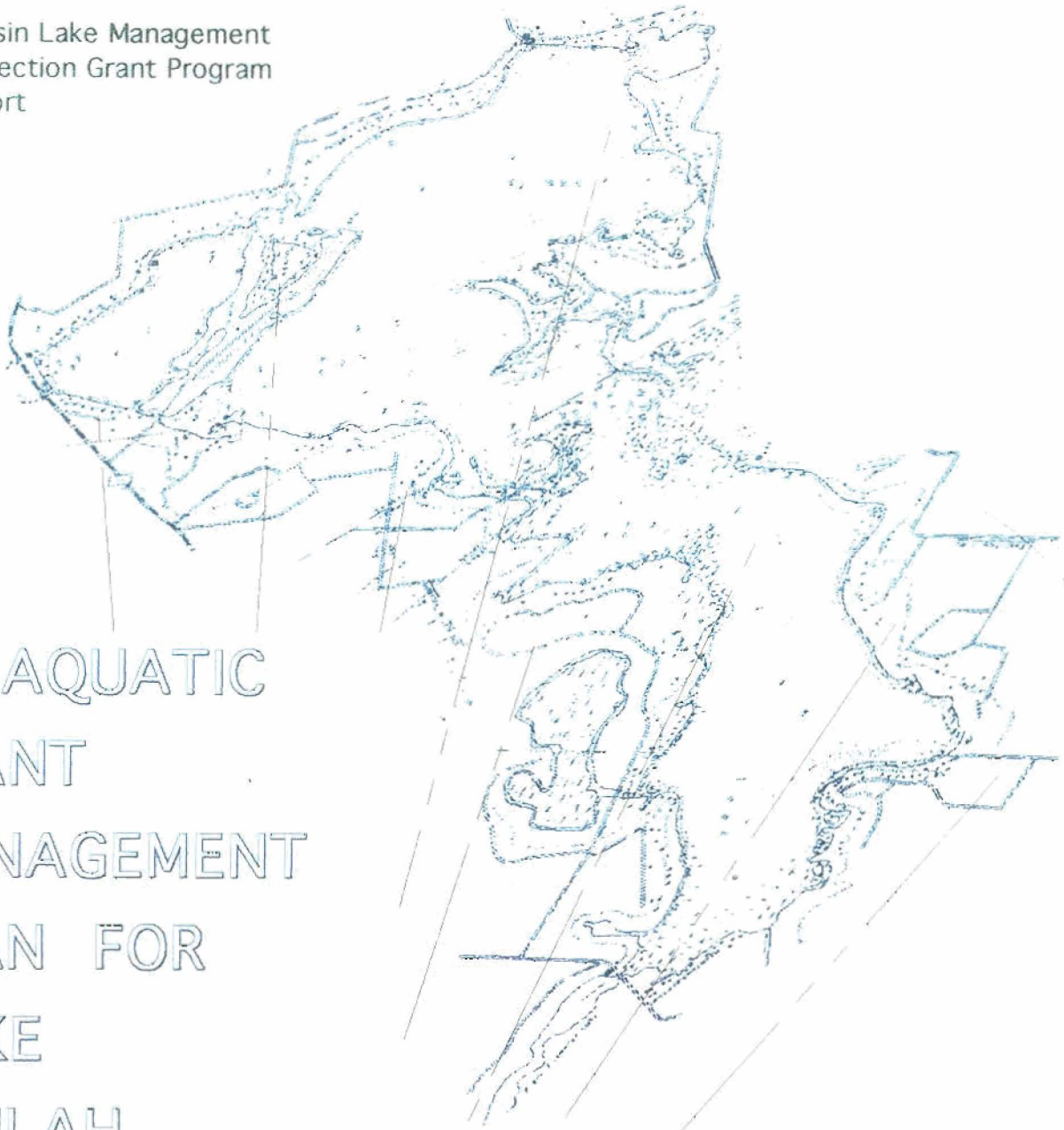
A Wisconsin Lake Management
Lake Protection Grant Program
Final Report



AN AQUATIC PLANT MANAGEMENT PLAN FOR LAKE BEULAH

Prepared for
The Lake Beulah
Management District
and
The Lake Beulah Protective
and Improvement Association
June, 1996
by
Lynn Carlson, Glenn Kreinbrink
and Phil Davis

PREFACE

The results presented in this report are intended to serve as a starting point for the development of a management plan for Lake Beulah. Much of the data included here can be updated to serve as a basis for future studies. Parts of this report will need to be expanded, while additional information will be required in other areas to develop a comprehensive lake management plan.

Funding for the project was provided by a grant from the Lake Protection Grant Program, administered by the Wisconsin Department of Natural Resources. The Lake Beulah Management District (formerly the Lake Beulah Sanitary District #1) and the Lake Beulah Protective and Improvement Association provided local funding for the project.

During the past several years a variety of plans, programs and efforts have been employed to eliminate or control the spread of undesirable exotic plants in Lake Beulah, particularly *Myriophyllium Spicatum,* Eurasian Water Milfoil. This report was prepared with two major purposes in mind. The first is to summarize the numerous efforts that have been used over the years to maintain the lake and to identify which approaches or procedures have provided the best results. The second purpose is to provide recommendations that can be used to maintain the health and beauty of our natural resource. Controlling the spread of various exotic invaders is just part of the solution, however. The development and maintenance of a healthy, diverse population of natural plants is an essential ingredient of any plan that is designed to protect and enhance the ecosystem of a lake. The recommendations are broad in scope and require the cooperation and teamwork of a number of organizations as well as individuals. The newly created Lake Beulah Management District, the Lake Beulah Protective and Improvement Association, the State of Wisconsin's Department of Natural Resources, the Town Board of East Troy, the citizens of East Troy, the riparian owners and anyone who uses the Lake all have an important role to play and should share a common goal to protect the Lake so that it can be kept as a valuable natural resource to be enjoyed by future generations. This report was written with the layman in mind. Technical materials and data were kept to a minimum. The sampling methods and resulting statistics derived from the field information are included as background for the recommendations presented. A sample of each plant found during the study period was dry mounted and placed in a protective plastic sheet protector. A color copy of each sample is included in the appendix of this report.

ACKNOWLEDGMENTS

Staff personnel from the Wisconsin Department of Natural Resources made themselves readily available for meetings, on site applications and for answering questions that came up during the field work and final preparation of the report. Dan Helsel and Bob Wakeman were especially helpful throughout the production of this report.

The management staff at Aquarius Systems Division of D & D Products, North Prairie, Wisconsin, namely, Jane Dauffenbach and Jack Dauffenbach, provided information about the variety of harvesting equipment available, examined our particular operations and suggested alternatives that would satisfy our needs. The support of Sanitary District #1 and the Lake Beulah Protective and Improvement Association was also very important in the development of this report.

A number of publications were reviewed and used as source material throughout the entire project. The primary sources are listed in the bibliography at the end of this report.

Members of the project team:

Lynn Carlson has a degree in Water Resources with an emphasis on limnology (aquatic biology). She was employed by the Marine Biochemist Corporation in Milwaukee for several years. Lynn is a lake resident and was just elected to the newly created Lake Beulah Management District.

Glenn Kreinbrink has a degree in Biology and teaches in the Elkhorn Public School System. He was in charge of the weed harvesting operation on Lake Beulah for several years. He was on the Lake Beulah Protective and Improvement Association for nine years. Glenn continues to provide data to the Department of Natural Resources regarding water clarity, water temperature, oxygen content and other pertinent information for the DNR

Phil Davis has an MA degree in Economics with emphasis on statistical analysis. He is retired from Ameritech and has experience in producing monthly economic reports, charts and summaries of economic data, and the preparation of an economic journal. He has been on the Board of the Lake Beulah Protective and Improvement Association for six years and has participated in several of the studies related to controlling the spread of Eurasian Water Milfoil.

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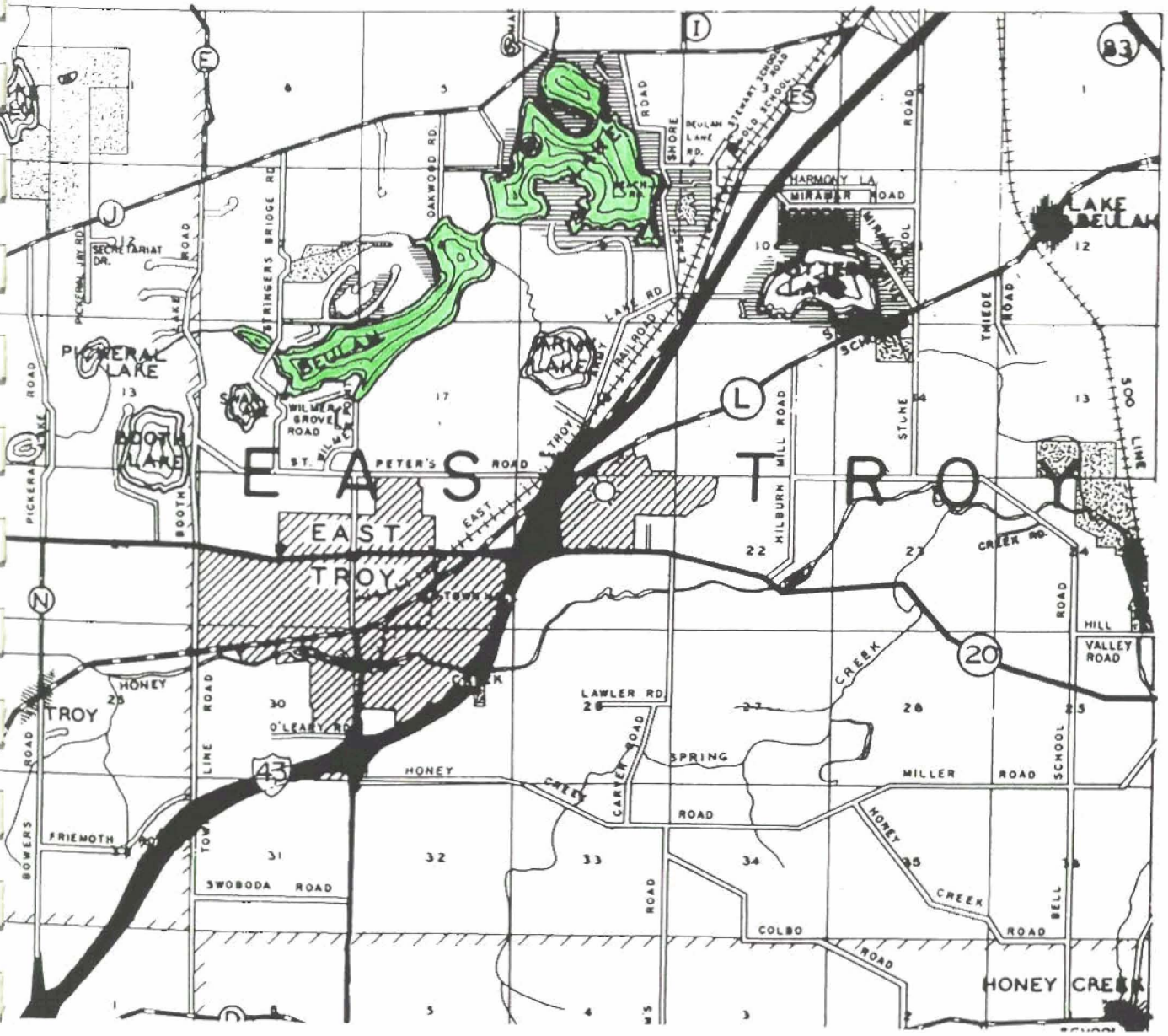
AQUATIC PLANT MANAGEMENT PLAN

FOR

LAKE BEULAH

WALWORTH COUNTY, WISCONSIN
1996

LAKE BEULAH is a valuable natural resource that serves the recreational needs of the population of Southeastern Wisconsin and the many visitors that come to the area each year. It is located in the Northeast corner of Walworth County in the Town of East Troy. (see Map 1) . In earlier years it was known as Crooked Lake because of its shape and irregular shore line. The lake was created when three small lakes connected by streams that wound through a forest of white pines, were linked with a fourth lake, known as Mill Lake. The name Mill Lake originated from the fact that the only mill in the area was located on a small waterfall at the outlet end of the lake. Dams were constructed to establish channels and to maintain the water level in the newly created lake to permit the navigation of steam powered launches between all of its parts. Legislation was enacted in 1894 that defined the appropriate water level of the lake and prohibited tampering with the dams.



Map Number 1

LAKE BEULAH

As a result, Lake Beulah consists of five distinguishable basins or bowls. The Northern most basin continues to be known as Mill Lake, which is separated from the second basin and the remainder of the lake by Jesuit Island. A narrow, canal-like channel on the Western end of the Island and a shorter, narrower channel on its Eastern end create the Island and provide passage between Mill Lake and the remaining basins. The next two basins appear to be one because they are connected by a passage that is wider and more open than the others. The third and fourth basins are connected by another channel that passes through a marsh area lined with lily pads and other emergent vegetation. There are a number of submerged tree stumps near each end of this channel that require boaters to exercise care as they navigate through the area. Long Lake, the southern most bowl of the lake is connected to the rest of the lake by another, less clearly defined channel.

The lake consists of approximately 834 acres of navigable water with an average depth of 17 feet. The deepest point in the lake is estimated to be 58 feet. Because its irregular shape includes many inlets and small bays, the lake has over 15 miles of shoreline. Lake Beulah is known for its clean, clear water that provides excellent recreational opportunities for the public. Fishing, boating, sailing, swimming, and water skiing, are popular summertime activities, while winter activities including, ice fishing, ice skating, ice boating, cross country skiing and snowmobiling, help to make the lake a popular place throughout the year.

Over time, various problems have surfaced to threaten the health and continued usefulness of the lake. Larger numbers of people using the lake, growing residential construction and an increasing number of summer cottages that are being converted to year round lakefront homes, have placed growing pressures on the ecological well being of the lake. Another factor that requires attention is the the role that aquatic plants play in the development and protection of the natural ecosystem of the lake. "A better understanding of aquatic plants and the role they play in a lake ecosystem is essential to the future of our inland lakes."[1]

Even though there are laws in place to protect the lake from pollution and other forms of destruction of its rich plant and animal habitats, an overall plan is needed to insure that the lake is properly cared for in the future - a plan that is designed to protect the lake to maintain its aesthetic environment and the recreational opportunities for which it is known. Careful planning, to determine actions to be taken now and in the near future, will determine how well the lake survives and how long it will continue to meet the needs of the public. The Aquatic Plant Management Plan that follows is intended to be one step toward the development of a comprehensive lake management plan.

LAKE ACCESSIBILITY

Prior to 1994 public access to the lake was limited. A commercial site on Mill Lake, a public launch at Wilmers Grove, a commercial site at what is now the Dockside Restaurant and another at Fred's Tap, located at the lower end of the lake provided access to the Lake. In addition to those locations, several camps on the lake, including Camp Edwards YMCA Camp, the Beber Camp and Alice Chester Camp, each provide boating and other water activities for their campers. The Divine Word Seminary has a retreat on the lake which also has only limited boat access. (See Fig. 1)

The commercial site on Mill Lake was closed to all launching in the early 1990's. Small fishing boats can still be rented and launched at the Dockside Restaurant and at Fred's Tap.

The public site at Wilmers Grove provided nearly all of the public access, but parking in the area was not sufficient to meet the needs of the public.

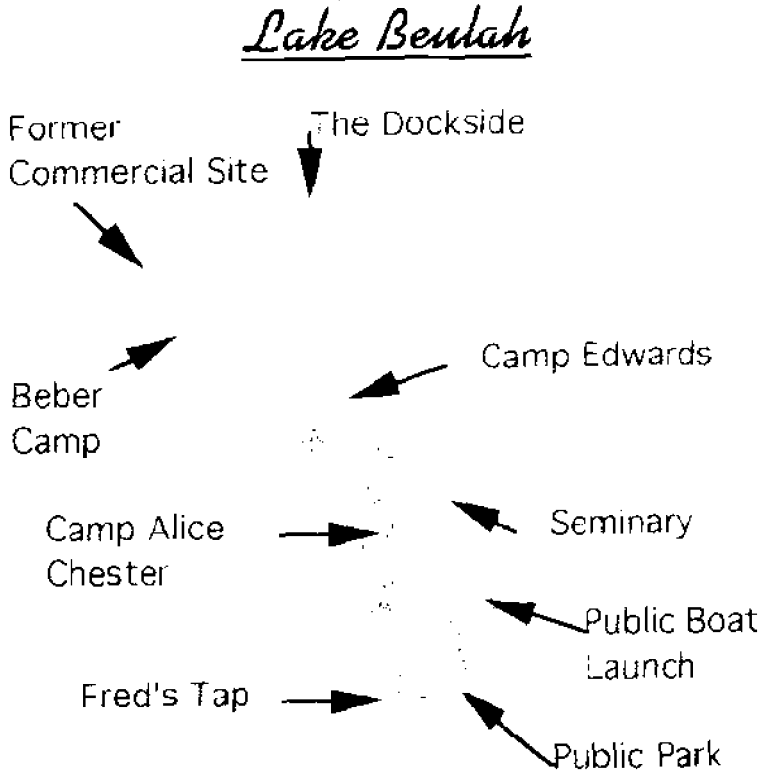


Figure 1.

During 1993 and 1994 the Town of East Troy, in cooperation with the Wisconsin Department of Natural Resources and with the support of Wisconsin's Stewardship Grant Program, purchased land in the Wilmer's Grove area. A new parking area was created, and the existing launch site was completely rebuilt. The launch site features a forty foot pier with concrete pads along each side for launching boats. The right side of the launch was modified to accomodate the entry and exiting of the District's weed harvesting equipment. The lower parking was enlarged and resurfaced. To meet the requirements of the Americans Disabilities Act, parking spaces adjacent to the launch site and a ramp onto the pier are provided. Portable toilet facilities are also available. The parking lot on the upper level, designed and landscaped to blend in with the surrounding area, provides parking spaces for 29 car-trailers.

The launch site and the parking lot are maintained by the Town of East Troy. It provides attendants to control the parking lot and to collect the fees. The town public works staff maintains the buildings and grounds and the police department enforces the rules and regulations on the lake. Fees to use the facility are established to be comparable to those at state parks and other similar facilities located throughout Wisconsin. The parking area was built to specifications and guidelines provided by the Department of Natural Resources to provide appropriate public access to the lake and to meet the requirements of the American Disabilities Act.

A small public park, in the Wilmers Grove area, has been established for public use. It provides a walking path to the lake with only limited access for small car top water craft such as canoes or rubber rafts. It serves as an observation point to view nature and wildlife found in this part of the lake.

PAST AQUATIC PLANT MANAGEMENT ACTIVITIES

The value of Lake Beulah as an asset to the community was recognized early, as evidenced by the creation of the Lake Beulah Protective and Improvement Association in 1894. The Association's early role was to help maintain the quality of the lake and to regulate activities related to the dams that controlled the water level of the lake.

In the early 1960's the Improvement Association and several riparian owners determined that certain areas of the lake were so badly infested with aquatic plants that they were no longer usable for recreational activity. An outside water treatment firm was contracted to spray those areas with a herbicide to eliminate the plants.

In 1968, the Town Board of East Troy established Sanitary District Number 1 to monitor the lake to prevent any degradation of its quality. That responsibility included the management of the plant growth in the lake to insure that the "weeds" did not interfere with the public use of the lake for swimming, fishing and boating. Controlling plant growth at this time was primarily to maintain the lake for its recreational value and preserve the habitats of various species of wildlife found in the area. An independent contractor was hired to harvest and remove a specified number of acres of plants from the lake each season. The Lake Beulah Protective and Improvement Association and Sanitary District began to share the mutual goal, of monitoring and caring for the proper use and development of the lake.

In 1970 the Sanitary District purchased equipment and assumed the responsibility for the annual harvesting of weeds in Lake Beulah. The prevailing philosophy at that time, was that there was a direct relationship between the volume of weeds and materials removed from the lake, and the quality of the water in the lake, i.e., the more weeds removed the higher the quality of water. Consequently, weeds were harvested from all areas of the lake, and during the first several years of operation, over 300 machine loads or 300 tons of plants were removed from the lake, anually.

