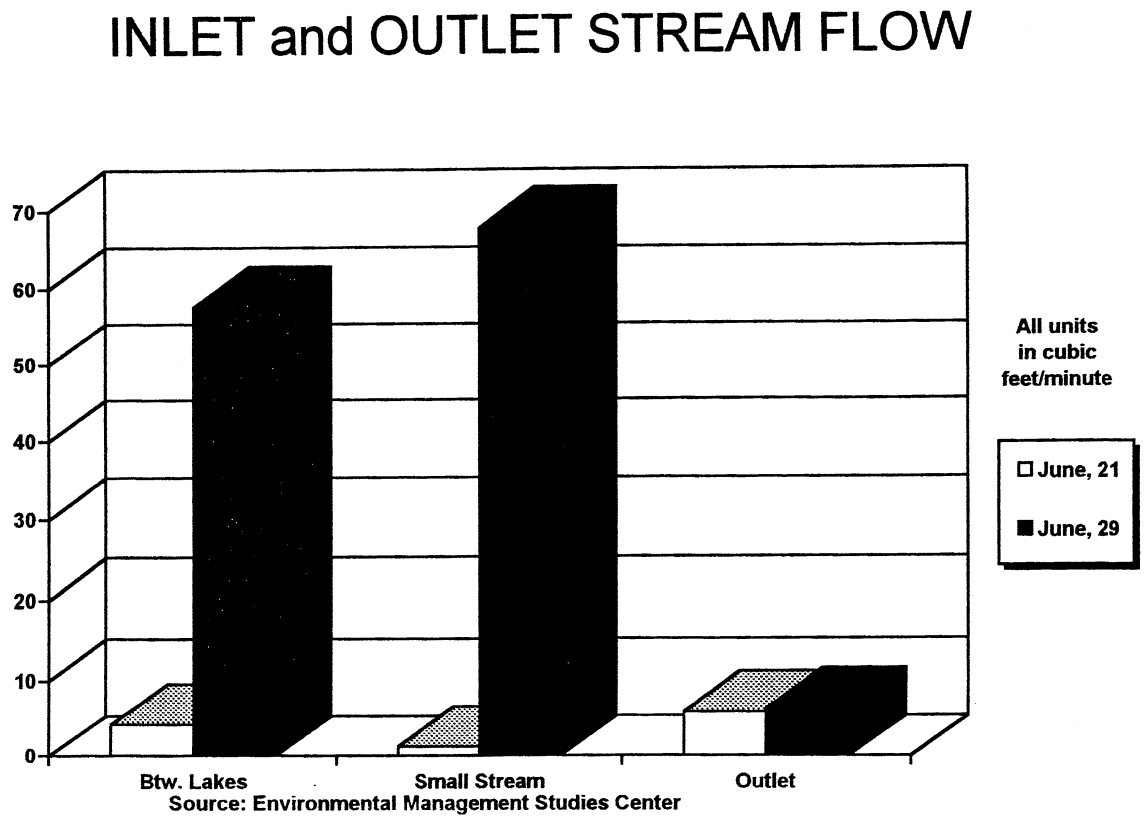
The surface area of Lake Miramichi is 205 acres and adjacent Little Lake Miramichi is 25 acres (36). The perimeter of Lake Miramichi is approximately 24,000 feet (4.55 miles). Lake Miramichi is located in the Muskegon River Watershed. The watershed for the lake includes Hodges Lake, woodlands, wetlands, agriculture land, two small unnamed streams, and several intermittent streams which were dry during the study. Hodges Lake is located south of Lake Miramichi, a swamp is located southeast of Little Lake Miramichi, and agriculture land is located south, southeast, and east of Lake Miramichi.

Flow Velocities

Three sites were selected to determine the flow into and out of the lakes. The sites selected were: (1) between Lake Miramichi and Little Lake Miramichi, (2) a small flowing creek located in the northeastern part of Lake Miramichi, and (3) the outlet of the lake. The flow at each site was measured and the volume calculated on two different days, June 21, and June 29, 1995. The first set of measurements were taken after a dry period. The second set of measurements were taken following a period of 1.25 inches of rain. Figure 8 represents the flow on the two days. A special point of interest is that the lake level was below the top overflow board, but there was still a flow coming out of the lake. This is because of leakage that is occurring within the overflow structure. Figure 8 also shows that the flow in the creeks increases dramatically when precipitation occurs. This indicates that substantial amount of runoff occurs after a significant rain. Since the small streams

had a minimal flow during the dry period, their flow is probably due to the presence of groundwater. The flow out of Lake Miramichi was 5.83 cubic feet per minute (CFM) and the total flow going into the lake was 5.48 CFM during the first flow measurement. The flow out of the lake does not include the loss of water from evaporation, so it can be concluded that there is a significant groundwater flow entering the lake.

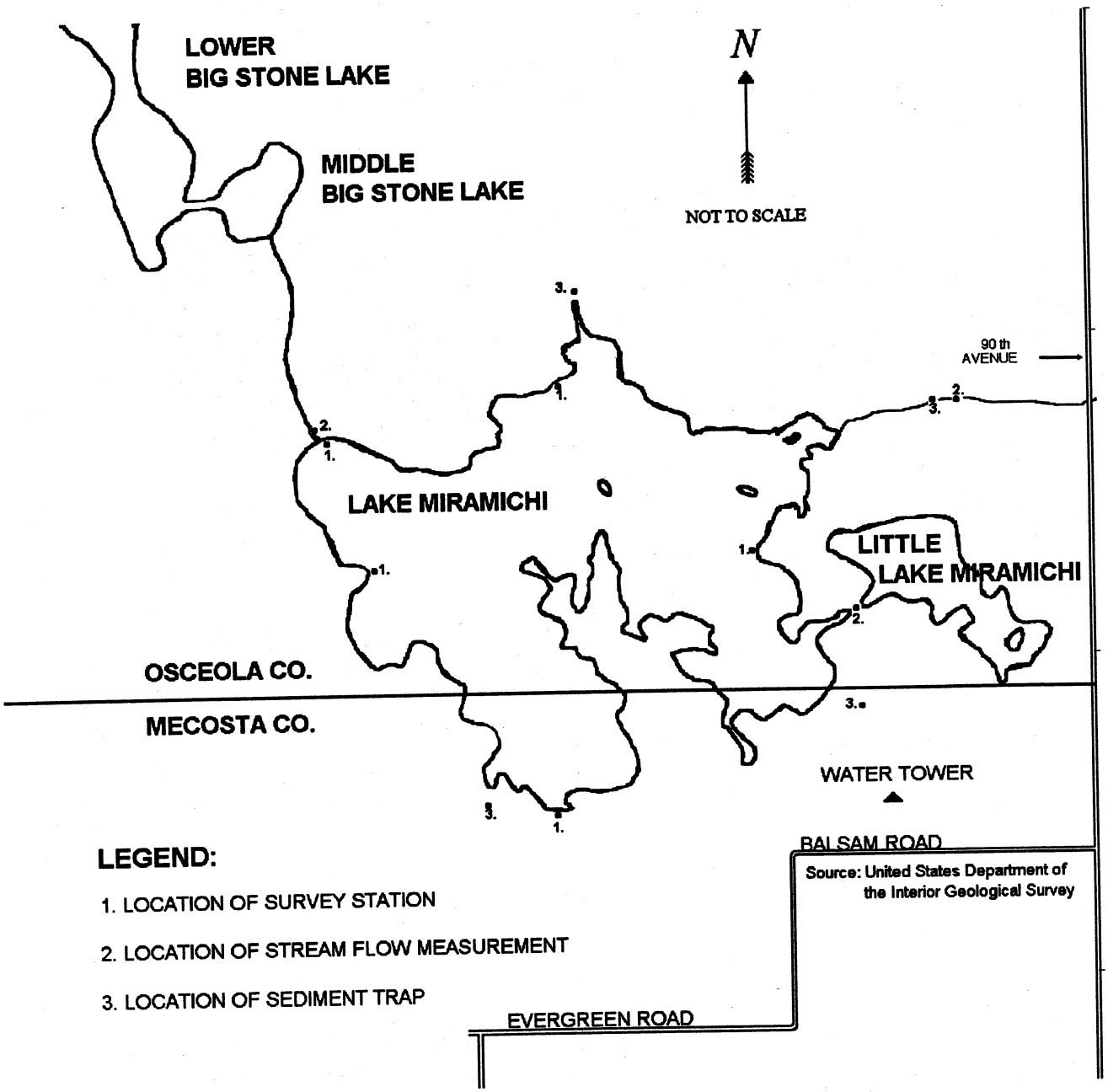
Figure 8



Watershed

Lake Miramichi's watershed contains a swamp and agricultural farmland. This makes Lake Miramichi a natural catch basin for runoff from nearby agriculture land use and organic natural decomposition from swamps. In order to intercept sediments and prevent their entrance to the lake, four sediment traps have been constructed. Three were built in 1991 and the fourth one was built in 1993 (Figure 9)(33). Three of the sediment traps are located on intermittent streams and the fourth is located on the small stream in the northern part of the lake. Traps allow much of the nutrient rich sediments to settle in the traps which slows the aging of

Figure 9


LOWER
BIG STONE LAKE
MIDDLE
BIG STONE LAKE
N
NOT TO SCALE
90 th
AVENUE
LAKE MIRAMICHI
LITTLE
LAKE MIRAMICHI
OSCEOLA CO.
MECOSTA CO.
WATER TOWER
BALSAM ROAD
EVERGREEN ROAD
LEGEND:
1. LOCATION OF SURVEY STATION
2. LOCATION OF STREAM FLOW MEASUREMENT
3. LOCATION OF SEDIMENT TRAP
Source: United States Department of
the Interior Geological Survey

the lake. During the study, the three sediment traps on the intermittent streams were found to contain very little sediment, while the one located on the small stream was filled with sediment (Figure 10). Since this trap in the perennial stream has filled, it should be cleaned out in order to preserve its function. In addition, to operate efficiently, these sediment traps must be regularly inspected.



Figure 10 Sediment trap in the southwest corner of Lake Miramichi. Photo taken facing southwest. July 17, 1995.

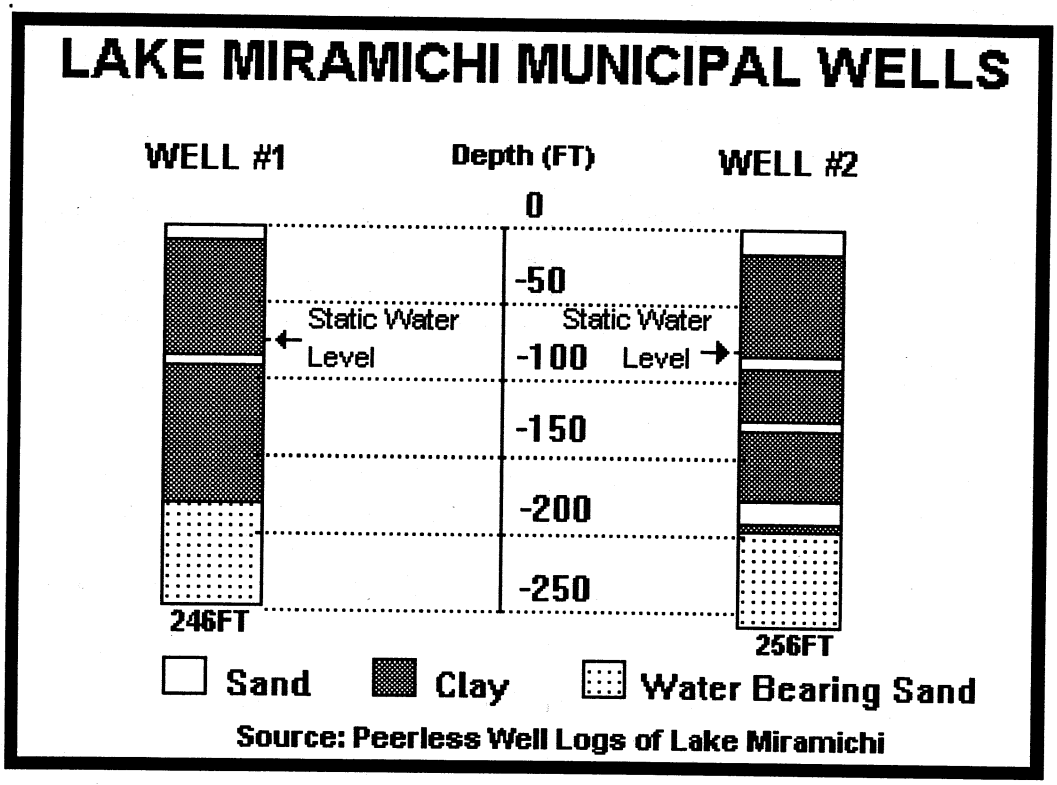
Groundwater

Groundwater makes up the subsurface component of the hydrologic cycle. During and after precipitation, water will runoff and become surface water or will infiltrate into the ground becoming groundwater. The types of rock and soil determine the rate of groundwater infiltration and recharge. The top of the zone of saturation is called the watertable. The rate of groundwater flow varies during the year depending on precipitation. The aquifer extends from the top of the zone of saturation down to a confing layer. Groundwater is a very important natural resource in Michigan (2). Rural areas like Lake Miramichi rely on groundwater for a potable water supply.

In the Lake Miramichi area the barriers and layers of glacial deposits include several confined aquifers. The lithology or well log data of the two wells supplying

Lake Miramichi confirm this statement. The community (type I) water system for Lake Miramichi is supplied by two wells with an average depth of 251 feet, located at 2163 Mohican Drive (Figure 11).

Figure 11



Land-Use

Zoning

Lake Miramichi is located in Evart Township, which is an unzoned township. Zoning refers to a plan to facilitate efficient land usage and involves subdividing land use into residential, industrial, commercial, and agriculture/forestry categories. Lake Miramichi Subdivision has a total area of 953 acres that was purchased by American Realty Service Corporation in 1966. The corporation zoned all building lots at Lake Miramichi as residential except those to be used for the marina, restaurant, and central water system (40). Residential properties include single family, multi-family, and seasonal residential homes.

Wetlands

Wetlands are classified as any land characterized by the presence of water at a frequency and duration sufficient to support vegetation or aquatic life that is characteristic of marshes, bogs, or shallow ponds. Lake Miramichi has no official

wetlands in the subdivision. However, reference maps indicate and field observations confirmed wetland areas are around Lake Miramichi (22, 32). These areas include the small creek flowing into Little Lake Miramichi and the intermittent creeks flowing into the southern part of Lake Miramichi. The adjoining property, located downstream of the lake's outlet, is classified as wetland. Mecosta County has an estimated 51,922 acres of wetlands (32). Osceola County has an estimated 55,517 acres of wetlands (34). Wetlands are necessary and valuable resources which provide habitat for diverse wildlife. They cannot legally be drained for any type of development. Wetlands play an important role in regulating stream flow and act as traps for nitrogen and phosphorus. These are two common nutrients from water runoff on heavily fertilized land (19).

Agriculture

Agricultural practices for Osceola and Mecosta Counties are related to the land availability and the fertility of the soil in the area. Hay and silage are the predominant crops in these counties. Factors limiting agriculture are soil fertility and land slope. Livestock rearing, diary production, and horse rearing are common in these two counties.

Woodlands

Lake Miramichi is characterized by rolling woodlands. Woodlands benefit Lake Miramichi by protecting watersheds from soil erosion, thus keeping rivers and reservoirs relatively free of silt. Woodlands reduce the severity of floods and facilitate aquifer recharge. They also provide habitat for many species of plants and animals (4).

SOCIOECONOMICS AND TRANSPORTATION

Demography

Housing

There are 135 homes in the Lake Miramichi Subdivision, all of which are single family households. Of those surveyed in the Lake Miramichi resident survey, 98.5% stated that they owned their housing units while one person stated they rented. The majority of the households are occupied by two or less persons.(44)

In Chippewa Township there are 1,039 housing units, while Evart Township has 806, and the city of Evart has a total of 785.

Age

The median age in Chippewa Township is 43.9 years, in Evart Township 35.3 years, and the median age of the city of Evart is 31.8 years (44). The median age of the residents of the Lake Miramichi Subdivision is not known. According to the survey, it has been determined that 56.1% are 60 years old and older (Figure 12) (44).

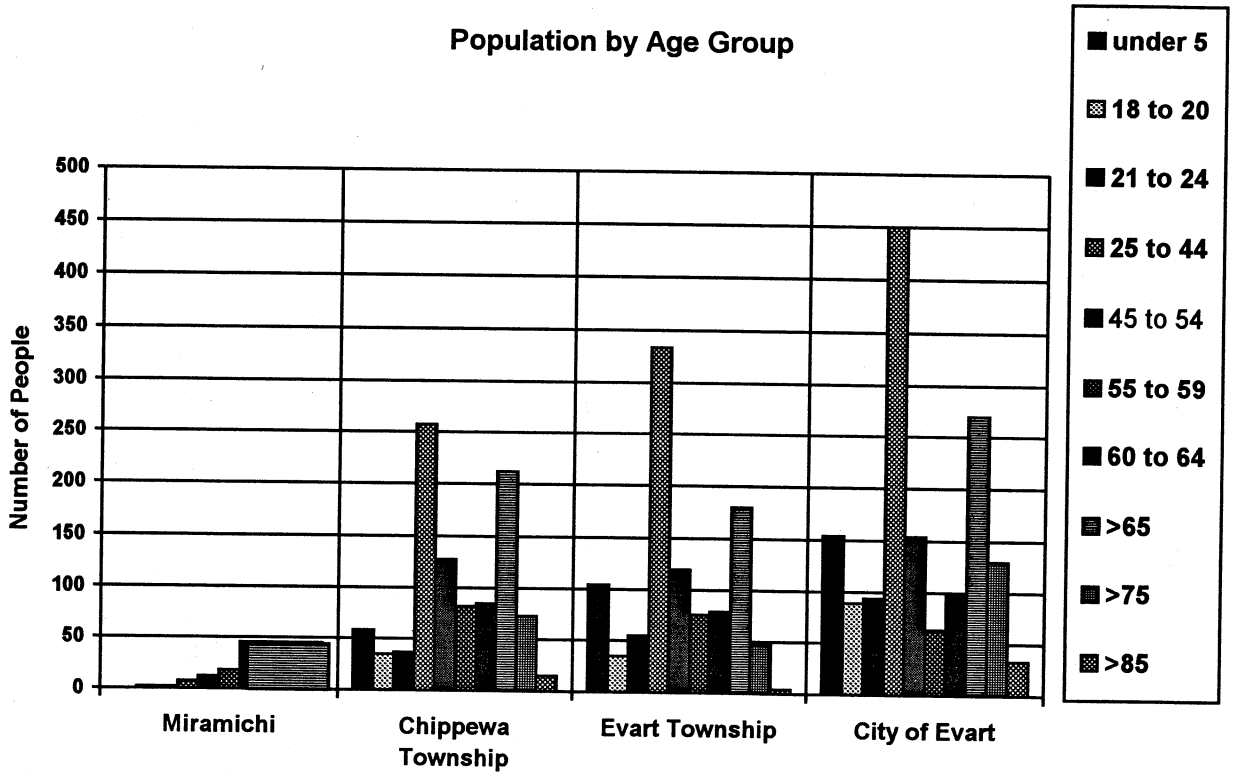
Race

The 1990 U.S. Census of Chippewa Township, Evart Township, and the city of Evart, indicated that 98.3% to 99.2% of the population is Caucasian. African Americans make up 0.5% to 0.8%, Native Americans: 0.0% to 0.5%, Asian and Pacific Islanders: 0.1% to 1.5%, and people of Hispanic background: 0.0% to 1.0% of the population. A survey of the racial background of the Lake Miramichi population was not completed.

