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**MMA, INC.**  
*CONSULTING ENGINEERS*

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**LAKE PLANNING STUDY**

**FOR**

**BASS LAKE AND MIDDLE LAKE**

Prepared for:

**SPREAD EAGLE CHAIN OF LAKES ASSOCIATION**

Florence, WI 54121

**MARCH 2001**

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# LAKE PLANNING STUDY FOR BASS LAKE AND MIDDLE LAKE

## EXECUTIVE SUMMARY

**Bass Lake** is located in Sections 4 and 5 of Township 39 North, Range 19 East, and in Sections 32 and 33 of Township 40 North, Range 19 East, in the Township of Florence in the northeastern portion of Florence County, Wisconsin. It is the south central lake of the Spread Eagle Chain of Lakes.

**Middle Lake** is located in Sections 32 and 33 of Township 40 North, Range 19 East, in the Township of Florence in the northeastern portion of Florence County, Wisconsin. It is the north central lake of the Spread Eagle Chain of Lakes.

The Spread Eagle Chain of Lakes consists of nine lakes totaling approximately 548 acres in size. Bass Lake is approximately 112 acres in size. The maximum depth of Bass Lake is approximately 68 feet (Ref. #3). Middle Lake is approximately 83 acres in size. The maximum depth of Middle Lake is approximately 54 feet (Ref. #3).

The watershed area of the Spread Eagle Chain of Lakes consists of approximately 3,200 acres located primarily to the northwest of the Spread Eagle Chain of Lakes. Runoff from the watershed of Montgomery Lake flows down Montgomery Creek to West Lake. The watershed consists predominantly of forest and wetlands with a scattering of residential development. The inlet to West Lake supplies much of the water coming into the Spread Eagle Chain of Lakes; springs and precipitation supply the remainder.

The outlet to the Spread Eagle Chain of Lakes is located on the south end of South lake. A small concrete compensation dam controls the lake level. Once water flows over the dam, it continues south and east as the Spread Eagle Outlet, flowing to the Menominee River.

**Overall water quality of Bass Lake** is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (8 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (41:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken in 1999 during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.

- Chlorophyll a results are low (1.02 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (16 - 24 feet) indicate very good water clarity.
- pH levels ranged from 7.8 (April) to 8.5 (June). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a and water clarity, Bass Lake is considered a Oligotrophic Lake (a lake with low nutrient levels).

**Overall water quality of Middle Lake** is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (9 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (44:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken in 1999 during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (1.2 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (15 - 23 feet) indicate good water clarity.
- pH levels ranged from 7.7 (April) to 8.6 (June). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a and water clarity, Middle Lake is considered a Oligotrophic Lake (a lake with low nutrient levels).

**Bass Lake and Middle Lake** have a well balanced population of desirable aquatic plants. Overall there are enough plants to provide cover, food and spawning locations for fish. Both Bass Lake and Middle Lake are deep lakes, so there are few areas that are clogged with plants that could make boat travel and other recreation activities difficult.

During the limited aquatic plant survey conducted in September of 1999 on Bass Lake and Middle Lake, eleven different species of aquatic plants were identified.

The plant species found on Bass Lake were Chara, Northern Water Milfoil, Water Celery, Illinois Pondweed, Leafy Pondweed, Common Waterweed, Coontail, White Water Lily, Floating-Leaf Pondweed and Smartweed.

The plant species found on Middle Lake were Chara, Northern Water Milfoil, Water Celery, Illinois Pondweed, Common Waterweed, Coontail, and Bulrush.

No exotic (foreign) species of aquatic plants were found in the aquatic plant survey of the two lakes.

**Fish evaluation** surveys were conducted on the Spread Eagle Chain of Lakes in 1993, 1994, and 1998. The results indicate that the Spread Eagle Chain of Lakes supports a dynamic and diverse fishery. The surveys showed that the Spread Eagle Chain of Lakes are fairly consistent throughout, with minor variations. Natural reproduction of all the major species present was observed. Overall, growth rates were found to be at or above the statewide average.

The fish found in the Spread Eagle Chain of Lakes during the most recent fish evaluation surveys include Walleye, Largemouth Bass, Northern Pike, Smallmouth Bass, Bluegill, Rockbass, Black Crappie (also known as Calico Bass), and Yellow Perch.

The following fish species use Bass Lake and Middle Lake as a spawning location: Walleye, Largemouth Bass, Northern Pike, Smallmouth Bass, Bluegill, Rockbass, and Black Crappie.

**Bass Island**, also known as Bacco Island, is a 0.6 acre island located in Bass Lake on the Spread Eagle Chain of Lakes. Bass Island has a rich cultural and recreational use history beginning with a resort in the late 1800's. For many years, the island was used for recreational purposes by the Bacco family, lake residents and visitors to the Spread Eagle Chain of Lakes. The island offered a concrete tennis court, two shuffle board courts with lattice cabanas, and a basketball court.

In 1999, Bass Island was suffering from erosion of the shoreline and degradation of structures on the island due to weather and disrepair. During 1999, the Island Restoration Committee, chaired by Ken Sovey, studied the use, condition, and maintenance of the island. On December 3, 1999, the Town of Florence entered into a land use agreement with the Wisconsin Department of Natural Resources for the purpose of implementing a management plan for Bass Island. The management plan is a partnership agreement between the Wisconsin Department of Natural Resources, the Town of Florence, and the Spread Eagle Chain of Lakes Association. The management plan will guide the recreational use, types of improvements, restoration, and educational initiatives that will occur on this island through the year 2009. Goals for the management plan include provisions for the following: Island Protection, Restoration, Recreation, Education, Cultural History, Access, and Maintenance.

**The following is a summary of recommendations** provided to improve the ecosystem of Bass Lake and Middle Lake:

- The Spread Eagle Lake Association should continue to monitor the water quality of Bass Lake and Middle Lake. Adverse lake trends can thereby be identified and corrected before irreversible damage to the lake has occurred.
- The Spread Eagle Lake Association should educate property owners about and involve them in measures that can maintain and improve water quality on Bass Lake and Middle Lake. Maintaining good water quality will help minimize aquatic plant growth and minimize future sedimentation.
- The level of fish stocking in the Spread Eagle Chain of Lakes should be maintained, but not increased. The addition of fish cribs should be continued. The cribs provide a habitat in which fish can thrive.
- Measures should be taken to protect the shoreline from erosion due to boat traffic. Keep aquatic plants growing near shore and rooted plants on shore to minimize shoreline erosion. In areas of shoreline erosion, obtain a permit to install rock rip-rap or soft protection near the shoreline.
- In 1999, the Wisconsin Department of Natural Resources and the Town of Florence entered into a land use agreement for the purpose of implementing a management plan for Bass Island. This study concurs with the goals of this management plan and no further recommendations regarding Bass Island are necessary.

# TABLE OF CONTENTS

|   |      |
|---|------|
| Cover Sheet.....                                    | i    |
| Transmittal Letter.....                             | ii   |
| Executive Summary.....                              | iii  |
| Distribution List.....                              | vii  |
| Signing Sheet.....                                  | viii |
| Table of Contents.....                              | ix   |
| <br>  |      |
| 1.0. INTRODUCTION.....                              | 1    |
| 1.1.Purpose.....                                    | 1    |
| 1.2.History.....                                    | 2    |
| 1.3.General Information.....                        | 3    |
| 2.0. DISCUSSION OF INFORMATION.....                 | 6    |
| 2.1.Property Owner Survey Results.....              | 6    |
| 2.2.Water Quality.....                              | 8    |
| 2.2.1.Methods of Sample Collection and Testing..... | 8    |
| 2.2.2.Results of Water Quality Analysis.....        | 9    |
| 2.2.2.1. Phosphorus.....                            | 10   |
| 2.2.2.2. Nitrogen.....                              | 11   |
| 2.2.2.3. Chlorophyll a.....                         | 12   |
| 2.2.2.4. Fecal Coliform.....                        | 13   |
| 2.2.2.5. Color.....                                 | 13   |
| 2.2.2.6. Turbidity.....                             | 13   |
| 2.2.2.7. Metals and Salts.....                      | 14   |
| 2.2.3. Secchi Depth.....                            | 15   |
| 2.2.4. Lake Temperature/Dissolved Oxygen.....       | 15   |
| 2.2.5. Water Quality Assessment – Bass Lake.....    | 18   |
| 2.2.6. Water Quality Assessment – Middle Lake.....  | 19   |
| 2.3. Aquatic Plant Survey Information.....          | 19   |
| 2.3.1. Methods of Testing.....                      | 19   |
| 2.3.2. Results of the Aquatic Plant Survey.....     | 20   |
| 2.4. Fish Species Information.....                  | 22   |
| 2.5. Watershed.....                                 | 24   |
| 2.6. Lake Usage Impact.....                         | 25   |
| 2.6.1. Fishing.....                                 | 25   |
| 2.6.2. Motorized Boating.....                       | 25   |
| 2.6.3. Shoreline Development.....                   | 26   |
| 2.7. Bass Island.....                               | 26   |
| 2.7.1. Use and Condition of Bass Island.....        | 26   |
| 2.7.2. Bass Island Management Plan.....             | 27   |
| 2.7.2.1. Island Protection.....                     | 27   |
| 2.7.2.2. Restoration.....                           | 28   |

|  |    |
|--|----|
| 2.7.2.3 Structures.....                            | 28 |
| 2.7.2.4 Recreation.....                            | 28 |
| 2.7.2.5 Education.....                             | 29 |
| 2.7.2.6 Cultural History.....                      | 29 |
| 2.7.2.7 Access.....                                | 29 |
| 2.7.2.8 Maintenance.....                           | 29 |
| 3.0. CONCLUSIONS.....                              | 30 |
| 3.1. Property Owner Survey.....                    | 30 |
| 3.2. Water Quality.....                            | 30 |
| 3.2.1. Water Quality Assessment – Bass Lake.....   | 30 |
| 3.2.2. Water Quality Assessment – Middle Lake..... | 31 |
| 3.3. Aquatic Plant Survey.....                     | 31 |
| 3.4. Fish Species.....                             | 33 |
| 3.5. Watershed.....                                | 34 |
| 3.6. Lake Usage Impact.....                        | 34 |
| 3.7. Bass Island.....                              | 34 |
| 4.0. RECOMMENDATIONS.....                          | 36 |
| 4.1. Water Quality Recommendations.....            | 36 |
| 4.2. Aquatic Plant Management Recommendations..... | 36 |
| 4.3. Fish Management Recommendations.....          | 37 |
| 4.4. Watershed Recommendations.....                | 37 |
| 4.5. Lake Usage Recommendations.....               | 37 |
| 4.6. Bass Island Recommendations.....              | 38 |
| 5.0. SUMMARY OF RECOMMENDATIONS.....               | 39 |
| 6.0. REPORT LIMITATIONS.....                       | 40 |
| 7.0. USE OF DOCUMENT BY OTHERS.....                | 41 |
| References.....                                    | 40 |
| Glossary of Terms.....                             | 42 |
| Appendix.....                                      | 46 |

## 1.0. INTRODUCTION

Bass Lake and Middle Lake are two of nine lakes of the Spread Eagle Chain of Lakes located in northeastern Florence County in northeastern Wisconsin. The Spread Eagle Chain of Lakes is located mid-way between Iron Mountain, Michigan and Florence, Wisconsin, near U.S. Highway 2/141. The locations of Bass Lake and Middle Lake are shown on Figure No. 1 - Location Map included in Appendix "A."

This section of the report provides a summary of the work to be performed during the study and some historical and general information pertaining to Bass Lake and Middle Lake and the Spread Eagle Chain of Lakes.

### **1.1. Purpose**

The Spread Eagle Chain of Lakes Association, Inc. was formed in 1988, with the objective of providing "**...a forum in which property owners, as members of the Association, can come together to discuss and act upon matters pertaining to the preservation and upkeep of their properties and of the surrounding area. Major interests include water quality, water safety, property improvement, relations with the Town of Florence, and the use of Spread Eagle waters by the general public.**" A copy of the Spread Eagle Chain of Lakes Association bylaws is included in Appendix "C."