In the early 1980's, the District's philosophy changed regarding the volume and locations of the harvesting. It was learned that a healthy, diverse stand of native plant growth was needed to maintain the lake's high quality of water and the excellent habitat for the variety of fish it supports. The District changed to a practice of more selective cutting i.e., cutting only where the weeds were a nuisance or a hindrance to navigation. As a result the amount of plant materials removed from the lake was reduced by more than 50%, of the amounts removed in the earlier days.

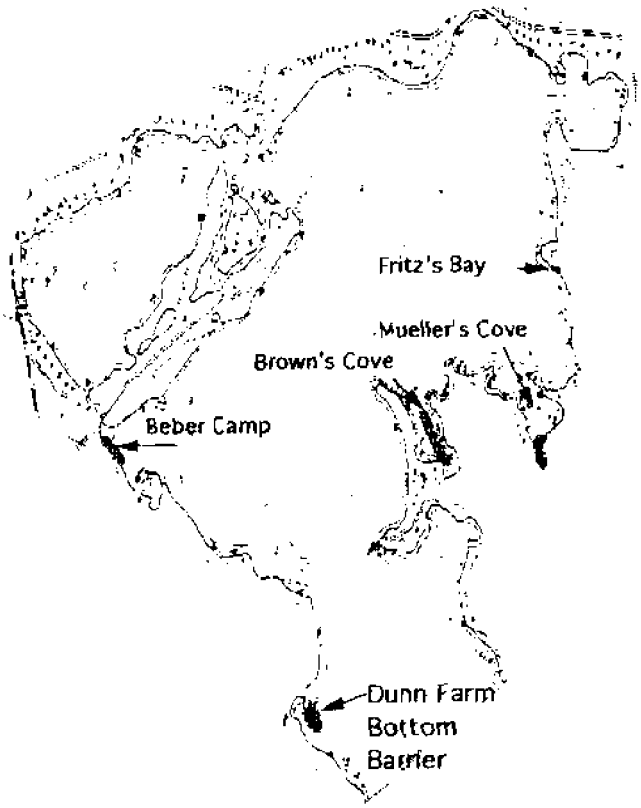


Figure 2

During the summer of 1990, the first significant infestation of Eurasian Water Milfoil (EWM) was detected. (Brown's Bay, see Figure 2) Eurasian Water Milfoil is a submersed aquatic plant that has an inexplicable abilty to regenerate itself. If allowed to grow without intervention it will inhibit the growth of native plants that are essential to the lake ecostructure. Large stands of this exotic plant can develop that will greatly inhibit the use of the lake for swimming and boating activities. The control or elimination of EWM became a major objective of the Improvement Association and the Sanitary District. The District attempted to stress the plant through the use of an aggressive harvesting plan. The weeds were harvested each week and were cut as close to the bottom as possible for the next two summers. Unfortunately, the results were more negative than positive.

By the end of 1991, EWM began to appear in other areas of the lake, as well. Most of the newly infested areas were those that had been exposed to dredging or some other major bottom disturbance during the previous 2 - 6 years. The disturbance of existing native plant growth in those areas provided open spaces for the milfoil to take hold and flourish.

During the winter of 1992-93 the Sanitary District, the Lake Beulah Protective and Improvement Association, and the Department of Natural Resources formed a committee to develop a plan to eliminate the EWM from the Lake, or at least to control it to keep it from spreading into other parts of the Lake. Their combined efforts developed an EWM Demonstration Control Project to be implemented in the summer of 1993. The project consisted of three components or phases.

In the first phase, the chemical 2,4-D was applied by professional, licensed applicators from Marine Bio-chemists Inc. to two carefully selected areas. The chemical 2,4-D was chosen because it is a simple organic acid that has a structure that is not suggestive of any carcinogenic activity. ".....the use of 2,4-D in lakes and rivers is quite common for the control of Eurasian Water Milfoil and....(it) is among the safest herbicides known and is suited to use in aquatic situations because it is highly water soluble and quickly undergoes phoyolysis- that is, it is broken down (primarily to carbon dioxide and water) by the sun's rays. Research indicates that it does not accumulate in living tissue, either human or in fish." [2] The control areas were small enclosed coves (Fritz's Bay and Mueller's Cove-See Figure 2) that could be isolated from the rest of the lake by barriers constructed of heavy plastic, wooden posts, and sand bags. Water inside and outside of the barrier was closely monitored by the DNR and the Sanitary District, to evaluate the effectiveness of the plastic barrier, record the breakdown of the chemical, and to perform herbicide residue monitoring.

The second phase involved the application of a heavy, black plastic bottom barrier/cover to a separate, heavily infested area of about 8/10 of an acre in size (Dunn's Farm). Concrete blocks and reinforcing bars were placed on the plastic to hold it in place. EWM in a fourth area was extensively harvested by the Sanitary District as the third part of the plan. In addition to the physical activity on the lake, renewed efforts were made to increase public knowledge about the EWM problem and encourage lakeside homeowners to be on the look out for the plant and its fragments. Pamphlets were distributed, signs were placed at launch sites and a public information meeting was held. Homeowners were encouraged to hand harvest where possible. DNR personnel and volunteer SCUBA divers manually removed plants found in other parts of the lake.

The results of this program were mixed. Over 90% of the Milfoil was eliminated in the chemically treated areas with no observed adverse affects on the natural plants or wildlife in the area. The bottom barrier trial proved to be very labor intensive as it took most of the summer to fully implement. The results were marginal, because there was as much damage done to the native plants as there was to the EWM. The results of the final part of the program are more difficult to evaluate, because no records were kept of how much EWM was removed by individual homeowners, how much was removed from boats before entering the lake, or what other measures were taken by individuals. Overall results of the study continue to be evaluated today.

Throughout the summer of 1993 additional information about EWM was provided to riparian owners to make them aware of the EWM problem and to inform them of efforts underway to curb its growth. In addition, homeowners were asked to do their part in the effort to minimize the impact of this intruder. A workshop was held to demonstrate how the plant can be identified and how it should be removed from the Lake.

During the summer of 1993 an extensive survey was undertaken by the DNR and the Sanitary District to determine if there were any new areas infested with Eurasian Water Milfoil. Based on that study, the DNR produced a report entitled, ***Lake Beulah Sensitive Area Assessment,*** in which they identified and described eight areas of the Lake that should be considered as Sensitive Areas. See Map 2.

> "Each of these areas possess characteristics which are beneficial to the lake as a whole. Their protection will help preserve the quality of water in Lake Beulah.... these areas support a diverse community of native aquatic plants with limited areas of Eurasian water milfoil." , . The areas were determined by a team of scientists from the Wisconsin Department of Natural Resources..."[3]

The "sensitive areas" are valuable to the lake for the following reasons, according to the Report:

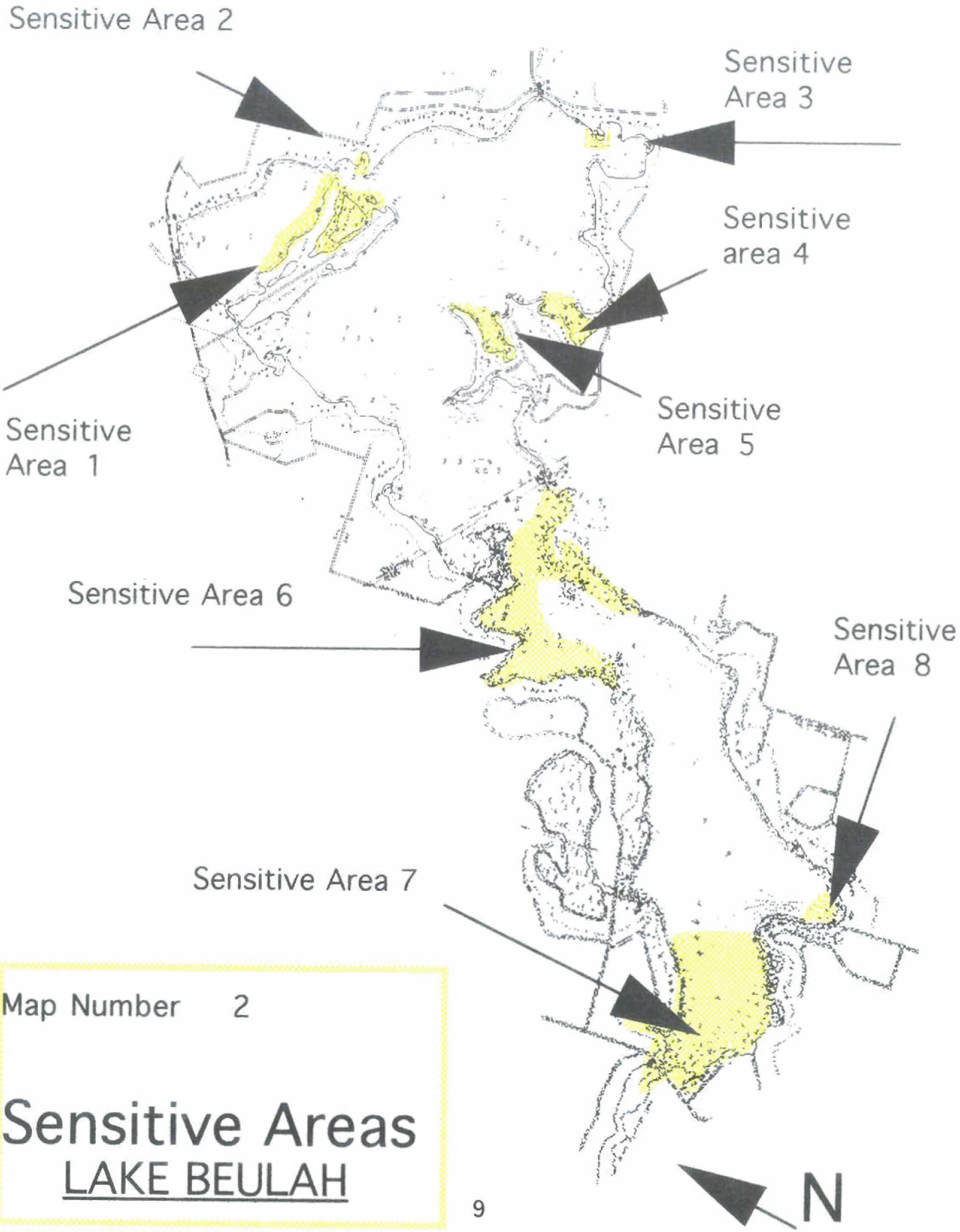
(1) their existence prevents non-desirable plants from proliferating.

(2) they offer spawning and nursery areas for a variety of fish species.

(3) they provide nesting habitat for animals and birds

(4) they act as sediment barriers and nutrient traps to help keep the water clean and clear

(5) they help protect against shoreline erosion.



Map Number 2

Sensitive Areas
LAKE BEULAH

The eight sensitive areas are described in more detail in the *Sensitivity Report*, which also includes site descriptions, resource assets of each area, and management recommendations for each area. Generally, these areas are to be undisturbed and left in their natural state. Chemical treatment or mechanical harvesting of any kind is generally not permitted in these designated areas. (except for navigation purposes)

Further observations of the bottom barrier area from the 1993 trial showed reinfestation of Eurasian Water Milfoil with only a marginal return of native plants to the area, even though attempts were made to transplant native plants to the area after the barrier was removed. During the winter of 1993-1994 a decision was made to introduce a second chemical application to the first infested area found in 1990. The application was made early in May of 1994.

During the Spring of 1994, 2,4-D was applied for the first time to the 3/4ths of an acre area designated as Brown's Bay, (Figure 2) following the plan established earlier. A major difference between this application and the earlier ones, was that this area was not easily isolated from the rest of the Lake, so it was not possible to construct a barrier similar to those used earlier. The application resulted in a 75% reduction of EWM in the area with no significant impact on fish or wildlife. Some of the *Nymphaea spp.* and *Nuphar spp.* (white and yellow water lily pads) in the immediate area displayed a slight curling of their outer edges. The affect was not permanent, as the pads returned their normal appearance within a few weeks.

The summer of 1994 served as an observation period to determine the effectiveness of the various approaches introduced to control the growth of the EWM. No further treatment was used during this period, while the DNR and the Sanitary District monitored the infested areas to determine the progress of existing programs. However, hand pulling was encouraged whenever EWM was sighted. Later in the year, the committee developed a program to address the problems and concerns expressed by property owners. That program called for the application of 2,4-D to five areas. One of the areas was treated in 1993 with a success rate of 75%. (Mueller's Cove). Also in 1993, a bottom barrier was tried in a second area, one which had become heavily reinfested with EWM (Dunn Farm.) The other three areas -the Dockside, the Beber Camp and Camp Edwards -were new infestations that had developed during the previous two years.

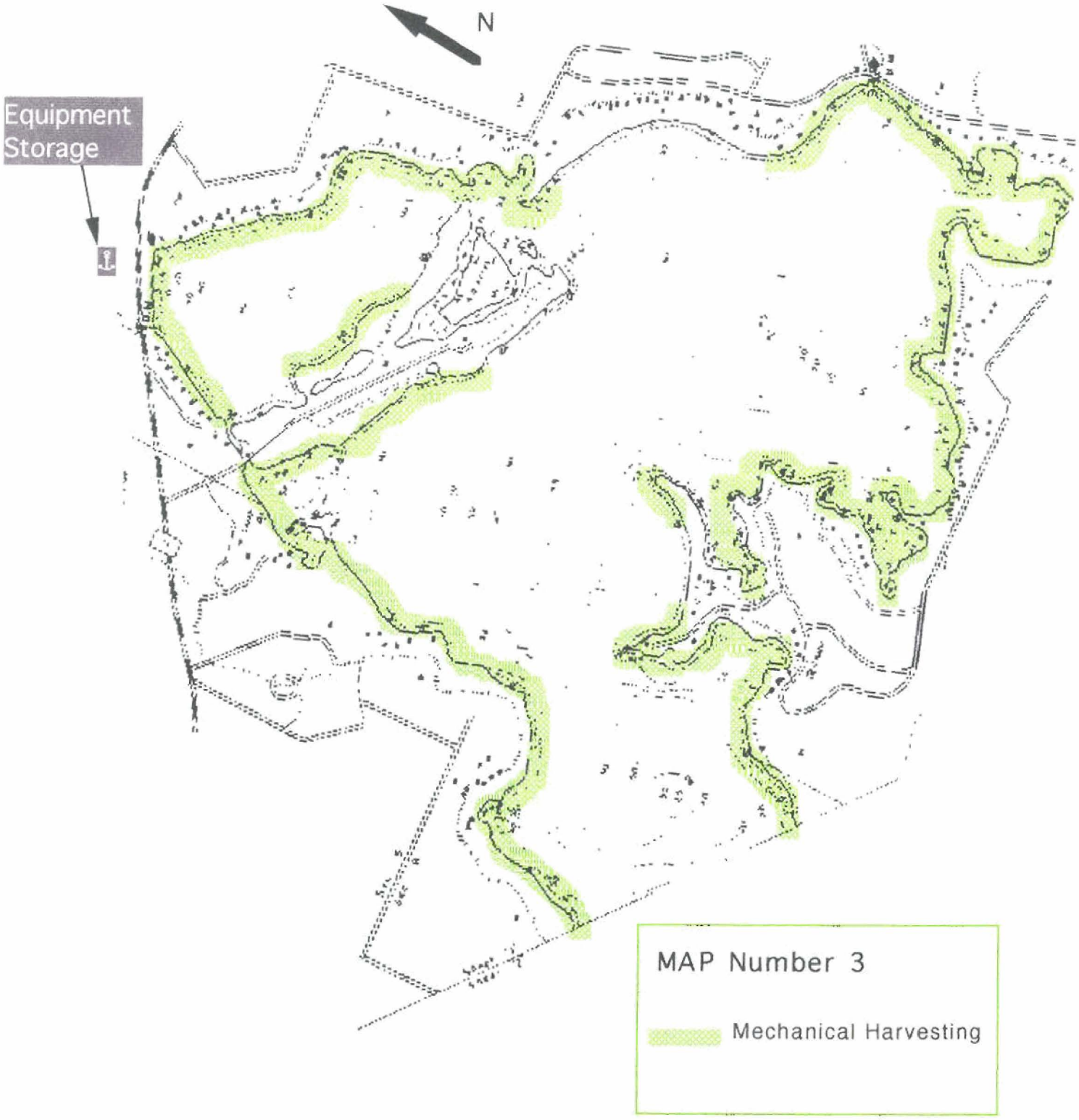
In the spring of 1995 concerns were expressed by some riparian owners who lived near one of the areas proposed for chemical treatment. They felt that the use of chemicals of any kind would be harmful to the lake. Following much discussion the Dunn Farm area was not treated at this time. The remaining three areas were treated, using techniques developed during earlier applications of 2,4-D. Overall results indicated that approximately 75% of the EWM was destroyed.

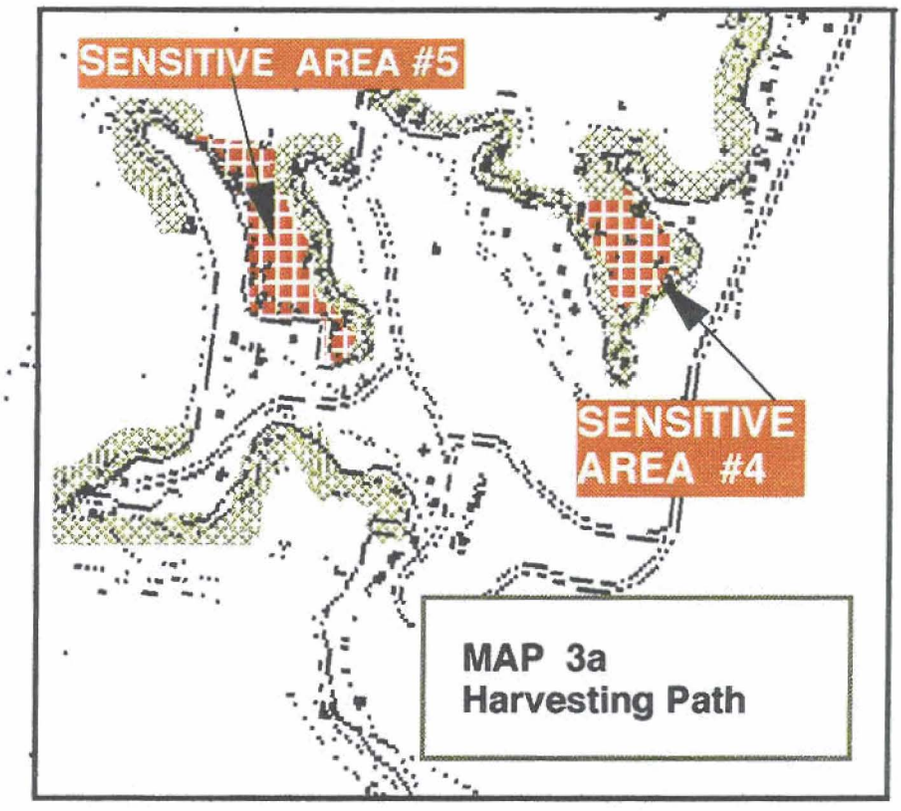
MECHANICAL HARVESTING PROCEDURES

The Lake Beulah Sanitary District has been involved with mechanical plant harvesting since 1968. The district owns and operates four basic pieces of harvesting equipment. It has a Model 620 Harvester, a matching Transporter, an Elevator, and a five yard dump truck. Harvesting techniques change with the growth pattern of the plants and the needs of the riparian owners. One of the original goals of the harvesting program was to remove as much nutrient plant material from the lake as possible. The District believed that this was the best way slow the eutrophication process of the lake. Actually, preserving a diverse population of native aquatic plants helps prevent the encroachment of undesireable foreign plants, such as Eurasian Water Milfoil and purple loosestrife and provides better fish and wildlife habitat. Consequently , the District adopted a more selective harvesting approach that would minimize any disturbance of native plants.

The annual harvesting operation usually begins during the last week in May or the first week in June. Two or three days are spent servicing the equipment to prepare it for the upcoming season. After the equipment has been serviced the harvester and transporter are put into the water at the public launch site and are moved to the shore at the Divine Word Seminary. The elevator is installed at the Seminary which serves as the District's base of operation for the summer. In 1990 the District acquired lakefront property at the N.E. end of Mill Lake. (see Figure 1, p. 4) that can be used by the district in the event of the loss of use of the Seminary site which is preferred because it is more centrally located.