Sex

The ratio of males to females in the study area is 509 males to 526 females in Chippewa Township, 616 males to 613 females in Evart Township, and 801 males to 943 females in the city of Evart. Such a of males to females in the Lake Miramichi Subdivision is not known.

Figure 12



Source: 1990 US Census and Student Survey

Political Structure

Lake Miramichi is a private lake development regulated by the LMPOA. This association consists of nine board members. Those currently holding positions include: Rebecca David-Wright, President; Edsel Sebring, Vice President; Gloria Jenkins, Secretary; and Phillip Gallihugh, Treasurer. Other members include Tom Dziuba, Lauren Duling, William Flachs, and Dennis Bryant. The LMPOA's primary functions are maintenance of properties and the stabilization of the community, both socially and economically. Board meetings are held monthly to address community problems and concerns. The president of the LMPOA receives monthly reports from the chairpersons of each separate committee concerning interests, problems, and concerns of the residents. The president also supervises each committee in the implementation of action (27). There are seven separate committees which have been established.

Committees

The Club House Control Committee, which is chaired by Gloria Jenkins, is responsible for the regulation of club house use by LMPOA members. This includes the reservations for, and the scheduling of personal parties and functions. This position entails overall maintenance and upkeep of this facility. Damage reports along with a monthly statement of conditions and concerns are presented to the board (41).

The Dam Committee, chaired by Dennis Bryant, is responsible for maintenance of areas surrounding the dams. This includes the removal of excess brush and upkeep of danger and weight restriction signs. This committee also handles inspection requirements and clearance concerns. A monthly report to the board concerning current conditions and desired actions are other aspects of this committee's responsibilities (41).

The Delinquent Dues Committee is responsible for taking action toward the collection of delinquent dues and reporting to the board on liens and court involvement. This committee also maintains up-to-date records of past due amounts and takes appropriate legal action, when necessary, concerning overdue claims (41). The chair of this committee is currently vacant, therefore, matters are handled by the association.

The Lake/Weed Harvest Committee, which is chaired by Rebecca David-Wright, Irv Turner, and Dennis Bryant is responsible for supervising the annual weed harvest, maintaining existing sediment ponds, and the general repair of boat ramps and docks owned by the association. Signs throughout the community regarding rules and regulations are also maintained by this committee. A monthly plan of action report is presented to the board which includes proposed dates of action and completion of projects. Long term project proposals are expected on a seasonal basis for budgeting purposes (27).

The Parks/Beach/Campground Committee is chaired by Tom Dziuba and is responsible for gathering volunteers to remove brush and mow grass in all LMPOA owned areas except along roadsides. Other duties include weed control around the lake, maintenance of picnic tables and waste dispensers in the park

and dumpster areas, placement of swimming area buoys before Memorial Day and the removal after Labor Day, and the maintenance of all equipment used in these functions. Monthly reports to the board are mandatory.

The Road Committee, chaired by Rebecca David-Wright is responsible for the overall maintenance of association property which includes: snow removal, sanding, grading, ditching, and the maintenance of culverts. An outlined plan of action, approximate costs, and a projected date of completion are all presented to the board before implementation. Other responsibilities include, setting up outside contracting bids and supervising their activities.

The Roadside Committee, chaired by Lauren Duling, is responsible for roadside brush and grass cutting, visibility of street signs, and maintenance of the pole building owned by the LMPOA. Volunteers to assist in these activites are gathered and supervised by the chair. Maintenance of all equipment used in these functions is also involved. Plan of action reports and concerns are to be discussed with the board and addressed in a monthly report (41).

Village Incorporation

An aspect of particular concern, which has recently been reviewed by the LMPOA , is the possibility of incorporating Lake Miramichi Subdivision as a village (27). The purpose is to establish a government capable of providing municipal services to residents (38). A home rule village regulates its own services by establishing an organizational structure. Creating and developing adequate public works and maintaining the public safety are other aspects of this incorporation (38). By January 1994, 48 villages in Michigan had adopted home rule charters. This total, in addition to 264 home rule cities, makes Michigan one of the leading home rule states in the nation (39). The Home Rule Village Act (Act 278, P.A .1909) requires that every village to be incorporated provide for the election of a president, clerk and legislative body, and for the election or appointment of such other officers and boards as needed. The president need not be directly elected by the people, but may be elected by the village council. Of the 48 home rule villages, only 13 have a village manager position (39).

The ability to incorporate is determined primarily by total population and density. A population of 150 and an average density of not less than 100 persons per square mile is needed (38). Lake Miramichi does meet these requirements with an approximate population of 250 persons in 1.5 square miles. A city completely separates itself from the township, but a village must continue to pay a township tax. This tax is higher if the village is within a charter township (38). In a charter township, chief executives of either appointed (a manager) or elected (a mayor) types are favored (39).

All incorporation of new villages must be carried out under the provisions of the Home Rule Village Act and the Boundary Commission Act (Act 191, P.A. 1968) (38). Incorporation and furnishings of municipal services will cost money. While certain non-property tax revenues are available, these costs must be met primarily by the levy of a property tax. (38).

The major sources of revenue for incorporated villages are property taxes and the State-Shared Revenue Program. This program involves pro-rated revenues from the State based on the ratio of population in the area incorporated to the entire township (38). Villages do receive their share of state sales, income, and single business tax revenues (38).

Advantages of Incorporation

Incorporation provides legal authority for exercising local control over functions which, within the township, are generally the responsibility of county agencies. These include police protection, traffic control, highway construction and maintenance, snow removal, street lighting, and health regulations. Incorporation also involves the financial ability to obtain all types of municipal services such as water, sewage disposal, fire protection, and recreational facilities (38). Another advantage involves the provision of legal power to levy taxes in order to provide needed municipal services. These state-collected, locally-shared taxes are returned to and used in the area where people live and where the density of population creates the greater need for governmental services (38). The LMPOA would no longer be needed to govern the community but could remain. If incorporation was to be implemented, village government would be elected and run according to State rules and regulations. Dues brought in could be allocated toward special needs and concerns not covered by State revenues and taxes (35).

Disadvantages of Incorporation

A new village and its services will require the payment of taxes to provide those municipal services that the people in the area desire and that are not now available or are performed inadequately (38). The current private status of Lake Miramichi would inevitably change. Lake access would have to be made available to the general public because the community would be utilizing tax dollars. However, restrictions could be made and enforced (35).

Incorporation Procedure

The first step in incorporation as a village is to obtain the necessary petitions from the State Boundary Commission located in Lansing, Michigan. There are no application fees. The procedure from that point is outlined below:

1. Original boundaries should be set with careful thought and foresight.
2. A petition is filed proposing incorporation with the Boundary Commission. The petition is composed of five parts, each is outlined specifically by the State Boundary Commission.
3. A land survey may be required by the commission. In addition, written description of the boundaries are included.
4. An evaluation questionnaire is sent by the commission, to the township clerk and is to be returned within 30 days of the initial filing.
5. The charter commission is elected. This commission is made up of five members who are registered to vote and who reside in the area. These

members are responsible for the framing of the charter which is submitted to the governor of the state for approval.

If this charter is approved, a referendum is held. If there are no conflicts to State or National law within the charter, it is sent back to the community and voted upon. If incorporation passes, the procedure begins. The effective date of implementation is outlined in the charter (35).

Local Economy

Employment

Chippewa Township and Evart Township have several industries which offer employment to area residents. These industries include agriculture, forestries, fisheries, construction, manufacturing, retail, and educational services. Most of the total residents in the Lake Miramichi subdivision are retired. Of the survey participants, 57.8% are retired, 35.8% are employed full time, 5.5% are employed part time, and 0.9% of the respondents are unemployed.

Local Business

The marina (located at 1790 Miramichi Drive) is the only local business at Lake Miramichi. The marina offers residents a boat launch and a place to dock their boats. Since there are no other businesses, the residents usually go to Evart or Big Rapids for their shopping needs.

Tax Appropriation

According to the 1994 Apportionment Report for the 1995 budget, $841,495.80 will be collected from Chippewa Township. This is 4.48% of the $18,792,042.54 in total taxes to be collected in Mecosta County.

According to the 1994 Apportionment Report for the 1995 budget, $444,625.08 will be collected from Evart Township. This is 5.84% of $7,611,546.67 in the total taxes to be collected in Osecola County. Separate figures for the Lake Miramichi area are unavailable from either county.

Millage

Millage is a method of determining how much tax a landowner will pay according to the assessment made on the parcel of land owned. The landowners' property tax dollars of Lake Miramichi are collected by two governing bodies: Mecosta County and Chippewa Township or Osceola County and Evart Township, depending upon their county of residence (Figure 13,14).

Figure 13

Chippewa Township 1994 Mills

Chippewa Hills School District	
Set Mills	6.000
Debt	2.250
Operation	18.000

Evart School District	
Set Mills	6.000
Debt	-
Operation	18.000

Mecosta, Osceola Intermediate School District	
Allocated	0.245
Voted	2.447
Career Center	1.566
Total	4.257

Mecosta County	
Allocated Op	5.854.
Voted	0.500
Hospital Bond	0.385
Ambulance	0.684
Total	7.423

Chippewa Township	
Township	1.032
Roads	0.826
Fire	0.826
Total	2.683

Source: Equalization Report for Mecosta County 1995

Figure 14

Evart Township 1994 Mills

Local School District	
State Ed Tax	6.000
Voted Op	18.000
Debt	0.000

Intermediate School District	
Allocated	0.245
Voted	4.012
Total	4.257

Osceola County	
Allocated	6.637
Comm. on Aging	0.787
Road Patrol	1.000
Total	8.424

Evart Township	
Township	0.9324

Source: Equalization Report for Osceola County 1995

Recreation and Social Activities

Recreational activities on Lake Miramichi are primarily related to the natural resources of the area. These include swimming, boating, fishing, and hunting (outside of the subdivision). Several scheduled parties and gatherings are also hosted by the LMPOA (Figure 15). A marina and numerous boat docks are available around the lake and an 800 foot long sandy beach with a separate play area is also available for children (Figure 16).

A private camping area is available to property owners. It is closed after December 31 and reopens April 1. Guests of home owners may park only on a property owner's lot and may not exceed two weeks. An annual 4th of July meeting is held at the club house located near the beach area. After a business meeting, food and refreshments are served. A boat parade follows, beginning at the beach area. This parade consists of boats, decorated by residents, touring across the lake. Following the parade, there is music and dancing at the club house.

Women residing in the community have the opportunity to join the Ladies Club. Meetings are held on the second and fourth Tuesday of each month at the club house. One of the activities sponsored by this club is their annual yard sale at the club house in late July.

Transportation

According to the Lake Miramichi residents survey, 37.5% of the people surveyed are permanent residents, while 27.5% use their house for weekend, holiday, or recreation and 17.5% use their home seasonally. Most part-time residents travel to and from Lake Miramichi passing through Evart off of U.S. 10.

Highways

U.S. 131, a major transportation route on the western side of Mecosta County, extends northward from the Indiana border to Petoskey. U.S. 27, U.S. 10, M-20, and M-66 are other major highways used by Lake Miramichi residents. These routes are given high priority by the county road commission for snow removal (Figure 17).

Airports

The nearest airport is the Evart Municipal Airport, approximately nine miles north of Lake Miramichi. Another nearby airport is the Roben-Hood Airport in Big Rapids, named after two local Big Rapids aviators who lost their lives during World War 1. Longer east-west runways capable of handling corporate jet aircraft have been added to Big Rapids Airport. These local airports handle small aircraft and some small commercial flights. For larger commercial flights, Kent County International Airport, in Grand Rapids, is approximately one hour and 45 minutes from Lake Miramichi (43).



Figure 15 Photo of annual board meeting at the clubhouse. Photo taken facing southeast. July 2, 1995.

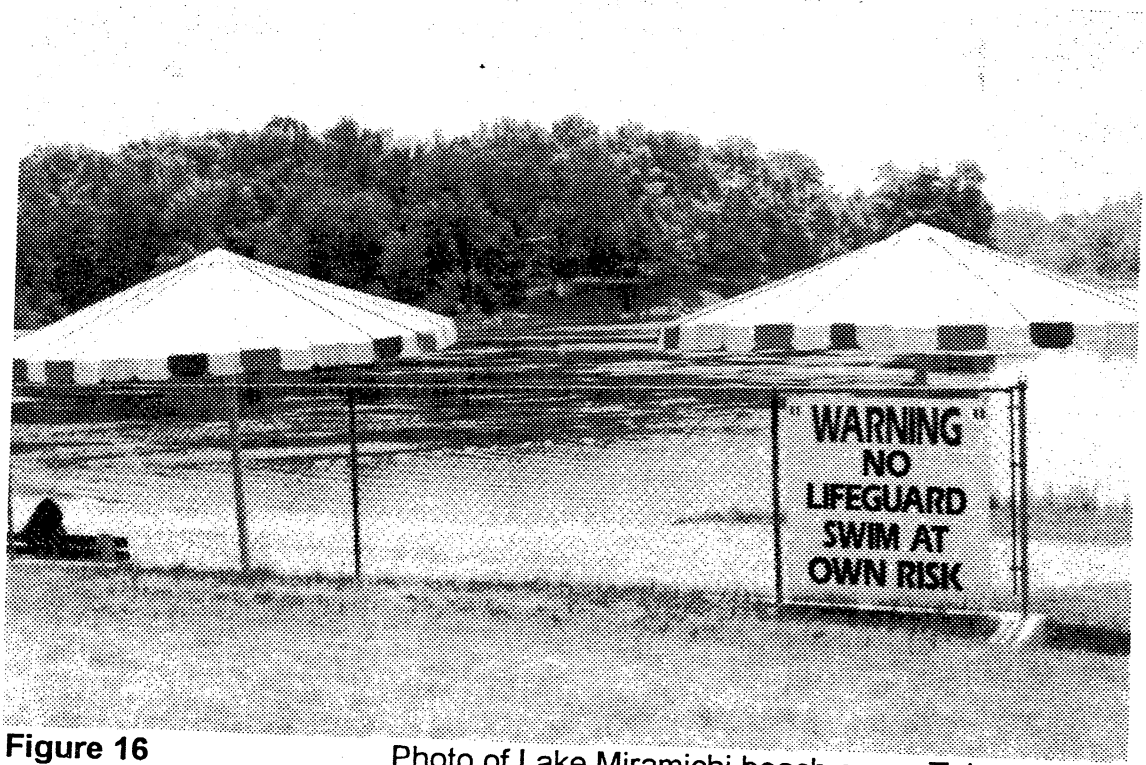


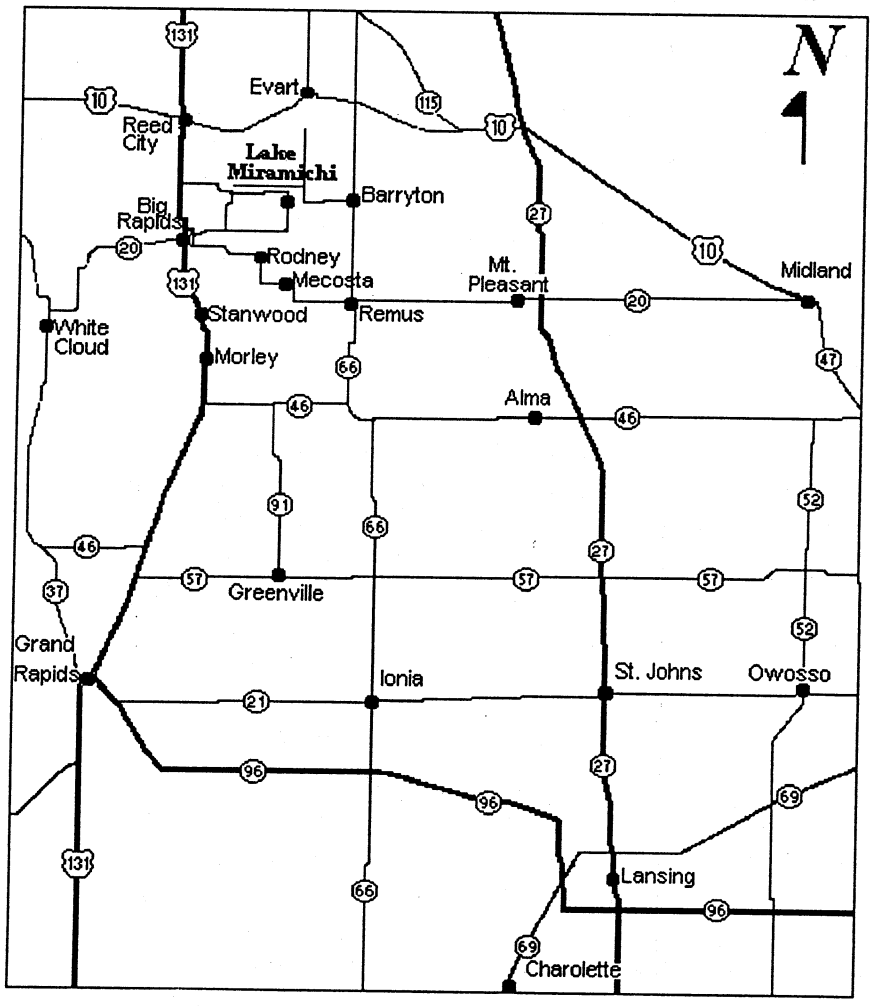
Figure 16 Photo of Lake Miramichi beach area. Taken facing southeast. July 2, 1995.

Bus Services

Statewide busing is provided by Indian Trails Motorcoach which stops in Big Rapids. Local busing transportation is provided by Mecosta-Osceola County Area Transit (MCAT). MCAT buses people to Lake Miramichi from Mecosta or Osceola County for a fee of $1.70 per person. There are two scheduled bus runs to the Lake Miramichi area per day. The first bus departs from Big Rapids at 6:30 a.m. and takes approximately one hour to arrive at Lake Miramichi while the second bus departs at 2:45 p.m. and arrives at Lake Miramichi at approximately 4:15 p.m.

Figure 17

TRANSPORTATION ROUTES TO LAKE MIRAMICHI



Legend

Paved 2 or more lanes

Interstate, State, and U.s. Routes

Not to Scale

Source:
Environmental and Community Study
Chippewa Lake Area 1979

Community and Public Services

Education

Ten children who reside at the Lake Miramichi Subdivision attend Evart Public Schools (29). Evart has one elementary school, grades kindergarten through fifth, and one junior/senior high school, grades six through twelve. Three of the ten students ride the bus to and from Evart Schools, while the other seven ride with their parents. The school bus picks the students up at the 90th Avenue entrance to Lake Miramichi.

Emergency Medical Service

The ambulance service for the Lake Miramichi Subdivision is provided by the Osceola County Emergency Medical Service (EMS). The Osceola EMS has an ambulance which is housed at the Evart Fire Department. In the event of an emergency, residents of Lake Miramichi have 911 service. Calls to 911 are received at a central dispatch in Paris, Michigan, with an approximate 15 minute response time to Lake Miramichi.