In 1998, the Spread Eagle Chain of Lakes Association sought financial assistance from the WDNR Lake Management Planning Grant Program for the purpose of conducting lake planning studies on Bass Lake and Middle Lake of the Spread Eagle Chain of Lakes. The Lake Management Planning Grant Program, authorized under Chapter 144.253, Wisconsin Statutes, provides for assistance to eligible sponsors for the collection and analysis of information needed to protect and restore lakes and their watersheds. Lake Planning Grants provide seventy-five percent of the costs incurred. The Spread Eagle Chain of Lakes Association received notice of grant eligibility in October, 1998.

On October 23, 1998, the Spread Eagle Chain of Lakes Association entered into an agreement with MMA, INC. of Green Bay, Wisconsin to provide the following services in conducting the lake planning study:

- Obtain water quality samples and analyze the samples through the State Laboratory of Hygiene for appropriate parameters five (5) times: during winter 1998-99 (ice on), spring 1999 (ice out), June, July and August, 1999.
- Prepare a limited assessment of the aquatic plant and fish community.
- Address the current usage and resulting impact on the lake.
- Assist the Spread Eagle Chain of Lakes Association, through the education of designated members, with the equipment operation and sampling procedures necessary to continue its efforts of monitoring the quality of the Spread Eagle Chain of Lakes.
- Consider all other lake management activities and other local interest groups in the lake study project.

- Tailor the work undertaken to comply, to the greatest extent possible, with the goals, objectives and recommendations of the Upper Green Bay Basin Water Quality Management Plan.
- Conduct a sociological survey consisting of a letter survey of landowners to identify lake management goals and objectives.
- Prepare a news release and attend a public informational meeting to enhance local understanding of the lake's water quality.
- Submit a minimum of two (2) progress reports during the project to the Spread Eagle Lake Association.
- Give recommendations in the areas of water quality, fish management and aquatic plant management.
- Include as part of the final report appropriate physical background information on Bass Lake and Middle Lake.
- Consult with the Lake Study Committee of the Spread Eagle Lake Association near the completion of the project to review material that will be included in the final report. The final report will be written so that the general public can easily understand it.
- Prepare a report summarizing the work to submit to the WDNR.

## 1.2. History

As with most of northern Wisconsin and the Upper Peninsula of Michigan, prior to the late 1800's the Florence area was a great virgin forest. The Iron Mountain and Florence areas developed in the late 1800's and earlier 1900's as a result of the logging and mining activities in the area.

Logging activities did not occur in the Florence area until the mid-to-late 1870's, shortly after the government land sales, which started in 1866. Most of the logs that were cut in the late 1800's and early 1900's were floated downriver to lumber mills. The Menominee River, located just north and east of the Spread Eagle Chain of Lakes, served as a main vehicle for transporting the logs to the lumber mills. By 1898, most of the large stands of virgin pine in Florence County had been cut by the major logging companies, including the virgin Red and White Pine stands in the Spread Eagle Chain of Lakes area. The last of the remaining small stands of virgin pine were harvested from the Spread Eagle Chain of Lakes in winter of 1907 - 1908 (Ref. #1).

Note: The references are noted in the report by insertion of (Ref. #00) at the end of each passage pertaining to the particular reference used

Iron ore was discovered by Hiram D. Fisher in the Florence area in 1873 and in Commonwealth in 1876. The Chicago and Northwestern Railway Company extended rail service to Commonwealth and Florence in 1880 to transport the iron ore mined from the Florence and Commonwealth area. Passenger rail service was provided to Spread Eagle, Commonwealth and Florence in 1881.

Rail service to Spread Eagle opened up the Spread Eagle Chain of Lakes area for recreation and tourism. In 1881, Fred John opened up a resort and an ice house on Bass Island on Bass Lake. It was expanded in 1889 when it was purchased by Emmanuel Chainey to include a popular dance pavilion. In 1894, a resort hotel opened with a saloon and icehouse on Eagle Island between Bass Lake and Middle Lake. Each of these resorts had steam powered boats to transport people from the train depot near Railroad Lake to the resorts. Paradise Island on East Lake had a small resort in the 1880's until 1894 (Ref. #2).

In 1882, the first private cottage was built by Mark Dunn on Dunn's Point near the entrance to West Lake. The first major building of cottages on the Spread Eagle Chain of Lakes did not occur until 1904 when the lots on Mosquito Bay of Bass Lake were sold.

Waterfront lots on Spread Eagle Chain of Lakes accessible by roads from the railroad depot sold quickly, while lots which were only accessible by water usually did not sell until the roads were provided shortly after World War 1.

Once roads were built around the Spread Eagle Chain of Lakes making the lots easily accessible, building around the Lakes flourished. Recently, building on vacant lots has given way to the conversion or replacement of summer cottages to year-round homes.

### **1.3. General Information**

Bass Lake is located in Sections 4 and 5 of Township 39 North, Range 19 East, and in Sections 32 and 33 of Township 40 North, Range 19 East, in the Township of Florence in the northeastern portion of Florence County, Wisconsin. It is the south central lake of the Spread Eagle Chain of Lakes.

Middle Lake is located in Sections 32 and 33 of Township 40 North, Range 19 East, in the Township of Florence in the northeastern portion of Florence County, Wisconsin. It is the north central lake of the Spread Eagle Chain of Lakes.

The Spread Eagle Chain of Lakes consists of nine lakes totaling approximately 548 acres in size. Bass Lake is approximately 112 acres in size. The maximum depth of Bass Lake is approximately 68 feet (Ref. #3). Middle Lake is approximately 83 acres in size. The maximum depth of Middle Lake is approximately 54 feet (Ref. #3). For complete details on the depths of the Spread Eagle Chain of Lakes refer to Figure Nos. 2 & 3 - Lake Survey Maps of the Spread Eagle Chain of Lakes, included in Appendix "A."

It should be noted that Wisconsin Department of Natural Resources (WDNR) Lake Survey Map shown as Figure No. 2 - Lake Survey Map of the Spread Eagle Chain of Lakes, included in Appendix "A," Clarkson map No. 3805 - Spread Eagle Chain and the United States Geological Survey (USGS) topographic map - Florence, East incorrectly shows an inlet into North Lake which in fact enters into West Lake.

The inlet to West Lake supplies much of the water coming into the Spread Eagle Chain of Lakes; springs and precipitation supply the remainder.

The outlet to the Spread Eagle Chain of Lakes is located on the south end of South Lake. A small concrete compensation dam controls the lake level. Once water flows over the dam, it continues south and east as the Spread Eagle Outlet, flowing to the Menominee River.

The soils around Bass Lake are predominately sandy loams. The primary soil series around Bass Lake is the Pense sandy loam, followed by Sarona - Vilas Complex (Ref. #4). Descriptions of each of these soil series are located in the Glossary of Terms at the end of this section.

The soils around Middle Lake are predominately sandy loams or loamy sands. The primary soil series around Middle Lake is Pense sandy loam, followed by Croswell loamy sand, and Sarona - Vilas Complex (Ref. #4). Descriptions of each of these soil series are located in Glossary of Terms.

The sandy soils found around the lakes are primarily glacial outwash created after the last stage of glaciation. It appears that the Spread Eagle Chain of Lakes were formed as a result of the glaciers approximately 12,300 years ago (Ref. #5).

These soils are typically well drained with permeabilities ranging from rapid to very rapid. On-site septic system drain fields function satisfactorily, but groundwater pollution is a potential problem because of the rapid to very rapid permeability in the lower soils (Ref. #4).

Bass Lake bottom soils are a mixture of sand, gravel, rubble, muck, and silt. The Bass Lake bottom soils are dominated by sand (sixty percent) followed by gravel, rubble, muck, and silt (Ref. #3). For complete details on the Bass Lake bottom soils refer to Figure No. 3 - Lake Survey Map of the Spread Eagle Chain of Lakes in Appendix "A."

Middle Lake bottom soils are a mixture of sand, gravel, muck, and rubble. Sand (fifty percent) followed by gravel (forty percent), muck (eight percent), and rubble (two percent) (Ref. #3) dominate the Middle Lake bottom soils. For complete details on the Middle Lake bottom soils refer to Figure No. 2 - Lake Survey Map of the Spread Eagle Chain of Lakes in Appendix "A."

The annual average precipitation in the Spread Eagle Chain of Lakes area is 29.8 inches. About 18 inches, or sixty percent, usually falls in May through September (Ref. #3).

Prevailing winds are from the west and northwest from late fall through early Spring, and from the southwest the remainder of the year. The average wind speed is six miles per hour (Ref. #3).

Public access to the Spread Eagle Chain of Lakes is gained on the southwest side of North Lake. The public access has adequate parking, a boat ramp, a dock, and a latrine.

There are approximately 80 seasonal and permanent residences on Bass Lake and approximately 47 seasonal and permanent residences on Middle Lake. There are approximately 330 property owners on the entire Spread Eagle Chain of Lakes.

## 2.0. DISCUSSION OF INFORMATION

The following sections of the report discuss the information generated during the study.

### **2.1. Property Owner Survey Results**

A letter survey was conducted of Spread Eagle Chain of Lakes property owners in November of 2000. The property owners were given an opportunity to express their concerns and offer suggestions regarding the Spread Eagle Chain of Lakes. The Spread Eagle Lake Association will use this information to establish its future goals and objectives. The survey had a very good return rate: fifty five percent of the property owners completed and returned the questionnaire. This response indicates that the Spread Eagle Chain of Lakes property owners want to actively participate in the decisions which affect the future of the Spread Eagle Chain of Lakes.

The following indicates the questions asked by the survey followed by a summary of the responses:

- 1. As part of the educational/safety portion of the Bass/Middle Lakes grant, the Skier Down Program was implemented. Flags were sold and literature was disseminated to promote water skier safety. What effects have you seen resulting from the Skier Down Program?*

| <b>% POSITIVE EFFECTS</b> | <b>% NEGATIVE EFFECTS</b> | <b>% NO EFFECT NOTICED</b> | <b>% UNAWARE OF THE PROGRAM</b> |
|---------------------------|---------------------------|----------------------------|---------------------------------|
| <b>31.9</b>               | <b>6.0</b>                | <b>9.9</b>                 | <b>42.3</b>                     |

The survey results indicate that most people responding to the survey, that were aware of the program, indicated they have seen positive effects as a result of the Skier Down Program. The survey results also indicate that many people were unaware of the Skier Down Program.

- 2. In 1999, the Wisconsin Department of Natural Resources put into effect a ruling that restricts personal watercraft (PWCs, commonly known as jetskis) to slow no wake within 200 feet of a shoreline or within 100 feet of any other boat. What effects have you seen as a result of the ruling?*

| <b>% POSITIVE EFFECTS</b> | <b>% NEGATIVE EFFECTS</b> | <b>% NO EFFECT NOTICED</b> | <b>% UNAWARE OF THE RULING</b> |
|---------------------------|---------------------------|----------------------------|--------------------------------|
| <b>38.5</b>               | <b>28.0</b>               | <b>18.7</b>                | <b>3.8</b>                     |

The survey results indicate that most people responding to the survey noticed negative effects or no effects as a result of the Wisconsin Department of Natural Resources slow no wake ruling. Approximately 71% of those responding to this question had a written comment regarding PWCs.

3. *Would you be willing to volunteer time to work with others in maintaining Bass Island (Bacco's Island)?*

| <b>% YES</b> | <b>% NO</b> |
|--------------|-------------|
| <b>36.3</b>  | <b>57.7</b> |

The survey results indicate that a large number of people would be willing to volunteer time to work with others in maintaining Bass Island.

4. *Would you be willing to donate funds toward hiring others to help maintain Bass Island (Bacco's Island)?*

| <b>% YES</b> | <b>% NO</b> |
|--------------|-------------|
| <b>35.7</b>  | <b>59.9</b> |

The survey results indicate that a large number of people would be willing to donate funds toward hiring others to help maintain Bass Island.

5. *Would you support an effort to improve the channel to East Lake for better boat access?*

| <b>% YES</b> | <b>% NO</b> |
|--------------|-------------|
| <b>44.0</b>  | <b>52.7</b> |

The survey results indicate that the majority of those responding to the survey would not support an effort to improve the channel to East Lake.

6. *Would you support an effort to improve the channel to South Lake for better boat access?*

| <b>% YES</b> | <b>% NO</b> |
|--------------|-------------|
| <b>31.3</b>  | <b>64.3</b> |

The survey results indicate that the majority of those responding to the survey would not support an effort to improve the channel to South Lake.

Copies of the returned questionnaires with written responses are found in Appendix "D."