Plant harvesting operations are performed by two full time, seasonal employees, supervised by one of the District Board Members (an unpaid volunteer). The week after the equipment is put into the water is used to train new operators and review the harvesting plans for the summer. The operators receive training on the use and operation of the equipment, safety, and all matters concerning specific harvesting techniques required at different locations around the lake. Harvesting takes place eight hours each day, Monday through Friday, for approximately ten weeks. No harvesting is done on weekends or holidays. Harvesting areas for the entire lake are shown on Maps 3 and 4. Maps 3a, 3b, and 4a provide more details in some of the sensitive areas.


N
Equipment Storage
MAP Number 3
Mechanical Harvesting

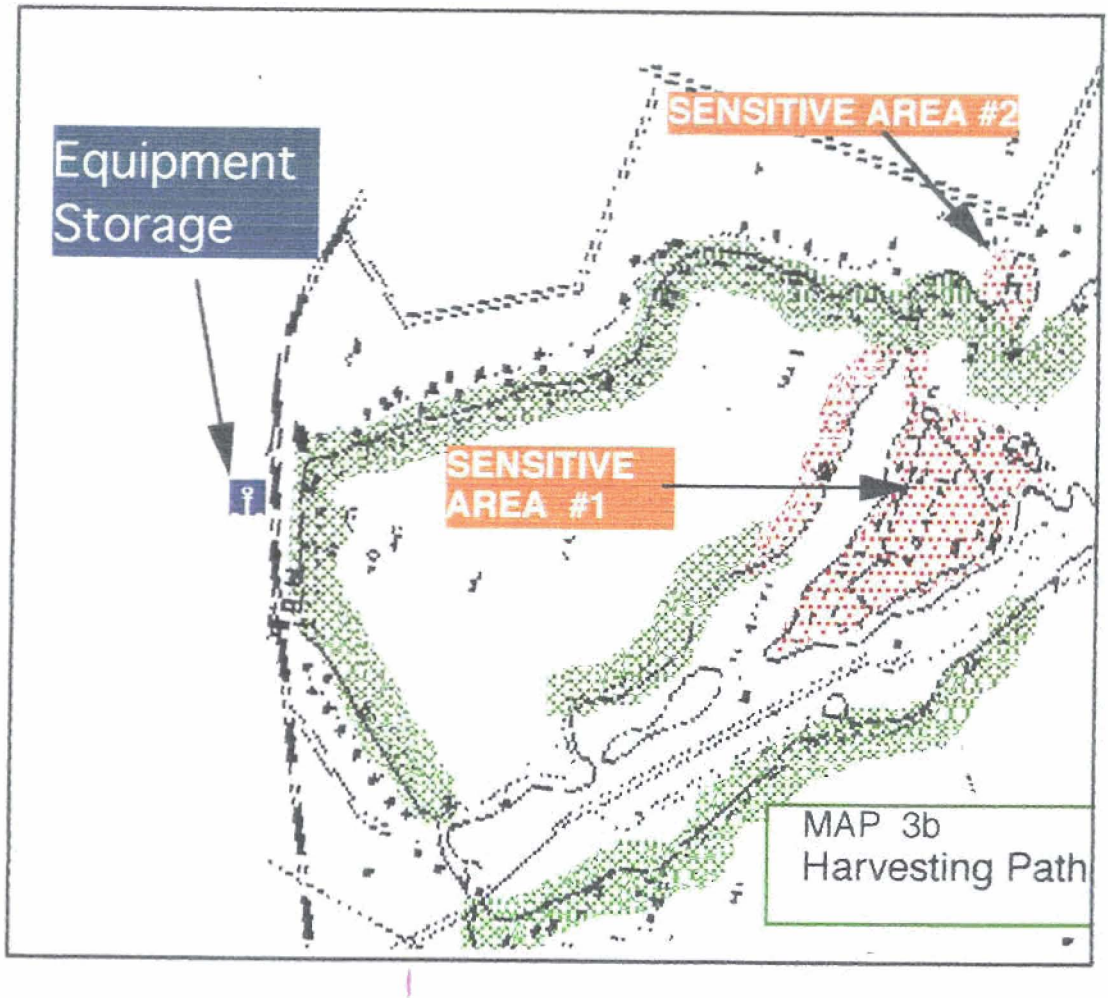


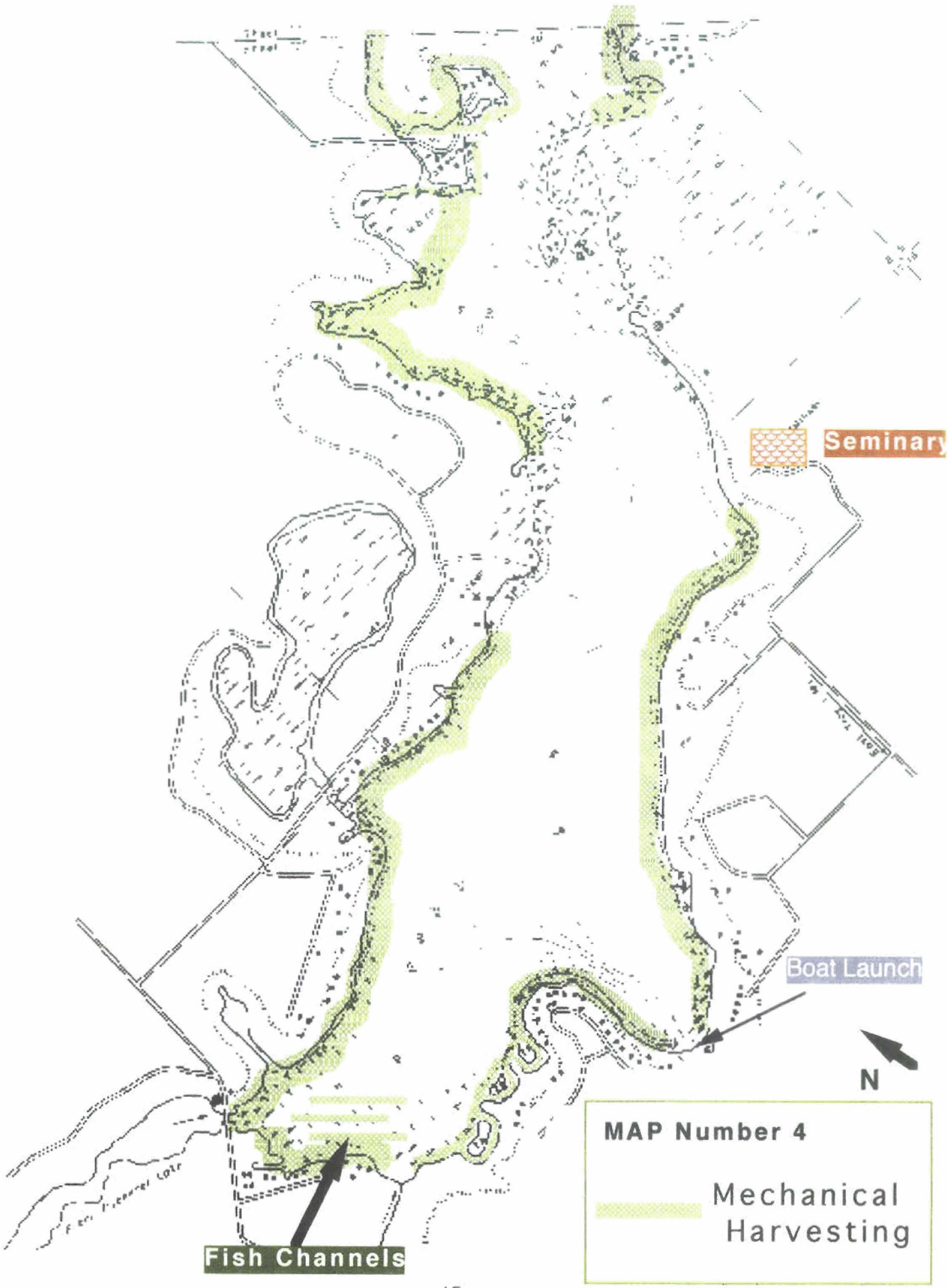
Sensitive Area #4, located on a southern shore of the lake is also referred to as Mueller's Cove. The diverse native plant growth found there serves as an effective nutrient and sediment trap that reduces the amount of nutrients in the water and helps maintain the clarity of the water while preventing wide spread growth of exotic plants. The area contains only a limited amount of EWM. The variety of native emergent and submerged plants provide spawning beds and an excellent feeding habitat for northern pike, bluegill and large mouth bass. The vegetation in this area also helps protect the shoreline from erosion. Wildlife, including ducks, great blue heron, muskrats, raccoons and opossum can be found here throughout the year. This cove was one of the test areas used to determine the effectiveness of 2,4-D in treating EWM. A plastic barrier was constructed across the entrance to the cove and was held in place by sand bags. The areas inside and outside of the barrier were closely monitored, indicating that the barrier was effective in keeping the 2,4-D inside the cove. An estimated 75% of the EWM was eliminated, while there was a slight curling of the leaves of some of the natural plants. Fish and other wildlife were not adversely affected by the chemical.

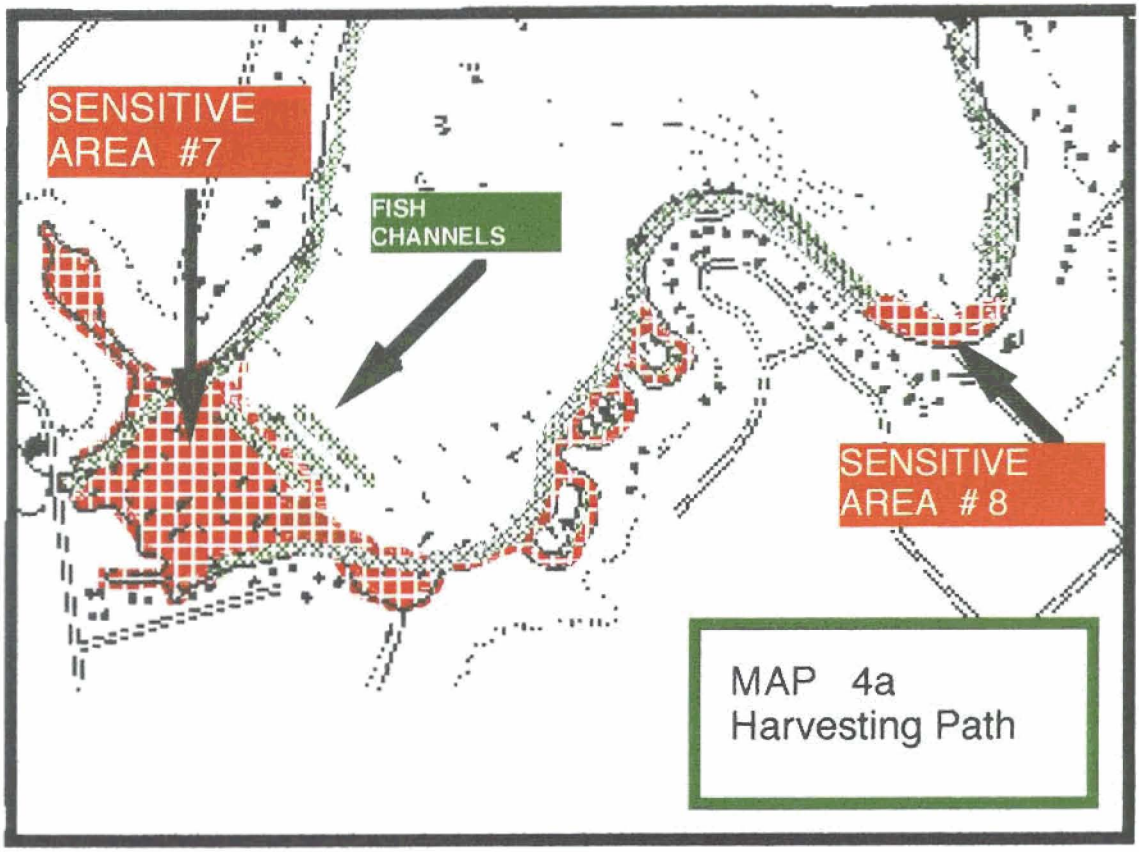
Sensitive Area #5, or Brown's Bay was also treated with 2,4-D but the area did not lend itself to isolation from the remainder of the lake. The impact on EWM was not as pronounced as it was in the trial areas. Once again, there were no observable adverse effects on fish or wildlife in the area. Harvesting in each of these two areas is very limited. The harvester is run along the west side of the Mueller's Cove and the east side of Brown's Bay. The areas harvested are in front of private residences, and is needed to provide passage to the lake. Neither of the center portions of these bays is harvested. Mechanical or chemical treatment is not to be used at either of these, sites unless the growth of EWM is considered to be growing at a threatening rate. Dredging or filling (addition of sand or pea gravel) are not permitted.

The detailed harvesting areas for Sensitive Areas #1 and #2 are shown below in Map 3b. The water is only 2-4 feet deep in this marsh/swamp area that provides natural habitats for swans, herons, and other birds. Raccoons, opossum, and muskrats can also be found in this area. Sensitive Area #1 includes the entire area that separates the very end of the island and includes the passage way into Mill Lake. The area is posted as a "SLOW, NO WAKE" zone to protect the growth of *Nymphaea spp. and Nuphar spp.*, White and Yellow Water Lily and other native plants that grow here and provide excellent cover for bass and bluegill. The sensitive area follows the shoreline through the passage and along the shore of Mill Lake. The depth of the lake drops off very quickly along this entire shoreline.

Sensitive Area #2 is a very small area on the other side of the channel. The harvester cuts across the opening but does not go all the way back in the cove. The water here is also very shallow and the harvester would cause signifcant disruption to the bottom. so harvesting is not permitted.




Seminary
Boat Launch
N
Fish Channels
MAP Number 4
Mechanical Harvesting



Map 4a shows the harvesting paths that are followed the end of the Long Lake and Sensitive Area #7. There is a large, thick weed bed here that includes a variety of native plants which have effectively restrained the growth of exotic plans including EWM. "Fish Channels" are cut through the weed bed that are about 10 feet wide and 20 feet apart. This technique has been used in other lakes to improve the fish habitat characteristics of the area. Results of this effort are unknown at this time. A narrow path is cut along the western side of the weed bed to accommodate homeowners. On the opposite side, cutting takes place but not as far into the weed bed. Passages between three small "islands" are harvested very "lightly.

Sensitive Area #8 is next to the public boat launch. The harvesting path excludes the entire sensitive area. However, special attention should be given to this area, because it is adjacent to the public launch. Exotic plants including EWM and small creatures like the zebra mussels are often transported from lake to lake when plant fragments and mussels attach themselves to a boat in one lake and are carried to the lake. Each boat owners should carefully inspect his/her boat, externally and internally, (including the bilge area), when they leave a lake, to make sure that they are not transmitting weed fragments or small creatures to the next lake they visit. Boats should be washed down after they are removed from the lake and allowed to dry out before going to another lake. When going to another lake it would not be a bad idea to inspect the boat once more and wash it before launching.

Figure Number 3
Sensitive Area # 6

Figure 3 is an aerial view of Sensitive Area #6. This sensitive area includes the channel and large areas of marsh/swamp on each side and on each end of the channel. The channel connects two major parts of the lake. It is a SLOW/NO WAKE zone through out its entire length. Boat traffic through the channel is sufficient to control the aquatic plants found there. The channel itself is only 3 to 5 feet deep and is not an appropriate area for harvesting. The harvesting that is done is primarily for navigational purposes for the homeowners that live along the shoreline. The "paths" that are harvested are easily seen in the upper left and the upper middle portion of the photo. Although not shown there are a number of submerged tree stumps on the right side of the channel as one enters the channel and on the right side as you exit the channel. (traveling in a north easterly direction or left to right in the picture). Care must be exercised to avoid the stumps as one travels through the area.

Sensitive Area #6 is the largest of the eight sensitive areas in the lake. It, like the other sensitive areas, supports a large diverse population of native aquatic plants; including: *Decodon verticillatus* (swamp loosestrife), *Typha spp.* (Cattail), *Nymphaea spp.* (white water lily) and *Nuphar spp.* (yellow water lily). The common submergent plants include, *Potamogeton pectinatus* (sago pondweed), *(Chara spp.)* muskgrass, *Elodea canadensis* (American elodea), and *Potamogeton natans* (Floating leaf pondweed).

An excellent fish spawning habitat, a high quality wildlife feeding area, a high quality habitat for a variety of birds, and a high quality nesting habitat area, are all descriptive terms that fit the area. The aquatic plants also serve as a nutrient and sediment trap, which promotes water clarity by limiting the amount of nutrients released into the lake. The healthy, diverse stand of native plants keeps exotic plants from having a place to start.

This unique area needs to be protected, (as do the other sensitive areas) from all types of exotic invasion, such as Eurasian Water Milfoil, Purple Loosestrife, zebra mussells and some that we don't even know about. All users of the lake, whether they are local or from out of the area, should be made aware of the importance of the need to protect this (and the seven other areas) area of the lake. This area's physical location, on a main channel connecting two major basins of the lake, make Sensitive Area #6 more susceptible to abuse. The SLOW/NO WAKE zone should followed by all lake users and should be strictly enforced by the lake patrol.

Harvesting usually begins in the southern-most basin of the lake. The exact location is determined by the absence or presence of spawning fish. During the early part of the season, operators are trained to look for and avoid spawning beds. At a later date, after the spawning period is over they return to those areas to complete the harvesting. As noted above, harvesting procedures have changed from those of earlier years. No harvesting is done any closer than one foot from the bottom of the lake or in water less than three feet deep. The maximum harvesting depth is five feet. These procedures are intended to help minimize disturbances to the lake bottom and native plants to avoid the creation of bare spots for EWM and other exotics plants to get a start. Protecting the native plants helps them to regenerate and maintain their dominance which in turn limits the spreading of unwanted plants.

Operators are instructed to observe the number of fish picked up by the harvester, and how to safely return large fish and turtles to the lake. When large numbers of fish are encountered, harvesting is temporarily stopped in that area until the fish have moved on. The operators begin harvesting parallel to the shoreline and in front of piers. After the areas in front of the piers have been cut, the operators then cut between the piers, but usually not before June 15. The District has been experimenting with fish habitat management in the large plant bed at the south end of Long Lake. The harvesters cut fish channels through the weed bed that are about ten feet wide and twenty feet apart, to provide a home for the fish population. (Map 4 and 4a). This practice has proven to be successful in other lakes with heavy plant growth and it is hoped that it will beneficial in Lake Beulah, as well.

The operators are trained to recognize EWM and to document any significant stands they encounter during their harvesting activities. As infested areas are harvested, the operators make an extra effort to pick up floating plant fragments to prevent further spreading of the EWM. As a further precaution, the machines are cleaned thoroughly after being exposed to large amounts of Milfoil.

After harvesting is completed in the southern basin , the operators move on to other parts of the lake and follow the same cutting procedures. The first complete cutting of the lake is usually done by July 4th. After the first cycle is completed, the operators return to the southern basin and begin the process over again. As indicated earlier, mechanical harvesting techniques have changed with respect to the depth and amount of cutting, especially in the more heavily infested areas. Harvesting has been modified in order to preserve and promote the growth of native plants. Very limited harvesting takes place in the Sensitive Areas, as shown in Maps 3a, 3b and 4a .

Currently, the amount of plant material removed from the lake during a season is about 50 machine loads or approximately 113 wet tons, considerably less than the amounts harvested during earlier years. Part of the reduction is attributed to the change in procedures, but some of the decline is the result of a decrease in the growth of native plants, which is of concern to the District. There are no agreed upon explanations as to why this decrease has occurred, and it has been noted that similar declines have been observed in other lakes; it is not unique to Lake Beulah.

Harvested plant material is removed from the lake at the Seminary site, and trucked to local farms where it is used as a fertilizer. Because it is not possible to pick up all weed fragments with the machine during the cutting process, riparian homeowners are asked to rake the areas in front of and around their piers and pile the fragments along the shoreline. The harvested material should be placed in an area that will prevent it or it's run off from getting back into the lake , especially when EWM is present. Within a day or two the transport operator will return and load the piles of plants onto the truck to be hauled away.

The normal harvesting season requires 2 to 3 complete cuttings of the harvesting areas. Some "hot spots" may occur because of rapid plant growth and may require cutting as many as 4 or 5 times during the summer The harvesting season usually ends during the last week in August or the first week in September. The equipment is cleaned thoroughly, inspected for worn, damaged, or missing parts, lubricated and prepared for storage. The District stores the equipment for the winter in its own building at the former commercial site at the end of Mill Lake (Figure 1, p.4).