Public Safety

Law Enforcement

The Osceola County Sheriff Department, located in Reed City, patrols the Lake Miramichi Subdivision. If additional officers are needed, the Michigan State Police are called to assist. A Sheriff Department patrol boat is used to enforce water safety laws. Lake Miramichi Property Owners Association Security Patrol is responsible for general surveillance and issuing trespass tickets.

Fire Department

The Evart Area Volunteer Fire Department is located at 109 Sixth Street Downtown Evart. This is the only department that serves the Lake Miramichi Subdivision, although the department has a mutual aid system with Mecosta and Clare Counties, if extra assistance is required. The types of equipment housed at the Evart Fire Department are: four pump trucks, one water tanker, one grass rig, and a snowmobile for winter rescue. The estimated response time to the lake is approximately fifteen minutes (30).

Water Supply

Residents of Lake Miramichi Subdivision get their water from a community water system, operated by Miramichi Utilities Incorporated (MUI), a private business owned by William Seltzer. Two homes have their own individual wells. The community system is supplied by two wells, 246 and 256 feet deep, drilled in 1968. A 100,000 gallon water tower adds pressure to the system (Figure 18). Due to higher seasonal water demand the water tower is placed into use only between April-December. From January-March water is supplied from a pump system that bypasses the water tower. Pressure in the system is supplied by the pump only. The water in the tower is kept at a fairly constant level to provide

water pressure. When the water reaches low levels a pump fills the tower. This is a continuing process throughout April-December. Since the water tower is not used on a daily basis a chlorine residual is not maintained at all times. The tower is filled and flushed in the spring and fall. At this time, liquid chlorine is added to the water supply. The wells were last inspected by Peerless-Midwest Inc. of Granger, Indiana on February 22, 1995. Irv Turner is responsible for checking the pipes and valves. He also collects water samples from both wells, and from his home once every month. The samples are sent to the Michigan Department of Public Health where they are analyzed for coliforms. In compliance with the Safe Water Drinking Act, the water is also tested every three years for organic and inorganic chemicals, metals, minerals, volatile organic compounds, and cyanide. Nitrates are tested annually (25). There have been no health hazards detected in the water within the last two years. Currently, if a sample was to indicate contamination, another sample would be collected and retested.

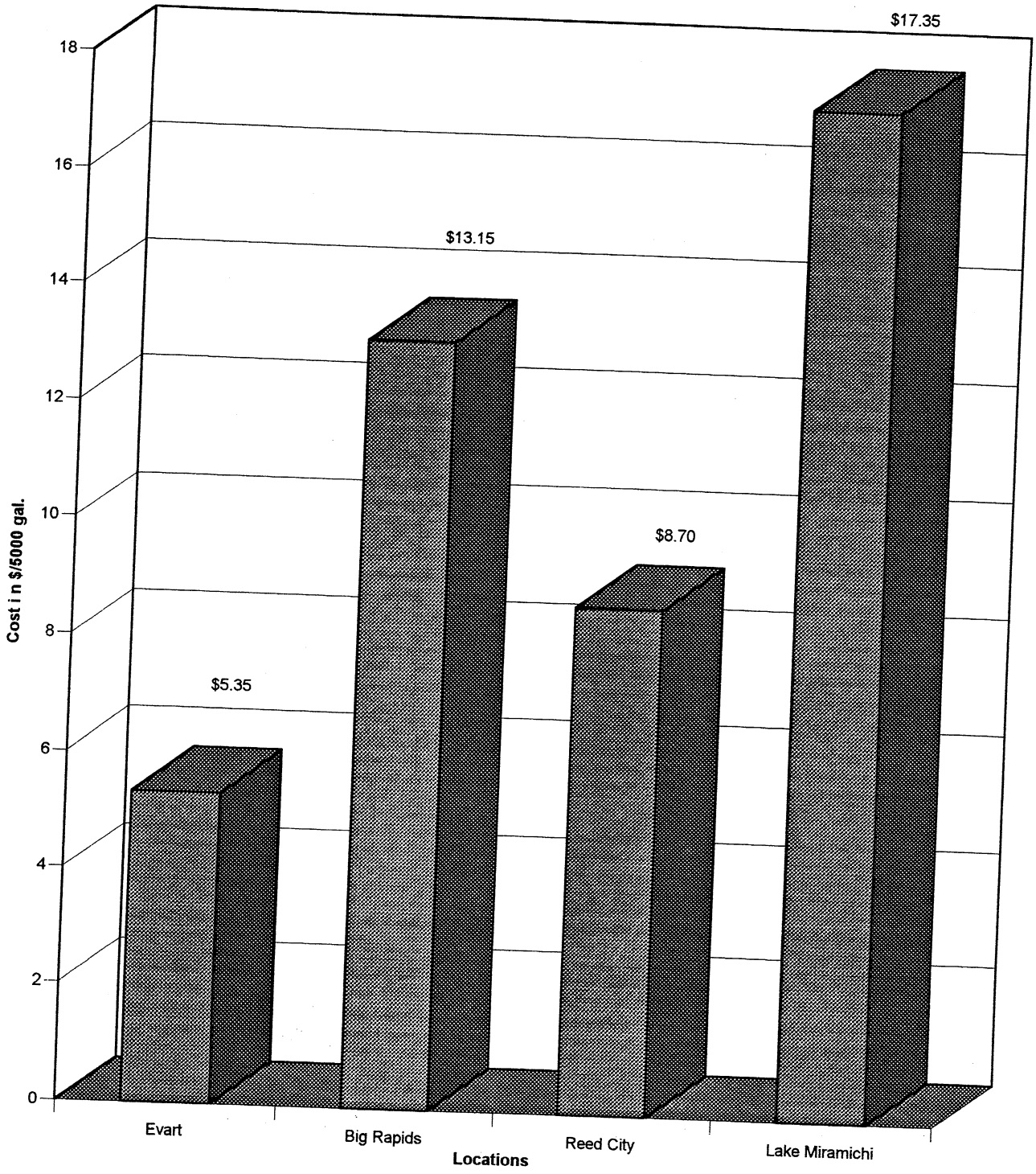
The current charge for water service is $17.35/month for homeowners, and $8.00/month availability charge for every lot owned (Figure 19). There is a tap-in fee of $600.00 between May 15th-November 15th, and a $800.00 tap-in fee between November 16th-May 14th. There is also a turn-on charge of $25.00, along with a turn-off charge of $25.00 for water services (36). These rates are subject to change.



Figure 18 Lake Miramichi community water tower. Photo taken facing southeast. June 29, 1995.

Figure 19

Water Cost Comparison for Local Area



Source: Melissa Kleppinger
Environmental Management Studies Center

Wastewater

Each homeowner of the Lake Miramichi Subdivision has his/her own septic tank system and drainage system for wastewater treatment and disposal (10). In both Mecosta and Osceola County, a septic tank system and drainage system must be at least fifty feet away from a lake, ten feet away from other water lines, and fifty feet away from an individual well (31). Some of the soils, especially lakeside lots are not appropriate for septic systems (31). This has caused problems because many property owners cannot build on, and/or have had difficulty selling their lots. Many lots are classified as unbuildable because they do not pass a percolation test which assesses soil permeability. The use of alternative drainage systems might be examined as a solution to this problem.

Most of the residents of Lake Miramichi have not experienced problems with their septic tank systems, in part, due to the Mecosta and Osceola County Health Departments' supervision of the construction of on-site wastewater systems. If a lot has been rated as marginal, the sanitarian will make the owner aware of all associated risks and make suggestions on how to prevent them. The sanitarian may suggest using water conserving appliances, and may recommend against having laundry facilities on-site. Homeowners can seek further information on septic system concerns with either the Mecosta or Osceola County Health Department, Environmental Health Division.

WATER QUALITY

Introduction

The purpose of the chemical, physical, and microbiological water quality study of Lake Miramichi and Little Lake Miramichi was to determine the existing condition of the lakes and use this information for further research, study, and recommendations for preserving the water quality of Lake Miramichi. In 1982, a baseline study of the lake was used to compare the 1995 results. The current study was accomplished by collecting samples from 10 different sample sites and by analyzing them for thirteen chemical and physical parameters and five microbiological parameters. This study excludes any and all streams, wetlands, etc. associated with the lakes.

Sample Site Identification and Sampling Procedures

Microbiological samples were collected in sterile plastic bottles and the chemical samples in chemically clean plastic and glass bottles. The surface samples were collected at a depth of 1 to 6 inches, using standard sampling methods. This is done by submerging the sampling bottles in the lake until they are full. The samples collected at site 9 were collected at the surface and at depths of 10', 20', 30', 40', 50', and 60' using a Kemmerer sampler. The samples collected at site 7 were taken at the surface and at depths of 4' and 8' using a Kemmerer sampler. The collected samples were taken to Ferris State University, College of Allied Health Sciences, Victor F. Spathelf Building, Room 423 for analysis.

Sample Site 1

The surface water samples were collected approximately 10 feet straight out from the center of the shoreline of the swimming area of the northeast beach of Lake Miramichi, in front of the Lake Miramichi Property Owners Association's clubhouse. GPS - N 43 49.18', W 85 16.63'

Sample Site 2

The surface water samples were collected approximately 3 feet from shoreline in a southwesterly direction from the west corner of the property line of 2196 Miramichi Drive, in the northernmost bay of Lake Miramichi. GPS - N 34 49.43', W 85 16.88'

Sample Site 3

The surface water samples were collected from the west side of Lake Miramichi at the dam. The site is located approximately 10 feet north of the discharge structure and approximately 2 feet from the shoreline. GPS - N 43 49.16', W 85 17.46'

Sample Site 4

The surface water samples were collected from the southwest section of the southeast bay of Lake Miramichi. The samples were collected 3 feet from the shoreline, on the property line between 2588 and 2654 Miramichi Drive. GPS - N 43 48.83', W 85 16.48'

Sample Site 5

The surface water samples were collected approximately 450 feet south-southwest of the little dam, which separates the two lakes, on the east side of Lake Miramichi and 25 feet northwest of lot #791, at 2649 Miramichi Drive. GPS - N 43 49.00', W 85 16.48'

Sample Site 6

The surface water sample area is located in the southwest corner of the southeast section of Little Lake Miramichi. The sample site is approximately 200 feet south of the island and 20 feet from both the southeast and the southwest shorelines of the southeast bay. GPS - N 43 48.90', W 85 16.15'

Sample Site 7

The surface water samples were collected from Little Lake Miramichi. The site is located approximately 300 feet northeast from a dock behind the residence at 2650 Miramichi Drive. Two samples were also taken at this site at 4 feet and 8 feet of depth.
GPS - N 43 49.06', W 85 16.41' (Figure 21).

Sample Site 8

The surface water samples were collected approximately 600 feet southwest of sample site 1. GPS - N 43 48.86', W 85 16.92'

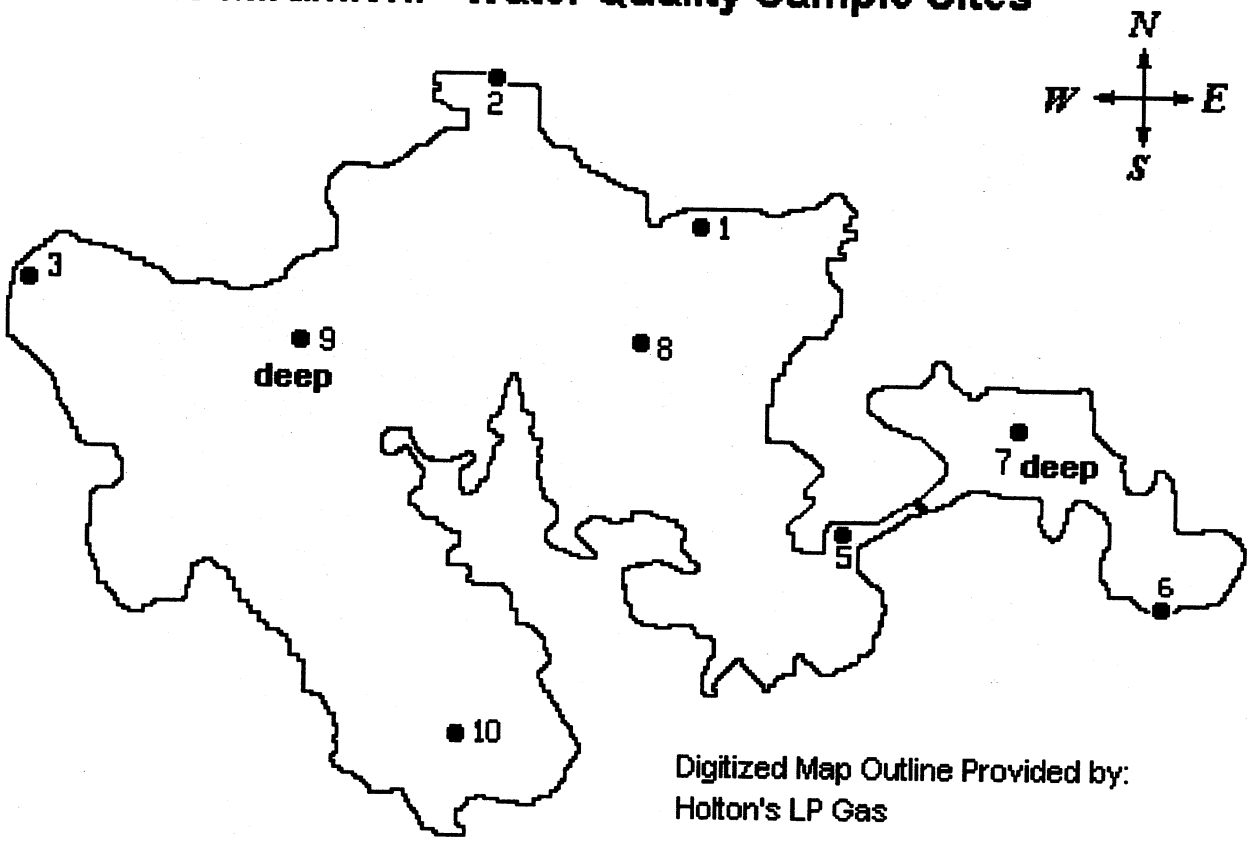
Sample Site 9

The surface water samples were collected east-northeast of the marina, approximately halfway between it and the house on the island that is connected to the mainland by a bridge. Six deep samples were also collected at 10 foot increments down to a maximum depth of 60 feet.
GPS - N 43 49.00', W 85 17.23'

Sample Site 10

The surface water samples were collected in the southeast section of the southernmost bay of Lake Miramichi. GPS - N 34 49.05', W 85 16.41'

Lake Miramichi - Water Quality Sample Sites



Location of Sample Sites

Figure 20 indicates the locations of the sample sites at Lake Miramichi. The Global Positioning System (GPS) defines the exact location of a point in latitude and longitude by triangulation with satellites in space. Specific latitude and longitude measurements can be found in the description of each sample site.

Water Quality Parameters

All data from the physical analyses can be found in Figure 23.

Physical Analysis and Results

Temperature

Temperature is very important when assessing a lake ecosystem. The aquatic organisms present in a temperate lake depend, in part on the temperature conditions. Temperature readings of Lake Miramichi were performed using both a metal (Hg) thermometer and the HACH Conductivity/Total Dissolved Solids Meter set at the temperature measurement mode (Figure 22).



Figure 21 Photo of sample site 7, located on Little Lake Miramichi. Taken facing north. June 29, 1995.

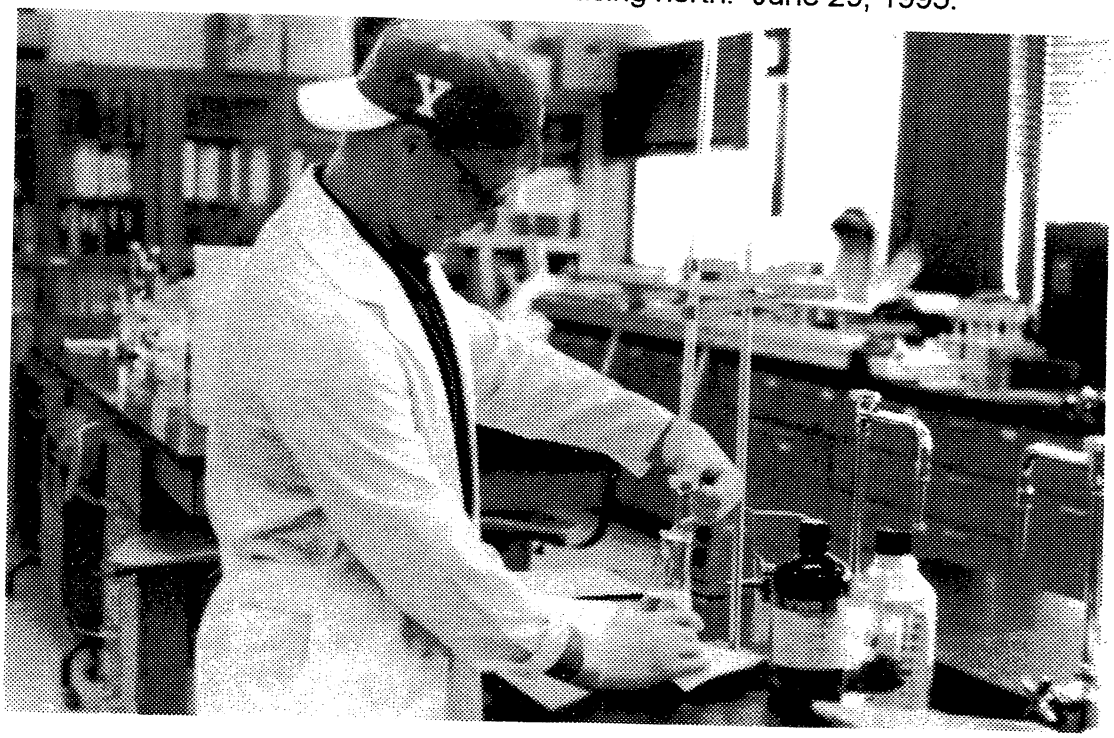


Figure 22 Photo of student analyzing water sample taken from Lake Miramichi. Taken at Victor F. Spathelf Building Laboratory 423. June 27, 1995.

The temperature of the water between the 10 surface sample sites and 8 depth sites ranged from a low of 20°C (68°F) to a high of 29°C (84.6°F). The 20°C temperature was recorded at two locations, site 2 on June 1, and site 3 on June 1 and 6. The 29°C temperature was recorded at the surface of site 5 on June 22. The increase in water temperature may have been a result of the increasing air temperature from June 1 to June 22. The average surface water temperature of all samples collected was 23.8°C (75°F).

Transparency

Transparency is the measure of distance that sunlight can penetrate into water. The depth that sunlight penetrates will determine where photosynthesis ends. Photosynthesis is the process by which plants convert carbon dioxide to oxygen using sunlight and chlorophyll. This process promotes the growth of aquatic plants.

Transparency was determined using a Secchi disk and the results were recorded in feet. The transparency was performed on four separate open water sites. Site 7, had an average transparency of 6'. Lake Miramichi had a low transparency of 7.5' (site 8) and a high transparency of 17' (site 9).