## 2.2. Water Quality

The purpose of testing a lake's water quality is to document changes in a lake that will help to distinguish between a lake's natural variability and the impacts of human activity. The following information provides a baseline for which future water quality testing of Bass Lake and Middle Lake can be measured.

Water quality samples were taken five times on Bass Lake and Middle Lake during 1999. They were ice-on (February), ice-out (April), and June, July and August. The location of water quality sampling on Bass Lake and Middle Lake is indicated in Appendix "A," Figure No. 4. The following table shows the analytical parameters for each water-sampling event:

| <u>Water Sampling Parameter</u>                       | <u>Month Tested</u>                 |
|---|-------------------------------------|
| Total Phosphorus.....                                 | February, April, June, July, August |
| Dissolved Phosphorus.....                             | February, April, June, July, August |
| TKN.....  | April                               |
| Nitrate/Nitrite.....                                  | April                               |
| Ammonia Nitrogen.....                                 | April                               |
| Color, Turbidity, Sulfate, Chlorides, Alkalinity..... | April                               |
| Magnesium, Sodium, Potassium, Calcium.....            | April                               |
| Iron, Manganese, Hardness.....                        | April                               |
| Chlorophyll <i>a</i> .....                            | April, June, July, August           |
| Fecal Coliform.....                                   | July                                |

### 2.2.1. Methods of Sample Collection and Testing

Water samples were collected for laboratory analysis with a Wildco®, clear acrylic, one-liter, horizontal style water sampler at specified depths and locations. Samples were immediately transferred to appropriate bottles, preserved (if necessary), labeled, packed in ice and sent via overnight express mail to the laboratory. The Wisconsin State Laboratory of Hygiene in Madison, Wisconsin conducted all laboratory analysis, using WDNR specified methods.

Sampling and analysis for total phosphorus and dissolved phosphorus were conducted during all sampling events. Phosphorus is normally the limiting factor in aquatic plant growth.

Sampling and analysis for total phosphorus, dissolved phosphorus, total kjeldahl nitrogen, nitrate/nitrite nitrogen, ammonia nitrogen, color, turbidity, sulfate, chlorides, alkalinity, magnesium, sodium, potassium, calcium, iron, manganese and hardness were all conducted during the April sampling event. The April sampling event took place shortly after spring turnover to take advantage of the natural mixing action that occurs at that

time. During spring and fall turnover in a lake, nutrients and sediments stored on the bottom are resuspended.

Sampling and analysis for chlorophyll *a* (a measure of algae growth) were conducted during the April, June, July and August sampling events. These are months when algae growth is expected to be the highest in a lake.

Sampling and analysis for fecal coliform (coliform bacteria found in feces) were conducted during the July sampling event. A high fecal coliform count is usually an indication of raw sewage entering the lake. The test was conducted in mid-summer because this is the time when lake residents and visitors use on-site systems the most.

In addition to the previously described water sampling, physiochemical parameters were measured in the field. These parameters included Secchi depth, dissolved oxygen (DO), pH, and water temperature.

The Secchi depth is a measure of water clarity. It is determined using a standard Secchi disc. The Secchi disk is a black and white circular plastic plate, 20 centimeters (~8 inches) in diameter. The Secchi disc is lowered over the downwind, shaded side of the boat into the water until it just disappears from sight, then raised again until it is visible. The average depth at which the Secchi disk disappears and reappears is the Secchi depth at that location. Water with greater clarity will have a greater Secchi depth. Secchi depth readings were measured on calm sunny days between 10 A.M. and 2 P.M.

Water temperature and DO readings were obtained with an ICM® Model 51601 water analyzer. The probe, located at the end of a 100-foot cable, was lowered into the water to a specified depth. Readings for DO and temperature were recorded at the prescribed elevation.

The pH (measure of acidity) of surface water in the lake was measured in February, April, June, July and August with a ICM® Model 51601 water analyzer. Readings for pH were taken at the same location as water samples.

### **2.2.2. Results of Water Quality Analysis**

Sections 2.2.2 through 2.2.6 of the report summarize the water quality sampling and laboratory analysis conducted on Bass Lake and Middle Lake. For complete details of the laboratory results refer to Appendix "E."

Aquatic plants need many elements for growth and survival: Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), Sulfur (S), Calcium (Ca), Magnesium (Mg), Potassium (K), and Iron (Fe). A number of other elements are also necessary, but in extremely small amounts. Only two of these elements are considered major limiting nutrients when it comes to plant growth in lakes: Nitrogen and Phosphorus (Ref. #6).

### 2.2.2.1. Phosphorus

Phosphorus is a highly variable nutrient in lakes. Its concentration has probably the greatest effect on aquatic plant growth. The concentration of Phosphorus in Bass Lake and Middle Lake was determined as Total Phosphorus and Dissolved Phosphorus.

Dissolved Phosphorus is, as the name implies, dissolved in the water and readily available for aquatic plant uptake. Its concentration generally varies throughout the year.

Total Phosphorus is a better indicator of the amount of Phosphorus ultimately available in a lake for aquatic plant growth. It is the sum of the dissolved Phosphorus and the Phosphorus contained in suspended plant and animal material in the water.

The following table provides the Total and Dissolved Phosphorus concentrations in water samples collected from Bass Lake and Middle Lake during 1999. The concentrations are presented in micrograms per liter (ug/l) or parts per billion.

**Total and Dissolved Phosphorus Concentrations - Bass Lake and Middle Lake**

| Month    | Sample | Total Phosphorus Bass Lake (ug/l) | Dissolved Phosphorus Bass Lake (ug/l) | Total Phosphorus Middle Lake (ug/l) | Dissolved Phosphorus Middle Lake (ug/l) |
|----------|--------|-----------------------------------|---------------------------------------|-------------------------------------|---|
| February | Top    | 11                                | 5                                     | 10                                  | 5                                       |
| February | Bottom | 82                                | 52                                    | 68                                  | 51                                      |
| April    | Top    | 6                                 | <2                                    | 9                                   | <2                                      |
| April    | Bottom | 433                               | 125                                   | 185                                 | 128                                     |
| June     | Top    | 6                                 | 2                                     | 6                                   | 3                                       |
| June     | Bottom | 89                                | 6                                     | 115                                 | 22                                      |
| July     | Top    | 6                                 | 2                                     | 7                                   | 3                                       |
| July     | Bottom | 192                               | 47                                    | 113                                 | 44                                      |
| August   | Top    | 11                                | <2                                    | 12                                  | <2                                      |
| August   | Bottom | 221                               | 51                                    | 126                                 | 69                                      |

\*Top samples were obtained within one meter of the surface.

\*Bottom samples were obtained within one meter of the bottom.

During anaerobic (no oxygen) conditions, phosphorous, iron and other nutrients can be driven out of bottom sediment (Ref. #8). This is very apparent in the results shown above by the elevated levels of Total Phosphorous and Dissolved Phosphorous in the bottom samples on both Bass Lake and Middle Lake. The dissolved oxygen levels in both lakes are shown later in this report in Section 2.2.4 – Lake Temperature/Dissolved Oxygen.

The phosphorous that is driven out of the bottom sediment can be precipitated out with iron and clay particles in the water thereby making it unavailable for use by plants (Ref.

#7). In addition, when thermal stratification occurs in deeper lakes such as Bass Lake and Middle Lake, very little mixing occurs between the hypolimnion (lower layer) and the epilimnion (upper layer) and the nutrients are not able to reach the upper layer where plants grow. It is further apparent from the high Secchi depth (Section 2.2.3) and low chlorophyll *a* results (Section 2.2.2.3) that the phosphorus from the bottom sediment is not mixing with the remainder of the lake and is localized near the bottom.

Since the elevated levels of phosphorus are likely due to anaerobic conditions occurring on the lake bottom and are not representative of nutrients readily available for plant uptake, only the top sample analytical results will be considered for the purposes of this report.

Dissolved Phosphorus concentrations should be less than 10 ug/l during spring turnover (April) to prevent summer algae blooms. The results of sampling on Bass Lake and Middle Lake indicate concentrations to be less than the detectable limit of 2 ug/l. This means that a very small amount of phosphorus is readily available for plant uptake.

The following table provides the average Total Phosphorus concentrations for Wisconsin's natural lakes and impoundments.

**Total Phosphorus Concentrations for Wisconsin Lakes and Impoundments Compared to Bass Lake and Middle Lake Summer of 1999. (Adapted from Ref. #8 and Ref. #9)**

| Water Quality Index | Total Phosphorus (ug/l) | State Ave. Total Phosphorus for all Lakes (ug/l) | State Ave. Total Phosphorus for Impoundments (ug/l) | State Ave. Total Phosphorus for Natural Lakes (ug/l) | Bass Lake Total Phosphorus (ug/l) | Middle Lake Total Phosphorus (ug/l) |
|---------------------|-------------------------|--|---|--|-----------------------------------|-------------------------------------|
| Very Poor           | > 150                   |  |   |  |                                   |                                     |
| Poor                | 55-150                  |  | 65  |  |                                   |                                     |
| Fair                | 32-55                   |  |   |  |                                   |                                     |
| Good                | 16-32                   | 31   |   | 25   |                                   |                                     |
| Very Good           | 2-16                    |  |   |  | 8                                 | 9                                   |
| Excellent           | <2                      |  |   |  |                                   |                                     |

The results of Total Phosphorus concentrations are less than those for other natural lakes and much less than those for all lakes (Ref. #9).

**2.2.2.2. Nitrogen**

Nitrogen is a relatively stable nutrient in most lakes compared to Phosphorus. Nitrogen is a major natural component in decomposing plant and animal matter. It exists in lakes in several forms including nitrate (NO<sub>3</sub>), nitrite (NO<sub>2</sub>), ammonia (NH<sub>3</sub>) and organic nitrogen. Total Kjeldahl Nitrogen (TKN) is the combined total of ammonia nitrogen and organic nitrogen. Total Nitrogen is the sum of TKN plus nitrate and nitrite nitrogen. The

following tables provide the results of Nitrogen testing on Bass Lake and Middle Lake conducted during spring turnover. The concentrations are presented in milligrams per liter (mg/l) or parts per million.

**Results of Testing for Nitrogen - Bass Lake, April 1999**

| Sample | Ammonia Nitrogen<br>(mg/l) | Nitrate/Nitrite<br>(mg/l) | TKN<br>(mg/l) | Total Nitrogen<br>(mg/l) |
|--------|----------------------------|---------------------------|---------------|--------------------------|
| Top    | 0.013                      | 0.067                     | 0.26          | 0.327                    |

**Results of Testing for Nitrogen - Middle Lake, April 1999**

| Sample | Ammonia Nitrogen<br>(mg/l) | Nitrate/Nitrite<br>(mg/l) | TKN<br>(mg/l) | Total Nitrogen<br>(mg/l) |
|--------|----------------------------|---------------------------|---------------|--------------------------|
| Top    | 0.016                      | 0.092                     | 0.30          | 0.392                    |

Wisconsin lakes have an average Total Nitrogen concentration of 0.86 mg/l, with seventy-one percent of the lakes falling between 0.30 and 1.0 mg/l (Ref. #9). Bass Lake and Middle Lake fall in the lower half of the range.

The Total Nitrogen to Total Phosphorus ratio (N:P ratio) for Bass Lake was found to average 41:1 for the year. The N:P ratio for Middle Lake was found to average 44:1 for the year. N:P ratios greater than 15:1 generally indicate Phosphorus is the limiting nutrient for aquatic plant growth.

**2.2.2.3. Chlorophyll a**

Chlorophyll a is a green pigment necessary for photosynthesis. The amount of chlorophyll a found in lake water is used to estimate algae (phytoplankton biomass) in the lake. The concentration of chlorophyll a found in water samples collected in April, June, July and August (algae season) from Bass Lake and Middle Lake are provided in the following table:

**Chlorophyll a - Bass Lake and Middle Lake, 1999**

| Month  | Chlorophyll <u>a</u><br>Bass Lake (ug/l) | Chlorophyll <u>a</u><br>Middle Lake (ug/l) |
|--------|--|--|
| April  | 1.00*                                    | 1.32*                                      |
| June   | 0.39*                                    | 0.54*                                      |
| July   | 1.03*                                    | 1.38*                                      |
| August | 1.66*                                    | 1.71*                                      |

\* Low Absorbency, result approximate

The average concentration of chlorophyll a in Wisconsin lakes was 14.8 ug/l with sixty-five percent of the lakes having a value of less than 10 ug/l (Ref. #9). The results indicate that Bass Lake and Middle Lake are well below the state average for chlorophyll a.