The following daily log is completed by the machine operators and is submitted every two weeks as a time sheet. The "AREA " harvested each day is shown by a line on a map of the lake, using a different color for each day of the week. The "TYPE" represents the predominant type of plant that is harvested on a given day. In addition, there is space on the form to record various machine costs such as, fuel costs, repairs and downtime.

Date : JUNE 2,1996

DAY	NUMBER OF LOADS	AREA	TYPE	HOURS WORKED

The Sanitary District has maintained harvesting data since the mid- 1960's. Total hours worked, machine costs such as fuel and repairs, and loads of plants removed, are recorded each time the harvester goes out. Data is also collected to permit the estimation of the amount of phosphorous in the lake each season.

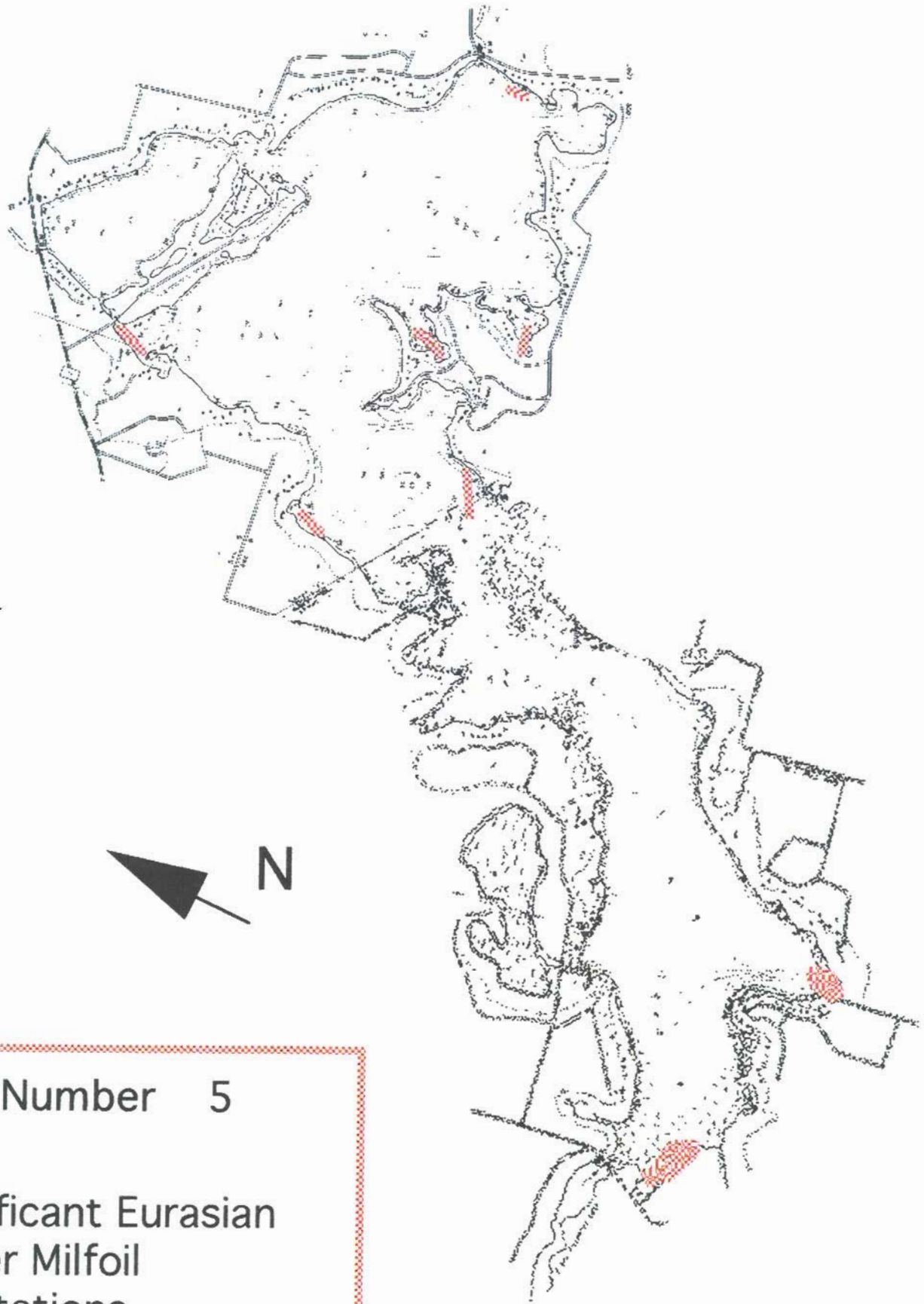
The areas harvested, the type of equipment used, the methods used, and the intensity of harvesting vary from season to season. The amount of material removed from the lake fluctuates from year to year, depending on climatic factors that affect the growth of the plants. During an average season approximately 100 acres of lake surface are harvested.

A formal plan is needed to address the problems facing the lake and to outline a strategy to prevent wide spread growth of undesirable plants, especially EWM. At the same time, native plant growth must be protected and even encouraged, so that the lake remains healthy and able to continue to provide an environment that will support fish and wildlife. In addition, the recreational and aesthetic values of Lake Beulah need to be kept in mind in such a plan. The purpose here is to provide several recommendations to be the foundation of that a plan.

Today, Lake Beulah has eight areas with significant stands of Eurasian Water Milfoil (Map 5) . Some of the areas have been chemically treated, another has been exposed to a bottom barrier, and hand pulling has been used in other areas. The success of these varied treatments has ranged from poor, with a return of most of the Eurasian Water Milfoil, to very good with the return of mostly native plants and less than 10% return of EWM.

Demonstrating an ongoing partnership, the Lake Beulah Protective and Improvement Association and the Sanitary District applied for and were awarded a grant to develop this Aquatic Plant Management Plan for Lake Beulah. The two groups provided the necessary local funds that were matched by the grant from the Wisconsin Department of Natural Resources and the Wisconsin Stewardship Program.

Furthermore, at the end of 1995, with the support of the Lake Beulah Protective Association and the existing Sanitary District, the Town of East Troy established the Lake Beulah Management District to replace the Sanitary District. A lake management district is a governmental unit established to maintain, protect, and improve the quality of a lake and its watershed. The lake district will include all riparian property owners and all off-lake property owners that benefit from the lake or affects its watershed. A lake management district is an example of participatory government that allows all permanent residents as well as, out of town property owners to have a voice in matters affecting the district. The Management District has authority to make contracts, purchase property including conservatory easements, assess fees, disburse money, apply for and accept grants. The board consists of five members, three that are elected by the public, one is appointed by the County and one by the Town Board. Its activities are governed by Chapter 33 of the Wisconsin Statutes. All property owners in the lake management district share in the costs of management functions performed by the District.



Map Number 5

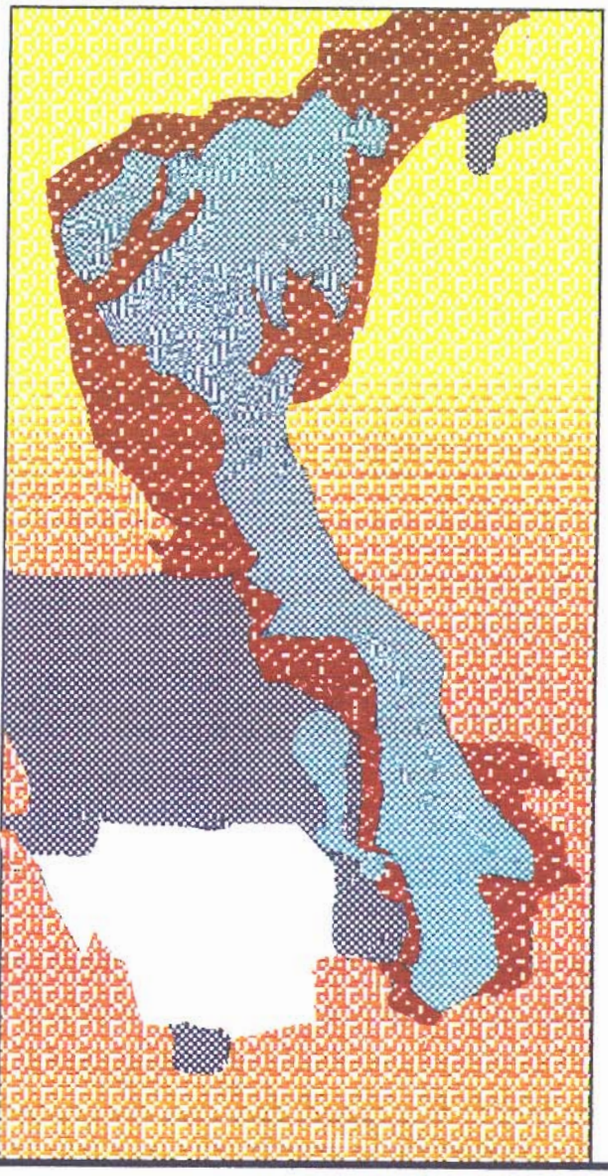
Significant Eurasian Water Milfoil Infestations

AN AQUATIC PLANT MANAGEMENT PLAN

PHYSICAL CHARACTERISTICS

An Aquatic Plant Management Plan requires a base or a reference point from which to begin. Assessments of various key physical attributes of Lake Beulah were completed during the late summer of 1995. Those physical attributes include, shoreline development or land use, shoreline structure, lake bottom features, inventory of aquatic plants, and water clarity. Each of these attributes is described below.

Land immediately adjacent to the lake is primarily all residential as shown in Map# 6. The one major exception is the large strip of shoreline that stretchs between Camp Edwards, on the North and the Seminary on the South, which is zoned rural-agricultural. However, a large part of that area is either steeply sloped or is part of one of the sensitive areas (Sensitive Area #6, defined earlier) that is made up of wetlands and marsh and is not suitable for either agricultural or residential use. Opportunities for any new development around the lake are very few.



Map Number6 Land Use Plan

Rural Residential

Residential

Agricultural- Rural

Exclusive Agriculture

Derived from Map 5, p. 22 Camiros, Ltd. Land Use Plan, Town of East Troy

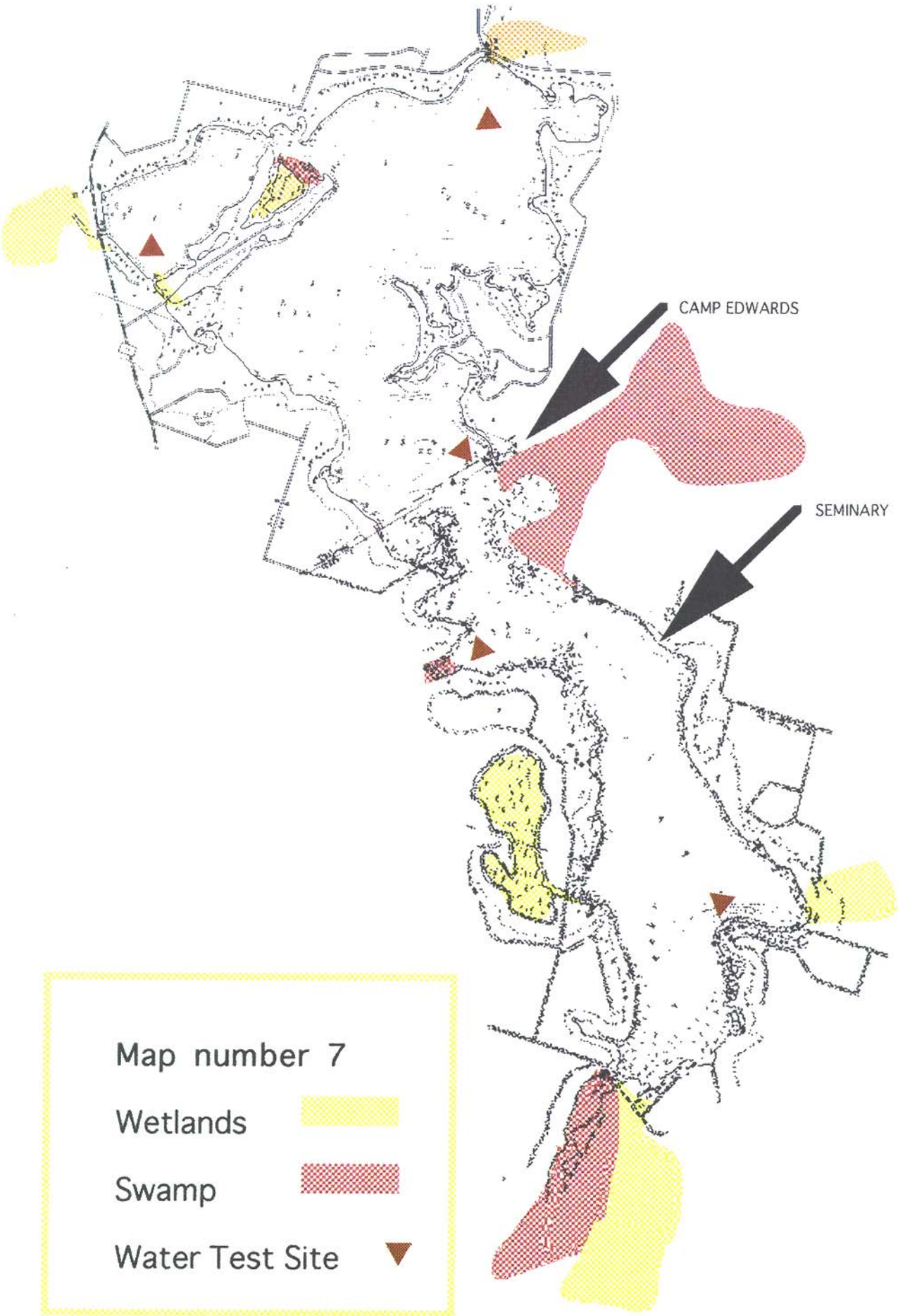
Wetlands on navigable waters that may be affected by activities such channel construction, filling or grading adjacent to wetlands are protected by state law. See Map #7 for the location of wetlands around Lake Beulah. Much of the shoreline remains in a natural state or consists of rip rap. Sea walls and bulkheads can also be found along the shores, but in only a few places, as shown on Map #8.

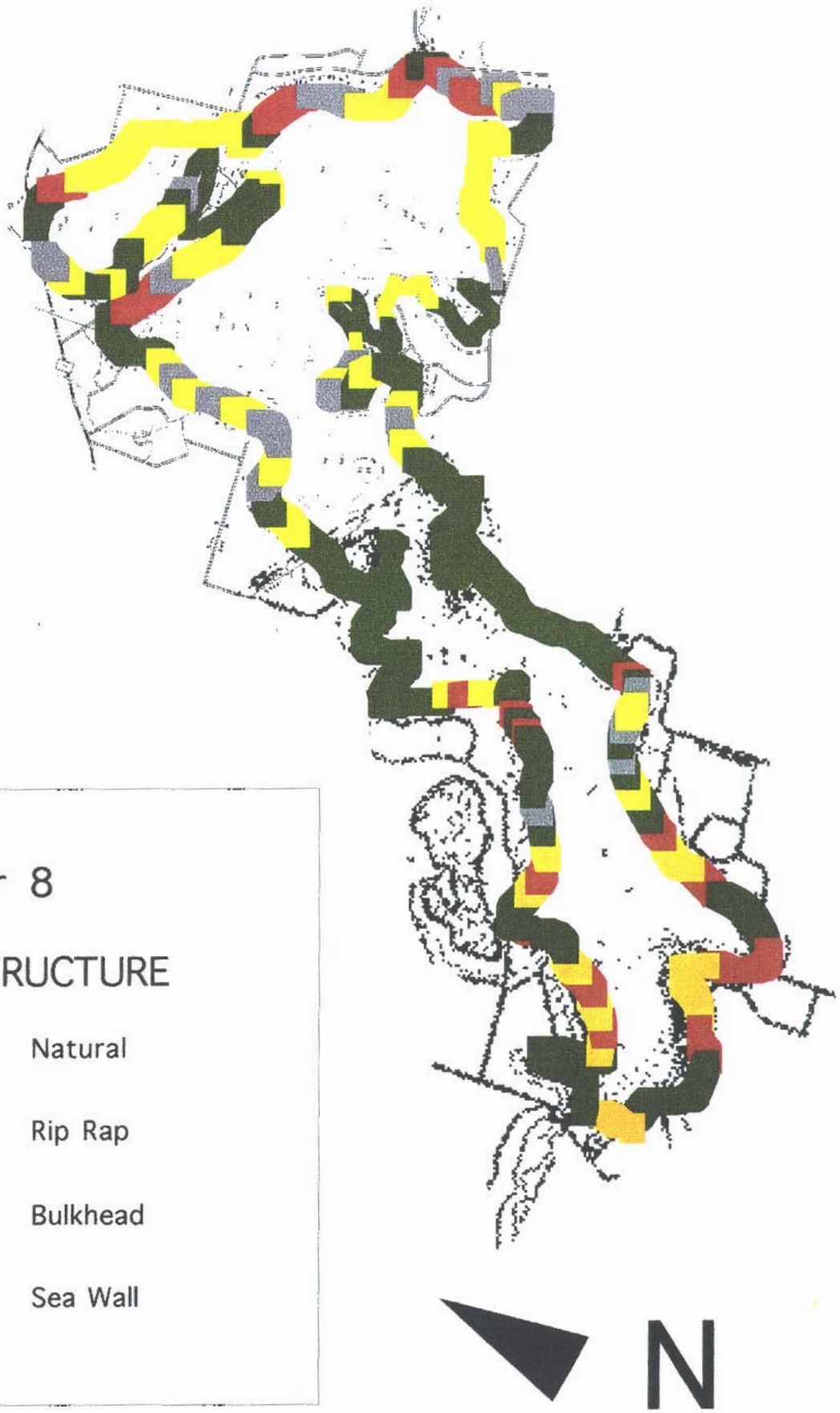
Bottom covering, shoreline stabilization, and limited draw down are defined as physical aquatic plant control procedures. The bottom covering method used at the Dunn farm area, mentioned earlier, demonstrated how cumbersome and difficult this procedure is and how the procedure destroyed native as well as exotic plants. In addition, it also showed that when all vegetation is destroyed, the first plants to return are the exotics, especially EWM. Bottom covering may be effective in some small areas or areas around piers and docks, but it must be put down with great care, or a new stand of EWM may result.

Rip rap used as shoreline protection and/or aquatic plant control closely resembles a natural shoreline. However, it is a form of bottom cover and several regulations govern the use of rip rap. The amount of land reclaimed is limited to the amount lost by erosion or ice push from a single storm or event. The existing shoreline must be followed with minimum encroachment into the water. The slope of the rip rap, the size of rocks, the type of filter fabric and the actual placement of the rip rap all have specifications that must be met to have an approved installation.

Concrete and treated wood sea walls have been traditional methods of providing shoreline protection. These methods have several unique disadvantages and their use is generally discouraged. They inhibit the movement of wildlife and amphibians that travel from the water to the land or from land to the water during their life cycle. The wave action against the walls creates barren areas near the shore that will not support the growth of plants or insects. Consequently, fish will not spawn or live in areas that do not provide them with protection or a food supply. Aesthetically, sea walls and bulkheads are not as attractive as the natural shoreline.

The lake bottom consists primarily of sand or a sand/gravel mix around most of the shoreline. This is especially true for areas that are shallow (3 feet or less) at the shoreline that gradually drop to 5 or 10 feet. Generally, the bottom becomes heavily weeded at the 10 to 15 feet depth and then it becomes muck. These features are illustrated on Maps #9 and #10.