There is no standard for transparency against which to compare the results, but when compared to the 1994 study of Chippewa Lake, Lake Miramichi has a significantly higher transparency. The transparency for Chippewa Lake ranged from 7.5' to 10.5'. In the 1982 Lake Miramichi study tests for transparency ranged from 3' to 6'. The 1995 study shows the water has become substantially clearer in the past 13 years. Since photosynthesis can take place to a depth of 17.5', this amount of transparency could explain excess aquatic plant growth in certain areas of the lake. Site 7, on Little Lake Miramichi, was transparent through the entire water column to the lake bottom, therefore, excess aquatic plant growth could also be explained by increased photosynthesis levels.

Chemical Analysis and Results

All chemical analysis data from surface samples can be found in Figure 24, and all chemical analysis data from deep samples can be found in Figure 25.

pH (Hydrogen ion concentration)

Measurement of pH is one of the most important and frequently used tests in water chemistry. The pH of water refers to a measurement of the hydrogen ion concentration. An excessive concentration of hydrogen ions may adversely affect water, therefore, pH is a measure of potential pollutants. The hydrogen ion concentration is also interrelated with the concentration of other substances because it controls the degree of separation of many substances.

The pH was determined using a calibrated HACH One pH Meter. The low pH was 7.22 at site 2, on June 22. The high pH was 9.47 at site 5, on June 6. The logarithmic average pH of all samples collected was 7.98.

State standards for Michigan surface water should be maintained within the range of 6.5 and 9.0, unless natural conditions within the lake cause the limitations to be exceeded (16). According to sample data, Lake Miramichi and Little Miramichi fall within the acceptable limits.

Conductivity

Conductivity is a measure of the ability of an aqueous solution, in this case water, to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, as well as the temperature of the water sample. Conductivity measurements are used to establish degrees of mineralization to assess the effect of the total ion concentration on chemical equilibria, physiological impact on plants or animals, and corrosion rates, etc. 37).

A HACH Conductivity/Total Dissolved Solids Meter was used to measure the conductivity and the result was displayed digitally in mS/cm (millisieverts per centimeter). The low conductivity was measured at 0.182 mS/cm at site 5, on June 6. The high conductivity was measured at 0.296 mS/cm at site 6, on June 1. The average conductivity of all samples collected was calculated at 0.231 mS/cm.

There are no state standards for conductivity, however, it directly relates to the Total Dissolved Solids (TDS) standard which is 500 mg/L. Therefore, the greater the conductivity, the greater the TDS (12).

Total Dissolved Solids (TDS)

While the conductivity measurement expresses the capacity of ions in solution to carry an electrical current, the TDS measurement expresses the concentration in milligrams/liter of the various ions in the sample. Dissolved solids consist mainly of carbonates, bicarbonates, chlorides, sulfates, and phosphates. Dissolved solids is another name for dissolved salts or dissolved mineral constituents in water.

The TDS was measured with a HACH Conductivity/TDS Meter in mg/L by introducing a probe into the water sample with the digital reading displayed in mg/L. This result is frequently compared with results of the hardness and alkalinity (1). The low TDS was measured at 97.4 mg/L at site 7, on June 22. The high TDS was measured at 153.7 mg/L at site 6, on June 1. The average TDS of all samples collected was calculated at 116.7 mg/L.

According to state standards, the TDS of surface water may not exceed 500 mg/L per month, and no more than 750 mg/L at any given time. The highest results came from Little Lake Miramichi (sites 6, 7) where the TDS varied between 144.8 mg/L to 153.1 mg/L. This indicates that both lakes are well below the state standards.

Dissolved Oxygen (DO)

Dissolved oxygen is the amount of oxygen dissolved per liter of water. It is essential for the survival of aquatic life. Generally, the higher the DO

concentration, the better the capability of the lake to support aquatic life, like fish. A high DO concentration also indicates whether or not a lake can cleanse itself. The analysis was performed using a calibrated HACH Portable DO Meter.

The low DO was 2.1 mg/L, at site 9, at depths of 50 and 60 feet. The high DO was 16.4 mg/L at site 4, on June 20. The average DO of all samples collected was 8.76 mg/L.

The high levels of DO in the surface water samples (8.76 mg/L average) and in the shallower depths of the open water samples indicates that the lake is well suited to support aquatic life. The DO concentrations decreased with an increase of depth. This is explained by the fact that oxygen levels naturally decrease in lakes as the depth increases because less oxygen can dissolve from the atmosphere and light cannot penetrate to promote photosynthesis and add oxygen to the water.

Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is the oxygen consumed by microorganisms in metabolizing organic material. It is also an indirect measure of organic pollutants.

The analysis was performed using the same calibrated HACH Portable DO Meter used in the DO analysis. BOD is the difference between the initial first day DO reading and the DO reading after incubating the samples at 20°C for 5 days. The result is reported in mg/L.

The surface sample at site 4, showed the highest amount of BOD at 7.6 mg/L on June 20. The low BOD was 0.10 mg/L at site 9, at a depth of 20 feet. The average BOD of all sites was 1.65 mg/L.

While there is no state standard for BOD, a high BOD leads to decreased levels of oxygen in the water. From the low BOD levels, it can be concluded that Lake Miramichi and Little Lake Miramichi have adequate oxygen to support aquatic life and no external source of highly organic pollution (Figure 26).

Carbon Dioxide (CO_2)

Dissolved CO_2 is present in all waters and wastewaters. This is because of CO_2 production from microbial decay of organic matter and atmospheric CO_2 dissolving into water. CO_2 is very soluble (up to 2000 ppm) and is always dissolving into surface waters depending on its partial pressure with atmospheric CO_2. CO_2 and its ionization products, bicarbonate ion and carbonate ion, have an extremely important influence on water chemistry (16). Many minerals are deposited as salts of the carbonate ion. CO_2 has not been shown to cause any adverse health effects. CO_2 is a good indicator of microbial growth and the levels of photosynthesis taking place in a body of water. The decomposition of organic matter by aerobic bacteria, on the other hand, leads to an increase in CO_2 when these organisms use DO and produce CO_2. The level of CO_2 present is a useful indicator of the inverse relationship between CO_2 and DO in surface waters of a lake. CO_2 was determined using a HACH Digital Titrator, a 3.636 N NaOH Titration Cartridge, and a Phenolphthalein Powder Pillow.

The lowest CO_2 was 8.50 mg/L at site 7, at the depth of 4 feet, on June 20. The high CO_2 was 47.0 mg/L at site 9, at the depth of 60 feet. The average CO_2 of the 8 depth sites was calculated at 24.6 mg/L.

Data shows that at site 7, CO_2 levels increased with depth, from 18 mg/L to 21 mg/L, and at site 9, CO_2 levels increased with depth from 16 mg/L to 47 mg/L. This increase in CO_2 is a result of less photosynthesis taking place by plant life. Low CO_2 and high DO levels at the surface indicate a healthy lake environment.

Total Hardness

Hardness is defined as the sum of the concentrations of calcium and magnesium carbonates and bicarbonates dissolved in water. Though some other metals contribute to hardness, their concentrations and significance in natural waters in Michigan are usually negligible. Calcium and magnesium are dissolved from rocks and soils, therefore, groundwater is generally harder than surface water. The presence of hardness in water contributes no odor, color, or turbidity to the water, but can serve as a buffer (pH neutralizer) to acid precipitation (37).

The analysis was performed using a HACH Digital Titrator and a HACH Company ManVer 2 Hardness Indicator Powder Pillow. The low total hardness was measured at 88 mg/L at site 5, on June 6. The high total hardness was measured at 160 mg/L at site 6, on June 1. The average total hardness of all samples collected was calculated at 121.2 mg/L. When compared to the 1982 study, the total hardness has increased from an average of 110.8 mg/L to 121.2 mg/L. This could be caused by an increase flow of groundwater into the lake.

There is no Michigan Department of Natural Resources standard for hardness, however, the 1994 state average for area lakes and streams was 156 mg/L. From the sample data, Lake Miramichi and Little Lake Miramichi are considered hard water lakes, however, they are considered softer than the state average. Hardness helps buffer the pH which, in turn, helps protect against damage to aquatic life. Large amounts of hardness can also be indicative of possible natural spring seepage through the bottom of the lake.

Alkalinity

Alkalinity is closely related to pH, and is a measure of the power of a solution to stabilize acidic concentrations. Alkalinity is caused by the presence of carbonates, and is expressed in the amount of calcium carbonate in the water. Water with a pH value of 7 to 8, and having a total alkalinity of 100 to 120 mg/L is ideal for aquatic life. Alkalinity can also serve as a buffer, to prevent sudden changes in the pH.

The low alkalinity was 64 mg/L at site 5, on June 6. The highest alkalinity was 150 mg/L at site 6, on June 1. The average alkalinity of all samples collected was 104.02 mg/L.

Figure 23

PHYSICAL DATA

Sample Site	Date	Conducti (ms/cm)	Water Temp (C)	Transparen (ft)	TDS (mg/L)
1	6/1	0.240	22	X	122.1
1	6/6	0.210	22	X	104.4
1	6/20	0.280	25	X	105.1
1	6/22	0.201	24	X	100.8
1	6/27	0.218	26	X	109.1
2	6/1	0.225	20	X	117.4
2	6/6	0.195	21	X	101.6
2	6/20	0.220	24	X	110.3
2	6/22	0.220	25	X	110.2
2	6/27	0.219	24	X	115.2
3	6/1	0.249	20	X	129.6
3	6/6	0.221	20	X	119.5
3	6/20	0.235	23	X	117.8
3	6/22	0.228	24	X	117.6
3	6/27	0.220	24	X	110.0
4	6/1	0.213	22	X	108.5
4	6/6	0.184	22	X	102.3
4	6/20	0.224	24	X	112.5
4	6/22	0.222	26	X	111.5
4	6/27	0.222	25	X	111.1
5	6/1	0.213	24	X	107.1
5	6/6	0.182	28	X	97.6
5	6/20	0.223	26	X	111.6
5	6/22	0.216	29	X	108.2
5	6/27	0.231	27	X	115.6
6	6/1	0.296	24	X	153.1
6	6/6	0.282	28	X	151.7
6	6/20	0.245	25	X	122.7
6	6/22	0.233	27	X	116.9
6	6/27	0.232	27	X	116.2
7	6/1	0.282	23	6.5	149.6
7	6/6	0.288	26	6.5	144.8
7	6/20	0.208	27	5.5	104.5
7	6/22	0.193	26	5.5	96.4
7	6/27	0.230	27	6	114.9
8	6/1	0.241	21	7.5	128.3
8	6/6	0.226	23	7.5	115.2
8	6/20	0.213	25	8.5	106.6
8	6/22	0.212	24	7.5	105.6
8	6/27	0.218	26	8	108.2
9	6/1	0.270	22	17	136.4
9	6/6	0.225	22	15	129.7
9	6/20	0.241	24	14	120.4
9	6/22	0.225	25	14	112.8
9	6/27	0.227	25	13	113.3
10	6/1	0.262	21	14	131.5
10	6/6	0.262	23	11	133.1
10	6/20	0.249	25	13.5	124.6
10	6/22		25	14.5	107.2
10	6/27	0.225	25	11.5	112.8

X= NO DATA

CHEMICAL DATA

Figure 24

Sample Site	Date	BOD (mg/L)	DO (mg/L)	Total Hardness (mg/L)	pH	Acidity (mg/L)	Alkalinity (mg/L)
1	6/1/95	2.00	11.30	117	8.53	X	66
1	6/6/95	3.65	13.80	96	8.86	X	90
1	6/20/95	0.80	11.00	96	9.09	5	86
1	6/22/95	1.80	10.80	98	7.84	5	110
1	6/27/95	2.80	6.80	111	7.26	6	97
2	6/1/95	1.50	14.00	115	8.64	X	111
2	6/6/95	4.70	16.30	98	8.93	X	87
2	6/20/95	2.50	13.90	104	9.17	7	96
2	6/22/95	1.70	10.80	105	8.17	4	100
2	6/27/95	3.50	8.30	113	7.22	5	100
3	6/1/95	1.50	9.80	130	8.49	X	124
3	6/6/95	2.80	12.00	121	8.55	X	119
3	6/20/95	2.20	12.60	124	9.09	7	98
3	6/22/95	0.50	10.30	107	8.32	7	101
3	6/27/95	2.20	8.60	119	7.37	6	102
4	6/1/95	1.80	11.00	108	8.78	X	97
4	6/6/95	3.00	12.70	100	8.89	X	81
4	6/20/95	7.60	16.40	112	9.28	3	101
4	6/22/95	2.60	6.00	110	7.37	9	84
4	6/27/95	3.80	7.40	113	7.45	10	103
5	6/1/95	1.40	13.60	106	8.72	X	96
5	6/6/95	2.30	14.70	88	9.47	X	64
5	6/20/95	4.20	8.00	101	9.14	9	95
5	6/22/95	2.60	7.80	108	8.09	6	94
5	6/27/95	2.10	7.50	110	7.47	6	98
6	6/1/95	2.10	10.40	160	8.19	X	150
6	6/6/95	1.90	10.30	154	8.81	X	143
6	6/20/95	2.20	12.20	123	9.12	8	108
6	6/22/95	1.70	11.20	116	8.34	5	106
6	6/27/95	2.00	6.60	101	7.56	5	106
7	6/1/95	4.60	12.70	147	8.01	X	143
7	6/6/95	1.00	9.70	136	8.38	X	137
7	6/20/95	0.80	11.80	116	9.25	5	100
7	6/22/95	1.40	12.20	110	7.80	6	95
7	6/27/95	2.40	6.00	106	7.63	5	97
8	6/1/95	2.80	11.20	126	8.46	X	116
8	6/6/95	0.70	10.80	117	8.68	X	107
8	6/20/95	0.40	10.00	97	9.21	5	90
8	6/22/95	1.40	9.80	112	7.91	4	98
8	6/27/95	1.80	7.80	111	7.67	4	101
9	6/1/95	1.00	9.60	131	8.13	X	121
9	6/6/95	0.70	9.30	128	8.12	X	117
9	6/20/95	1.20	9.20	121	9.05	11	107
9	6/22/95	1.00	8.60	123	7.92	9	100
9	6/27/95	1.20	8.20	115	7.78	10	99
10	6/1/95	1.40	9.50	137	8.32	X	126
10	6/6/95	0.40	9.10	127	8.48	X	118
10	6/20/95	0.80	8.80	124	8.98	9	108
10	6/22/95	1.20	7.80	120	8.34	8	104
10	6/27/95	1.40	8.60	125	7.87	8	104

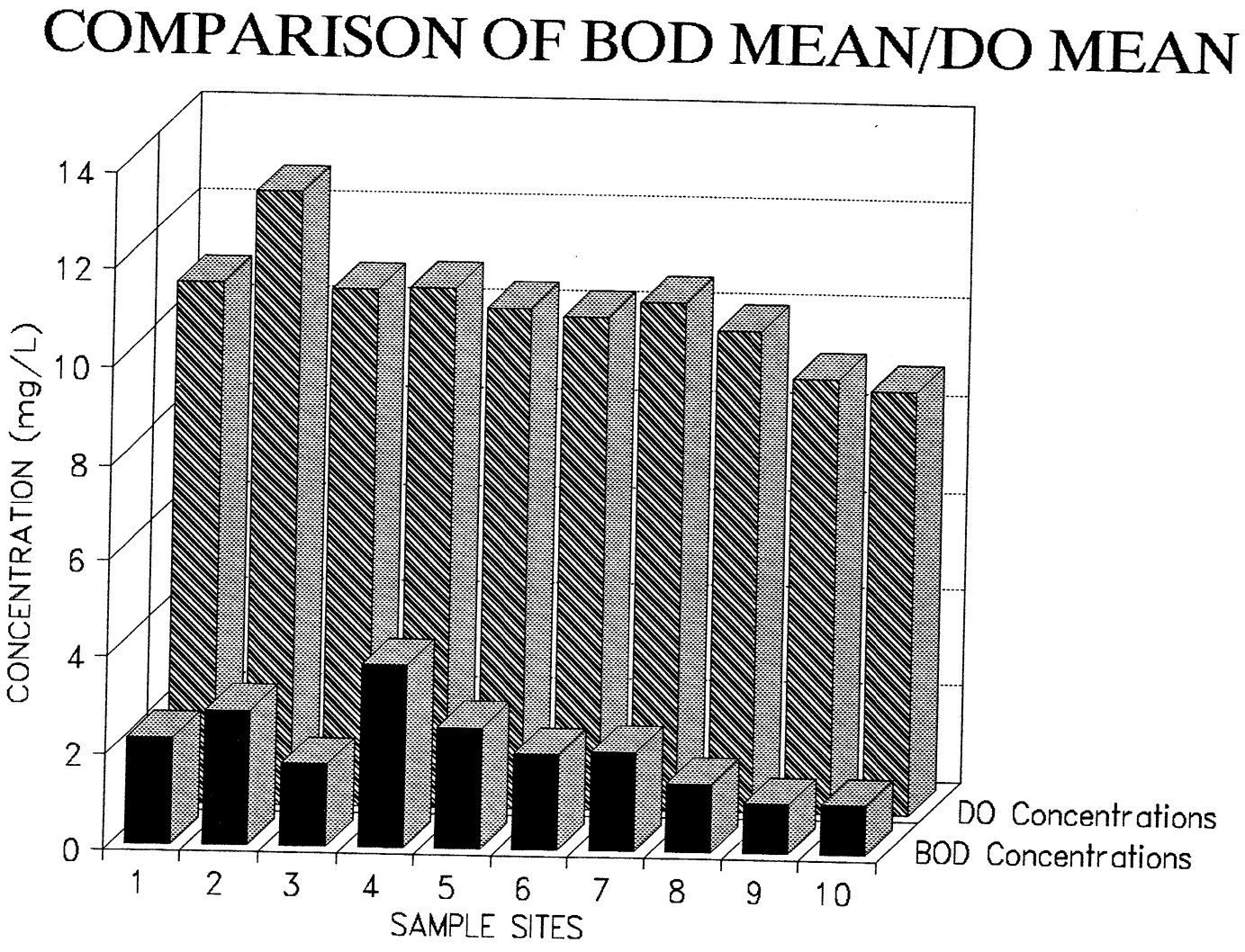
X= NO DATA

Figure 25

DEPTH DATA

Sample Site	Date	BOD (mg/L)	DO (mg/L)	Carbon Dioxide
7(s)	6/1/95	4.60	12.70	ND
7(s)	6/6/95	1.00	9.70	18.00
7(s)	6/20/95	0.80	11.80	11.50
7(s)	6/22/95	1.40	12.20	13.00
7(s)	6/27/95	2.40	6.00	ND
7(-4)	6/1/95	ND	ND	ND
7(-4)	6/6/95	1.00	9.70	21.00
7(-4)	6/20/95	1.80	16.00	8.50
7(-4)	6/22/95	1.30	10.00	13.50
7(-4)	6/27/95	4.40	6.60	ND
7(-8)	6/1/95	ND	ND	ND
7(-8)	6/6/95	0.90	11.60	21.00
7(-8)	6/20/95	ND	12.40	14.00
7(-8)	6/22/95	1.60	10.80	16.50
7(-8)	6/27/95	2.90	6.50	ND
9(s)	6/1/95	1.00	9.60	ND
9(s)	6/6/95	0.70	9.30	17.00
9(s)	6/20/95	1.20	9.20	19.00
9(s)	6/22/95	1.00	8.60	16.00
9(s)	6/27/95	1.20	8.20	ND
9(-10)	6/1/95	ND	ND	ND
9(-10)	6/6/95	0.80	10.20	20.00
9(-10)	6/20/95	1.70	10.50	20.50
9(-10)	6/22/95	1.30	10.40	17.00
9(-10)	6/27/95	0.70	5.30	ND
9(-20)	6/1/95	ND	ND	ND
9(-20)	6/6/95	0.80	7.30	21.00
9(-20)	6/20/95	0.50	5.00	27.50
9(-20)	6/22/95	0.10	5.50	33.50
9(-20)	6/27/95	0.30	4.60	ND
9(-30)	6/1/95	ND	ND	ND
9(-30)	6/6/95	0.45	6.50	27.00
9(-30)	6/20/95	0.50	4.70	21.00
9(-30)	6/22/95	1.20	4.60	37.00
9(-30)	6/27/95	0.50	5.20	ND
9(-40)	6/1/95	ND	ND	ND
9(-40)	6/6/95	0.60	9.00	27.00
9(-40)	6/20/95	0.60	4.00	27.00
9(-40)	6/22/95	0.80	3.20	37.50
9(-40)	6/27/95	0.80	3.40	ND
9(-50)	6/1/95	ND	ND	ND
9(-50)	6/6/95	1.30	2.10	40.00
9(-50)	6/20/95	0.60	3.40	34.50
9(-50)	6/22/95	0.20	3.60	40.00
9(-50)	6/27/95	0.20	0.60	ND
9(-60)	6/1/95	ND	ND	ND
9(-60)	6/6/95	0.90	2.10	47.00
9(-60)	6/20/95	0.60	3.10	36.00
9(-60)	6/22/95	1.10	2.80	35.00
9(-60)	6/27/95	0.60	0.80	ND

Figure 26


COMPARISON OF BOD MEAN/DO MEAN
CONCENTRATION (mg/L)
0
2
4
6
8
10
12
14
1
2
3
4
5
6
7
8
9
10
SAMPLE SITES
DO Concentrations
BOD Concentrations

Waters with a total alkalinity of 100 mg/L to 120 mg/L are considered to be the best for supporting diverse aquatic life. Alkalinity serves as a buffer to help prevent fluctuations in the pH which can adversely affect aquatic life. The high alkalinity at site 6 is possibly due to the high numbers of aquatic plant life in Little Lake Miramichi which release higher quantities of carbonates and bicarbonates into the water.