#### 2.2.2.4. Fecal Coliform

Fecal coliform are coliform bacteria originating from animal feces. A high count from a fecal coliform test (greater than 200 colonies per 100 ml sample) usually indicates raw sewage is entering the lake. A test was conducted during mid-summer because this is the time when residents and visitors use the systems the most. The Bass Lake samples taken in July had a count of 20 colonies per 100-ml sample. The Middle lake samples taken in July had a count of less than 10 colonies per 100-ml sample.

This indicates that raw sewage was not detected in the sample obtained.

#### 2.2.2.5. Color

The color of a lake is a measure of the amount of material dissolved in the water. Color is mainly aesthetic, but it can affect light penetration and heat absorbancy of lakes. Tannic and humic acids originating from decomposing plant material can give a lake a natural brown color. Bass Lake and Middle Lake were sampled in April for color. The following table provides the water color range from low to high as correlated to standard units (SU) of color, and the results of the samples obtained from Bass Lake and Middle Lake.

**Water Color (Ref. #8) - Bass Lake and Middle Lake, April 1999**

| Range        | Color  | Bass Lake and Middle Lake Top Sample (SU) | Bass Lake and Middle Lake Bottom Sample (SU) |
|--------------|--------|---|--|
| 0-40 units   | Low    | 5   | 5  |
| 40-100 units | Medium |   |  |
| >100 units   | High   |   |  |

The results indicate the color of Bass Lake and Middle Lake is low; this indicates good water clarity.

#### 2.2.2.6. Turbidity

The turbidity of a lake is a measure of the amount of organic and inorganic matter suspended in the water. Levels of turbidity between 0 and 2 Jackson Turbidity Units (JTU) were recorded in forty-four percent of a random data set of Wisconsin lakes according to a 14 year study done by Lillie and Mason. The average Turbidity was listed at 3.1 JTU. Nephelometric Turbidity Units (NTU) are the laboratory units used to measure the turbidity of the Bass Lake and Middle Lake samples. For our purposes, JTU's and NTU's can be assumed to be the same. The Bass Lake April 1999 sample indicated a value of 0.5 NTU. The Middle Lake April 1999, sample indicated a value of 0.4 NTU.

The results for Bass Lake and Middle Lake indicate relatively low turbidity.

### 2.2.2.7. Metals and Salts

The metals and salts found in lake water are primarily related to the types of minerals found in the watershed. The purpose of sampling for these metals and salts is to get a good baseline for future readings to confirm the presence of sources of pollution.

For example, the presence of chloride above its naturally occurring level may be an indicator of a pollution source. Sources of chloride may include septic tank effluent, animal waste, potash fertilizer, and drainage from road salt. The presence of sulfate in lake water can be an indicator of acid rain.

The following is a chart indicating the results of spring testing for metals and salts:

**Water Sampling Results for Metals and Salts**

| <b>Parameter</b> | <b>Bass Lake<br/>(mg/l)</b> | <b>Middle Lake<br/>(mg/l)</b> |
|------------------|-----------------------------|-------------------------------|
| Calcium          | 22                          | 24                            |
| Chloride         | 5.4                         | 5.8                           |
| Alkalinity       | 94                          | 103                           |
| Iron             | 0.02                        | 0.01                          |
| Magnesium        | 9.8                         | 11                            |
| Manganese        | *                           | 11                            |
| Potassium        | 1.0                         | 0.8                           |
| Sodium           | *                           | 2.7                           |
| Sulfate          | 3                           | 4                             |

\*Results not available

Alkalinity was also included in the testing and is shown in the results above. Alkalinity acts to buffer lakes from the effects of acid rain because the bicarbonate and carbonate neutralize hydrogen ions from acid inputs. A lake's alkalinity and hardness are primarily determined by the type of minerals in the soil and watershed bedrock, and by how much the lake water comes in contact with these minerals. If a lake gets groundwater from aquifers containing limestone minerals such as calcite and dolomite, hardness and alkalinity will be high. Lakes with alkalinity values less than 25 mg/l are sensitive to acid rain.

The results of testing for metals and salts in Bass Lake and Middle Lake provide a baseline for future readings. They are all in the low to average range compared to other lakes in Wisconsin.

### 2.2.3. Secchi Depth

Secchi depth is a measure of water clarity. It measures the combination of color and turbidity and takes into account algae growth as well. Secchi depth is generally a good indicator of a lake's overall water quality. The following table provides a general index of water clarity using Secchi depth:

#### Water Clarity Index

| <u>Water Clarity</u> | <u>Secchi Depth (ft.)</u> |
|----------------------|---------------------------|
| Very Poor            | 3                         |
| Poor                 | 5                         |
| Fair                 | 7                         |
| Good                 | 10                        |
| Very Good            | 20                        |
| Excellent            | 32                        |

The following table provides the actual Secchi depth measured by MMA, Inc. during the summer months of 1999.

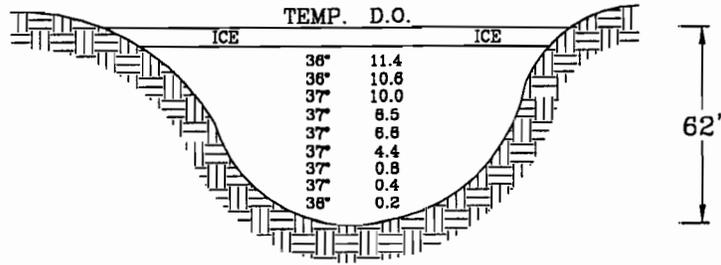
#### Secchi Depths Measured for Bass Lake and Middle Lake

| <u>Month</u> | <u>Bass Lake<br/>Secchi Depth (ft.)</u> | <u>Middle Lake<br/>Secchi Depth (ft.)</u> |
|--------------|---|---|
| April        | 16.4                                    | 20.3                                      |
| June         | 23.0                                    | 23.0                                      |
| July         | 18.0                                    | 21.0                                      |
| August       | 17.7                                    | 15.4                                      |

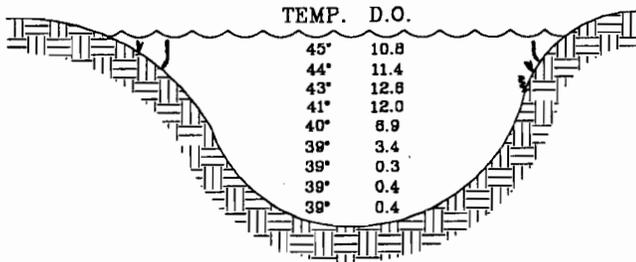
The Secchi depth measured in Bass Lake and Middle Lake in comparison to the water clarity index, indicates Bass Lake and Middle Lake have good to very good water clarity.

### 2.2.4. Lake Temperature/Dissolved Oxygen

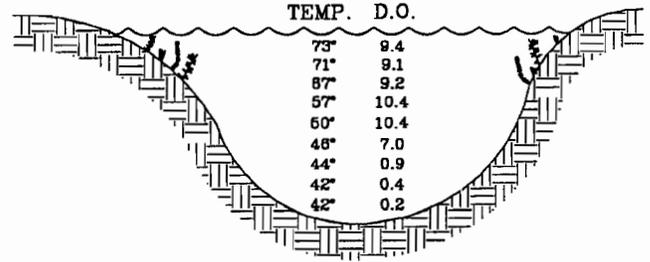
Wave action, mixing of the lake, and photosynthesis all add dissolved oxygen (DO) to lake water. Plant and animal respiration and decomposition will decrease the DO supply in a lake. The amount of DO present is also dependent upon water temperature. The lower the temperature of the water, the greater the oxygen solubility and vice versa. For example, the maximum solubility of oxygen in water at 32° F is 15 mg/l; at 68° F the maximum solubility of oxygen in water is 9 mg/l (Ref. #8). The maximum density (weight per unit volume) of water is at 39° F. All these factors interplay when you assess a lake's DO level at any time of the year. The following figures provide the temperature and DO levels for Bass Lake and Middle Lake measured during 1999.



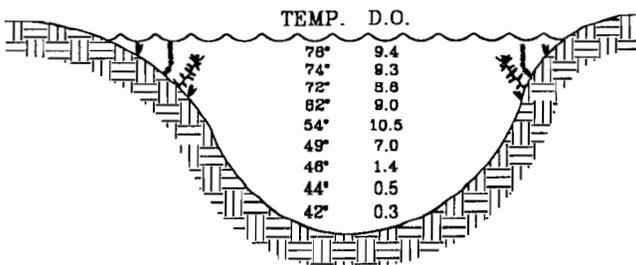
FEBRUARY



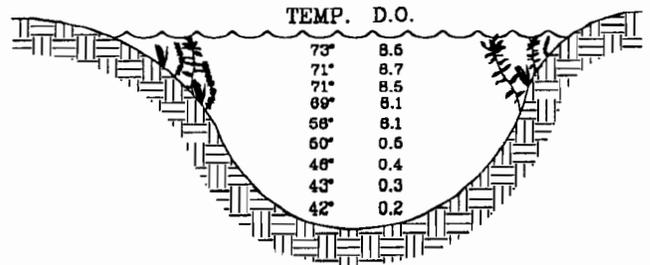
APRIL



JUNE



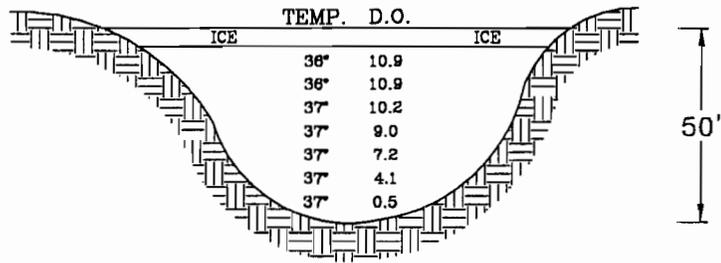
JULY



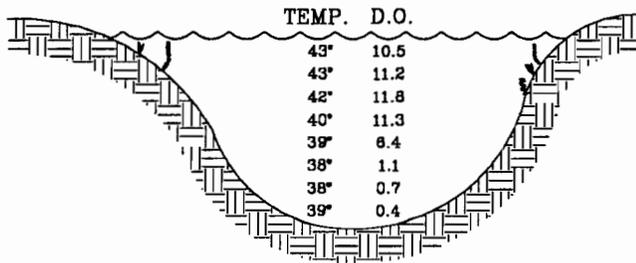
AUGUST

TEMPERATURE (°F)  
 DISSOLVED OXYGEN (mg/l)  
 TWO METER INTERVALS SHOWN

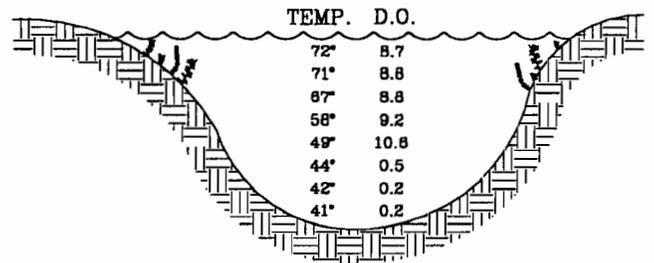
TEMPERATURE/DISSOLVED OXYGEN PROFILES - BASS LAKE



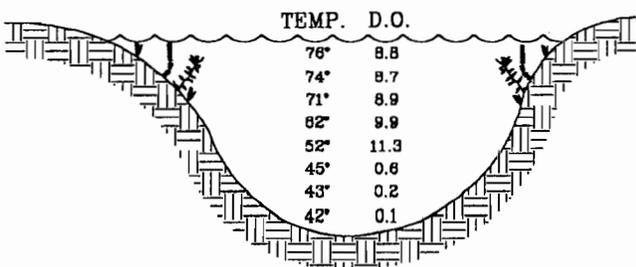
FEBRUARY



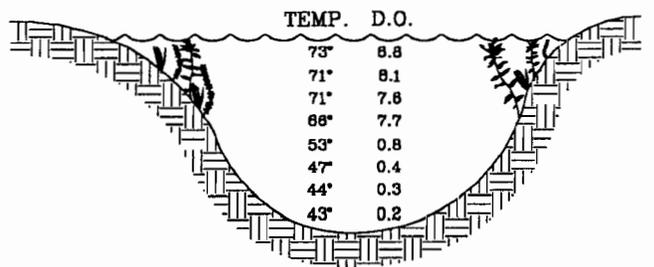
APRIL



JUNE



JULY



AUGUST

TEMPERATURE (°F)  
 DISSOLVED OXYGEN (mg/l)  
 TWO METER INTERVALS SHOWN

TEMPERATURE/DISSOLVED OXYGEN PROFILES - MIDDLE LAKE

The temperatures and DO levels were measured in Bass Lake and Middle Lake at the sample locations in February, April, June, July and August. During February, the temperature at the ice/water interface was the coldest recorded, 32° F. The surface water temperatures were the highest in July at 78° F for Bass Lake and 76° F for Middle Lake. The highest DO levels were recorded within 15 feet of the surface throughout the year due to wind action and plant respiration. The lowest DO levels were recorded at the bottom of the lakes where it dropped to near 0 mg/l due to the decomposition of plant and animal material.