CAMP EDWARDS
SEMINARY
Map number 7
Wetlands
Swamp
Water Test Site



Map Number 8

SHORELINE STRUCTURE

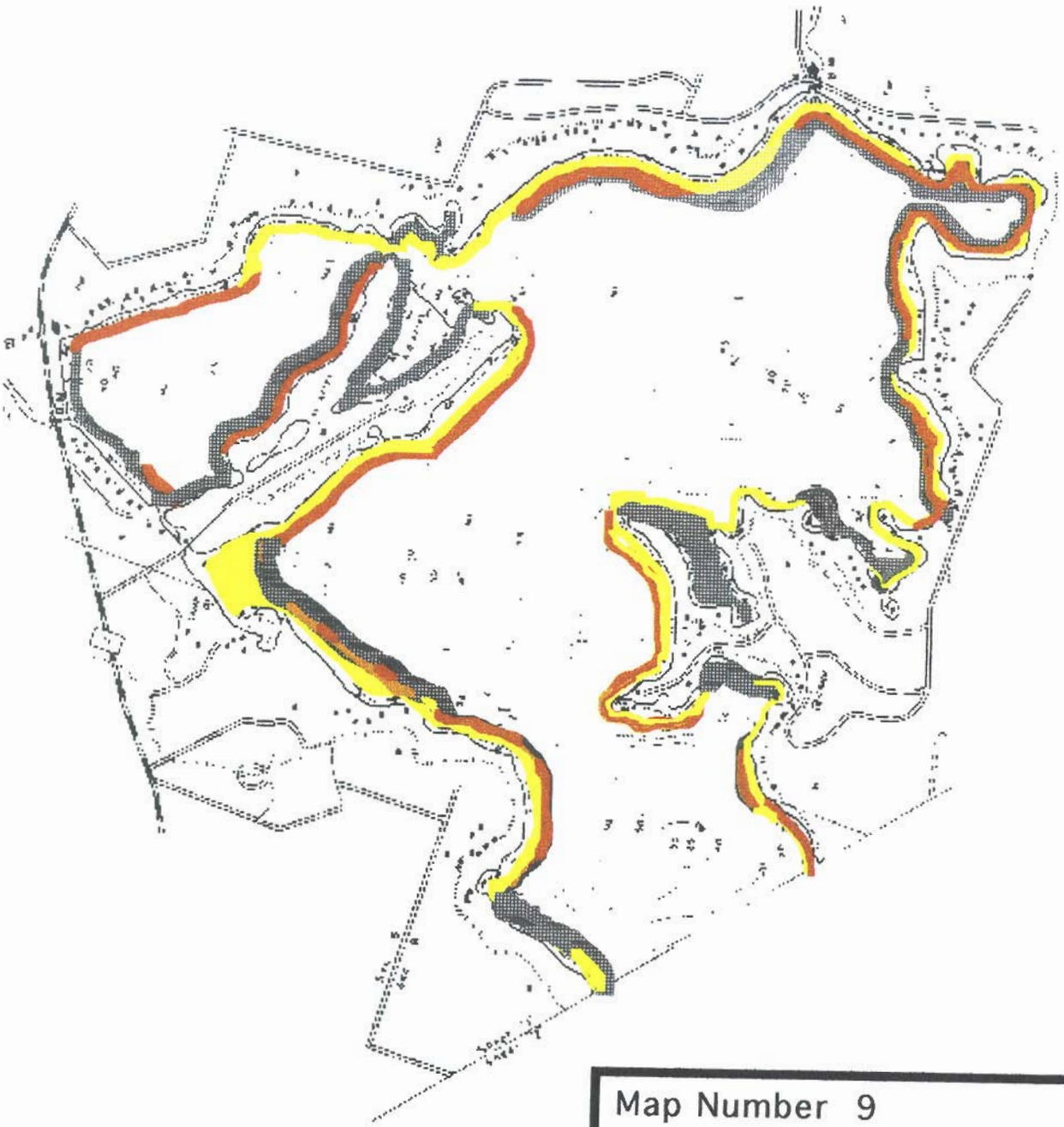
Natural

Rip Rap

Bulkhead

Sea Wall

N



Map Number 9

LAKE BOTTOM

Sand

Gravel

Muck

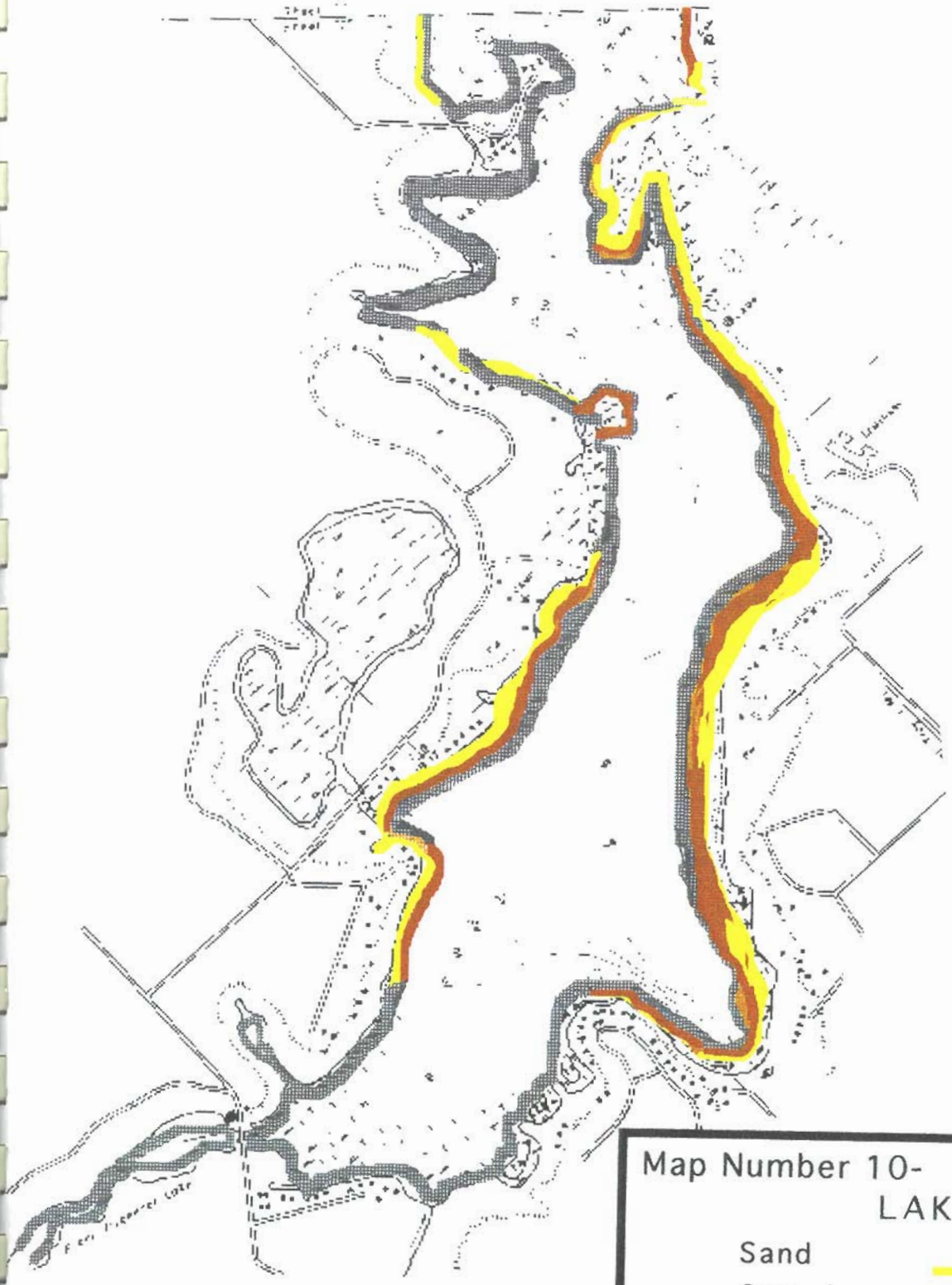
Draw down has had limited success as a means of aquatic plant control. The method consists of a temporary lowering of the water level in the lake to expose plants to seasonal temperature extremes. A number of conditions must exist before this approach can be successful. First, the draw down must occur over a four to six month period to allow for a complete summer or winter season to be effective. The large demand for recreational use of Lake Beulah prevents a summer shut down and subsequent drying out of plants or a winter period to allow for the freezing of all plants. Limited draw down is not a selective approach. All plants both native and exotic are destroyed in either season. Finally, there is no operable dam on Lake Beulah so draw down is really not a feasible approach.

AQUATIC PLANT INVENTORY

An aquatic plant inventory was taken during the summer of 1995. Forty eight sites were selected around the lake. The sites were chosen to include representative samples of plant growth from the entire the lake, including the Sensitive Areas defined by the DNR.(see page 7). A point on the lake was selected and a compass heading from that point to an identifiable landmark on shore were recorded. An imaginary line between the point on the lake and the landmark formed a transect. The transects used are defined in Table 1 and are shown on Maps #11 and #12.

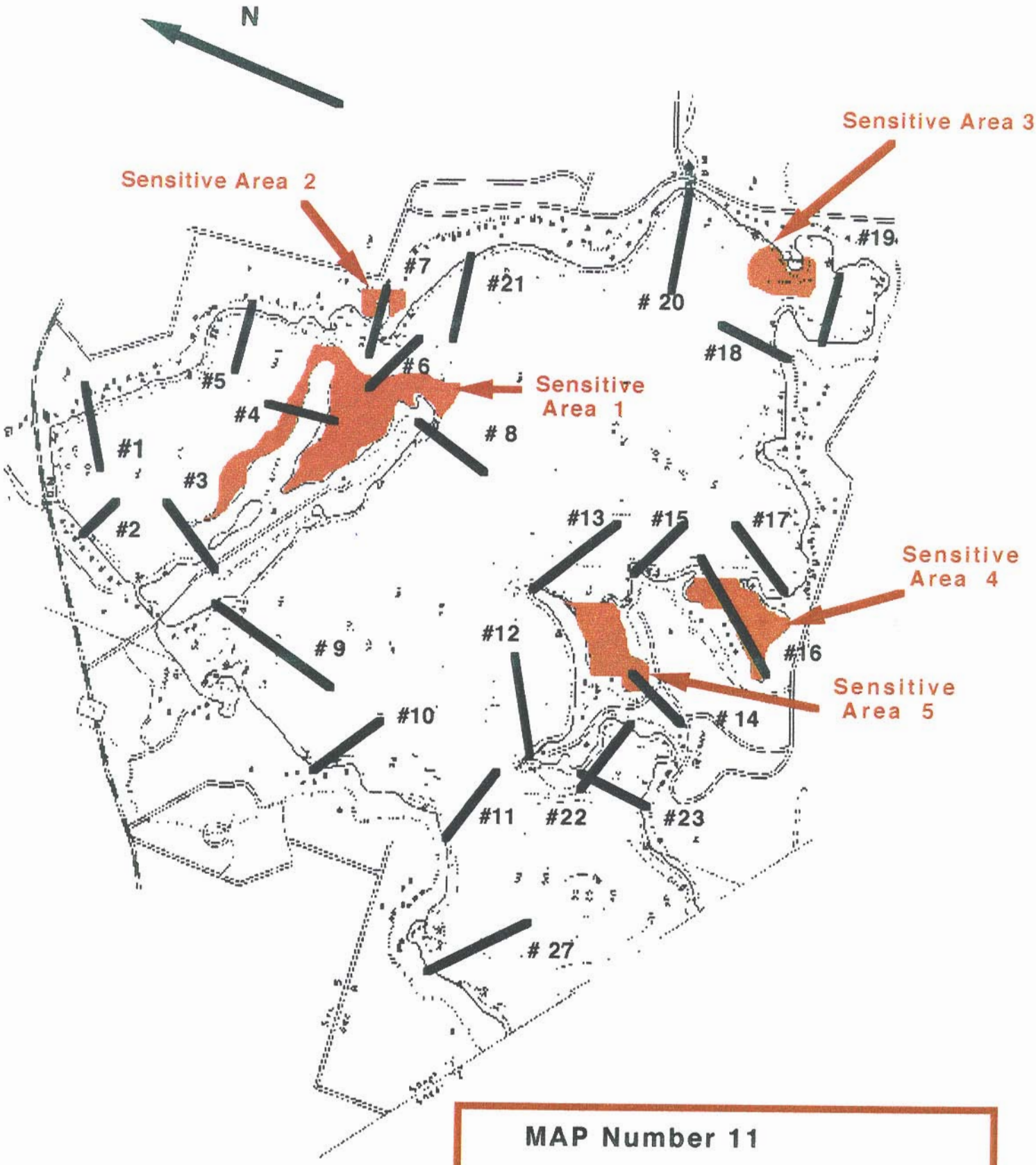
Three plant samples were taken at depths of three, five, ten, and fifteen feet along each transect, providing 192 sample points for the survey. As each new type of plant was identified, a sample was dry mounted and placed in a plastic sheet protector. Twenty eight species of aquatic plants were identified during this study. Muskgrass (*Chara spp.),* found at 93 sample points was the most common plant in the survey. Native milfoil (*Myriophyllum heterophyllum)* and Sago pondweed (*Potamogeton pectinatus)* were next in abundance, each occurring at 71 sample points. Eurasian Water Milfoil *(Myriophyllum Spicatum)* was found at 23 sample points while Purple Loosestrife *(Lythrum saslicaria*), another exotic nuisance was found at only one sample point. A complete list of all aquatic plants identified during this survey is provided in Table 2. Table 3 lists the aquatic plants and the occurrences of each (column B).

Several additional statistics are also shown in Table 3. These statistics are derived from calculations based on formulas and definitions contained in a DNR memorandum prepared on February 4, 1994 , by Stan Nichols. The formulas used are shown in Table #4.



Map Number 10-
LAKE BOTTOM

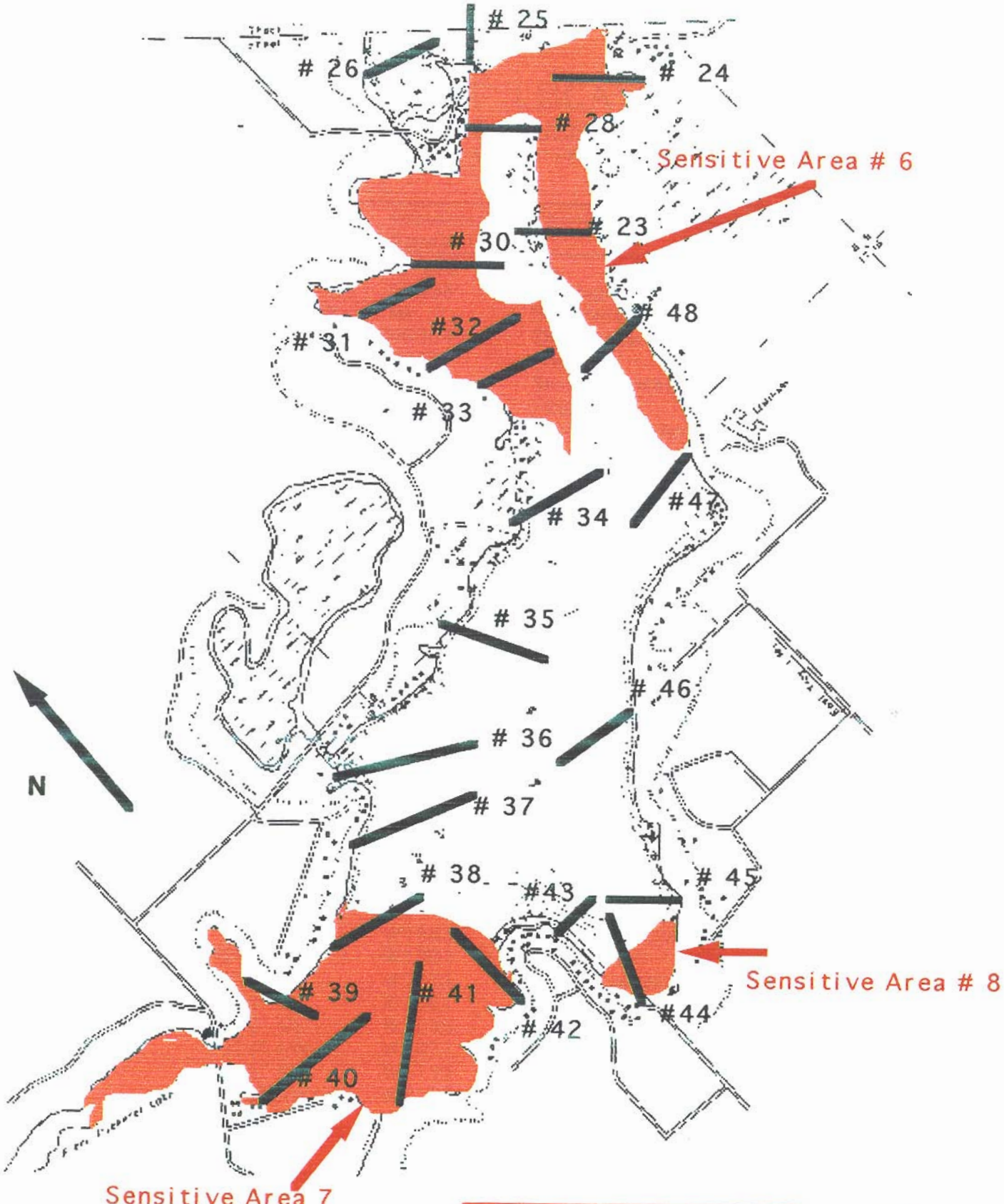
Sand
Gravel
Muck



MAP Number 11

Transect Points July 1995

Sensitive Areas 1, 2, 3, 4, and 5.



Map Number 12

Transect Points July 1995
Sensitive Areas 6, 7, and 8.

Table Number 1

TRANSECT LOCATIONS

LAKE BEULAH

JULY/AUGUST 1995

Transect Number	Compass Heading	Residence Number	Physical Landmark
1	55° NE	W1575	NA
2	295° NW	N9554	Bird house pole
3	205° S-SW	NA	Boat ramp
4	180° S	N9384	Single cedar tree
5	90° E	N9491	Flag pole
6	255° W-SW	NA	Sensitive area-large dead tree
7	105° E-SE	N9409	Flag pole
8	15° N	N9363	Dead cotton wood with sign
9	45° NE	N9459	House door
10	270° W	N9368	Flag pole
11	270° W	W1739	Peak of two story white boathouse
12	225° SW	W1799	Basketball standard
13	270° W	NA	Flag pole
14	220° SW	NA	Wood duck nest box
15	255° SW	N9328	Flag pole
16	210° SW	W1596	Steps of Aspin home
17	200° SW	W1522	Flag pole
18	135°SW	N9139	Birch tree
19	240° W	N9102	Steps to residence
20	75° NE	N9228	Dockside TV antenna
21	75° NE	N9365	Trellis over walk
22	90° E	W1759	Dead birch tree
23	180° S	W1645	Flag pole
24	130° SE	N8899	Camp Edwards boat bay
25	225° SW	N9080	Boat house peak B-67
26	300°NW	N9202	Small sand beach
27	315°NW	N9288	Very large oak tree
28	320° NW	N9103	Yellow house
29	135° SE	NA	Center of second island
30	330° NW	W1965	Dead elm tree on point
31	270° W	W1901	Old log cabin
32	255 SW°	W1933	East end of brick home
33	330° N	W1961	Telephone pole behind home
34	310° NW	W2035	Large willow tree in front of lodge
35	320° NW	W2071	Small beach house
36	335° NW	W2135	Flag pole
37	315° NW	W2189	White pump house
38	330° NW	W2243	Steps
39	360° N	NA	Old bridge north side of channel
40	240° SW	W2246	Steps on deck
41	180° S	N8684	Widow walk on top of house
42	150° SE	NA	Largest tree on northern most island
43	235° SW	N8728	Large four story house
44	180° SW	NA	Flag pole on top of hill
45	155° SE	W2032	Flag pole
46	135° SE	W1964	Trolley track
47	200° S	N8855	Boat house
48	30° NE	NA	Stumps left of small willow tree