Nutrients

All nutrient data can be found in Figure 27.

Nitrogen

Nitrogen, a necessary nutrient to all forms of life, is found in two basic forms in an aquatic environment: ammonia nitrogen (NH_3-N) and nitrate nitrogen (NO_3-N). It is the combined froms of nitrogen, combined with the levels of phosphorus in the correct ratios between 15:1 and 30:1 that will promote weed growth.

Ammonia Nitrogen (NH_3-N)

Ammonia nitrogen is a product of the microbiological decay of plant and animal protein. Ammonia nitrogen can be used directly by plants and is used commonly in commercial fertilizers. Ammonium ions supply nutrients for microorganisms. It stimulates the growth of bacteria, and upon oxidation to nitrate, stimulates the growth of algae. The ammonia nitrogen analysis was performed using the HACH CEL DR/700 Colorimeter.

The low ammonia nitrogen was 0.00 mg/L at several sites. The high ammonia nitrogen was 0.12 mg/L at site 8, on June 27. The average ammonia nitrogen of all samples collected was 0.03 mg/L.

There is no standard for ammonia nitrogen, but its presence is important for algae growth. With the suggested maximum level of 0.2 mg/L, Lake Miramichi and Little Lake Miramichi are well below the maximum level. The low ammonia concentrations in the presence of higher levels of oxygen will promote the oxidation of ammonia to nitrate.

Nitrate Nitrogen (NO_3-N)

NO_3 is the most highly oxidized and stable form of nitrogen found in natural waters. It is normally present in small concentrations (<1 mg/L). When larger concentrations occur in ground or surface waters, primary causes are runoff or seepage from excessive agriculture fertilizer applications, wastewater treatment plants, and on-site wastewater systems (septic tanks and drain fields). In addition, nitrates can occur in waters that have become polluted and undergone self-purification. NO_3 is a limiting factor to the growth of aquatic flora if its concentration is below 0.100 mg/L. Optimum growth will occur within the range of 0.9 and 3.5 mg/L. The analysis was performed using a calibrated HACH One ISE Meter with a Nitrate electrode.

The low nitrate nitrogen was 0.176 mg/L at site 3. The high nitrate nitrogen was 0.380 mg/L at site 6. The average nitrate nitrogen of all samples collected was 0.274 mg/L.

The minimum level of 0.3 mg/L is needed to promote excess algae growth. According to the collected data, the average level of 0.274 mg/L explains the increased algae growth in certain areas, like site 6.

Total Nitrogen

Total nitrogen is the sum of ammonia and nitrate nitrogen levels. It is used for the determination of the nitrogen to phosphorus ratio. The lowest value was 0.00 mg/L at sites 3, 4, 5, 6, 8,9, and 10, all on June 6. The high was value was .463 mg/L at site 8, on June 27. The average total nitrogen was .244 mg/L. The ideal levels of total nitrogen that will promote weed growth is between 0.9 mg/L and 3.5 mg/L . All sites are well below these levels, however, the minimum level needed to promote weed growth is 0.3 mg/L . Figure 27 shows that several sites exceed the minimum level, which would explain some of the excess weed growth.

Phosphorus

Phosphorus is a necessary nutrient to all forms of life. Phosphate compounds metabolically act to trap and transfer energy. This energy is transferred to activities which demand it for locomotion, reproduction, and growth. Without the phosphorus to build these energy compounds, cell life cannot exist. An excessive amount of phosphorus in natural water bodies stimulates bacterial and algae growth. Bacterial growth is limited to available oxygen in the water but algae growth is not. Because of this, massive algal blooms may occur with the resultant deposition of excessive solids. This will eventually fill up the water body, shortening it's life. This process is known as eutrophication.

Three basic types of phosphates are: orthophosphate (total reactive phosphates), polyphosphates (acid-hydrolyzable phosphates), and organic phosphate. Orthophosphate is the only form of phosphate that can be directly tested for in a laboratory, and is the form that bacteria use for metabolic processes (42). Polyphosphates can be converted to orthophosphate by acid addition and boiling the sample. Organic phosphate can be converted to orthophosphate by digestion with a strong oxidizing agent. All phosphates will gradually hydrolyze in natural waters to the ortho form. The rate is increased by lowering pH, raising temperature, and addition of bacterial enzymes (42).

Total Reactive Phosphorus (PO_4)

Total reactive phosphorus is frequently referred to as orthophosphate. In either case, it is the PO_4 which is free or available in the water column as a nutrient for aquatic vegetation. In addition, PO_4 has a limiting effect on biological growth if its concentration is below 0.009 mg/L. Optimum growth concentrations range between 0.09 mg/L and 1.8 mg/L.

The analysis was performed using the Stannous Chloride Method for total reactive phosphate and a Bausch & Lomb Spectronic 21.

The low total reactive phosphorus was measured to be Below Minimum Detectable Concentration (BMDC) (< 0.003 mg/L) at several sites. The high total reactive phosphorus was measured at 0.033 mg/L at site 4. The average total
reactive phosphorus of all detectable samples collected was calculated at 0.0048 mg/L.

A level of 0.01 mg/L is needed to promote excess algae growth. According to the collected data, the average level of 0.0048 mg/L means that total reactive phosphorus does not promote excess algae growth. Site 4's high amount (0.033 mg/L) is 3 times the minimum level needed to promote algae growth. At this site, algae growth could be excessive when compared to the rest of the lake.

Acid-Hydrolyzable Phosphorus

The acid-hydrolyzable phosphorus is phosphorus which has already been taken up by plants or animals and is unavailable for use as a nutrient. With acid hydrolysis, the sum of the combined (fixed) and total reactive phosphorus is determined. Subtracting the total reactive phosphorus from the acid-hydrolyzable will result in the amount of fixed or combined phosphorus (16).

The analysis was performed using the Acid-Hydrolyzable Phosphorus Procedure followed by the Stannous Chloride Method.

The low acid-hydrolyzable phosphorus was 0.005 mg/L at site 10, on June 10. The high acid-hydrolyzable phosphorus was 1.000 mg/L at site 1, on June 6. The average acid-hydrolyzable phosphorus of all samples collected was 0.0434 mg/L.

Total Phosphorus

Total phosphorus is the sum of the total reactive phosphorus and the acid-hydrolyzable phosphorus. The lowest value was BMDC at site 7, site 8, site 9, and site 10 all on June 20. The high was 1.000 mg of Phosphorus/Liter (mg P/L) at site 1, on June 1. The average total phosphorus level was 0.039 mg/L which is 3 times the minimum level needed to stimulate excess algae growth.

Nitrogen:Phosphorus (N:P) Ratio

The nitrogen to phosphorus ratio is useful in determining the possibility of algae overgrowth in surface water. N is the total nitrogen (sum of ammonia, nitrite, and nitrate) and P is the total phosphorus (sum of the total reactive and combined phosphorous). A N:P ratio of 15:1 to 30:1 (15 or 30 parts of nitrogen to 1 part of phosphorus) is considered the optimum ratio for extensive growth of algae (Figure 28). Any ratio above 30:1 would be considered phosphorus poor, and any ratio below 15:1 would be considered nitrogen poor (1).

Figure 27

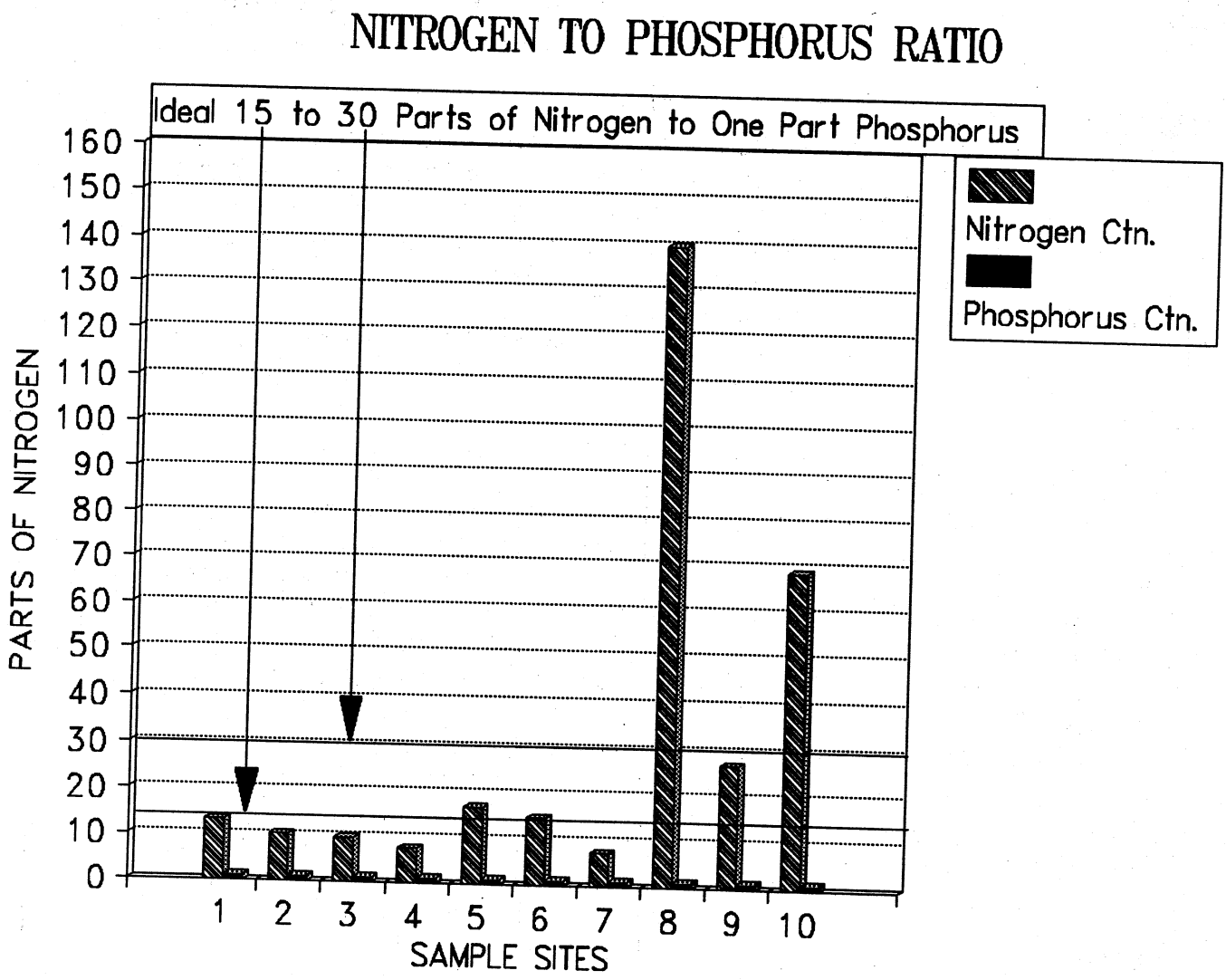
NUTRIENT DATA

Sample Site	Date	Nitrate (mg/L)	Ammonia (mg/L)	Total Nitrogen (mg/L)	Total Reactiv Phosphorus (mg P/L)	Acid Hydroly Phosphate (mg P/L)	Total Phosphorus (mg P/L)
1	6/1	0.292	0.08	0.372	BMDC	1.000	1.000
1	6/6	X	0.00	0	0.006	0.012	0.018
1	6/20	0.273	0.00	0.273	NS	0.12	0.12
1	6/22	0.278	0.06	0.338	0.004	X	0.004
1	6/27	0.335	0.04	0.375	0.008	0.022	0.03
2	6/1	0.269	0.08	0.349	BMDC	0.012	0.012
2	6/6	X	0.11	0.11	0.027	0.045	0.072
2	6/20	0.201	0.00	0.201	0.0014	0.014	0.0154
2	6/22	0.375	0.04	0.415	0.004	X	0.004
2	6/27	0.310	0.06	0.37	0.014	0.028	0.042
3	6/1	0.176	0.03	0.206	BMDC	0.012	0.012
3	6/6	X	0.00	0	0.005	0.020	0.025
3	6/20	0.326	0.02	0.346	0.0034	0.024	0.0274
3	6/22	0.233	0.02	0.253	0.002	X	0.002
3	6/27	0.235	0.06	0.296	0.002	0.016	0.018
4	6/1	0.257	0.07	0.327	0.008	0.015	0.023
4	6/6	X	0.00	0	0.033	0.025	0.058
4	6/20	0.246	0.02	0.266	0.0014	0.028	0.0294
4	6/22	0.238	0.00	0.238	0.014	X	0.012
4	6/27	0.352	0.00	0.352	0.012	0.022	0.01
5	6/1	0.263	0.03	0.293	BMDC	0.014	0.021
5	6/6	X	0.00	0	0.004	0.015	0.024
5	6/20	0.233	0.04	0.274	0.0015	0.024	0.006
5	6/22	0.266	0.00	0.266	0.012	X	0.004
5	6/27	0.316	0.00	0.316	0.004	0.006	0.02
6	6/1	0.380		0.38	0.003	0.018	0.028
6	6/6	X	0.00	0	0.003	0.021	0.024
6	6/20	0.216	0.00	0.216	BMDC	0.006	0.006
6	6/22	0.342	0.02	0.362	0.004	X	0.004
6	6/27	0.338	0.09	0.428	0.008	0.012	0.02
7	6/1	0.240	0.03	0.27	0.010	0.018	0.028
7	6/6	X	0.02	0.02	0.003	0.019	0.022
7	6/20	0.270	0.00	0.27	BMDC	BMDC	BMDC
7	6/22	0.236	0.00	0.236	0.002	X	0.002
7	6/27	0.285	0.09	0.375	0.020	0.038	0.058
8	6/1	0.244		0.244	BMDC	0.016	0.016
8	6/6	X	0.00	0	BMDC	0.050	0.05
8	6/20	0.233	0.00	0.233	BMDC	BMDC	BMDC
8	6/22	0.277	0.06	0.337	0.002	X	0.002
8	6/27	0.343	0.12	0.463	0.002	0.012	0.014
9	6/1	0.255	0.03	0.285	0.005	0.012	0.017
9	6/6	X	0.00	0	BMDC	0.010	0.01
9	6/20	0.239	0.00	0.239	BMDC	BMDC	BMDC
9	6/22	0.245	0.00	0.245	0.002	X	0.002
9	6/27	0.336	0.00	0.336	BMDC	0.004	0.004
10	6/1	0.184		0.184	BMDC	0.012	0.012
10	6/6	X	0.00	0	BMDC	0.005	0.005
10	6/20	0.218	0.00	0.218	BMDC	BMDC	BMDC
10	6/22	0.298	0.04	0.338	0.004	X	0.004
10	6/27	0.303	0.00	0.303	BMDC	0.008	0.008

X= NO DATA

BMDC= BELOW MINIMUM DETECTABLE CONCENTRATION

Figure 28


NITROGEN TO PHOSPHORUS RATIO
Ideal 15 to 30 Parts of Nitrogen to One Part Phosphorus
Nitrogen Ctn.
Phosphorus Ctn.
PARTS OF NITROGEN
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10
SAMPLE SITES

All of the 10 sample sites were well below 30:1 except for sample sites 8 and 10. These had extremely high ratios of 139:1 and 69:1 probably due to too many BMDCs which could not be used in the averaging of data in the nitrogen to phosphorus ratio calculation. Data error in the acid-hydrolyzable phosphorus tests also contributed to the high ratios. Sites 1, 2, 3, 4, 6, and 7 had levels below the ratio of 15:1 with the low being 7.25:1 and the high being 14.61:1. Figure 28 is a graphic representation of these nitrogen to phosphorus ratios. These levels indicate that the water is nitrogen poor. If the ratios were high, the lake would be phosphorus poor. Sample sites 5 and 9 had ratios higher than 15:1 but lower than 30:1. This indicates an area of optimal algae growth.

Microbiological Analysis and Results

All data for microbiological analyses can be found in Figure 29. Water contains many types of pathogens, however, the testing process for these types of organisms is too slow and expensive to perform on a regular basis, therefore, instead of testing for these certain pathogens, it is easier to look for the fecal bacteria that are associated with them. When such bacteria are found, there is a possibility for adverse health effects.

Five species of coliform bacteria were tested for. These include: fecal coliform, fecal streptococcus, Escherichia coli, Enterococci, and Pseudomonas aeruginosa.

Fecal coliform

Fecal coliform are found in the intestinal tracts of animals and humans, and serve as an indicator of recent fecal contamination and potentially harmful pathogens associated with feces. There are no processes to distinguish between human and non-human fecal coliforms, therefore, the use of a fecal coliform to fecal streptococcus ratio is used to indicate the origin of the contamination. It does not confirm the extent of contamination, so there are no established standards (37).

Fecal coliform was measured on the surface of all 10 sample sites. No fecal coliform contamination was found at several sites. The highest amount was found at site 3, on June 6, with 318 colonies per 100 mL. Site 3 had substantially higher amounts of fecal coliform contamination than the other 9 sites. While sampling, a decaying beaver was noticed near the sample site and if the stomach and/or the intestine was ruptured, it could have caused an increased level in the amounts of fecal coliform contamination.