During April, spring turnover occurred. As the sun warmed the surface water up to 39° F, the 39° F water began to sink to the bottom since the maximum density (weight per unit volume) of water peaks at 39° F. Water that was cooler than 39° F (lighter) began to rise. A great deal of mixing occurred at this time, until the temperatures at the top and bottom were the same. During this turnover, some of the decomposed matter and nutrients on the bottom were resuspended. A similar phenomenon occurs in the fall as 39° F water sinks as the surface water is cooled and is replaced by warmer (lighter) water.

During June, July and August, temperatures adjust to the season. The sun keeps the water nearest the surface warm, while the bottom is somewhat cooler. The DO levels remain higher near the surface due to wave action and photosynthesis. Summer stratification appears to take place in both Bass Lake and Middle Lake. Stratification occurs in most lakes greater than 20 feet, a metalimnion layer exists between the warm surface water layer (epilimnion) and the cooler bottom layer (hypolimnion) and prevents complete mixing.

Temperature and DO levels measured in Bass Lake and Middle Lake in February indicate DO readings greater than 2 mg/l in the upper 20 feet. In shallow lakes, oxygen depletion (winterkill) occurs when plant and animal material decay use up available oxygen. Winterkill of fish can occur when the DO levels fall much below 1 to 2 mg/l (Ref. #10). No winterkill can be expected in either Bass Lake or Middle Lake due to their depths.

### **2.2.5. Water Quality Assessment – Bass Lake**

Overall water quality of Bass Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (8 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (41:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (1.02 ug/l), indicating a relatively small amount of algae growth.

- Color, Turbidity and Secchi depths (16 - 24 feet) indicate very good water clarity.
- pH levels ranged from 7.8 (April) to 8.5 (June). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a and water clarity, Bass Lake is considered an Oligotrophic Lake (a lake with low nutrient levels).

### **2.2.6. Water Quality Assessment – Middle Lake**

Overall water quality of Middle Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (9 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (44:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (1.2 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (15 - 23 feet) indicate good water clarity.
- pH levels ranged from 7.7 (April) to 8.6 (June). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a and water clarity, Middle Lake is considered a Oligotrophic Lake (a lake with low nutrient levels).

## **2.3. Aquatic Plant Survey Information**

### **2.3.1. Methods of Testing**

A limited aquatic plant (macrophyte) survey was conducted by boat in September of 1999. A limited aquatic plant survey, instead of a complete aquatic plant survey, was conducted because neither Bass Lake nor Middle Lake appeared to have a problem with aquatic plant abundance. Aquatic plants in Bass Lake and Middle Lake were expected and found to be similar to those found in North Lake and West Lake because the lakes are adjoining. In-depth aquatic plant survey information is available from previous lake studies on North Lake and West Lake on the Spread Eagle Chain of Lakes. Aquatic plants were pulled up with a garden rake in the shallow areas of Bass Lake and Middle Lake. No plants were found to exist below 16' - 20' depth. All plants were found in the littoral zone (zone of light penetration).

### **2.3.2. Results of the Aquatic Plant Survey**

Both Bass Lake and Middle Lake had very few aquatic plants compared to West Lake. This is primarily due to the lack of shallow areas along both lakes. The places where aquatic plants were primarily located were in quiet bays on the leeward side of the lakes and in shallow areas where the water depth was less than 16 feet.

During the limited aquatic plant survey conducted in September of 1999 on Bass Lake and Middle Lake, eleven different species of aquatic plants were identified. The plant species found on Bass Lake were

- Chara
- Northern Water Milfoil
- Water Celery
- Illinois Pondweed
- Leafy Pondweed
- Common Waterweed
- Coontail
- White Water Lily
- Floating-Leaf Pondweed
- Smartweed

The plant species found on Middle Lake were

- Chara
- Northern Water Milfoil
- Water Celery
- Illinois Pondweed
- Common Waterweed
- Coontail
- Bulrush

For complete details on aquatic plants refer to "Guide to Wisconsin Aquatic Plants" (Ref. #11), provided in Appendix "G."

The most prominent aquatic plant found on Bass Lake and Middle Lake appeared to be Chara. Even though Chara looks like a plant, it is actually a type of algae. Chara grows entirely below the water surface. It covers a large portion of the lake bottom. Chara has stem-like branches with forked leaves. It has a hollow stem, rough-textured leaves and smells similar to musk when crushed. Chara provides cover for fish and supports insects that provide food for fish and waterfowl (Ref. #11). See Appendix "G" - Guide to Wisconsin Aquatic Plants for a pictorial representation of Chara.

## Plant Identification on Bass Lake and Middle Lake

| <u>TAXA</u><br>Common Name   | <u>TAXA</u><br>(Scientific Name)  |
|------------------------------|-----------------------------------|
| Chara .....                  | (Characeae spp.)                  |
| Northern Water Milfoil ..... | ( <i>Myriophyllum sibiricum</i> ) |
| Water Celery .....           | ( <i>Vallisneria americana</i> )  |
| Illinois Pondweed .....      | ( <i>Potamogeton illoensis</i> )  |
| Leafy Pondweed .....         | ( <i>Potamogeton robbinsii</i> )  |
| Common Waterweed .....       | ( <i>Elodea canadensis</i> )      |
| Coontail .....               | ( <i>Ceratophyllum demersum</i> ) |
| White Water Lily .....       | ( <i>Nymphaea odorata</i> )       |
| Floating-Leaf Pondweed ..... | ( <i>Potamogeton natans</i> )     |
| Bulrush .....                | ( <i>Scirpus validus</i> )        |
| Smartweed .....              | ( <i>Polygonum amphibium</i> )    |

No exotic (foreign) plant species were found during the aquatic plant survey of Bass Lake and Middle Lake.

### 2.4. Fish Species Information

The Spread Eagle Chain of Lakes has been shown to support the natural reproduction of a number of pan and game fish species. Electrofishing surveys were conducted by the WDNR on the Spread Eagle Chain of Lakes in September of 1993, September of 1994, and October 1998. A fyke net survey was also conducted in April 1998. The results of the fish evaluation surveys indicate that the Spread Eagle Chain supports a dynamic and diverse fishery. The surveys showed that the Spread Eagle Chain of Lakes is fairly consistent throughout, with minor variations.

Based on the results of the most recent electrofishing and fyke net surveys, walleye, largemouth bass, northern pike, and smallmouth bass were the main predator fish found in the Spread Eagle Chain of Lakes. A total of 285 walleye, 163 largemouth bass, 126 northern pike and 119 smallmouth bass were captured in the 1998 fish evaluation surveys (Ref. #19).

Bluegill were the dominant panfish species present followed by rock bass, black crappie and yellow perch. Other species encountered in the surveys included white sucker, pumpkinseed, and hybrid sunfish (Ref. #19).

The following table indicates the size variations of the major species captured during the 1998 fyke net survey:

**1998 WDNR Fyke Net Survey – Spread Eagle Chain of Lakes**

| Species         | Length Range (Inches) | Average Length (Inches) | Comments            |
|-----------------|-----------------------|-------------------------|---------------------|
| Walleye         | 7.0 – 28.9            | 15.9                    | 50% over 15"        |
| Largemouth Bass | 3.5 – 20.9            | 12.5                    | 10% over legal size |
| Northern Pike   | 10.0 – 32.4           | 19.7                    | 51% over 20"        |
| Smallmouth Bass | 3.0 – 19.9            | 12.0                    | 8% over legal size  |
| Bluegill        | 2.8 – 9.3             | 5.9                     | 23% over 7"         |
| Rockbass        | 2.7 – 9.0             | 6.3                     |                     |
| Black Crappie   | 3.8 – 11.2            | 8.4                     |                     |
| Yellow Perch    | 2.8 – 11.8            | 9.3                     |                     |

Natural reproduction of all the major species present was observed. Overall, growth rates were found to be at or above the statewide average.

The results of fish evaluation surveys conducted by the WDNR in 1993, 1994, and 1998 are included in Appendix "I."

Available information on the fish species identified during the fish evaluation survey is included in Appendix "H." The information includes identification, distribution, habits, habitat, life cycles, fishing hints and environmental concerns for each of these species.

The spawning and nursery locations of fish on Bass Lake and Middle Lake are shown on Figure No. 4, located in Appendix "A" (Ref. #14). The following fish species use Bass Lake and Middle Lake as a spawning location:

- Bass
- Crappie
- Walleye
- Northern
- Bluegill

## 2.5. Watershed

The watershed area of the Spread Eagle Chain of Lakes consists of approximately 3,200 acres located primarily to the northwest of the Spread Eagle Chain of Lakes. Runoff from the watershed of Montgomery Lake flows down Montgomery Creek to West Lake. The watershed consists predominantly of forest and wetlands with a scattering of residential development. Figure No. 5 - Watershed Area of the Spread Eagle Chain of Lakes, included in Appendix "A," shows the watershed area and surface runoff patterns in the watershed.

Approximately 450 acres of wetland make up part of the Spread Eagle Chain of Lake's watershed area. Wetland locations are shown in Figure No. 6, included in Appendix "A." Much of the wetland area is located to the northwest of the Spread Eagle Chain of Lakes along Montgomery Creek and the tributaries to Montgomery Creek.

The estimated Phosphorus loading of the watershed is approximately 250 lb/year for a dry year, 617 lb/year for a normal year, and 1,580 lb/year for a wet year. These results are based on values obtained using the WDNR Wisconsin Lake Model Spreadsheet (WILMS version 1.01) and the input of watershed data for the Spread Eagle Chain of Lakes Watershed (see Appendix "I" for the printout of the WILMS spreadsheet). The results obtained reflect the low nutrient loading from forested watersheds. If the Spread Eagle Chain of Lakes was located in Dane County, for example, where the watershed contains a higher amount of nutrients and the land is primarily agricultural, the phosphorus loading would be of approximately 522 lb/year for a dry year, 2,140 lb/year for a normal year and 6,350 lb/year for a wet year.

The inlet to West Lake was tested twice in June of 1996 for Phosphorus content. Total Phosphorus content was also low (11.5 ug/l), confirming the watershed is supplying a low amount of phosphorus to the Spread Eagle Chain of Lakes.

The drainage basin/lake area ratio (DB:LA) of the Spread Eagle Chain of Lakes is approximately 5.8:1. This is based on a watershed (drainage basin) area of 3,200 acres and a lake area of 548 acres. The Spread Eagle Chain of Lakes has a low DB:LA ratio which is generally an indicator of low phosphorus loading.

Figures No. 2 & 3 - Lake Survey Maps of the Spread Eagle Chain of Lakes, included in Appendix "A," indicate areas of steep slopes around the lakes.

## **2.6. Lake Usage Impact**

The purpose of this section is to evaluate the current usage of Bass Lake and Middle Lake and its resulting environmental impact on the lake.

### **2.6.1. Fishing**

Fishing on Bass Lake and Middle Lake has had no significant ecological impact. The Bass Lake and Middle Lake fishery is in excellent condition with no appreciable reduction in the fish population due to overfishing. The overall size of some game fish may have been reduced by fishing, but a healthy population exists of significant size.