Table Number 2

AQUATIC PLANTS

LAKE BEULAH

JULY/AUGUST 1995

	COMMON NAME	SCIENTIFIC NAME
1.	Muskgrass; Attached-erect Algae	*Chara spp.*
2.	Perch Weed;Stonewort	*Nitella spp.*
3.	Wild Celery; Eel Grass (plant)	*Vallisneria Americana*
4.	Wild Celery; Eel Grass	*Vallisneria Americana*
5.	Coontail	*Ceratophyllum Demersum*
6.	American Elodea	*Elodea Canadensis*
7.	Eurasian Water Milfoil	*Myriophyllum Spicatum*
8.	Native Milfoil	*Myriophyllum heterophyllum*
9..	Brittle Naiad, Spiny naiad	*Najas marina*
10.	Naiad	*Najas spp.*
11.	Whitestem pondweed	*Potamogeton praelongus*
12.	Largeleaf pondweed	*Potamogeton amplifolius*
13.	Floating leaf pondweed	*Potamogeton natans*
14.	Curly leaf pondweed	*Potamogeton crispus*
15.	Flatstem pondweed	*Potamogeton zosteriformis*
16.	Sago pondweed	*Potamogeton pectinatus*
17.	Variable pondweed	*Potamogeton gramineus*
18.	Leafy pondweed	*Potamogeton foliosus*
19.	Bladderwort	*Utricularia spp.*
20.	Burreed	*Sparganium spp.*
21.	Water Bulrush	*Scirpus subterminalis*
22.	Arrowhead (underwater leaf)	*Sagittaria spp.*
23.	Arrowhead (emergent leaf)	*Sagittaria spp.*
24.	White water lily, fragrant water lily	*Nymphaea spp.*
25.	Yellow water lily, spatterdock	*Nuphar spp.*
26.	Wild rice	*Zizania aquatica*
27.	Sedge	*Carex comosa*
28.	Bulrush	*Scirpus spp.*
29.	Cattail	*Typha spp.*
30.	Purple Loosestrife	*Lythrum salicaria*
31.	Water willow, swamp loosestrife	*Decodon verticillatus*
32.	Marsh milkweed	*Asclepias incarnata*

AQUATIC PLANT DISTRIBUTION

Table Number 3 — July 1995

A	B	C	D	E	F	G	H	I	J	K	L
COMMON NAME	Occurrence	Frequency	RelativeFrequency	Rel Freq Sqrd	3'	5'	10'	15'	Density	192	Importance Value
American Elodea	8	0.041666667	0.011816839	0.000139638	9	5			14	0.072916667	0.086164451
Arrowhead (underwater leaf)	4	0.020833333	0.005908419	3.49094E-05	4				4	0.020833333	0.012309207
Bladderwort	57	0.296875	0.084194978	0.007088794	24	27	27	14	92	0.479166667	2.28028065
Brittle Naiad,Spiny Naiad	33	0.171875	0.048744461	0.002376022	12	16	19	5	52	0.270833333	1.320162482
Burreed	2	0.010416667	0.00295421	8.72736E-06	5				5	0.026041667	0.007693255
Cattail	2	0.010416667	0.00295421	8.72736E-06	5				5	0.026041667	0.007693255
Coontail	10	0.052083333	0.014771049	0.000218184	9	5	2	7	23	0.119791667	0.176944855
Curly Leaf Pondweed	2	0.010416667	0.00295421	8.72736E-06	2				2	0.010416667	0.003077302
Eurasian Water Milfoil	23	0.119791667	0.033973412	0.001154193	19	12	2	4	37	0.192708333	0.654695963
Flat Stem Pondweed	12	0.0625	0.017725258	0.000314185	22	3			25	0.130208333	0.230797637
Floating Leaf Pondweed	31	0.161458333	0.045790251	0.002096747	27	8	10		45	0.234375	1.07320901
Large Leaf Pondweed	35	0.182291667	0.051698671	0.002672753	17	15	12	13	57	0.296875	1.534804284
Leafy Pondweed	16	0.083333333	0.023633678	0.000558551	9	8		2	19	0.098958333	0.233874938
Muskgrass	93	0.484375	0.137370753	0.018870724	115	128	112	84	439	2.286458333	31.40925037
Naiad, Bushy	46	0.239583333	0.067946824	0.004616771	36	22	9	10	77	0.401041667	2.724950763
Narrow Leaf Pondweed	1	0.005208333	0.001477105	2.18184E-06	1	1			2	0.010416667	0.001538651
Native Milfoil	71	0.369791667	0.104874446	0.010998649	53	48	82	33	216	1.125	11.79837518
Perch Weed	12	0.0625	0.017725258	0.000314185	1		3	32	36	0.1875	0.332348597
Purple Loosestrife	1	0.005208333	0.001477105	2.18184E-06	2				2	0.010416667	0.001538651
Sago Pondweed	71	0.369791667	0.104874446	0.010998649	42	27	32	6	107	0.557291667	1.099864944
Variable Pondweed	29	0.151041667	0.042836041	0.001834926	18	17	2		37	0.192708333	0.825486214
Water Bulrush	9	0.046875	0.013293944	0.000176729	11	9	5		25	0.130208333	0.173098227
WaterWillow, Swamp Loosestrife	3	0.015625	0.004431315	1.96365E-05	10				10	0.052083333	0.023079764
White WaterLily (Fragrant Water Lily)	19	0.098958333	0.028064993	0.000787644	52	5	3		60	0.3125	0.877031019
Whitestem Pondweed	13	0.067708333	0.019202363	0.000368731	3	10		4	17	0.088541667	0.170020926
Wild Celery:Eel Grass	58	0.302083333	0.085672083	0.007339706	50	36	18	12	116	0.604166667	5.176021664
Wild Rice	1	0.005208333	0.001477105	2.18184E-06	4				4	0.020833333	0.003077302
Yellow Water Lily, Spatterdock	15	0.078125	0.022156573	0.000490914	30	4			34	0.177083333	0.392355982
	677	3.526041667	1	0.073503968	592	406	338	226	1562	8.135416667	62.62974554

STATISTICS

The total number of sample points 192

Frequency = number of occurrences/number of sample points

ADEN(average density) = sum of density ratings for a species/number of sampling points

RFREQ(relative frequency) = FREQ of a species / total FREQ of all species

The sum of the relative frequencies should= 100%.

*IV(importance value) = RFREQ *ADEN*100*

An indication of the dominance of a species in a community based on both frequency and density,

Simpsons diversity = 1-Sum(RFREQ)2is an index of community diversity.

The closer the value is to one the greatere the diversity in the population.

FORMULA

AQUATIC PLANT SURVEY

LAKE BEULAH

JULY/AUGUST 1995

Table Number 4

1. FREQ (frequency) = $\frac{\text{Number of occurrences of a species}}{\text{Number of sample points with vegetation}}$

2. RFREQ (relative frequency) = $\frac{\text{FREQ of a species}}{\text{Total frequency of all species}}$

3. ADEN(average density) = $\frac{\text{Sum of density ratings for a species}}{\text{Number of Sample points with Vegetation}}$

4. IV (Importance Value) = RFREQ*ADEN*100

5. SIMP = 1 - sum $(\text{RFREQ})^2$ is an index of community diversity

Formulas 1 and 2 are standard Frequency and Relative Frequency calculations used in traditional statistical analysis. Forty- eight transects were selected from around the lake, to provide representative samples of plant growth from all areas of the lake. A point on the lake was selected and a compass reading from that point to an identifiable landmark was recorded. An imaginary line between that point on the lake and the landmark formed the transect. Along each transect three samples were taken at depths of 3, 5, 10 and 15 feet. The transect sites are defined in Table 1 and are shown on Maps numbered 11 and 12.

The number of times each plant was selected was recorded and its frequency and relative frequency were calculated using Formulas 1 and 2. The results are listed in columns B and C (Table #3). Table 5 shows the 11 most frequently observed plants. Muskgrass *(Chara spp.)* appeared in 93 of the 192 sample points giving it a relative frequency of .484. Eurasian Water Milfoil *(Myriophyllum Spicatum),* was the 11th most frequently found plant with a frequency of 0.119.

Formula 3, is the Average Density value for each plant type. This value was derived from the density ratings assigned to each sample as it was taken. Density ratings are from 1 to 5, with 5 being dense and 1 is sparse. The total density of all species is shown in Table 3. Table 6 lists the twelve plants with the highest densities. Again, *Chara spp.* with a density of 439, compared to 37 for EWM, is the most dominant plant in the lake.

FREQUENCY
AQUATIC PLANT SURVEY
LAKE BEULAH
JULY/AUGUST 1995

Table Number 5

Ranked by Frequenccy (FREQ)

	Name	Frequency	Occurences
1.	Muskgrass	0.484375000	93
2.	Native Milfoil	0.369791667	71
3.	Sago Pondweed	0.369791667	71
4.	Wild Celery	0.302083333	58
5.	Bladderwort	0.296875000	57
6.	Bushy Naiad	0.239583333	46
7.	Large Leaf Pondweed	0.182291667	35
8.	Brittle Naiad	0.171875000	33
9.	Floating Leaf Pondweed	0.161458383	31
10.	Variable Pondweed	0.151041667	27
11.	*EURASIAN WATER MILFOIL*	*0.119791660*	*23*

A comparison of Tables 5 and 6 shows little variation in the ranking of the plants using frequency or density.The sums of the density ratings for each plant are shown in Column J of Table 3. Table 5 lists the 11 most dominant plants based on the frequency of occurrence and the density of the plants The average density is determined by dividing the total density for each species by the number of sample points. This value provides an indication of the significance of a species based upon frequency of occurrence and the density of the plant in the samples taken.

The Importance Value (IV-Formula 4) indicates the importance of each type of plant relative to the community in which it is found. This measure is calculated using the RFREQ value and the ADEN values. Based on theses numbers *Chara spp.* has an importance value of 31.4 compared to an 11.8 for EWM. Using both the frequency and density should provide a more reliable statistic to use when comparing plants within the community.

Formula 5, Simpson's Diversity, provides an index of the diversity of plants in a community. The closer this value is to one (1) the greater is the diversity of plants. The Simpson's Diversity value from this study is 0.9265, indicating that Lake Beulah has a very good diversity of aquatic plants. As mentioned earlier in this report, the greater the diversity of plants and the healthier those plants are the easier it is to keep unwanted exotic plants from getting a foothold in the lake .

Because statistics are not available for earlier periods it is difficult to judge the effectiveness of past plant management programs using these results alone. However, as suggested in the Nichol's memo, a second round of sampling should be done to validate the results of this study, to provide period to period comparisons of the statistics, and to provide data that can be used to determine if any trends are developing. Local trends are important for the management of the aquatic plant population in the lake. The data will be useful for comparisons and analyses of aquatic plant community parameters on a state wide basis.

IMPORTANCE VALUE

AQUATIC PLANT SURVEY

LAKE BEULAH

JULY/AUGUST 1995

Table Number 6

Ranked by Importance Value (IVAL)

	Name	Importance Value	Density
1.	Muskgrass	31.40925037	439
2.	Native Milfoil	11.79837518	216
3.	Wild Celery	5.176021664	116
4.	Bushy Naiad	2.724950763	77
5.	Bladderwort	2.280280650	92
6.	Large Leaf Pondweed	1.534084284	57
7.	Brittle Naiad	1.302162482	52
8.	Sago Pondweed	1.099864944	107
9.	Floating Leaf Pondweed	1.073209000	45
10.	White Water Lily	0.877031019	60
11.	Variable Pondweed	0.825486214	37
12.	*EURASIAN WATER MILFOIL*	*0.654959963*	*37*

WATER TESTING

The clarity of the water in a lake is an aesthetic characteristic that nearly everyone can see and enjoy. Cool, clear water is more inviting than warm, cloudy water. Water clarity provides an overall indication of water quality in a lake. The are two main elements of water clarity. The first is its true color which is determined by the materials that are dissolved in the water. Second is its turbidity which is the materials that are suspended in the water such as algae and silt. "The algae population is usually the largest and most variable component."[4]

Water clarity is measured using a device known as a Secchi disc. It is a weighted disc, eight inches in diameter that is painted black and white. The disc is lowered into the water until it just disappears from sight. That depth is noted and the disc is then raised until it appears again. The second depth is also recorded. The average of these two readings is recorded as the Secchi Depth. Table 7summarizes Secchi Depths recorded for Lake Beulah for the past six years. The readings were taken six times each year at five different sites as shown on Map #7 (page 2). The values shown in the table are averages of the readings at all sites for each year. The Secchi disc readings for the periods shown indicate consistent water clarity for Lake Beulah. Readings will vary with algae growth, water temperature and the volume of recreational traffic on the lake. Secchi depths recorded over a number of years is an inexpensive way to monitor long-term changes in water quality.

SECCHI DEPTHS

LAKE BEULAH

1990-1995

Table Number 7.

YEAR	STATION	AVERAGE DEPTH
1990	1-5	08.75 ft.
1991	1-5	08.55 ft.
1992	1-5	11.29 ft.
1993	1-5	08.80 ft.
1994	1-5	08.79 ft.
1995	1-5	08.51 ft.

Source:Glenn Kreinbrink

The Sanitary District has recorded this data for several years as a participant in the "Self-Help Monitoring Program for Lakes", that is sponsored by the Wisconsin Department of Natural Resources. The District has historical data showing the amount of dissolved oxygen in the water and water temperature, along with the Secchi disk readings. Water testing is part of the DNR's expanded TSI (Trophic State Index) Program. The historical data files need to be reviewed and put into a mechanized format or data base that can be more easily accessed. The data needs to be reviewed to determine if it is complete . If not, what is missing? Can the missing data be added? Does it exist somewhere? If historical data is not available what needs to be done to make the files more complete for future analysis? Obtaining answers to these questions would be a worth while project for the District to consider, as it would be an important resource for future studies and comparisons.

ADMINISTRATION

In the late 1960's Sanitary District #1 was formed to assist in the maintenance of the quality of the lake and its surrounding area. Both the Lake Beulah Protective and Improvement Association and the Sanitary District have actively pursued common goals related to maintaining the quality of the lake. A primary goal of the two organizations has been to monitor, preserve and protect Lake Beulah. As stated in the bylaws of the Protective Association, "The objective of this association shall be the general improvement and protection of Lake Beulah and the streams and waters adjacent thereto,... and the promotion of taking action tending to the improvement and safe enjoyment of the Lake, its streams, and natural resources and habitat thereof." [5]

Until 1996 the harvesting program was directed by the Lake Beulah Sanitary District, a three person board. With the consent of both the Improvement Association and the East Troy Town Board, the Sanitary District was converted to the Lake Beulah Management District. A five member board, made up of a Town Board representative, a representative from the County Board, and three elected riparian owners,will assume the responsibilities of the Sanitary District, plus other lake related activities. All riparian owners will have a voice in matters affecting the lake and its watershed. As the lake and its surroundings undergo change, it is important for these organizations. as well as all interested groups, to remain flexible and continue to be partners in their efforts to maintain the quality of Lake Beulah and its watershed.

One of the first considerations of the new organization should be to establish a new District position, Harvesting Supervisor. The main responsibility of this position would be to oversee the complete harvesting operation. The position should be occupied by a non-Board individual and should be a paid position. The Board should develop a job description and then conduct a job search to find an individual to fill the position.

INSURANCE

At the present time the District maintains sufficient insurance to cover the plant management operations. The cost of liability insurance for the plant harvesting operations should be the responsibility of the Lake Beulah Management District. Policies in force include :

Commercial Marine
Commercial Property
Commercial General Liability
Commercial Automobile Liability
Workmen's Compensation

It is important for the Management District to review its insurance coverage each year so that necessary adjustments can be made to meet any changes that occur in the value of the property or the equipment it owns and operates.

EQUIPMENT

At the present time the district is operating a D and D 620 Harvester, a matching transporter, and a shore conveyer, all of which are nine years old. The normal life expectancy of equipment of this type is ten years. Regular routine maintenance has prolonged the life of these machines by another three to five years. Since this equipment was purchased, harvesting requirements and practices have undergone change. The amount of open water harvesting has been reduced and the depth of harvesting has decreased. There has been a steady increase in the number of larger and more elaborate pier structures around the lake. Each of these factors changes the requirements that must be met by the harvesting equipment. The present equipment does not fully satisfy theses new requirements. Larger machines have served the district well during the past nine years, but that is no longer the case.

Current needs indicate that a smaller machine, which would be more maneuverable and more efficient, should be considered. A smaller machine would make harvesting around piers and other structures much easier. The following table provides a comparison of three different sized machines. The harvesting estimates are based on the following assumptions:

1. The harvesting period generally is from mid-June until the end of August, providing about 8 weeks of harvesting. depending on the weather and the growth rate of the plants.
2. Actual cutting time is estimated to be five (5)hours per day.
3. Actual harvesting area is between 85 and 100 acres.
4. The harvesting depth will be 5 feet.

Table 8 shows that a harvester with a 7' cutting bar , a capacity of 440 cubic feet or 8500 pounds would be the best fit to meet the requirements of Lake Beulah.

HARVESTING MACHINE CAPACITIES

LAKE BEULAH

JUNE/JULY 1995

TABLE NUMBER 8.

Cutter Width	Rated Capacity Acres/Hr	Actual Capacity Acres/Hr	8 200	weeks hours
5'	.61	.30	122	60
7'	**.85**	**.425**	**170**	85
9'	1.21	.62	242	124

All units are manufactured by Aquarius Systems, North Prairie, Wi.

One H-420-Harvester and one TR-12 Trailer	$75,215
One T-12 Transporter and one TR-12 Trailer	$60,000
TOTAL	$135,715

A relatively small cost would be incurred to modify the old elevator so it would match the new machine. The present equipment has some market value which would help defray some of the costs of new equipment. The present equipment has an estimated current value of between $20,000 and $30,000, which lower the outlays for the new equipment. With an Aquatic Plant Management Plan in place, the District can apply to the Wisconsin Waterways Commission for financial assistance to purchase new equipment. A significant reduction in the total outlay by the district would be realized. Therefore , it is the recommendation that the Lake Management District purchase new equipment as soon as possible.

EWM MANAGEMENT

Managing Eurasian Water Milfoil in Lake Beulah is a concern of the Management District, the Lake Beulah Protective and Improvement Association, riparian owners and others concerned about the well being of the lake. When EWM was first discovered, the Improvement Association formed an Aquatic Plant Committee. The Committee is made up of an Association member, a Management District member, a riparian owner and a representative from the DNR. The purpose of the committee continues to be to seek out methods to treat EWM infestations found in the lake. Thus far the committee has been very helpful to the District both in determining the appropriate method to use and then helping implement it. The committee has also helped by distributing news releases, about EWM, via the Association's newsletter and other publications.

Table # 9 lists alternative methods used for treating EWM. The methods are placed in order of effectiveness in dealing with EWM and in the order that should be used to keep EWM growth under control. It is necessary to understand that each individual infestation of EWM requires individual evaluation and that each area is likely to require a different method of treatment; i.e., one single procedure cannot be used in all areas.

Table Number 9

MILFOIL MANAGEMENT METHODS

LAKE BEULAH

JULY/AUGUST 1996

TYPE OF INFESTATION	TREATMENT	RESPONSIBILITIES
Shallow water, near obstructions Riparian/District/Contract Density level low-moderate	Hand removal	Everyone
Water- 3 feet or deeper Little or no obstruction Density level -heavy	Mechanical	District
Any depth of water Obstruction/No obstruction 75% EWM-major infestation Seasonal reoccurring & spreading	Chemical, 2-4-D	District/Contract
Shallow water Very High Density Area of less than 200sq. ft.	Bottom barrier	District/Riparian

When machine harvesting or other mechanical means of removing EWM are used, it is extremely important that all floating fragments be removed from the lake to prevent the spreading of EWM. Hand raking of the shoreline by riparian owners and/or District employees is always extremely helpful.

EDUCATION

The LBPIA and the District have produced and distributed newsletters and other materials to keep the community informed about the lake and the various problems it faces. Those materials include descriptions of the programs being instituted to address lake problems and how individuals can take part in those programs. Informational meetings and discussions have also been held for the public. The dissemination of information, regardless, of the format, is a very worth while tool that should be continued and , where possible, expanded. Information about routine harvesting, EWM treatment, other future concerns, and lake ordinances all need to be publicized so that the entire lake community is aware of what is taking place. A good working relationship between the District, the LBPIA and the DNR should be maintained and nurtured for the benefit the entire lake community.

RECOMMENDATIONS

1. The Lake Beulah Management District should retain as its primary objective the protection Lake Beulah and its watershed.

2. The Lake Beulah Management District, the Lake Beulah Protective and Improvement Association, the Town Board of East Troy and the Wisconsin Department of Natural Resources must continue as partners and work together as a team to promote the well being of all aspects of Lake Beulah. The existing Aquatic Plant Committee should be maintained

3. The "team" should develop a job description for the position of Harvesting Supervisor, and hire a full time person to perform those duties for the May through September time frame.

4. The District should obtain the necessary approvals and complete the paperwork to purchase a new harvester and trailer. They should arrange to have the necessary modifications made to the present elevator so that it is compatible with the new harvester. Finally they should oversee the sale of the existing equipment that is no longer needed.

5. In conjunction with Item 4, a grant application should be prepared and submitted to the DNR to obtain funds to assist in the purchase of the new harvesting equipment in the Spring of 1997.