Site 2 also had some fecal coliform contamination possibly caused by a large amount of Canada goose droppings noticed on the property in front of the sample site.

Fecal streptococcus

Fecal streptococcus is normally found in the intestinal tracts of animals and humans, however, they are found in higher concentrations in non-human animals. It is not used to determine the extent or amount of contamination, just

the origin. Fecal streptococci do not multiply in surface waters and rarely do they occur in surface soil or on vegetation not contaminated by sewage (37).

There are no established standards for fecal streptococcus. It is used primarily to determine whether or not the fecal coliform contamination is of human origin. The origin is determined by a ratio of fecal coliform to fecal streptococcus (FC:FS). A ratio of 4 fecal coliform to 1 fecal streptococcus indicates that the waste is of human origin. Ratios of 1:1 or less, indicates the waste is of non-human origin. Ratios between 1-4:1 indicates a mix of human and non-human fecal contamination.

Many of the sites had high amounts of fecal streptococcus, although site 3 was significantly higher. This sample site is near the discharge structure of the main dam and this may contribute to the high levels. This is unexplainable due to the fact that there is no evidence of a specific source of fecal contamination.

When compared to the fecal coliform data, it appeared that the contamination was of non-human origin.

Escherichia coli (E. coli)

Escherichia coli is found in the intestinal tracts of both humans and animals. It is also present in fecal material and can be used as an indicator of fecal contamination. E. coli standards as set by the MDNR for total body contact with water is 130 colonies per 100 milliliters (mL) of sample (16). Each of the 10 sample sites were tested for E. coli. Several sites contained zero colonies, while sample site 3 had colonies that were Too Numerous Too Count (TNTC). These, along with the June 6th count of 398, are above the established standard and are considered potentially harmful (Figure 30).

Enterococci

Enterococci are species of bacteria which are found in the intestinal tracts and fecal material of both humans and animals. These bacteria are also members of the streptococcus group, therefore, they can be used as an indicator of fecal streptococcus contamination (37). Although there is no established MDNR standard for Enterococci, it is recommended that the concentration be equal to or less than 33 organisms per 100 mL of water. Each of the 10 sample sites were tested for Enterococci. These sites contained levels ranging from zero to 201 organisms per 100mL of water. Sample site 3 contained the lowest count of zero, while site 2 contained the highest count of 201.

Pseudomonas aeruginosa

Pseudomonas aeruginosa is associated with human fecal waste and, when detected in surface waters indicates potentially serious health hazards that may exist due to the presence of other pathogens. It has been linked as the causative agent of numerous infections that may be transmitted through a contaminated water supply. Site concentrations ranged between zero and 100 organisms per 100 mL of water. Several sites contained zero organism counts, while site 2 contained 100 organisms per 100 mL of water. When compared to

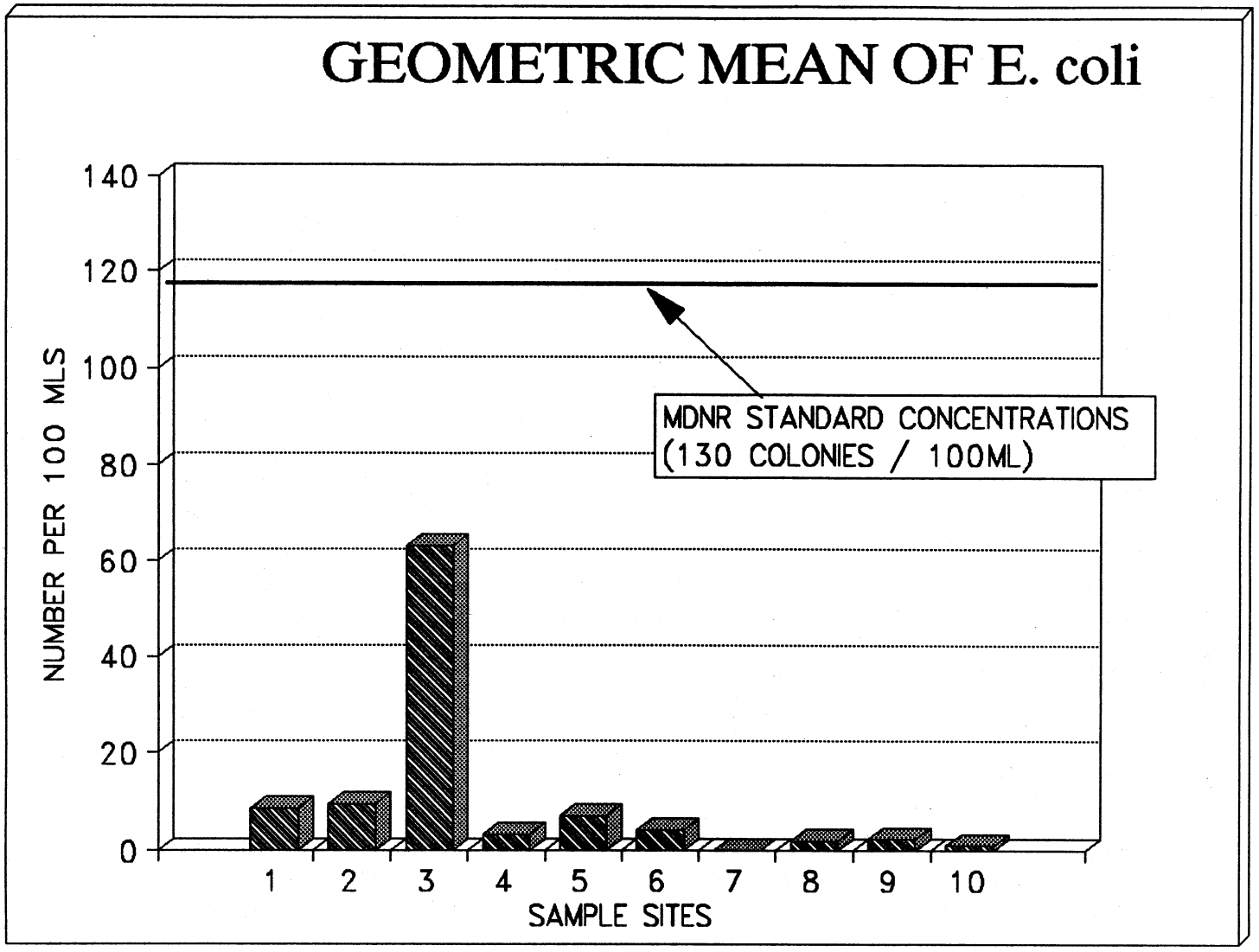
Figure 29

MICROBIOLOGICAL DATA

Sample Site	Date	Fecal coliform	Fecal streptococcus	Escherichia coli	Enterococci	Pseudomonas aeruginosa
1	6/1/95	2	130	16	18	0
1	6/6/95	11	90	2	53	0
1	6/20/95	0	18	0	3	0
1	6/22/95	0	24	0	0	X
1	6/27/95	19	52	19	36	0
2	6/1/95	0	1800	2	0	0
2	6/6/95	148	700	0	4	20
2	6/20/95	0	0	0	7	0
2	6/22/95	0	0	0	0	X
2	6/27/95	3	0	43	201	100
3	6/1/95	6	104	10	38	0
3	6/6/95	318	118	398	51	0
3	6/20/95	8	178	TNTC	12	50
3	6/22/95	15	54	TNTC	0	X
3	6/27/95	66	174	TNTC	79	60
4	6/1/95	6	340	4	16	0
4	6/6/95	0	4	4	3	0
4	6/20/95	0	2	0	9	0
4	6/22/95	0	10	0	2	X
4	6/27/95	64	54	2	82	30
5	6/1/95	0	0	0	0	0
5	6/6/95	0	1	0	1	0
5	6/20/95	3	3	8	0	0
5	6/22/95	5	1	11	5	X
5	6/27/95	4	17	4	5	10
6	6/1/95	2	0	2	0	0
6	6/6/95	12	3	5	1	0
6	6/20/95	0	100	2	1	2
6	6/22/95	0	98	5	3	X
6	6/27/95	7	26	12	0	6
7	6/1/95	0	2	0	4	0
7	6/6/95	0	0	0	1	14
7	6/20/95	0	1	0	0	0
7	6/22/95	0	123	0	0	X
7	6/27/95	20	0	0	0	0
8	6/1/95	0	0	2	2	0
8	6/6/95	0	0	0	0	0
8	6/20/95	0	0	0	0	2
8	6/22/95	0	4	0	0	X
8	6/27/95	0	106	2	11	2
9	6/1/95	0	0	0	0	0
9	6/6/95	0	1	1	23	0
9	6/20/95	0	0	0	0	0
9	6/22/95	0	1	0	0	X
9	6/27/95	12	31	5	0	0
10	6/1/95	0	2	0	0	0
10	6/6/95	0	0	1	0	0
10	6/20/95	0	0	1	0	0
10	6/22/95	0	15	0	0	X
10	6/27/95	1	54	1	0	0

TNTC=Too Numerous To Count
X=No Data

Figure 30


GEOMETRIC MEAN OF E. coli
140
120
100
80
60
40
20
0
NUMBER PER 100 MLS
MDNR STANDARD CONCENTRATIONS
(130 COLONIES / 100ML)
1
2
3
4
5
6
7
8
9
10
SAMPLE SITES

the fecal coliform and fecal streptococcus data, Pseudomonas aeruginosa will confirm whether the contamination is of human or non-human origin. The FC:FS ratio in sample site 3, on June 6, was 2.69:1. This indicates that the organisms present are of non-human origin, the absence of Pseudomonas aeruginosa confirms this. Although there is a high amount of Pseudomonas aeruginosa contamination at site 3 (100 organisms/100 mL), the fecal streptococcus and fecal coliform data indicate that there is no significant harm in the recreational use of this water.

NATURAL HISTORY

Lake Ecology

The distribution and abundance of aquatic plants in a lake is dependent upon the lake's chemical and physical properties. These include the amount of light available, water levels, water temperatures, type of lake bottom sediments, current or wave action, and the concentration of dissolved gases and nutrients (18). Nutrients and light availability are most often the factors that limit plant growth in a lake. Nutrients include, but are not limited to, chemicals such as nitrogen, phosphorus, carbon, and potassium which plants require for their growth. There are both natural and athropogenic (man made) sources for these nutrients (18). Natural processes at work within the lake's watershed continually carry these nutrients into the lake. A lake's watershed is the land around a lake from which water drains into the lake. The natural movement of nutrients to a lake is dependent upon the characteristics of the watershed including size and topographic relief. Lakes become more productive, or "age" with time as they collect nutrients. This aging process is commonly referred to as *eutrophication*. Without human influence, the natural aging process is generally slow, often taking thousands of years to produce any noticeable changes in lakes. Human activity on the watershed, however, may greatly accelerate the aging process by increasing the quantity of sediments and nutrients entering the lake.

According to limnologists (lake scientists), lakes may be classified on the basis of productivity into three types: oligotrophic, mesotrophic, and eutrophic (43). The oligotrophic type is represented by Lake Superior, Lake Huron, and many northern glacial lakes. Oligotrophic lakes are characterized by clear, cold water with little organic matter and high levels of oxygen. Their waters are clear because of a lack of floating algae (phytoplankton), due to low levels of dissolved nutrients in the lake. The fish species in this type of lake are primarily trout (Salmo sp.), salmon (Oncorhynchus sp.), and whitefish (Coregonis sp.) (8).

Mesotrophic lakes are characterized by a moderate amount of nutrients, and are generally warmer then oligotrophic lakes. Fertility, clarity, levels of dissolved oxygen, and total biomass are intermediate between that of oligotrophic and eutrophic lakes. Biomass is defined as the total weight of all the organisms living in the ecosystem. The fish species in this type of lake are largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), northern pike

(Esox lucius), and yellow perch (Perca flavescens) (8). Lake Miramichi has the characteristics of a mesotrophic lake.

Eutrophic lakes are characterized by very warm and shallow waters with low oxygen levels, undesirable features such as a muddy bottom (poor spawning surface for most desirable fish), and algal blooms, which are dramatic increases in algal growth in a lake or stream. Algal blooms result from high levels of nutrient pollution. The type of fish present in this type of lake are mainly carp (Cyprinis carpio) and black bullhead (Ictalurus melas) (8).

Each lake has four zones of habitat: littoral zone, limnetic zone, profundal zone, and benthic zone (Figure 31). The littoral zone is the shallow marginal region of a lake that is characterized by rooted vegetation. The vegetation in this zone includes emergents such as cat-tails (Typha sp.), bulrush (Scripus sp.), and sedge (Carex sp.); floating vegetation, including duckweed (Spirodela sp. and Lemma sp.) and water lilies (Nymphaea sp. and Nuphar sp.); and submergent vegetation, including many species of pondweeds (8). This zone is rich in plankton and has high photosynthetic levels. The littoral zone provides food, cover, and breeding sites for many organisms. Per unit volume this zone produces more biomass than all the others combined (8).

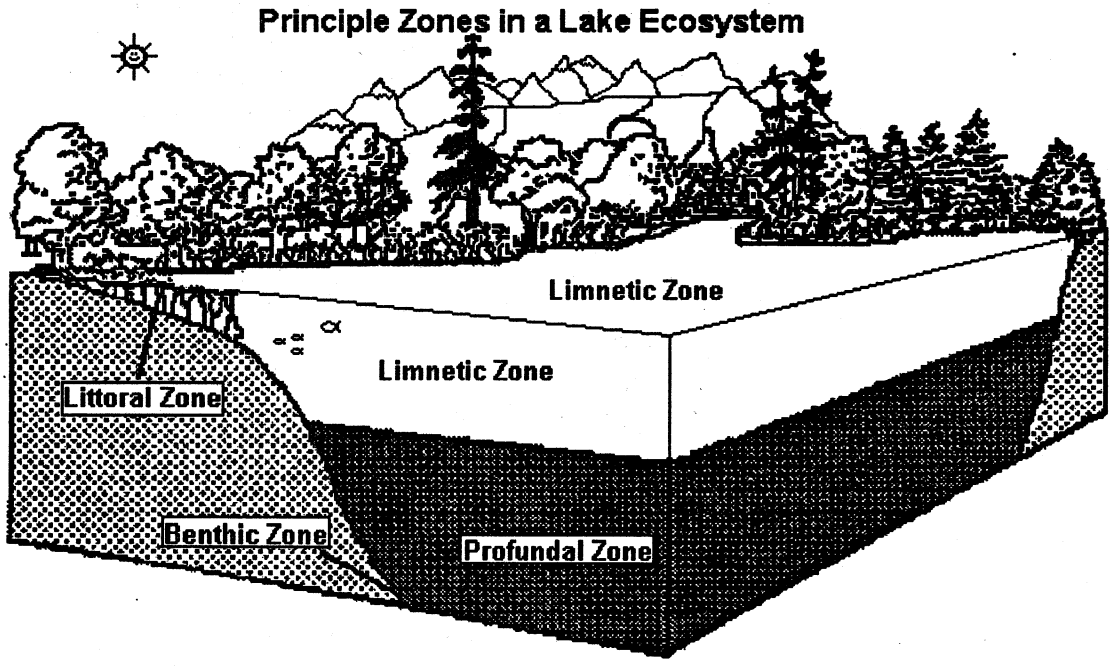


Figure 31 Diagram of the principle zones in a lake ecosystem (42).

The limnetic zone is the region of open water beyond the littoral zone down to the maximum depth where there is sufficient light for photosynthesis. This zone has a large amount of phytoplankton, particularly filamentous algae and diatom blooms. Oxygen is acquired from photosynthesis and the atmosphere. Zooplankton and fish are also present in the limnetic zone (8).

The profundal zone is the area from the limnetic zone to the lake bottom. Green plant life is absent due to the lack of sunlight sufficient to sustain photosynthesis. This zone has the warmest water in the winter and the coldest in the summer (8).

The benthic zone includes the bottom sediments of the lake. Bacteria and fungi live in this zone and decompose the organic matter which accumulates on the lake bottom lowering the level of oxygen in the profundal zone (42).

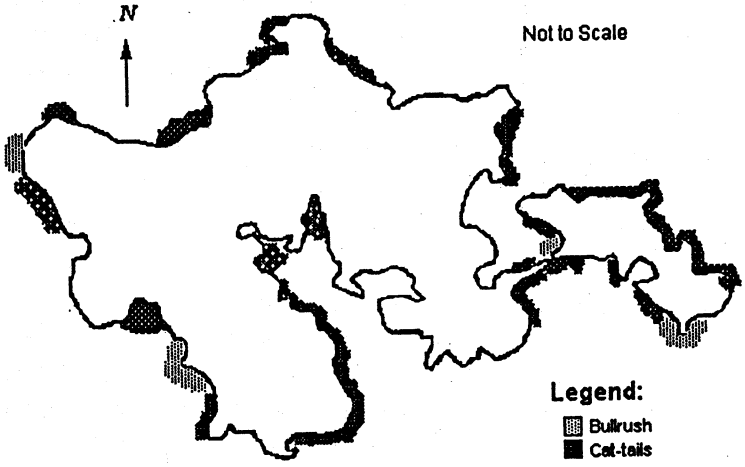
Aquatic Flora

Algae are the simplest plants and the chief producers of carbohydrates in all natural waters. Algae are divided into planktonic, filamentous, and macroalgae forms. Planktonic forms are microscopic free floating plants. In large numbers, these algae can cause water to appear green, brown, or yellow depending on the species present (17). Filamentous algae, commonly called "pond scum", can form masses over the water surface, and are primarily restricted to bays and sheltered shorelines. Filamentous algae can also become attached to the lake bottom or docks. Macroalgae are rooted plants found in a lake or pond. They are usually large and can be easily seen, although some are small enough that dozens of plants can be held in a persons hand. Chara and Nitella are examples of macroalgae (17). Algae can exist as emergent, floating, and submergent vegetation. Algae release large amounts of dissolved oxygen (DO) into the water as a byproduct of photosynthesis. A lake's ability to support populations of different species increases as DO levels increase. Increased nutrient levels may lead to algae blooms, large mat-like masses of algae, that, if they become too large, can stop sunlight from reaching underlying vegetation. If this occurs, vegetation dies and DO is used up during microbial decomposition. When DO levels decrease, die-off of other life occurs due to lack of oxygen (42). Blue-green algae are a major component of algae blooms and can be toxic to animals if ingested (42). Blue-green algae are capable of nitrogen fixation, a process by which nitrogen gas is changed to ammonia. Only minimal amounts of Oscillatoria, a blue-green algae, and Spirogyra, a green algae, were identified in the bay areas of Lake Miramichi.

Emergent vegetation (Figure 32) is located on and near the shoreline. Several different species make up this aspect of the lake's ecosystem. The most abundant emergents in the Lake Miramichi ecosystem include soft-stemmed bulrush (Scirpus validus), cat-tail (Typha latifolia), bur-reed (Sparganium eurycarpum), spikerush (Eleocharis sp.), and iris (Iris pumila).