### **2.6.2. Motorized Boating**

The use of motorized boats on Bass Lake and Middle Lake has had some impact on the lakes. The use of motorized boats has shifted sediment in the lakes. The sediment shift due to boat traffic is generally only in the shallow areas of the lakes. Plants growing in the bays are generally coated with sediment throughout the summer months. It is unknown how much effect this has on aquatic plant growth or fish reproduction in the bays. Increased sediment concentration in the water does decrease the amount of sunlight available for photosynthesis. When boats resuspend sediment, they also resuspend nutrients normally unavailable for use by aquatic plants. Sediment resuspension by boats is generally limited to water depths 10 to 15 feet below the surface. The greater the horsepower, the larger the particles that can be resuspended as well as the greater the depth affected. The frequency of boat traffic also increases the settling time of sediment (Ref. #15).

Boat traffic also increases shoreline erosion. How much shoreline erosion has taken place on Bass Lake and Middle Lake due to boat traffic is unknown since no baseline points have been established along the shore for that purpose. Shoreline which does not have aquatic plants nearby to help dampen the wave action, or shoreline devoid of rooted vegetation or rip-rap are the most vulnerable to erosion.

Personal watercraft (Jet Skis) have had no greater effect on Bass Lake and Middle Lake than other motorized boat traffic. Personal watercraft are more obvious than conventional boats due to the type of noise they produce and their ability to turn tight circles and operate closer to shore. Their affect on the environment, however, is no different than that of a conventional boat. The operation and subsequent safety concerns of personal watercraft is not within the scope of this report.

### **2.6.3. Shoreline Development**

Shoreline development on both Bass Lake and Middle Lake has reduced some areas once available to wildlife. The areas along the shoreline that once provided a source of food, shelter and breeding for a number of birds and mammals have been reduced.

Approximately 30% of the area within 100' of the Bass Lake shoreline and approximately 33% of the Middle Lake shoreline is now without tree cover. Leaving a natural buffer area of trees and shrubs near shore provides wildlife habitat and reduces the chances of soil erosion and the addition of nutrients into the lake.

Associated with shoreline development is increased motorized boat traffic. As noted in Section 2.6.2 - Motorized Boating, boats will resuspend sediment near shore causing the addition of nutrients available to plants in the water, increasing plant growth. Conversely, aquatic plants are also removed by boats in the traffic area. The removal of plants reduces the dampening effect they have to wave action, making shoreline erosion a greater possibility when boats enter or leave.

With each house built along shore is a septic system. The effect of the septic systems on Bass Lake and Middle Lake does not appear to be significant. Water quality analytical results do not indicate excessive levels of nutrients entering the water from septic systems.

## **2.7. Bass Island**

The purpose of this section is to evaluate the use and condition of Bass Island and to present the Bass Island Management Plan.

### **2.7.1. Use and Condition of Bass Island**

Bass Island, also known as Bacco Island, is a 0.6 acre island located in Bass Lake on the Spread Eagle Chain of Lakes. Bass Island is one of two State owned islands on the Spread Eagle Chain of Lakes. The other State owned island is Paradise Island located in East Lake. The location of Bass Island is shown on Figure No. 4 – Spawning & Nursery Locations, included in Appendix A.

Bass Island has a rich cultural and recreational use history beginning with a resort in the late 1800's as noted in Section 1.2 – History. The Island was leased from the State of Wisconsin by the Bacco family for many years until 1975 when the lease expired and the Wisconsin Department of Natural Resources entered into a maintenance agreement with the Town of Florence.

Many of the original facilities installed by the Bacco family were still located on the Island in 1999. There were one 110' x 50' concrete tennis court with fence, one basketball hoop, one 10' x 12' storage shed, two shuffle board courts, and two lattice cabanas located at the ends of the shuffle board courts. Much of the facilities were in a state of

1999 Photos of the Island facilities are shown in Appendix “B” – Photographic Documentation. No docking facilities existed on the Island.

Near the shore of the southwest corner of the Island, a concrete foundation can still be found.

A great deal of erosion has taken place on the north and south sides of the Island. Possibly as much as six to eight feet of shoreline has eroded in places. See Appendix “B” – Photographic Documentation. Logs were installed in places along the shoreline many years ago to curb erosion around the Island. Many of these logs are now completely exposed. The shoreline has been eroded behind them.

### **2.7.2. Bass Island Management Plan**

During 1999, the Island Restoration Committee, chaired by Ken Sovey, studied the use, condition, and maintenance of the island. On December 3, 1999, the Town of Florence entered into a land use agreement with the Wisconsin Department of Natural Resources for the purpose of implementing a management plan for Bass Island. The management plan is a partnership agreement between the Wisconsin Department of Natural Resources (WDNR), the Town of Florence and the Spread Eagle Chain of Lakes Association. The management plan guides the recreational use, types of improvements, restoration, and educational initiatives that will occur on the island through the year 2009. All projects covered in the new management plan are to be completed by July 1, 2003. A copy of the Land Use Agreement and the Bass Island Management Plan are located in Appendix “F” – Agreements and Plans.

The goals for the new management plan are as follows:

- Island Protection
- Restoration
- Structures
- Recreation
- Education
- Cultural History
- Access
- Maintenance

#### **2.7.2.1 Island Protection**

The shoreline on Bass Island has eroded measurably. Under the Island Protection goal of the management plan, WDNR staff and the Florence County Zoning Department will develop a protection strategy for the shoreline. The protection will most likely be a “soft” protection, such as wood buffering and shoreline plantings rather than “hard” protection, such as rip-rap. The WDNR will supervise and fund this protection. The Wisconsin Conservation Corp will implement the protection plan.

### **2.7.2.2 Restoration**

The east one-half of the island will be replanted to native grasses, shrubs, and trees. The WDNR staff, in coordination with the Florence County Zoning Department, is to develop the planting plan. The WDNR will supervise and fund the project. The Wisconsin Conservation Corp will implement the project.

Restoration needs for nearshore fish habitats will be assessed by a WDNR Fish Biologist. The WDNR will supervise and fund the project. The Wisconsin Conservation Corp will implement the project.

### **2.7.2.3 Structures**

Since the use of the existing structures on Bass Island is low, many of these structures will be removed.

The tennis court fencing and poles will be removed. A portion of the tennis court concrete will be removed. The final size of the concrete slab that will remain will be that necessary to accommodate an open air picnic shelter and a fishing site for visitors with disabilities.

The storage shed, two lattice cabanas, and the two shuffle board courts will be removed.  
\*Work completed in 2000.

The following structures will be constructed or added to the site:

- Roof only open air picnic shelter
- Two picnic shelters
- One set of horseshoe pits at the existing shuffle board location
- One 10' x 10' sandbox with cover
- Boat dock courtesy pier
- Electrically powered decomposing toilet

No garbage collection receptacles will be provided on the island. Island users will be responsible for their own refuse.

### **2.7.2.4 Recreation**

One set of horseshoe pits and a sandbox will be available. These facilities will be assessed for removal if sustained use is not evident. Users of the horseshoe pits will provide their own shoes. There is no formal plan to accommodate swimming at the island. Use of the island will be allowed from sunrise to sunset.

### **2.7.2.5 Education**

Education will be provided through interpretive signage. It will explain the native species plantings, shoreline protection strategy, and the near shore fisheries habitat work. The courtesy dock will also include design specifications and interpretation. The WDNR will supervise and fund the project. The Wisconsin Conservation Corp will implement the project.

### **2.7.2.6 Cultural History**

Interpretive signs along with historical photos and text will be located on the island. The WDNR will work with the Spread Eagle Chain of Lakes Association to develop this. The WDNR will supervise this project. Funding will come from donations. The Wisconsin Conservation Corp will implement the project.

### **2.7.2.7 Access**

The island will be ADA accessible. The dock, open air picnic shelter, and interpretive sites will meet these requirements. The southeast corner of the concrete slab left in place from the tennis court will allow for an accessible fishing platform.

### **2.7.2.8 Maintenance**

Periodic maintenance of the new structures to be constructed on the island will be the responsibility of the Town of Florence per land use agreement requirements. Lawn mowing and the frequency of mowing on the south half of the island around the day use area will be the responsibility of the Spread Eagle Chain of Lakes Association. Removal of litter will be the responsibility of the island users. No formal system for refuse disposal is planned for the island. Occasional refuse removal will be needed. This will be a cooperative effort between the Town of Florence and the Spread Eagle Chain of Lakes Association. WDNR personnel will inspect the island two times per summer season to evaluate maintenance agreement standards.

### **3.0. CONCLUSIONS**

The following section contains the conclusions drawn from the information collected during the study of Bass Lake and Middle Lake.

#### **3.1. Property Owner Survey**

Based on the results of the survey, the following were indicated:

- The grant committee should continue to promote the Skier Down Program with an emphasis on education of all those using the Spread Eagle Chain of Lakes.
- The grant committee should look at additional education of all those using the Spread Eagle Chain of Lakes regarding the Wisconsin Department of Natural Resources' slow no wake ruling for PWCs.
- The grant committee should not pursue improving the channel into East Lake.
- The grant committee should not pursue improving the channel into South Lake.

#### **3.2. Water Quality**

##### **3.2.1. Water Quality Assessment – Bass Lake**

Overall water quality of Bass Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (8 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (41:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (1.02 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (16 - 24 feet) indicate very good water clarity.
- pH levels ranged from 7.8 (April) to 8.5 (June). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a and water clarity, Bass Lake is considered a Oligotrophic Lake (a lake with low nutrient levels).

### 3.2.2. Water Quality Assessment – Middle Lake

Overall water quality of Middle Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (9 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (44:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (1.2 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (15 - 23 feet) indicate good water clarity.
- pH levels ranged from 7.7 (April) to 8.6 (June). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a and water clarity, Middle Lake is considered a Oligotrophic Lake (a lake with low nutrient levels).

### 3.3. Aquatic Plant Survey

During the limited aquatic plant survey conducted in September of 1999 on Bass Lake and Middle Lake, eleven different species of aquatic plants were identified. The plant species found on Bass Lake were

- Chara
- Northern Water Milfoil
- Water Celery
- Illinois Pondweed
- Leafy Pondweed
- Common Waterweed
- Coontail
- White Water Lily
- Floating-Leaf Pondweed
- Smartweed

The plant species found on Middle Lake were

- Chara
- Northern Water Milfoil
- Water Celery
- Illinois Pondweed
- Common Waterweed
- Coontail
- Bulrush

No exotic species of aquatic plants were found in the aquatic plant survey of the lakes.

Bass Lake and Middle Lake have a well-balanced population of desirable aquatic plants. Overall, there are enough plants to provide cover, food and spawning locations for fish. Both Bass Lake and Middle Lake are deep lakes so there are few areas that are clogged with plants that would make boat travel and other recreation activities difficult.

#### **3.4. Fish Species**

Fish evaluation surveys were conducted on the Spread Eagle Chain of Lakes in 1993, 1994, and 1998. The results indicate that the Spread Eagle Chain supports a dynamic and diverse fishery. The surveys showed that the Spread Eagle Chain of Lakes is fairly consistent throughout, with minor variations. Natural reproduction of all the major species present was observed. Overall, growth rates were found to be at or above the statewide average.

The Spread Eagle Chain of Lakes supports natural reproduction of a number of pan and game fish species. The fish found during the most recent fish evaluation surveys include

- Largemouth Bass
- Smallmouth Bass
- Walleye
- Northern
- Bluegill
- Rockbass
- Yellow Perch
- Black Crappie
- White Sucker
- Pumpkinseed
- Hybrid Sunfish

The following fish species use Bass Lake and Middle Lake as a spawning location:

- Largemouth Bass
- Smallmouth Bass
- Walleye
- Northern
- Bluegill
- Rockbass
- Black Crappie

### **3.5. Watershed**

The watershed area of the Spread Eagle Chain of Lakes consists of approximately 3,200 acres located primarily to the northwest of the Spread Eagle Chain of Lakes. Runoff from the watershed of Montgomery Lake flows down Montgomery Creek to West Lake. The watershed is predominantly forest and wetland with a scattering of residential development.

Since the watershed is predominantly forest and wetland, its runoff is low in nutrients.

### **3.6. Lake Usage Impact**

There have been no significant impacts on the ecosystem of Bass Lake and Middle Lake due to lake usage. Sediment shifts due to boat traffic and decreased wildlife habitat (due to shoreline development) are the main impacts related to the usage of Bass Lake and Middle Lake.

### **3.7. Bass Island**

Bass Island was suffering from erosion of the shoreline and degradation and disrepair of structures on the Island.