6. Harvesting operations need to be modified to accomodate the change in the amount of materials being removed from the lake. The present operation involves one operator driving the harvester while the second operator mans the transporter and the truck. Since harvesting has become more selective, and the amount of material removed from the lake has declined, the transport operator should collect the plants that are accumulated by homeowners. A weekly schedule or (some regular schedule) should be established for the collection of these plants. The operators should continuously survey the lake for floating EWM fragments and remove them from the lake.

7. Current aquatic plant management practices to control EWM should be continued, using the methods summarized in Table #9.

8. The recommendations made in the Sensitive Area Study should be followed as closely as possible:

   a. Avoid mechanical harvesting in the Sensitive Areas.

   b. Prohibit dredging or any activity that might involve major disruptions to the lake bottom.

   c. Use herbicides or other chemicals only in well controlled areas.

   d. Continue mechanical harvesting only in predetermined areas and at specific depths to avoid disturbing the lake bottom.

9. The District and the Association should participate regularly in programs, seminars, workshops and discussion groups, sponsored by the DNR and other lake associations.

10. Water testing activities should be continued, including Secchi depth readings, oxygen content, water temperatures and other measures as recommended by the DNR.

11. The District should arrange to have its historical data organized and displayed in a more usuable format.

12. Existing publications, public education materials and informational sessions should be continued and regularly reviewed for ideas and suggestions about aquatic plant management techniques. This includes making others aware of successes and failures of the Lake Beulah team.

13. Stay alert for other exotic nuisances that may attempt to enter the lake and create problems; i.e. purple loosestrife, zebra mussels etc.

14. Plan to update the Aquatic Plant Management data during 1997- especially the aquatic plant inventory, and report on the progress of all efforts to control/eliminate EWM, including the Herbivore Weevil testing program currently underway by the DNR. Even though Lake Beulah was not selected as a test site for the current experiments with the weevil, review the results produced by that trial and use as appropriate.

15. All watercraft (power boats, jet skis, canoes, sailboats etc.) entering and leaving the lake should be thoroughly inspected for EWM fragments, evidence of zebra mussels, and other exotics. Fragments should be removed and the boats thoroughly washed. A washing station, with a high pressure hose should be installed at the upper level, public parking area in the Wilmers Grove location for this purpose. Signs should be installed and maintained at all launch sites stating these requirements.

16. Pay careful attention to <u>all</u> shoreline development, especially new construction and or other proposed modifications of the shoreline, to insure that all requirements are being met.

17. Conduct a review of construction/building permit requirements that have an impact on the lake. Are permits being obtained when they should be ? Are activities taking place today that do not require permits that should require permits ? Are permits being granted when they should not be ? Are permits being granted today that are based on "old" reasons ? When permits are obtained, what organization is responsible for enforcing the requirements of that permit ? What recourse is available when illegal activities have taken place without a permit ?

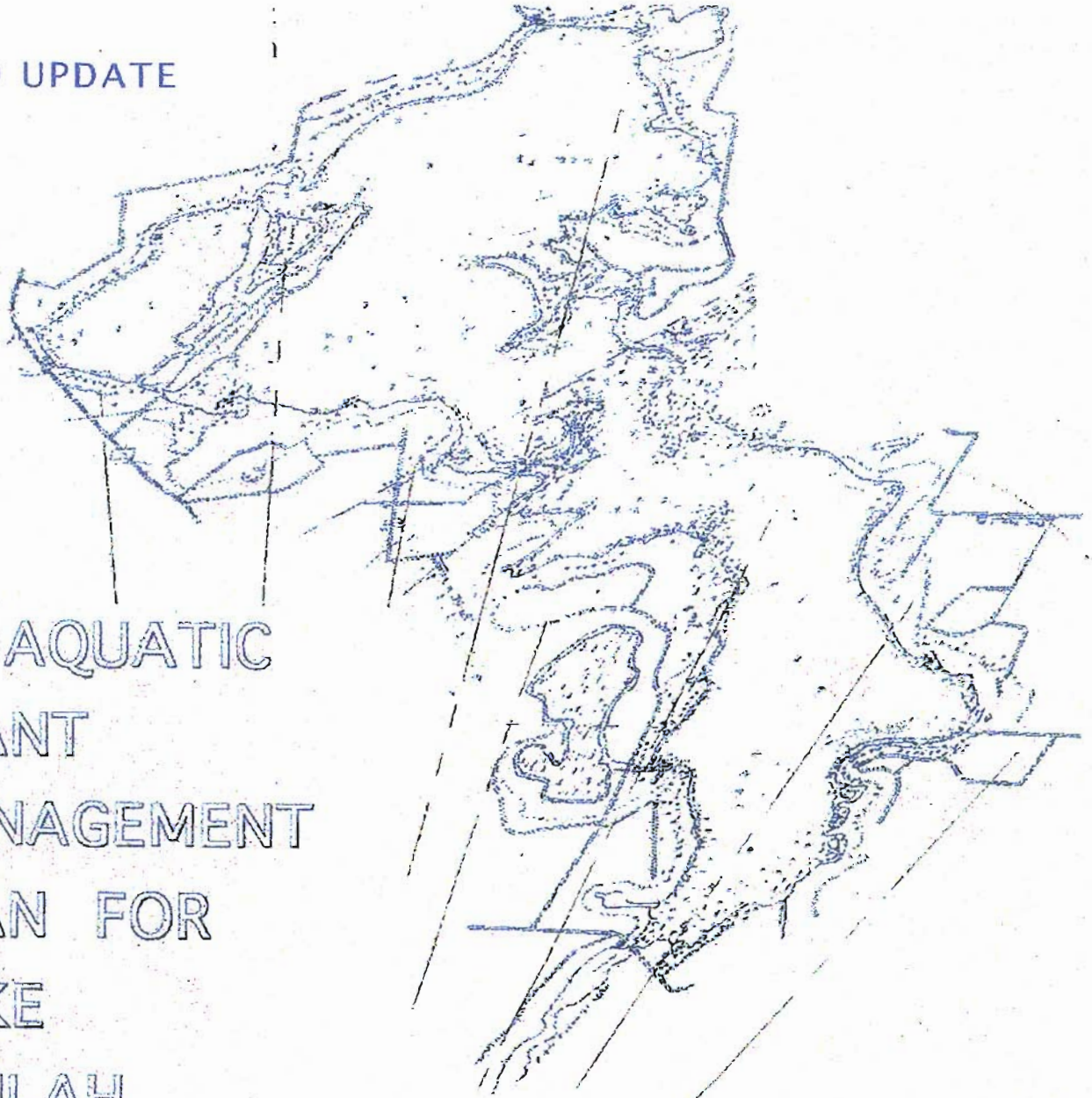
CONCLUSIONS

The list of recommendations summarizes and repeats, in some cases, key concerns and activities that need to be considered, and undertaken by the organizations responsible for the well being and future good health of Lake Beulah. They are repeated in order to emphasize their importance.

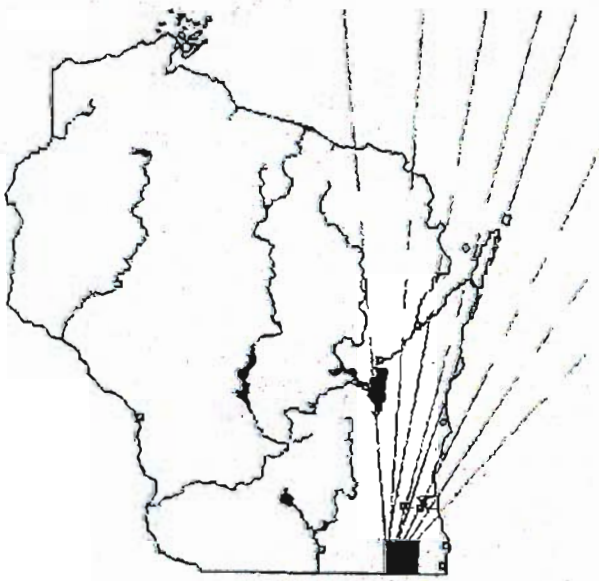
As Lake Beulah changes so will its surrounding areas. Urban sprawl is beginning to encroach upon the lake community. It is imperative that the organizations involved, look toward the future to determine what is good not only for the lake but the entire environment surrounding it. The Management District should spearhead an effort to apply to the DNR for assistance to complete a Lake Management Plan. This document is intended to be the first step. A comprehensive Lake Management Plan requires looking at and analyzing the entire Lake Beulah watershed. In the future, the District may conclude that its current boundaries need to be expanded and not limited to just the riparian owners.

Old problems, such as lake dredging, building code violations, and careless boating activities may re-emerge and will need to be dealt with. Purple Loosestrife needs to be carefully watched and its spread needs to be stopped before it starts. The harvesting process needs to be monitored, analyzed and modified as circumstances dictate. Communication with other Lake Districts and the DNR is essential and can be maintained by attending workshops, conventions and seminars. Many outside organizations have a variety of materials that can be helpful to us as we continue to strive to keep our valuable resource .....**VALUABLE!!**

1999 UPDATE



AN AQUATIC PLANT MANAGEMENT PLAN FOR LAKE BEULAH



Pepared for
The Lake Beulah
Management District
by
Lynn Carlson, Glen Kreinbrink
and Phil Davis

APRIL, 2000

The following report is an update to *An Aquatic Plant Management Plan for Lake Beulah* that was prepared in June 1996 for the Lake Beulah Management District and the Lake Beulah Protective and Improvement Association.

The earlier report was the first formal study developed to identify the aquatic plant life in Lake Beulah and present a plan to track and control the growth of plants in the lake. The plan was developed as a starting point to create a database that could be updated in the future to provide an ongoing history of the "health" of the lake and how it responds to the various tools and techniques employed to manage and maintain its quality.

The research team that collected the data for the earlier study used the same methodologies for gathering, analyzing and presenting the data for this update. Lynn Carlson and Glen Kreinbrink conducted the field studies to gather the data. Phil Davis prepared the statistics and all three team members participated in the analysis of the data and the preparation of the final report.

After reviewing the new data and comparing it to the results of the earlier study, recommendations for future courses of action and supporting activities are proposed. In addition, progress made with respect to the recommendations made in the first report are summarized (See Appendix A at the end of this report).

The acknowledgements and reference materials cited in the first report continue to play an important role in the preparation of this report. They are shown on page 23.

DATA COLLECTION AND ANALYSIS

During the summer of 1999, the 48 transect points, shown on Map 1, were revisited and samples of aquatic plants were obtained. Table 1 lists the name of each species found, the number of occurrences of each, and the densities of each sample. The sample data was used to calculate the statistics shown in the table as defined at the bottom of the table.

Twenty-nine different aquatic plant species were identified, with the greatest growth concentrations at the three and five feet depths. It should be noted that three species found in 1995 were not found in 1999; Curly Leaf Pondweed, Purple Loosestrife, and Narrow Leaf Pondweed. Similarly, there were three species found in 1999 that did not appear in the 1995 samples; Duckweed, Filamentous Algae and Spike Rush.

The Simpson's Diversity Factor (defined in an internal memo from the Department of Natural Resources dated February 4, 1994, from Stan Nichols to various staff members, regarding "An Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lake",) provides an indication of the relative diversity of the plant population in a lake. The diversity of plant growth in a population increases as the Simpson's value approaches 1. The latest value for Lake Beulah of .9178 is not significantly different from the 1995 value of .9265, indicating that Lake Beulah continues to have an excellent diversity of plant growth.

Data in Tables 2 and 3 were extracted from Table 1 to demonstrate several specific points. Table 2 lists the most common species identified in the 1999 study based on the frequency of each plant . The frequency is calculated using the number of occurrences of each species divided by the total number of observation points.

The frequency of Muskgrass, or Chara moved from 7th place in 1995 to 1st in 1999. Native Milfoil and Sago Pondweed moved from the top spot in 1995 to 2nd and 4th, respectively. Eurasian Water Milfoil maintained its 5th place status. The number of occurrences of Chara, Eurasian Water Milfoil, Whitestem Pondweed, and Yellow Water Lily were all higher in 1999, while the remainder of this subset declined.

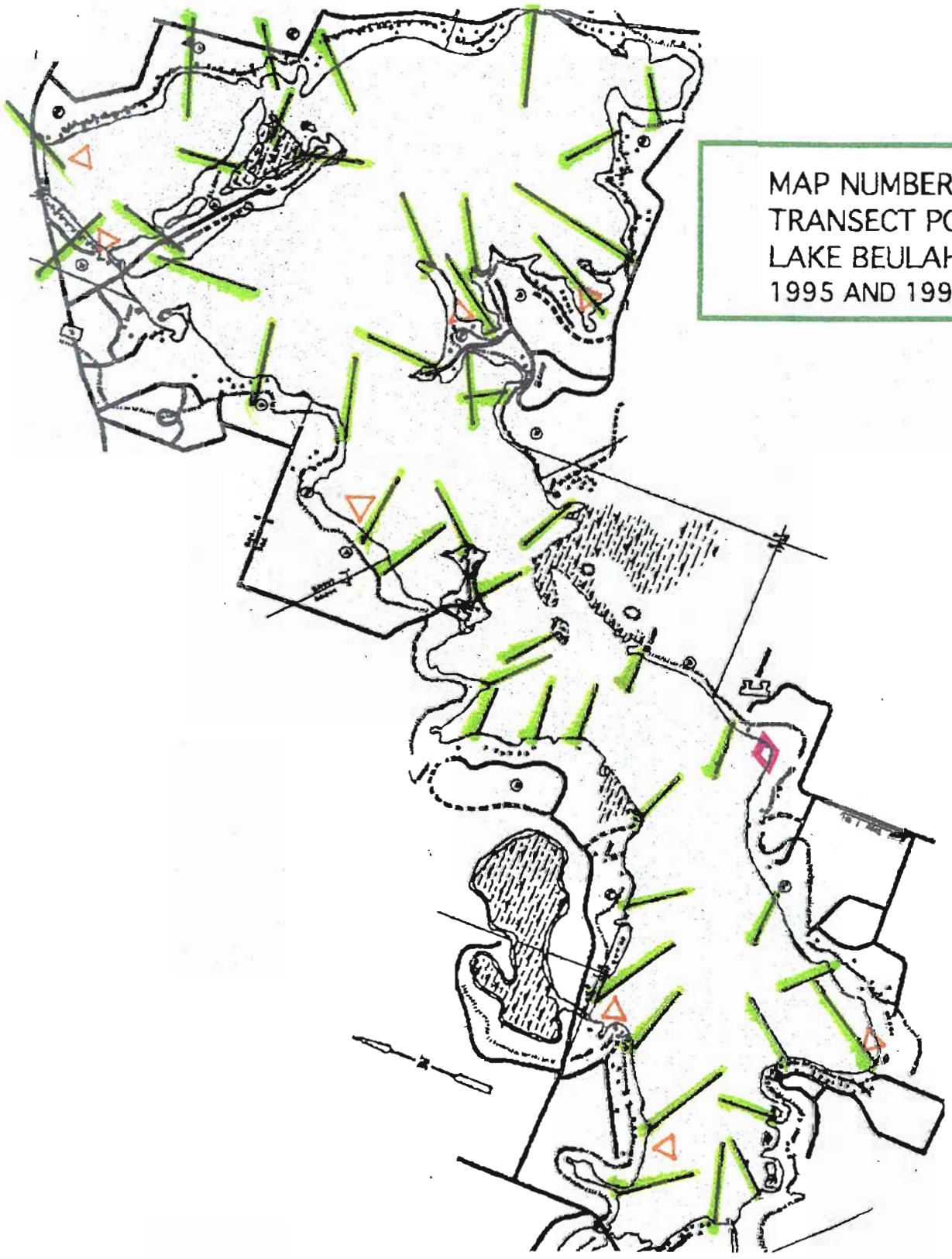

MAP NUMBER 1
TRANSECT POINTS
LAKE BEULAH
1995 AND 1999
Transect Points 1995 and 1999
1999 Chemically Treated Areas
Zebra Mussels
on Harvesting Equipment
3, 5, 10, 15 foot

TABLE 1

AQUATIC PLANT DISTRIBUTION
July 1999

COMMON PLANT NAME	Occurrences	Frequency	Rel. Frequency	Rel. Freq. Sqrd.	3'	5'	10'	15'	Density	Ave. Density 192	Importance Val.
American Elodea	5.0	0.0260417	0.00907441016	0.00008234492	5	3	0	0	8	0.04166666667	0.03781004235
Arrowhead (emergent leaf)	0.0	0.0000000	0	0	0	0	0	0	0	0	0
Arrowhead (underwater leaf)	3.0	0.0156250	0.0054446461	0.00002964417	3	1	0	0	4	0.02083333333	0.0113430127
Bladderwort	28.0	0.1458333	0.05081669691	0.00258233669	10	13	11	6	40	0.20833333333	1.0586811857
Brittle Naiad, Spiny Naiad	16.0	0.0833333	0.02903811252	0.00084321198	12	12	0	1	25	0.13020833333	0.37810042347
Bulrush	3.0	0.0156250	0.0054446461	0.00002964417	8	0	0	0	8	0.04166666667	0.02268602541
Burreed	1.0	0.0052083	0.00181488203	0.0000032938	0	0	0	1	1	0.04166666667	0.00756200847
Cattail	3.0	0.0156250	0.0054446461	0.00002964417	10	0	0	0	10	0.05208333333	0.02835753176
Coontail	3.0	0.0156250	0.0054446461	0.00002964417	4	0	1	1	6	0.03125	0.01701451906
Curly Leaf Pondweed	0.0	0.0000000	0	0	0	0	0	0	0	0	0
Duckweed	3.0	0.0156250	0.0054446461	0.00002964417	3	1	0	0	4	0.02083333333	0.0113430127
Eurasian Water Milfoil	39.0	0.2031250	0.07078039927	0.00500986492	39	19	10	6	74	0.38541666667	2.7279945554
Filamentous Algae	7.0	0.0364583	0.01270417423	0.00016139604	8	3	0	0	11	0.05729166667	0.07278433152
Flatstem Pondweed	18.0	0.0937500	0.03266787659	0.00106719016	24	5	0	1	30	0.15625	0.51043557169
Floating Leaf Pondweed	24.0	0.1250000	0.04355716878	0.00189722695	38	11	4	0	53	0.27604166667	1.2023593466
Large Leaf Pondweed	21.0	0.1093750	0.03811252269	0.00145256439	34	27	0	0	61	0.27604166667	1.0520644283
Leafy Pondweed	7.0	0.0364583	0.01270417423	0.00016139604	11	2	0	0	13	0.06770833333	0.08601784634
Muskgrass	113.0	0.5885417	0.20508166969	0.04205849124	153	174	78	62	467	2.4322916667	49.881843618
Naiad, Bushy	19.0	0.0989583	0.03448275862	0.00118906064	17	8	3	4	32	0.16666666667	0.57471264368
Narrow Leaf Pondweed	0.0	0.0000000	0	0	0	0	0	0	0	0	0
Native Milfoil	47.0	0.2447917	0.08529945554	0.00727599711	49	31	57	13	150	0.78125	6.6640199637
Nitella	10.0	0.0520833	0.01814882033	0.00032937968	2	0	0	8	34	0.17708333333	0.32138535995
Purple Loosestrife	0.0	0.0000000	0	0	0	0	0	0	0	0	0
Sago Pondweed	47.0	0.2447917	0.08529945554	0.00727599711	31	30	9	3	73	0.38020833333	3.2431563823
Spike Rush	1.0	0.0052083	0.00181488203	0.0000032938	4	0	0	0	4	0.02083333333	0.00378100423
Variable Pondweed	25.0	0.1302083	0.04537205082	0.002058623	19	17	1	0	37	0.19270833333	0.87435722928
Water Bulrush	5.0	0.0260417	0.00907441016	0.00008234492	7	14	0	0	21	0.109375	0.09925136116
Water Willow, Swamp Loosestrife	3.0	0.0156250	0.0054446461	0.00002964417	11	0	0	0	11	0.05729166667	0.03119328494
White Water Lily(Fragrant Water Lily)	14.0	0.0729167	0.02540834846	0.00064558417	35	8	3	0	46	0.23958333333	0.60874168179
Whitestem Pondweed	25.0	0.1302083	0.04537205082	0.002058623	11	23	21	12	67	0.34895833333	1.5832955233
Wild Celery, Eel Grass	37.0	0.1927083	0.06715063521	0.00450920781	57	19	17	0	93	0.484375	3.2526088929
Wild Rice	5.0	0.0260417	0.00907441016	0.00008234492	0	8	2	4	14	0.07291666667	0.06616757411
Yellow Water Lily,Spatterdock	19.0	0.0989583	0.03448275862	0.00118906064	50	2	0	10	62	0.32291666667	1.1135057471
TOTALS	551.0	2.8697917	1	0.08219669896	655	431	217	132	1459	7.59375	75.542574108

NOTES ON STATISTICAL CALCULATIONS

Total number of sample points =192

Frequency=Number of occurrences/number of sample points

ADEN(average density)= sum of density ratings for a species/number of sample points

RFREQ(relative frequency) = FREQ/total freuency of all species

Sum of relative frequencies = 100%

IV(importance value) = RFREQ*ADEN*100. An indicationof the dominance of a species in a community based on both frequency and density.