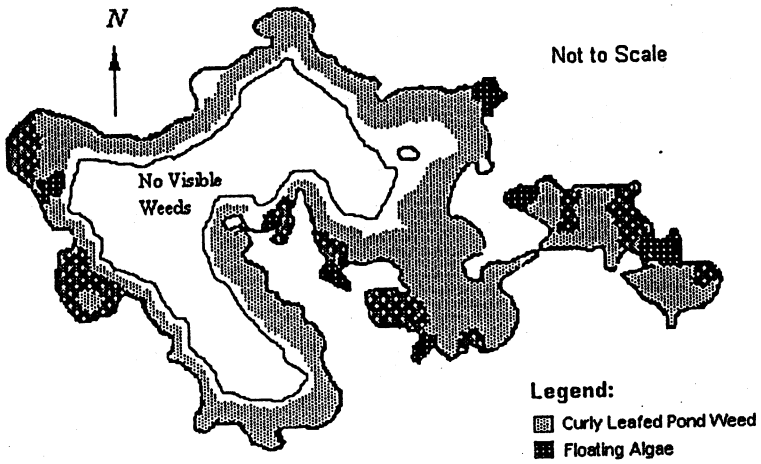
Figure 32

EMERGENT VEGETATION OF LAKE MIRAMICHI STUDY AREA



Digitized Map Outline Provided by:
Holton's LP Gas

SUBMERGENT VEGETATION OF LAKE MIRAMICHI STUDY AREA



DIGITIZED MAP OUTLINE PROVIDED BY:
HOLTON'S LP GAS

Submergent vegetation (Figure 32) is among the most important of waterfowl foods. Some species of waterfowl feed primarily on pondweed seeds and rootstocks (9). These aquatic plants are also important as spawning areas and provide protection for many different fish. They also provide fish with shade from the sun. In addition, they aid in the support of the overall ecosystem of the lake by providing oxygen (42).

The most prevalent form of submergent vegetation observed was curly leafed pondweed (Potamogeton crispus). This plant has a finely toothed leaf with closely puckered edges. It is found in hard or brackish water, or where pollution has occurred (Figure 33).

Curly leafed pondweed was introduced from Europe and serves as a valuable food source, shelter, and spawning ground for fish like carp. Curly leafed pondweed also serves as a food source for aquatic birds. This plant tends to die-back on its own by mid-summer making way for an infestation of water milfoil. In northern waters, two types of milfoil are northern milfoil (Myriophyllum heterophyllum) and eurasian milfoil (Myriophyllum spicatum). Both species are in Lake Miramichi (Figure 34).

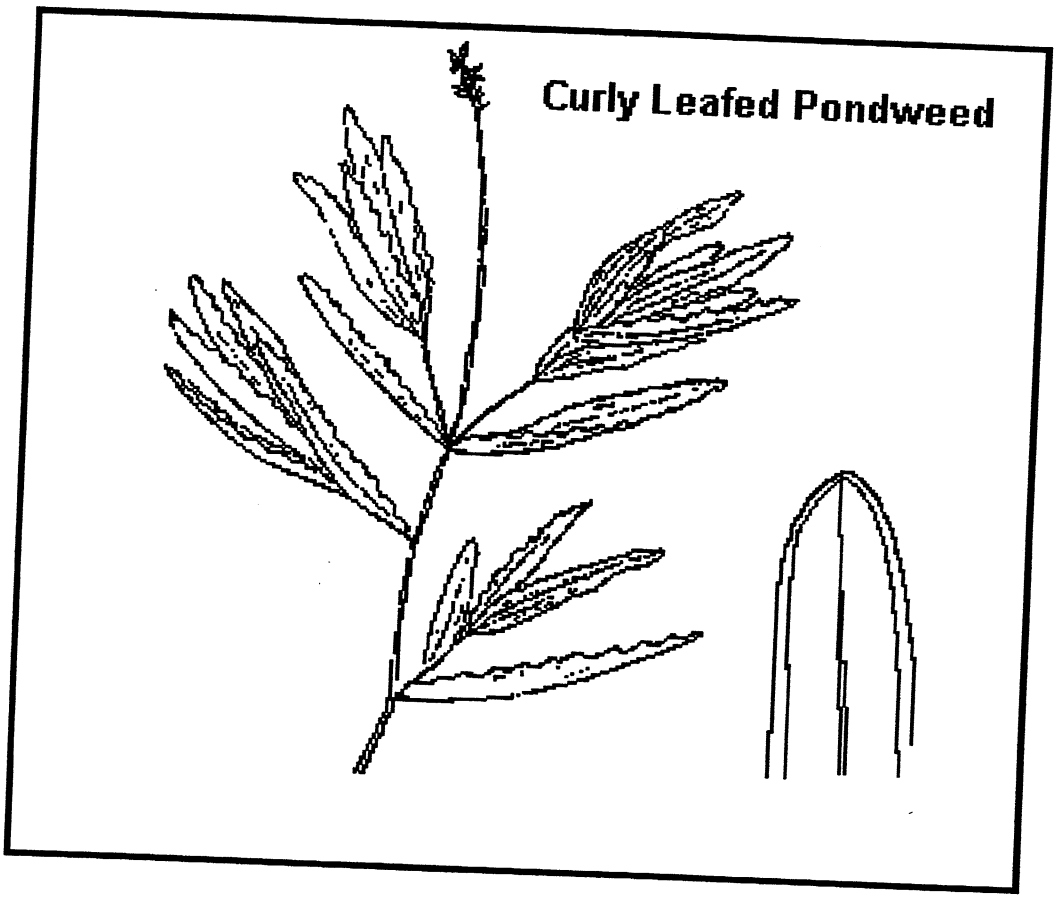


Figure 33 Curly Leafed Pondweed (13).

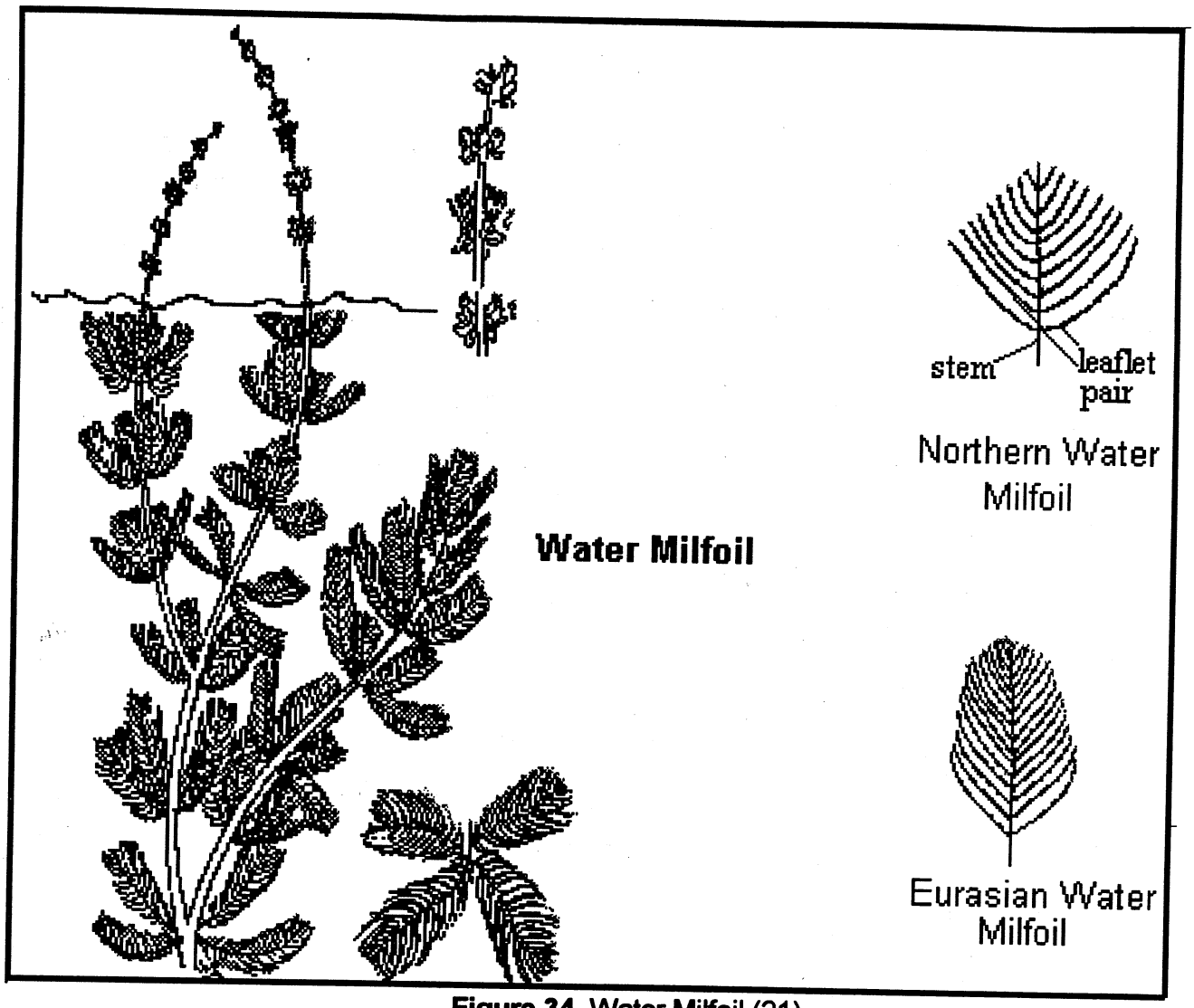


Figure 34 Water Milfoil (21).

Eurasian milfoil is an exotic species and is of special concern to lake users due to its choking effect on lake ecosystems. It was accidentally introduced into North America and has spread to inland lakes where its dense growth has hampered swimming, boating, and fishing. It can form vast mats of surface foilage that shade out native aquatic plants. This diminishes the lake's aesthetic beauty and effects recreational use. Other submergent vegetation identified included sago pondweed (Potomageton pectinatus), bigleaf pondweed (Potomogeton amplifolius), and stonewort (Chara vulgaris) which, in hard water environments, can produce significant amounts of marl, a calcium carbonate deposit found in fresh water lakes and streams (42).

Another observed example of aquatic flora was a free floating algae commonly called lesser duckweed (Lemna minor). This is an unattached plant observed along the shoreline and among weed beds on Lake Miramichi. Masses of free-floating algae decrease light penetration which causes the death of plants below the surface. This increases the rate of sedimentation and the rate of accumulation of organic matter on the lake bottom. Through photosynthesis, algae converts carbon dioxide into glucose and then release large amounts of DO into the water. The rise in DO increases the lake's ability to support populations of many types of organisms (42).

Figure 35 contains aquatic submergent =(1), floating =(2), emergent =(3), and shoreline=(4) vegetation that was observed or known to inhabit the area:

Figure 35

Aquatic Flora

Common name	Scientific name
Bladderwort (1)	Ultricularia sp.
Bur Reed (3)	Sparganium eurycarpum
Bracken Fern (4)	Pteridium aquilinum
Broad leafed Cat-tail (3)	Typha augustifoila
Bigleaf Pondweed (1)	Potamogeton amplifolius
Narrow leafed Cat-tail (3)	Typha latifolia
Chara (1)	Chara vulgaris
Common Milkweed (4)	Asclepias syriaca
Curly Leafed Pondweed (1)	Potamogeton crispus
Horsetail (4)	Equisetum arvense
Lesser Duckweed (2)	Lemna minor
Reed Canary Grass (4)	Phalaris arundinacea
Sago Pondweed (1)	Potamogeton pectinatus
Sedge (3)	Carex sp.
Sensitive Fern (4)	Onoclea sensabilis
Softstem Bulrush (3)	Scirpus validus
Spikerush (3)	Eleocharis sp.
Swamp Milkweed (4)	Asclepias incarnata
Eurasian Milfoil (1)	Myriophyllum spicatum
Northern Milfoil (1)	Myriophylum heterophyllum
Wild Mustard (4)	Brassica sp.

Mechanical weed harvesting is contracted out each year by the LMPOA (Figure 36). A budget of $12,000 is allocated for weed harvesting (33). This year (1995) is the fifth year of weed harvesting. In the past, weed control was done chemically. Due to its turbid affect on Lake Miramichi, it has been replaced with mechanical weed control. With each year, the volume of weeds harvested is decreasing. Weed growth appears to be associated with the sites that collect the most runoff (33). Runoff carries sediments and nutrients and these sediments make the lake shallower. This increases the littoral zone, while the nutrients fertilize the weeds increasing growth. This is occuring primarily on the east side of the lake. The LMPOA has installed sediment ponds to help control runoff problems (33). Waterfowl feces, landowners using fertilizers (discouraged by the LMPOA), and possible leaking drainfields are all potential contributors to the eutrophication of the lake.



Figure 36 Mechanical weed harvester located near the beach area, facing southwest. Photograph taken on June 25, 1995.



Figure 37 Largemouth bass caught on northwest side of Lake Miramichi. June 26, 1995.

Aquatic Fauna

The aquatic fauna of Lake Miramichi consists of numerous species of invertebrates and vertebrates. The most commonly observed invertebrates in Lake Miramichi are listed in Figure 38.

Figure 38

Invertebrates

Common name	Scientific name
Aquatic Nematode	Phylum Nematoda
Belted Skimmer larvae	Macromia magnifica
Black Fly	Simulium sp.
Blackwing Damselfly	Calopteryx maculata
Caddisfly larvae	Trichoptera sp.
Copepods	Subclass Copepoda
Cyclops	Cyclops sp.
Dragonfly	Libellula sp.
Eastern Crayfish	Cambarus bartoni
Leech	Erpobdella punctata
Mayfly larvae	Ephemeroptera sp.
Midge Larvae	Chaoborus sp.
Mosquito	Culex sp.
Orb Snail	Helisoma anceps
Papershell Clam	Anodonta grandis
Protozoa	Phylum Protozoa
Rotifer	Keratella quadrata
Rotifer	Philodina roseola
Seed Shrimp	Cypria sp.
Stonefly larvae	Plecoptera sp.
Trematoda	Neascus sp.
Water Spider	Dolomedes urinator
Water Strider	Gerris sp.
Whirligig Beetle	Dineuts americanus

Aquatic macro-invertebrates are an important food source for many fish (42).

Fish

The fish most frequently collected during the study was the bluegill. Bluegill specimens were most commonly obtained close to shore in the littoral zone.

The pumpkinseed (Lepomis gibbosus), a member of the sunfish family, was also collected. These fish rarely exceed 8" in length. Like the bluegill, the pumpkinseed is often located in schools in weedy parts of the lake, where they feed on insects and small crustaceans.

Largemouth bass (Micropterus salmoides) were also observed and collected. The largemouth bass is one of the major predators in Lake Miramichi (Figure 37). The northern pike is a common fish in Lake Miramichi (Figure 39). Some fish of this species show signs of trematode infestation, characterized by black spots on the skin of the fish. Trematodes of this species (Neascus spp.) have a life cycle that involves three hosts: the great blue heron, a snail, and several species of fish. The cercaria stage of this parasite is a free swimming larval form that leaves the snail and burrows into the flesh of the fish. Another organism which sometimes appears as black spots on the fins of fish are the glochidium or clam larvae. These larval forms of the clam lie on the lake bottom or on vegetation until a fish swims close enough to allow the glochidium to attach to the fish's gills or fins. This insures dispersal of the larvae throughout the lake.

It is normal for freshwater fish to have parasite infestation and if the fish is properly cooked this should present no harmful effects. One method for making sure that fish products are free of parasites is cooking fish to a minimum of 140° Fahrenheit (F). Freezing to -10° F can be effective, but requires seven days in order to kill the parasites (3). In addition, failure to clean fish soon after catching them allows the parasites to move from internal organs to muscle tissues.

Figure 39 lists fish either observed during the study period, or known to inhabit Lake Miramichi:

Figure 39

Fish

Common name	Scientific name
Black Crappie	Pomoxis nigromaculatus
Bluegill	Lepomis macrochirus
Bullhead	Ictylurus sp.
Carp	Cyprinis carpio
Channel Catfish	Ictalurus punctatus
Dogfish/Bowfin	Amia calva
Largemouth Bass	Micropterus salmoides
Long-Nose Gar	Lepisosteus osseus
Northern Pike	Esox lucius
Pumpkinseed	Lepomis gibbosus
Rock Bass	Ambloplites rupestris
Smallmouth Bass	Micropterus dolomieui
Suckers	Catostomus sp.
Yellow Perch	Perca flavesecens

Reptiles and Amphibians

Several species of reptiles and amphibians were observed. The most commonly seen reptiles were the midland painted turtle (Chrysemys picta) (Figure

11) and the snapping turtle (Chelydra serpentina). A northern watersnake (Nerodia sipedon) was also observed. Amphibians observed at Lake Miramichi included the green frog (Rana clamitans), bullfrog (Rana catesbeiana), leopard frog (Rana pipiens), and the American toad (Bufo americanus). Figure 40 lists reptiles and amphibians observed or known to inhabit the study area:

Figure 40

Reptiles and Amphibians

Common name	Scientific name
American Toad	Bufo americanus
Bullfrog	Rana catesbeiana
Common Garter Snake	Thamnophis sirtalis
Green Frog	Rana clamitans
Leopard Frog	Rana pipiens
Midland Painted Turtle	Chrysemys picta
Northern Water Snake	Nerodia sipedon
Snapping Turtle	Chelydra serpentina
Wood Turtle	Clemmys insculpta

Terrestrial Flora

Tree and shrub species observed on the shoreline of Lake Miramichi included American elm (Ulmus americana), northern red oak (Quercus rubra), sugar maple (Acer saccharum), weeping willow (Salix babylonica), big-toothed aspen (Popolus grandidentata), and white birch (Betula papyrifera). The sugar maple is a popular shade and ornamental tree because of its colorful red/yellow fall foliage. The weeping willow, an introduced species that is native to China and known for its ornamental aspects, is also present at Lake Miramichi. Shoreline vegetation around Little Lake Miramichi includes hemlock (Tsuga canadensis), white birch (Betula papyrifera), and white pine (Pinus strobus), tree species consistent with wetlands.



Figure 41 Northern pike caught on northwest side of Lake Miramichi. Black spots from trematodes were present in this fishes flesh. July 10, 1995.



Figure 42 Midland painted turtle observed on east side of Lake Miramichi near culvert. June 26, 1995.

Figure 43 lists terrestrial flora observed in the Lake Miramichi area:

Figure 43

Trees and Shrubs

Common name	Scientific name
American Beech	Fagus grandifolia
American Elm	Ulmus americana
American Basswood	Tilia americana
Big-Toothed Aspen	Populus grandidentata
Elderberry	Sambucus sp.
Eastern Hemlock	Tsuga canadensis
Northern Red Oak	Quercus rubra
Northern White Cedar	Thuja occidentalis
Paper Birch	Betula papyrifera
Quaking Aspen	Populus tremuloides
Red Pine	Pinus resinosa
Silver Maple	Acer saccharinum
Staghorn Sumac	Rhus typhina
Sugar Maple	Acer saccharum
Weeping Willow	Salix babylonica
White Ash	Fraxinus americana
White Pine	Pinus strobus
Wild Blackberry	Rubus sp.
Wild Grape	Vitus sp.

Wildflowers

Common name	Scientific name
Chicory	Cichorium intybus
Field Daisy	Chrysanthemum leucanthemum
Marsh St. Johnswort	Hypericum virginicum
Wild Vetch	Vitus sp.
Yellow Sweet Clover	Melilotus officinalis

Terrestrial Fauna

The terrestrial fauna of Lake Miramichi includes invertebrates, amphibians, reptiles, birds, and mammals.