During 1999, the Island Restoration Committee, chaired by Ken Sovey, studied the use, condition, and maintenance of the island. On December 3, 1999, the Town of Florence entered into a land use agreement with the Wisconsin Department of Natural Resources for the purpose of implementing a management plan for Bass Island. The management plan is a partnership agreement between the Wisconsin Department of Natural Resources (WDNR), the Town of Florence and the Spread Eagle Chain of Lakes Association.

The management plan guides the recreational use, types of improvements, restoration, and educational initiatives that will occur on the island through the year 2009. All projects covered in the new management plan are to be completed by July 1, 2003. The management plan includes provisions for the following:

- Island Protection
- Restoration
- Structures
- Recreation
- Education
- Cultural History
- Access
- Maintenance

## **4.0. RECOMMENDATIONS**

The following section contains recommendations on water quality, aquatic plant management, fish management, watershed practices, and lake usage.

### **4.1. Water Quality Recommendations**

The water quality of Bass Lake and Middle Lake is very good as compared to other Wisconsin Lakes. Continued sound ecological practices by residents are necessary to maintain or improve water quality. Education and involvement of property owners should be promoted.

Mailers can be sent to property owners informing them of sound ecological practices which include the following:

- Have your septic system checked by a qualified individual.
- Have your septic tank pumped every three to five years.
- Keep an undisturbed buffer zone of natural trees and plants between the lake and your dwelling.
- Avoid using chemical fertilizers, if you choose to have a lawn.
- Don't dump leaves or grass clippings in the lake.

It is important that the Spread Eagle Association continues to monitor the water quality of Bass Lake and Middle Lake. Adverse lake trends can be identified and corrected before irreversible damage to the lake has occurred.

### **4.2. Aquatic Plant Management Recommendations**

Bass Lake and Middle Lake have a well-balanced quantity of aquatic plants necessary for a healthy ecosystem. Aquatic plants that hinder boat access to docks can be removed by small scale cutting or pulling. Large-scale removal of aquatic plants or the use of chemicals to kill aquatic plants is not recommended. Large-scale removal of native aquatic plants will only provide areas for exotic plants to move in if they are once introduced.

#### **4.3. Fish Management Recommendations**

The Spread Eagle Chain of Lakes supports an excellent fishery. It has been shown to support the natural reproduction of a number of pan and game fish species. Overall, growth rates were found to be at or above the statewide average.

Walleye are being lightly stocked in the Spread Eagle Chain of Lakes with the addition of approximately 3,000 to 5,000 fingerlings every couple of years. It is not recommended at this time to increase fish stocking, but rather to maintain stocking at its present level to maintain the predator/prey balance. If walleye stocking were increased dramatically, they would be in competition with bass and thereby reduce their numbers. Only walleye and northern would be left if this were to occur. This may be good for the avid fisherman, but for kids and the average fisherman it would not, since bass are fish everyone can have fun catching.

The addition of fish cribs on the Spread Eagle Chain of Lakes should be continued. The cribs provide a beneficial habitat in which fish can thrive.

If the Spread Eagle Lake Association has any questions on stocking fish, Russ Heiser of the WDNR - Peshtigo office is able to assist them in making fish management decisions. After June of 2001, Robert Young at the WDNR - Woodruff office will be handling fish management for the Spread Eagle Chain of Lakes. This change is being made as part of the WDNR restructuring.

#### **4.4. Watershed Recommendations**

The water quality of Bass Lake and Middle Lake is very good. Continued sound ecological practices of residents within the watershed are necessary to maintain or improve water quality. Education and involvement of property owners should be promoted as is recommended in Section 4.1 - Water Quality Recommendations.

#### **4.5. Lake Usage Recommendations**

Since the use of boats on the lakes is not going to decrease in the foreseeable future, it is best to protect the shoreline as much as possible. Keep aquatic plants growing near shore and rooted plants on shore to minimize shoreline erosion. In areas where shoreline erosion develops, it is recommended that the owners secure a permit to install rock rip-rap or soft protection near the shoreline. Leave a natural buffer area of trees and shrubs near shore to provide a wildlife habitat as well as to reduce the chances of soil erosion and filter nutrients that could enter the lake.

To obtain information about a permit to install rip-rap or soft shoreline protection, contact Liesa Nesta, Water Regulation and Zoning Specialist at the WDNR Woodruff Office.

#### **4.6. Bass Island Recommendations**

In 1999, the Wisconsin Department of Natural Resources and the Town of Florence entered into a land use agreement for the purpose of implementing a management plan for Bass Island. The management plan includes provisions for the following:

- Island Protection
- Restoration
- Structures
- Recreation
- Education
- Cultural History
- Access
- Maintenance

This study concurs with the goals of this management plan and no further recommendations regarding Bass Island are necessary.

## **5.0. SUMMARY OF RECOMMENDATIONS**

The following is a summary of recommendations provided to improve the ecosystem of Bass Lake and Middle Lake:

- The Spread Eagle Lake Association should continue to monitor the water quality of Bass Lake and Middle Lake. Adverse lake trends can thereby be identified and corrected before irreversible damage to the lake has occurred.
- The Spread Eagle Lake Association should continue to educate and involve the of property owners in measures that can maintain and improve water quality on Bass Lake and Middle Lake. Maintaining good water quality will help minimize aquatic plant growth and minimize future sedimentation.
- The level of fish stocking in the Spread Eagle Chain of Lakes should be maintained, but not increased. The addition of fish cribs should be continued. The cribs provide habitat for fish to thrive.
- Measures should be taken to protect the shoreline from erosion due to boat traffic. Keep aquatic plants growing near shore and rooted plants on shore to minimize shoreline erosion. In areas of shoreline erosion, obtain a permit to install rock rip-rap or soft protection near the shoreline.
- In 1999, the Wisconsin Department of Natural Resources and the Town of Florence entered into a land use agreement for the purpose of implementing a management plan for Bass Island. This study concurs with the goals of this management plan and no further recommendations regarding Bass Island are necessary.

## **6.0. REPORT LIMITATIONS**

This document was developed and prepared as a limited investigation and evaluation subject to the constraints of cost and time. This document is not intended to represent a total, complete, exhaustive or extensive investigation and evaluation.

The report was performed with the degree of care and levels of skill and experience ordinarily used, under like or similar circumstances, by professional consultants practicing in this general locality and similar areas. No other warranty or guarantee, expressed, or implied, is made with respect to the findings, conclusions and professional advice and opinion included in this document.

The report contained in this document is based upon an observation of site conditions, information provided by the WDNR and investigation of historical and public records.

**7.0. USE OF DOCUMENT BY OTHERS**

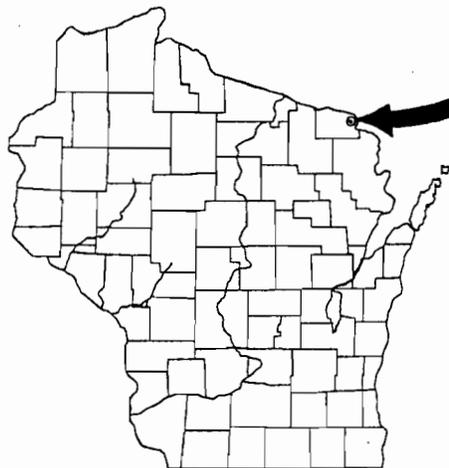
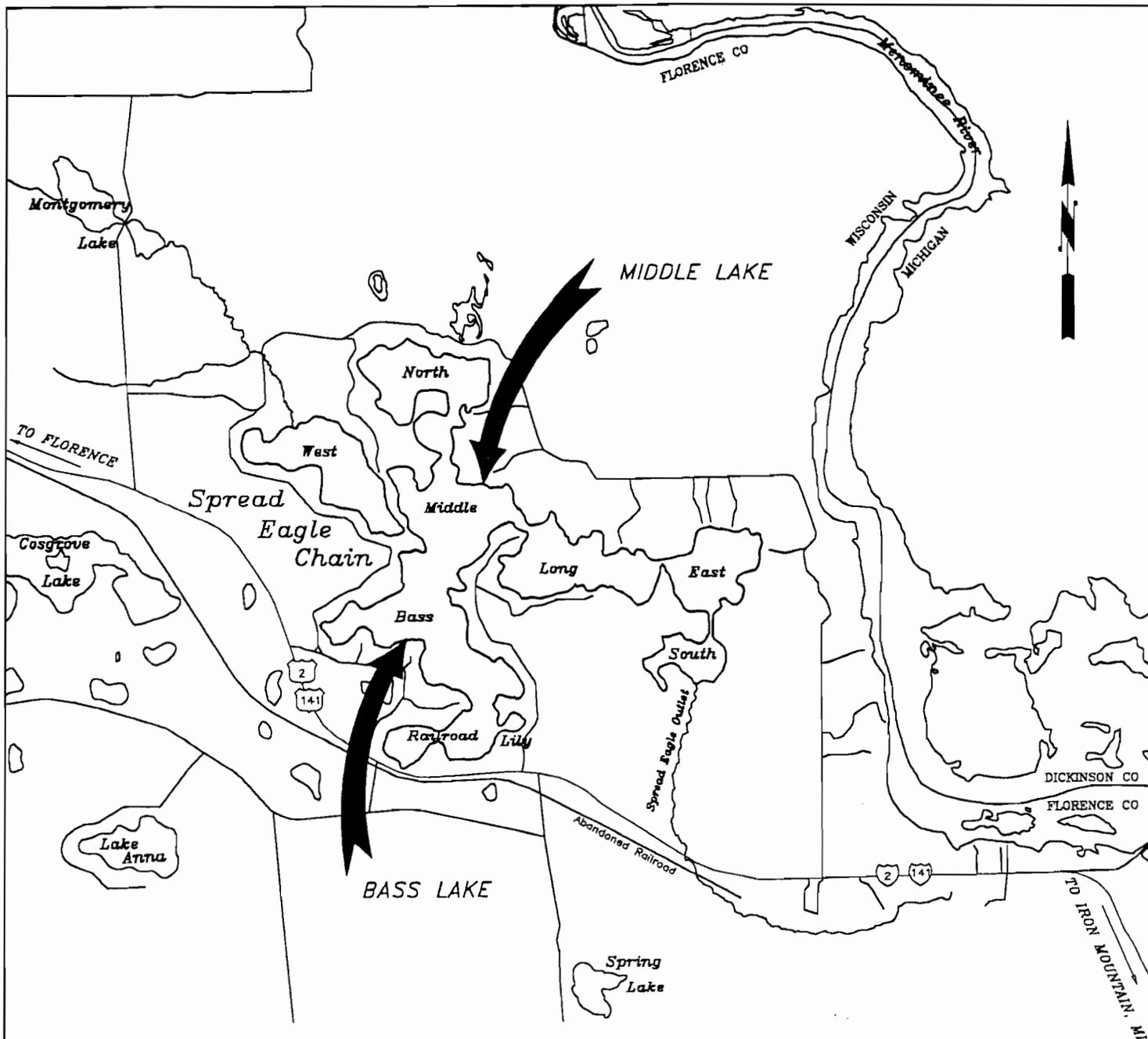
This document has been developed and prepared for a specific application, under specific limitations. This document, therefore, may not be used without the prior written approval of the authors, Bass Lake and Middle Lake Grant Committee and MMA, INC.