Figure 44 lists the terrestrial invertebrates observed during the study.

Figure 44

Invertebrates

Common name	Scientific name
Bumblebee	Bombus sp.
Centipede	FamilyScutigeridae
Daddy Longlegs	Liobunum sp.
Deer Fly	Chrysops allidus
Field Cricket	Nemobius sp.
Firefly	Photinus pyralis
Horse Fly	Tabanus atratus
June Bug	Phyllophaga sp.
Millipede	Julida sp.
Yellow Jacket	Vespula sp.

Birds

Many birds come to the Lake Miramichi area to feed. Among these birds are bald eagle (Haliaeetus leucocephalus) (26), red-tailed hawk (Buteo jamecensis), osprey (Pandion haliaetus), great blue heron (Ardea herodias), canada goose (Branta canadensis), and mallard (Anas platyrhynchos).

Figure 45 lists birds that were observed during the study or are known to inhabit the area.

Figure 45

Birds

Common name	Scientific name
American Robin	Turdus migratorius
Bald Eagle	Haliaeetus leucocephalus
Barn Swallow	Hirundo rustica
Baltimore Oriole	Icterus galbula
Blue Jay	Cyanocitta cristata
Brown-headed Cowbirds	Molothrus ater
Canada Goose	Branta canadensis
Common Loon	Gavia immer
Eastern King Bird	Tyrannus tyrannus
Great Blue Heron	Ardea herodias
Great Horned Owl	Bubo virginianus
Killdeer	Charadrius vociferous
Little Green Heron	Butorides striatus
Mallard	Anas platyrhynchos
Northern Cardinal	Cardinalis cardinalis
Osprey	Pandion haliaetus
Song Sparrow	Melospiza melodia
Tree Swallow	Iridoprocne bicolor

Birds Continued

Turkey Vulture	Cathartes aura
Red-Tailed Hawk	Buteo jamecensis
Red Wing Blackbird	Agelaius phoeniceus
Ruby-Throated Hummingbird	Archilochus colubris
Wild Turkey	Meleagris gallopavo
Wood Duck	Aix sponsa
Wood Thrush	Hylocichla mustelina

The common loon is another bird that frequents Lake Miramichi to feed. It is a fish eating, diving bird. Sometimes, when a loon is approached it will stand on the water surface with its wings folded like a penguin. The "penguin dance" is a sign of extreme distress, and is usually accompanied by frantic calls. If this response is observed, the loon should be left alone (14).

Mammals

Some of the mammals observed included white-tailed deer (Odocoileus virginianus), raccoon (Procyon lotor), beaver (Castor canadensis), and muskrat (Ondatra zibethica). The large population of muskrats at Lake Miramichi appears to be causing erosion problems. They burrow under and around retaining walls causing them to collapse (27). The muskrat population in the area increased after trapping decreased at Lake Miramichi. The decrease in trapping was due to the low demand for pelts. Lake Miramichi property owners have been shooting muskrats in an attempt to control the population (26). The lake's islands are also having problems with erosion. This could be due in part to muskrat's burrows, and wave action.

Figure 46 lists the mammals observed in the area during the study or mammals known to inhabit the area.

Figure 46

Mammals

Common name	Scientific name
Beaver	Castor canadensis
Eastern Cottontail Rabbit	Sylvilagus floridanus
Eastern Chipmunk	Tamias striatus
Fox Squirrel	Sciurus niger
Grey Squirrel	Sciurus carolinensis
Mink	Mustela vison
Muskrat	Ondatra zibethica
Opposum	Didelphis marsupialis
Raccoon	Procyon lotor
Red Squirrel	Tamiasciurus hudsonicus
White-tailed Deer	Odocoileus virginianus

Management of Aquatic Plants

Long Term Management (Nutrient Control)

Aquatic plants require nutrients for growth and reproduction. The nutrients most often considered to be in the shortest supply and, therefore, limiting plant growth are phosphorus and nitrogen. Since aquatic plant populations are directly dependent upon the amount of nutrients available, nuisance growths of plants are only symptoms of high nutrient levels. This is important because all too often aquatic plant control programs are directed only at the aquatic plants, and not what causes the plants to grow (nutrients). An effective aquatic plant management program must give proper consideration to the amount of nutrients entering the lake (18).

Aquatic plant management techniques designed only to "kill weeds" must be considered as only temporary measures to reduce the symptoms of high nutrient levels. It is better to control the movement of nutrients and (sediments) from the watershed, whenever possible, than to attempt remedial action after the nutrients have entered into the lake. The management of nutrients over the long run can help reduce the rate of lake aging (18).

Limiting the movement of nutrients off the watershed into lakes will require the management of nutrient sources. *Natural* sources of nutrients enter a lake without human influence and contain very small amounts of nutrients usually introduced over a long period of time, as compared to, *anthropogenic* (human) sources of nutrients which are usually large in volumes and high in concentrations and delivered over a shorter period of time. As previously mentioned, cultural sources can greatly accelerate the rate of lake eutrophication (18).

All nutrient sources will have different levels of manageability. Some may be controlled with little effort and cost, while others may be very expensive and difficult to control. It is important to note that some may even be uncontrollable. Ideally, it is desirable to know which sources are contributing nutrients to a lake and in what quantities. It is then possible to adjust funds and activities to control nutrient sources to most effectively reduce the amount of nutrients into a lake. This approach will require extensive study by a trained limnologist (18).

The best time to begin a nutrient control program is before the aquatic plants have attained nuisance levels. The management of nutrient sources is an on going responsibility which must be intensified as development of the watershed continues. Methods of nutrient source management include:

1) Proper land use - The Soil Erosion and Sedimentation Control Act of 1972 was enacted to limit the movement of sediments and associated nutrients into surface waters during earth moving activities (except agricultural tillage).

2) Wise Consumer Use of Commercial Products - There are several commercial products, such as detergents and fertilizers, used for domestic and commercial purposes which can contribute significant amounts of nitrogen and phosporus to natural waters. Restricting the use of these products or

substituting similar products of low nitrogen and phosphorus content would substantially reduce the loading of nutrients to natural waters.

Waterfront property owners should take special care in the use of detergents and fertilizers. If lawns must be fertilized, soils should be tested to determine which chemical nutrients are needed. County cooperative extension agents can provide information on soil testing procedures and the best methods for applying fertilizers.

3) Treatment of Inflowing Waters High in Nutrients - In certain situations it may be possible or necessary to treat inflowing waters to reduce nutrient levels before they enter a lake. An inflowing stream or drain may carry substantial amounts of nutrients collected from many sources, such as agricultural drainage or urban storm water drainage. In certain situations it may be more feasible to chemically or physically treat the inflowing water to reduce nutrients than to control the many diffuse nutrient sources draining into it.

Short Term Management

Although the initial and continuing phase of aquatic plant management should be the control of nutrient sources, many lakes have such serious plant problems that short-term management techniques may be needed to maintain the recreational and economic interests in the lake. Also, in cases where nutrient control is impractical, such as shallow reservoirs on major, agricultural or urbanized river systems, short-term management practices may have to be conducted annually. Even in such cases, however, under no circumstances should the complete eradication of aquatic plants be considered. This practice is environmentally unsound and could have very undesirable consequences. In some lakes it may be necessary to alter recreational activities somewhat to suit the lake's state of eutrophication, rather than attempt to change the lake to meet recreational demands. In situations where nutrient control is possible, short-term management techniques should be considered only as temporary measures, designed to replace nuisance plant species with plant species that conflict less with recreational and economic interests. The short-term methods for managing aquatic plants include:

1) Biological Control - This method introduces an organism that competes with, preys upon, inhibits the growth of, causes disease in or parsitizes a plant species which has created a problem. The use of biological agents has many potential hazards. Therefore, the use of this control technique in either the terrestrial or the aquatic environment will always be under the direct supervision of state agencies. Some disadvantages are that competitor vegetation occasionally grows in excessive amounts, which uses up the DO necessary for survival of aquatic life. Also, the killed vegetation decays causing odor problems.

2) Mechanical Harvesting - This method involves the pulling or cutting and removal of macrophytes (rooted plants found in a lake or pond) from selected areas of a lake. It may employ hand tools or highly sophisticated motorized cutting or rotovating devices. When large areas of aquatic plants are

harvested, the cut material should be removed from the lake. If left in the lake, the cut plant parts will decompose, sometimes only partially, and contribute nutrients and organic material to the lake bottom. This helps to nourish new plant growth (18).

Mechanical harvesting also has drawbacks which must be considered. It has a high initial investment if a specially manufactured harvester is purchased. Many of these machines are large, heavy and can be damaged by obstructions (logs, boulders, and debris) hidden below the lake surface. Harvesting could aid the spread of a plant problem, since fragments of certain plants (milfoil) could drift into unaffected areas, take root and grow (18). The EMSC recommends the continuation of mechanical weed harvesting to further reduce nutrient levels in the lake.

3) Drawdown - Water level manipulation is a potential mechanism for controlling certain types of aquatic vegetation. In this technique, water levels are lowered for a period of time to expose shallow water areas. This dries out the exposed plants and kills them. Many submergent macrophytes are susceptible to this procedure, but certain emergent macrophytes actually benefit from it. In addition, this method does not control algae. A drawdown period of approximately two months is necessary for drying and freezing to be effective during winter drawdown.

4) Intensive Use and Periodic Manual Clearing - This method will in many cases prove to be an effective means of aquatic plant control in small beach areas. The rooted plants must produce sufficient food in their leaves to maintain their root systems. Frequent cutting of the leaves or their destruction by wading and swimming will eventually lead to death of the root system. This is particularly effective with emergent vegetation such as water lilies.

5) Use of Herbicides - Chemical control is another means of temporarily controlling aquatic plants and algae. There are a number of chemicals available which offer varying degrees of action time, persistence, cost, selectivity, and safety to humans, other animals, and aquatic animal life. It is important that herbicides be used with extreme care to ensure that both the environment and individuals involved are not adversely effected. A permit is required from the Michigan Department of Natural Resources (MDNR) prior to any chemical treatment of a waterbody (18).

The use of herbicides to control aquatic plants has certain drawbacks. Most herbicides control all forms of plant life to some extent. Beneficial aquatic plants may be killed along with the nuisance plants. It is also difficult to control the drift of herbicides under certain conditions, consequently plants may be killed over a much wider area than intended. Herbicides give only temporary control. In lakes where herbicides are used repeatedly on a large scale, dramatic shifts in plant populations can occur which may seriously alter the lake's ecology (18). Also when the plants die, they fall to the bottom and decay, releasing nutrients for next years growth.

6) Covering of Bottom Sediments with sheeting material (such as black plastic) and/or particulate matter (sand, clay) can perform two functions in

controlling aquatic plants. It can prevent the exchange of nutrients from the sediments to the overlying water and it can retard the establishment of rooted aquatic macrophytes. Disadvantages of this technique are that bottom dwelling animals are usually killed when the sediment is covered and often gas is produced under the plastic sheeting causing it to float to the surface. Sheetings are now available that have pores which allow gasses to escape. Experience with this technique, so far, has resulted in good temporary control, however, macrophytes will gradually recolonize the area unless the sheeting is removed periodically and cleared of any growth (18.)

DISCUSSION

Water chemistry data collected during the study period correlates with the type of flora and fauna present in the Lake Miramichi ecosystem and explains why they are present in the amounts observed.

The transparency of the lake is excellent. High transparencies increase the depth to which photosynthesis occurs, promoting the growth of aquatic vegetation. Transparency is not the only factor that affects the growth of aquatic vegetation. The combination of transparency with the amount of available nutrients and dissolved carbon dioxide present in the water also directly effect growth of plants. Dissolved carbon dioxide comes from the atmosphere and from the aerobic decomposition of organic material found in the lake.

Nutrients, specifically nitrogen and phosphorus, promote excess weed growth. As stated, the ideal nitrogen to phosphorus ratio (N:P) for optimum weed growth in aquatic ecosystems is between 15:1 and 30:1. At sites 8 and 10, the N:P ratio was very high, 139:1 and 69:1 respectively. The water at these sites is phosphorus poor, which means that any increase in phosphorus will cause an increase in weed growth. At site 9 the N:P ratio falls in the optimum range. Due to depth and consequent lack of light penetration, submergent vegetation cannot grow at this site and remove the nitrogen and phosphorus. As a result, the only plant life available to use the nutrients are phytoplankton. Since there is no of growth macroalgae in this area, nutrients tend to accumulate to the ideal ratio. At the remaining sites, the N:P ratios are below the optimum ratio because vegetation, such as curly-leafed pondweed and milfoil, have used up most of the available nitrogen. These areas are nitrogen poor, but have adequate reserves of phosphorus. In these areas, any addition of nitrogen will result in an immediate increase in weed growth.

Additions of nitrogen and phosphorus from the burning of yard waste, the use of fertilizers, or an abundance of waterfowl or animal feces will promote increased amounts of weed growth if these materials are allowed to enter the aquatic ecosystem.

Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) are inversely related. A high BOD will cause a low DO and vise versa. When there is an excess growth of aquatic vegetation, more decomposition of dead plants occurs which increases BOD. The mechanical harvesting and removal of weeds

from Lake Miramichi removes potential BOD. In Lake Miramichi, at current rates, the decomposition of weeds does not appear to be causing a significant drain on dissolved oxygen reserves.

Certain types of Total Dissolved Solids (TDS) including hardness and alkalinity, encourage the growth of vegetation found in Lake Miramichi, particularly curly leafed pondweed and chara. TDS, alkalinity, and hardness are all related since they are all measurements of a different form of calcium carbonate and bicarbonate. Alkalinity is expressed as mg/l of calcium carbonate. TDS includes the nutrient salt compounds calcium carbonate and magnesium, and hardness results from the combination of calcium ions, magnesium ions and carbonate. The measurements of samples collected show that TDS, hardness and alkalinity are all found in approximately equal amounts, in the 100 to 120 mg/l range. This means that there are few dissolved solids (chemicals) in the water other than hardness and alkalinity, which is indicative of clean conditions.

The overall water quality of Lake Miramichi is exceptional, and is one of the few lakes that the Environmental Management Studies Center has studied which shows an improvement since 1982, when a preliminary study was done. This is due to the efforts of the LMPOA to maintain and improve the quality of the lake. Continued efforts and support of the LMPOA will insure that the quality of Lake Miramichi will remain or improve for continued enjoyment for the residents of Lake Miramichi.

CONCLUSIONS AND RECOMMENDATIONS

Physiography

Conclusions

From research and field work, the physiography group produced a bathymetric chart of the lake and determined lake level fluctuation from the difference in stream flow caused by dry and wet periods. The two larger creeks had a dramatic increase in flow after the area received rainfall on June 27, 1995. The outlet of Lake Miramichi had a flow even though the water level in the lake was below the top of the overflow boards. The sediment traps on the intermittent streams do not appear to be catching much sediment, except the small stream sediment trap which was completely full.

A study of informational resources of soils and glacial activity indicate the abundance of groundwater because a confined aquifer feeds the groundwater system and surface water of Lake Miramichi. The soils of Lake Miramichi are characterized by a thin organic layer covering the glacial outwash. Sewage disposal installation limitations are apparently due to heavy clay soils (confining layers) found in the area as seen from the well lithology.

Recommendations

1. Before development, the soil of each property should be evaluated to determine soil types. If a majority of the undeveloped lots are not suitable for septic systems, a

community sewer and disposal system would be the only way to develop these areas. This must be addressed if continued residential development is desirable.
2. Sediment traps need to be consistently dredged to clean them of sediment build up. The addition of more traps on the two small streams that are continuously flowing will decrease the sediment build up in the lake.

Socioeconomics and Transportation

Conclusions

The Lake Miramichi area is primarily used for recreation. These activities bring in revenue for the marina and the surrounding area businesses. Since there is an absence of any municipal services at Lake Miramichi, the residents choose to travel to the city of Evart. Development was not favored with 44.1% of the residents at Lake Miramichi desiring little or no future development. Of those who were in favor, 23.5% chose recreational development over commercial and tourism at 10.8% . Industrial and agricultural development were least desired.

Almost half of the resident population was undedcided on whether to incorporate Lake Miramichi Subdivision into a village. Over 41% were on neither side. The highest percentage below this were the opposed at 39.4%, only 19.3% were in favor . These figures show that there may be little knowledge on the subject of incorporation but noticeable concern.

Recommendations

1. The LMPOA should do more to encourage residents and property owners to become active participants in functions that are planned by the association.
2. The LMPOA should develop a program to inform residents of the advantages of increasing dues for the association. This would allow the LMPOA to provide increased services such as road and dam maintenance, weed harvesting, and general upkeep of the property.
3. Village incorporation is not immediately recommended for the Lake Miramichi community. Residents need to be better informed about the advantages and disadvantages to formulate an educated opinion. After this topic has been further researched and understood, it is recommended that incorporation again be considered.

Water Quality

Conclusions

Lake Miramichi and Little Lake Miramichi were assessed by performing 13 physical and chemical parameters and 5 microbiological parameters on five different sampling days. Overall, the water quality of Lake Miramichi and Little Lake Miramichi are within state standards. Both lakes are well buffered to help stabilize pH which is necessary for survival of aquatic life.

One area of concern is site 1 because of its high phosphorus level which, in turn, promotes accelerated aquatic plant growth. A possible cause for the high phosphorus level could be a result of human waste, since site 1 was located inside the designated swimming area.

Another concern is high amounts of fecal contamination found at sites 2 and 3. This could become a potential health concern for those who are in contact with the water.

Recommendations

In order to maintain the overall quality of Lake Miramichi, the following recommendations may be considered:

1. Limit the accumulation of waterfowl in the area which are causing non-human fecal contamination of the water.
2. Conduct further physical, chemical, and microbiological analysis of Lake Miramichi and Little Lake Miramichi to determine how water quality fluctuates during and between seasons.

Natural History

Conclusions

Lake Miramichi is a warm-water mesotrophic lake that contains a wide variety of plant and animal species. Based on field studies conducted by the study group, it appears that the ecological condition of the lake is stable.

1. According to the survey 64.9% of Lake Miramichi property owners reported no change in the size of fish from Lake Miramichi. Those that did notice a change reported smaller bass (42.9%) and larger perch (66.6%) and bluegill (66.6%).
2. According to the survey, the number of legal size predator fish in the lake, such as bass and pike have decreased in numbers.
3. According to the survey 63.5% of the residents indicated in the survey that aquatic vegetation is "weed-choking" bay areas.
4. Little Lake Miramichi was totally weed choked before weed harvesting.
5. According to the survey 7.9% of lake residents stated recreational boats travel too fast on the lake causing erosion and disturbing other boaters.
6. Of those surveyed, 18.1% of residents located around the lake fertilize their lawns.
7. Residents indicated (in the survey) that Canada geese, muskrats, and beaver are considered nuisance animals.

Recommendations

1. Continue weed harvesting to decrease nutrient levels.
2. Recommend that the boat speed limit laws be better enforced on the lake.
3. Encourage residents to eliminate lawn fertilizing through education and by incorporating a "fertilizer watch program" to report improper practices.
4. Continued MDNR program of translocating nuisance animals.
5. Determine by specimen collection and analysis, why predator fish in Lake Miramichi are of a small size.

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