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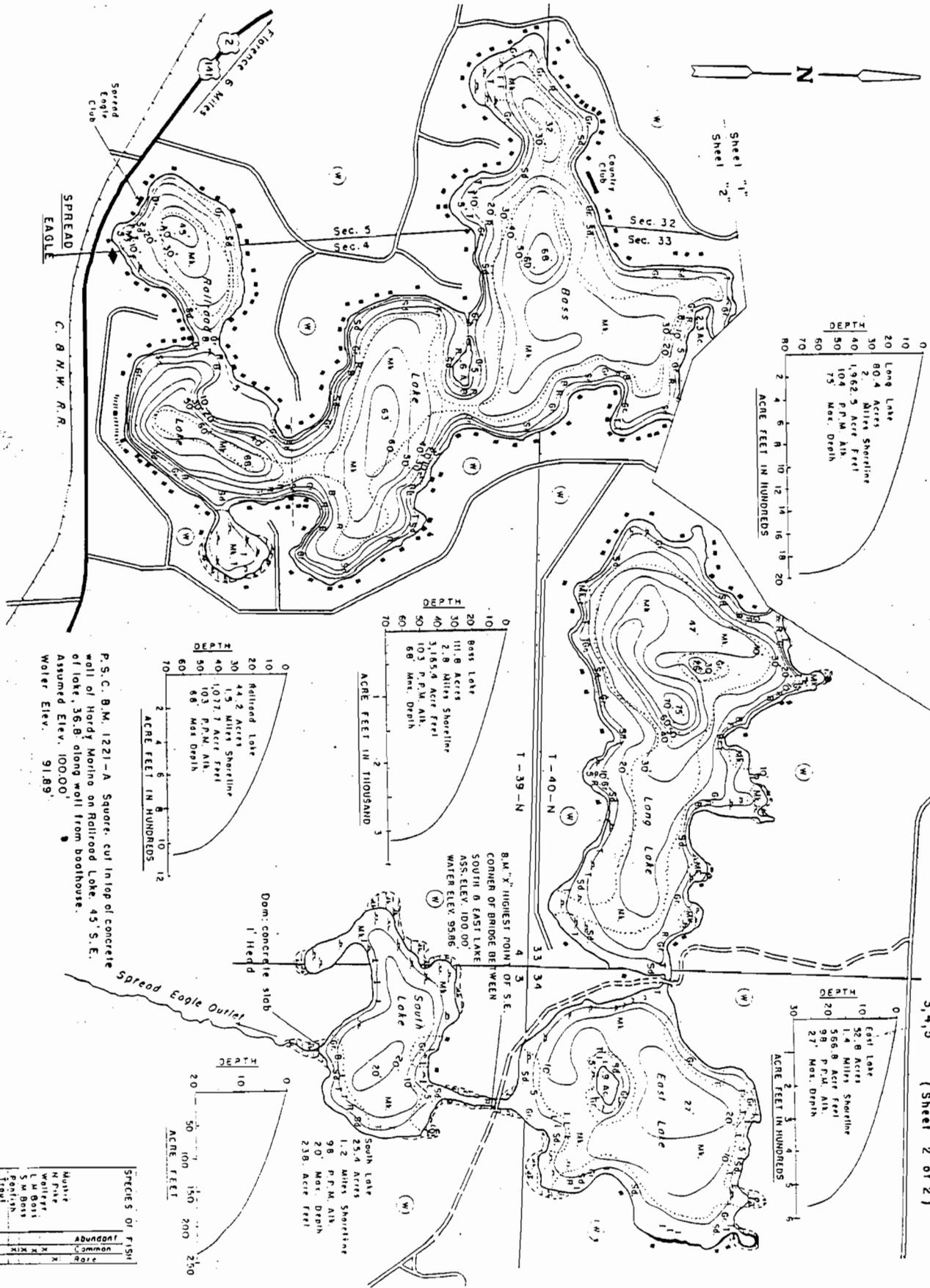
Note: The references are noted in the report by insertion of (Ref. #00) at the end of each passage pertaining to the particular reference used.



BASS LAKE AND MIDDLE LAKE  
 SPREAD EAGLE CHAIN OF LAKES  
 (FLORENCE COUNTY)

|  |                  |               |
|--|------------------|---------------|
| <b>LOCATION MAP</b>                                  |                  |               |
| <b>BASS LAKE AND MIDDLE LAKE</b>                     |                  |               |
| SCALE: 1"=3000'                                      | APPROVED BY:     | DRAWN BY: SMF |
| DATE: 11/9/00  |                  | REVISED:      |
| SPREAD EAGLE LAKE ASSOCIATION<br>Florence, Wisconsin |                  |               |
| MMA, INC. - Florence, WI                             | FIGURE NUMBER: 1 |               |





DEPTH

|    |                   |
|----|-------------------|
| 0  | Long Lake         |
| 10 | 20 Acres          |
| 20 | 80.4 Acres        |
| 30 | 2 Miles Shoreline |
| 40 | 1,962.5 Acft Feet |
| 50 | 104 P.F.M. Aft.   |
| 60 | 75 Mos. Depth     |
| 70 |                   |

ACRE FEET IN HUNDREDS

DEPTH

|    |                     |
|----|---------------------|
| 0  | East Lake           |
| 10 | 52.8 Acres          |
| 20 | 1.4 Miles Shoreline |
| 30 | 566.8 Acft Feet     |
| 40 | 98 P.F.M. Aft.      |
| 50 | 27 Mos. Depth       |

ACRE FEET IN HUNDREDS

ACRE FEET IN THOUSANDS

|    |                     |
|----|---------------------|
| 0  | Bass Lake           |
| 10 | 11.8 Acres          |
| 20 | 2.8 Miles Shoreline |
| 30 | 3,185.4 Acft Feet   |
| 40 | 103 P.F.M. Aft.     |
| 50 | 68 Mos. Depth       |

ACRE FEET IN HUNDREDS

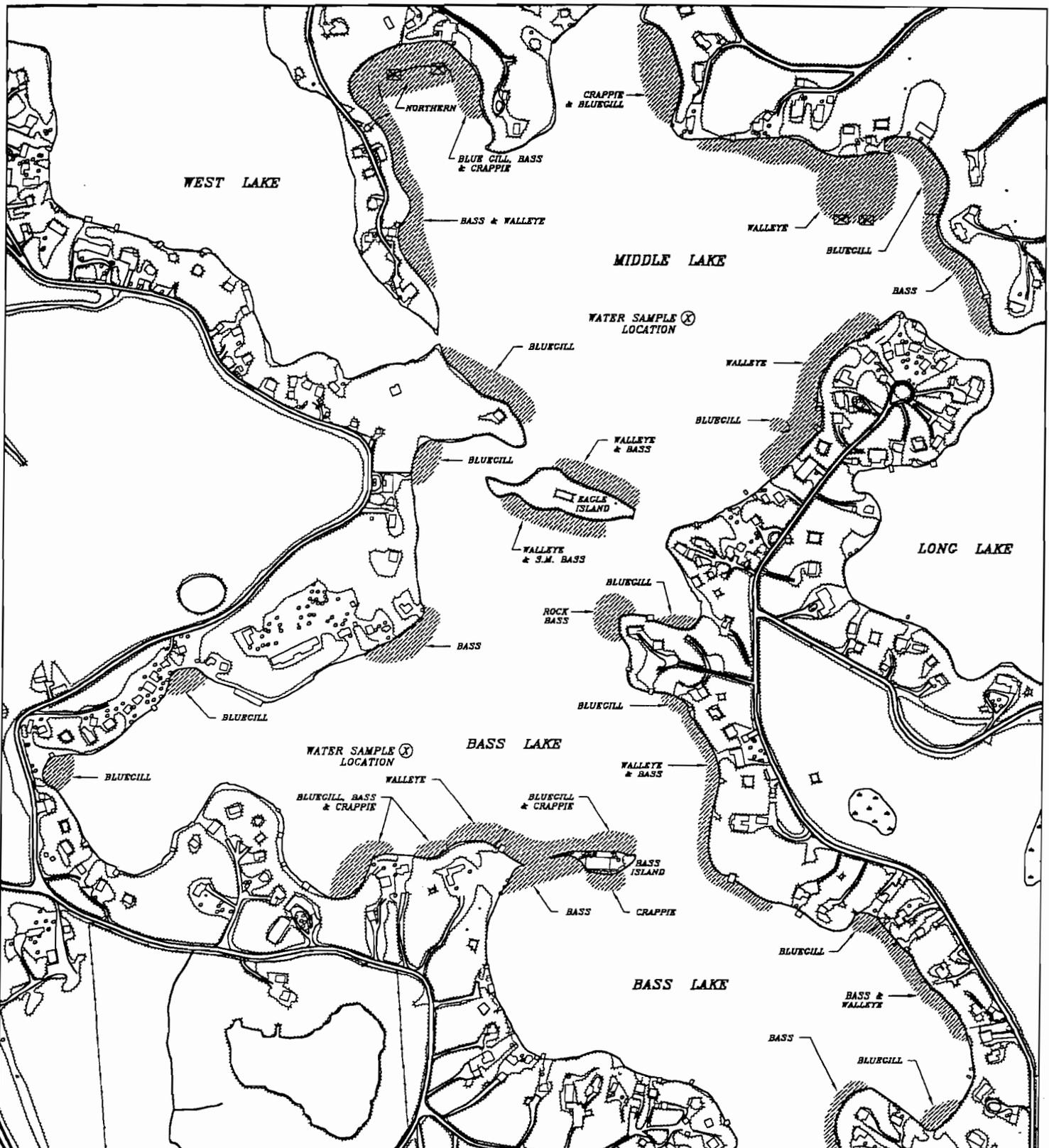
|    |                     |
|----|---------------------|
| 0  | Rolland Lake        |
| 10 | 4.2 Acres           |
| 20 | 1.5 Miles Shoreline |
| 30 | 1,077.7 Acft Feet   |
| 40 | 103 P.F.M. Aft.     |
| 50 | 88 Mos. Depth       |

P.S.C. B.M. 1221-A Square, cut in top of concrete wall of Hardy Marina on Rolland Lake, 45° S. E. of lake, 36.8' along well from boathouse. Assumed Elev. 100.00' Water Elev. 91.89'

- EQUIPMENT RECORDING SONAR MAPPED AUGUST 1966
- WATER ELEV. 91.89
- TOPOGRAPHIC SYMBOLS
- Brush
  - Perennially wooded
  - Clear
  - Pastured
  - Agricultural
  - Big Branch Area
- LAKE BOTTOM SYMBOLS
- Gravel
  - Sand
  - Clay
  - Submerged vegetation
  - Perennially flooded
  - Intermittent stream
  - Spring
  - Marsh
  - Strip slope
  - Indefinite shoreline

- SCALE
- 0 500' 1,000' 1,500' 2,000' 2,500'
- Access
- Boat Livery
- Species of Fish
- |          |                 |
|----------|-----------------|
| Abundant | Whitefish       |
| Common   | Walleye         |
| Common   | Yellow Perch    |
| Common   | Smallmouth Bass |
| Common   | Rock Bass       |
| Common   | Bluegill        |
| Common   | Trout           |
| Rare     | Brook Trout     |
- AREA 552.2 WITH ISLANDS  
548.4 ACRES
- UNDER 3 FT. 11 %  
OVER 20 FT. 40 %
- VOLUME 10,896 ACFT
- TOTAL ALK. 92-104 P.F.M.
- SHORELINE 14.8 MILES
- MAX DEPTH 75 FEET

Figure No. 3 - Lake Survey Map Sheet 2 of 2



**LEGEND**

-  FISH SPAWNING & NURSERY LOCATIONS
-  FISH CRIB LOCATIONS
-  SAMPLE LOCATIONS



**SPAWNING & NURSERY LOCATIONS**

|                |              |               |
|----------------|--------------|---------------|
| SCALE: 1"=600' | APPROVED BY: | DRAWN BY: SMF |
| DATE: 11/14/00 |              | REVISED:      |

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION  
Florence, Wisconsin

|                          |                  |
|--------------------------|------------------|
| MMA, INC. - Florence, WI | FIGURE NUMBER: 4 |
|--------------------------|------------------|

DIGITAL BASE MAP FILES USED WITH PERMISSION FROM THE FLORENCE UTILITY COMMISSION.



LEGEND

ARROWS INDICATE SURFACE RUNOFF PATTERNS  
AND WATER FLOW DIRECTION



**WATERSHED AREA OF THE  
SPREAD EAGLE CHAIN OF LAKES**

SCALE: 1"=4000'

APPROVED BY:

DRAWN BY: SMF

DATE: 11/27/00

REVISED:

**SPREAD EAGLE CHAIN OF LAKES ASSOCIATION**  
Florence, Wisconsin

MMA, INC. - Florence, WI

FIGURE NUMBER:

5



LEGEND

▲▲ WETLAND AREA



|  |                  |               |
|--|------------------|---------------|
| <b>WETLAND AREAS OF THE<br/>SPREAD EAGLE CHAIN WATERSHED</b>   |                  |               |
| SCALE: 1"=4000'  | APPROVED BY:     | DRAWN BY: SMF |
| DATE: 11/27/00   |                  | REVISED:      |
| SPREAD EAGLE CHAIN OF LAKES ASSOCIATION<br>Florence, Wisconsin |                  |               |
| MMA, INC. - Florence, WI                                       | FIGURE NUMBER: 6 |               |