Simpson's diversity = 1- sum(RFREQ)2 is an index of community diversity

The closer the value to (1) the greater the diversity of the population.

Table 2 FREQUENCY/OCCURRENCE RANKING

AQUATIC PLANT	1999 FREQUENCY	1995 FREQUENCY	1999 OCCURRENCE	1995 OCCURRENCE
Muskgrass	0.58854166667	0.0484375	113	93
Native Milfoil	0.24479166667	0.369791667	47	71
Wild Celery, Eel Grass	0.24479166667	0.302083333	37	58
Sago Pondweed	0.203125	0.369791667	47	71
Eurasian Water Milfoil	0.19270833333	0.11979166	39	23
Whitestem Pondweed	0.14583333333	0.067708333	25	13
Floating Leaf Pondweed	0.13020833333	0.161458383	24	31
Yellow Water Lily,Spatterdock	0.13020833333	0.161458333	19	15
Bladderwort	0.125	0.296875	28	57
Large Leaf Pondweed	0.109375	0.182291667	21	35
Variable Pondweed	0.09895833333	0.151041667	25	27

Table 3 ranks the most common plants according to their respective 1999 Importance Value, which includes both the frequency and the density of the plants and gives an indication of the dominance of a species in the lake community. (See Appendix B for pictures of these plants.) When comparing the 1999 ranking with that of 1995 it can be seen that Muskgrass, Native Milfoil, Wild Celery and Sago Pondweed maintained their positions from one study to the next.

TABLE 3 IMPORTANCE VALUE RANKING

AQUATIC PLANT	1999 IMPORTANCE VALUE	1995 IMPORTANCE VALUE
Muskgrass	49.881843618	31.40925037
Native Milfoil	6.6640199637*	11.79837518
Wild Celery, Eel Grass	3.2526088929*	5.176021664
Sago Pondweed	3.2431563823	2.724950763
Eurasian Water Milfoil	2.7279945554	0.654959963
Whitestem Pondweed	1.5832955233	0.170020926
Floating Leaf Pondweed	1.2023593466	1.073209
Yellow Water Lily,Spatterdock	1.1135057471	0.392355982
Bladderwort	1.0586811857*	2.280228065
Large Leaf Pondweed	1.0520644283*	1.534084284
Variable Pondweed	0.87435722928	0.825486214

* declined in Importance Value from 1995 study

The Importance Value of the following species

Increased	Muskgrass Sago Pondweed Eurasian Water Milfoil Whitestem Pondweed Floating Leaf Pondweed Yellow Water Lily Variable Pondweed

while these

X	decreased	Native Milfoil Wild Celery Bladderwort and Large Leaf Pondweed

Although, Eurasian Water Milfoil experienced a significant increase in Importance Value, it dropped from 5th place to 7th in the ranking, while Whitestem Pondweed dropped from 6th to 9th following its decline in importance value. While the values decreased, from their earlier levels, the positions of Native Milfoil and Wild Celery did not change. In another case, Bladderwort jumped from 9th to 5th as its importance value declined.

Because survey techniques were consistent between the two study periods, basic comparisons of data collected at various transect points are reasonable. Table 4 highlights specific transect points and several plant species that appear to have undergone the most significant changes in density between 1995 and 1999.

(1) There has been some decline in the density of EWM in areas that received chemical treatment in 1999 (see Map 1 that shows areas that received treatment during 1999.)

(2) Some of the areas experiencing a decline in EWM are showing a corresponding increase in the density of chara and wild celery.

(3) Most of the significant changes that were observed took place in either 3' or 5' of water.

(4) Two of the transects were not treated in 1999.

Table 4

PLANT DENSITY COMPARISONS

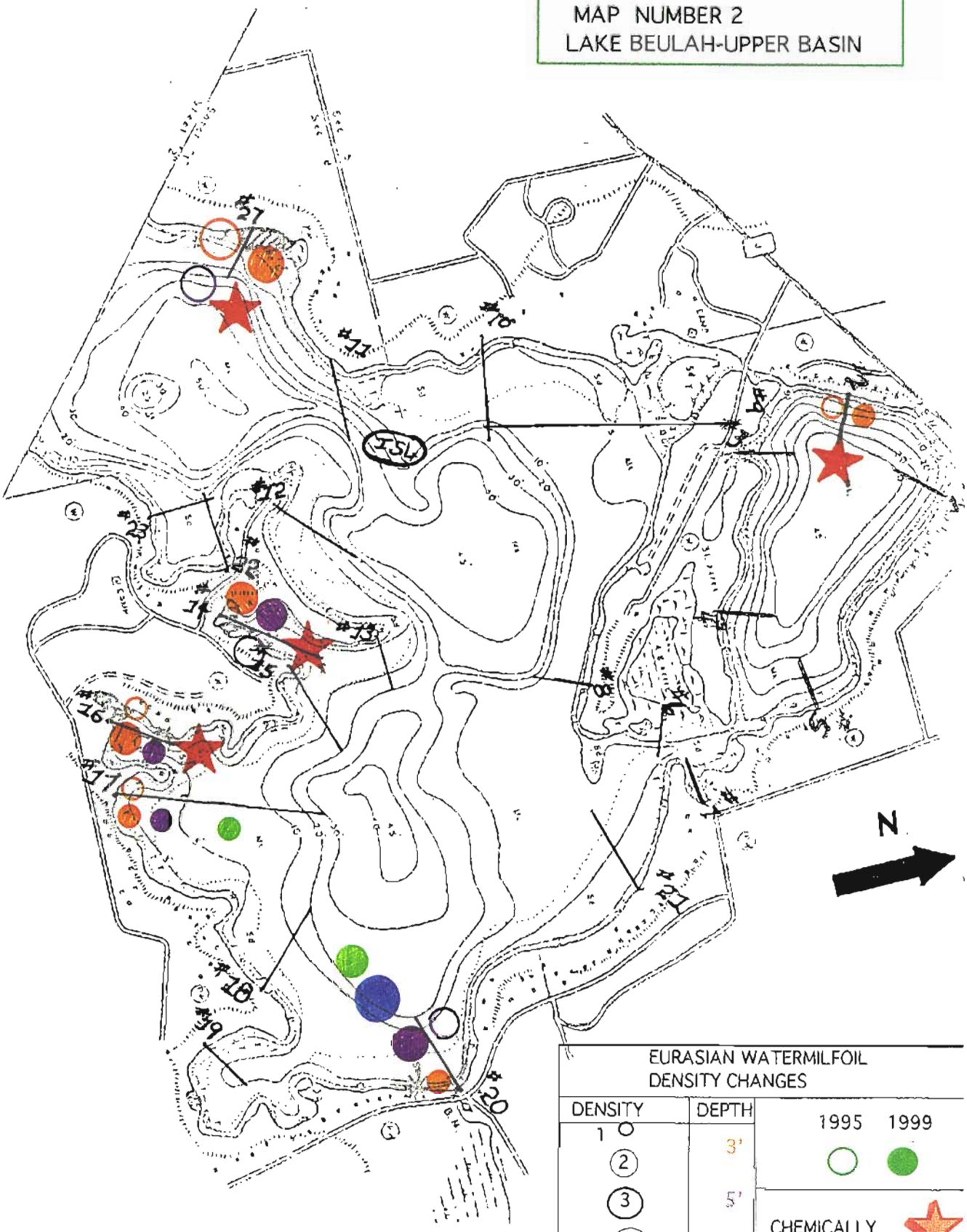
DATE	TRANSECT NUMBER	SPECIES	DEPTH IN FEET			
	Mill Lake-Skotarzak Area		3	5	10	15
1995	2	Native Milfoil	5	3	1	0
1999	2		5	2	0	0
1995	2	Muskgrass (Chara)	1	3	5	5
1999	2		2	3	5	5*
1995	2	Eurasian Water Milfoil	1	0	0	0
1999	2		1	0	0	0
	2	Treated Spring 1999		*	Chara	only
	Bay near Howard Bindrim's Residence					
1995	14	Muskgrass (Chara)	0	0	n/a	n/a
1999	14		0	2	n/a	n/a
1995	14	Eurasian Water Milfoil	0	2	n/a	n/a
1999	14		2	2	n/a	n/a
1995	14	Wild Celery	3	5	n/a	n/a
1999	14		3	0	n/a	n/a
1995	14	Sago Pondweed	3	1	n/a	n/a
1999	14		0	2	n/a	n/a
1995	14	Whitestem Pondweed	0	0	n/a	n/a
1999	14		2	0	n/a	n/a
	14	Treated Spring 1999				
	Steps at Aspin Residence					
1995	16	Muskgrass (Chara)	5	5	n/a	n/a
1999	16		5	5	n/a	n/a
1995	16	Eurasian Water Milfoil	1	0	n/a	n/a
1999	16		2	1	n/a	n/a
1995	16	Wild Celery	0	1	n/a	n/a
1999	16		4	1	n/a	n/a
	16	Treated Spring 1999				
	Flagpole on Patricia Porter Property					
1995	17	Native Milfoil	3	0	0	0
1999	17		3	3	0	0
1995	17	Muskgrass (Chara)	3	4	5	0
1999	17		3	5	0	0
1995	17	Eurasian Water Milfoil	1	0	0	0
1999	17		1	1	0	1
1995	17	Wild Celery	1	0	0	0
1999	17		3	0	0	0

Table 4 (cont.)

PLANT DENSITY COMPARISONS

DATE	TRANSECT NUMBER	SPECIES	DEPTH IN FEET			
	Dockside Area					
			3'	5'	10'	15'
1995	20	Muskgrass (Chara)	3	0	4	3
1999	20		0	0	0	5
1995	20	Eurasian Water Milfoil	0	2	0	0
1999	20		1	3	5	2
1995	20	Wild Celery	2	0	0	0
1999	20		5	3	1	0
	Dunn's Farm Area					
1995	27	Muskgrass (Chara)	0	0	n/a	n/a
1999	27		3	5*	n/a	n/a
1995	27	Eurasian Water Milfoil	4	3	n/a	n/a
1999	27		3	0	n/a	n/a
1995	27	Wild Celery	2	3	n/a	n/a
1999	27		3	0	n/a	n/a
	27	Treated Spring 1999		*	Chara	only
	Goat Island Area					
1995	36	Muskgrass (Chara)	0	4	n/a	n/a
1999	36		0	4	n/a	n/a
1995	36	Eurasian Water Milfoil	0	2	n/a	n/a
1999	36		3	5	n/a	n/a
1995	36	Wild Celery	4	0	n/a	n/a
1999	36		0	5	n/a	n/a
1995	36	Sago Pond Weed	3	2	n/a	n/a
1999	36		0	2	n/a	n/a
	36	Treated Spring 1999				
	Boat Launch Area					
1995	44	Muskgrass (Chara)	1	3	5	5
1999	44		5	4	0	0
1995	44	Eurasian Water Milfoil	4	0	0	0
1999	44		2	0	1	0
1995	44	Wild Celery	0	0	0	0
1999	44		4	4	4	4
1995	44	Whitestem Pondweed	0	4	0	3
1999	44		2	3	4	4
	44	Treated Spring 1999				

MAP NUMBER 2
LAKE BEULAH-UPPER BASIN



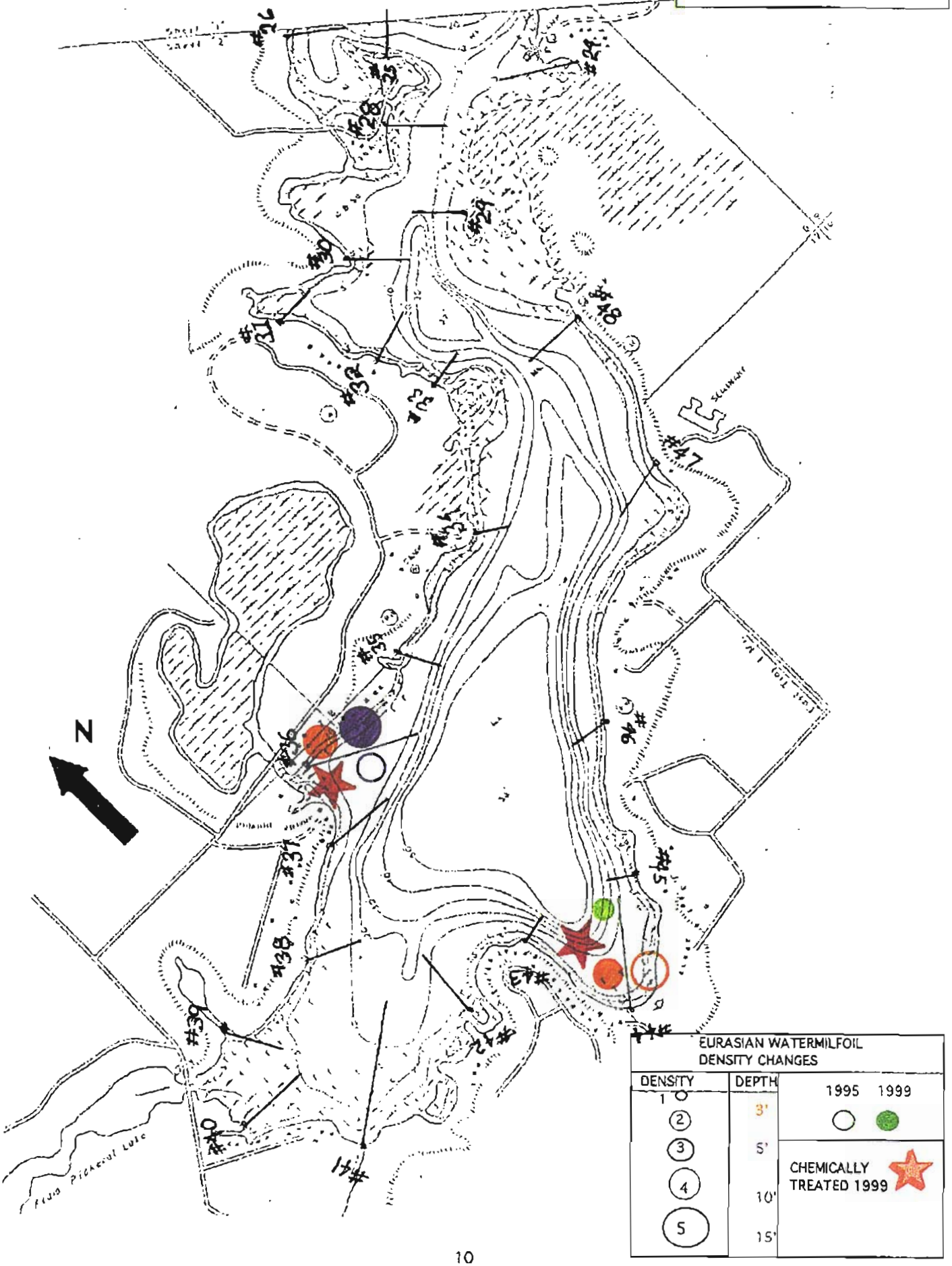
EURASIAN WATERMILFOIL
DENSITY CHANGES

DENSITY	DEPTH
1	3'
2	
3	5'
4	10'
5	15'

1995 1999

CHEMICALLY TREATED 1999

MAP NUMBER 3
LAKE BEULAH-UPPER BASIN



The data in Table 4 from the 8 selected transect sites highlights significant changes in Chara and Eurasian Water Milfoil. No observations were possible at the 10' and 15' levels at 4 of the transect locations

Transect #2, located in Mill Lake in front of the Skotarzak residence is an example of a property owner maintaining the native plant population and minimizing the opportunity for EWM to get a start. Chara was the only plant found at the 10' and 15' depths. Chara is an excellent bottom stabilizer that appears to be a strong deterrent to the establishment and spread of EWM. It is also noted that Native Milfoil maintained a dominant status at 3' in this area.

Transect #14, located in the bay near the Howard Bindrim residence was also identified as one of the lake's sensitive areas in an earlier DNR study. Here we find that numerous chemical treatments have resulted in a variety of species in the area. Although not a sample point, this is the general area that has a stand of Purple Loosestrife.

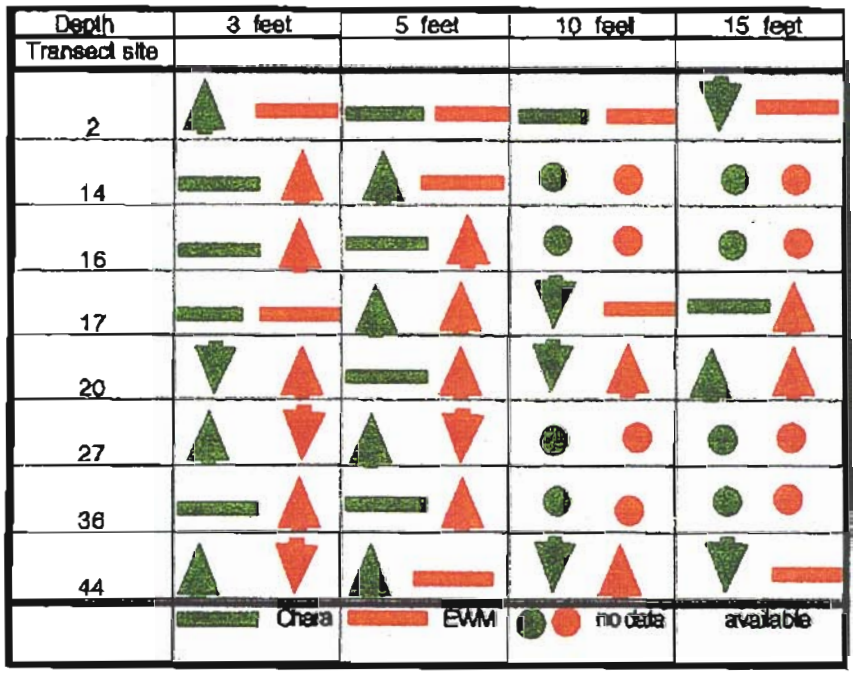
Transects #16 and #17, at the steps of the Aspin residence and the flagpole near the Patricia Porter residence, exhibit further examples where a strong presence of Chara appears to have inhibited the establishment of EWM.

Transect #20, the Dockside Area, is an area that has shown significant growth in Eurasian Water Milfoil. It is a generally open water area that is not conducive to chemically treatment because of so much wind and wave action and heavy boat traffic. In addition, it is an area that is difficult to mechanically harvest because of all of the piers in the area. This area must be closely monitored.

Transect #36, the Goat Island Area, is an area with some definite problems. Aerators are keeping the water open in this area, which allows a longer growth period for EWM. No Chara was found at the 3' level. There were significant increases in EWM at both the 3' depth (density from 0-3) and 5' (density from 2-5) depth. EWM also seems to have replaced the Wild Celery at the 3' depth which dropped in density from 4 to 0. However, Wild Celery was more prolific at the 5' level where it's density level was recorded as 5.

Transect #44, the Boat launch Area has experienced sustained growth in chara at 3' and 5' along with significant increases in Whitestem Pondweed and Wild Celery all all depths. The growth in these native plants is considered to be more desirable than an invasion of EWM, which coincidentally has shown some decline in this area at 3'.

The following Chart illustrates changes in densities of EWM and Chara at the selected transect points. At 18 of the sample points chara density increased or remained unchanged; it increased at 8 of the sites. Eurasian Water Milfoil decreased or was unchanged at 12 points; it was less dense on 3 occasions. On the other hand EWM density increased at 12 locations; in 10 of those locations chara was not changed. There were 6 places where chara increased while EWM dropped or remained unchanged. The most common increases in EWM were found at the 3'and 5' levels. It is believed that the increase in these areas is attributed to the "floaters" created during the harvesting operations.

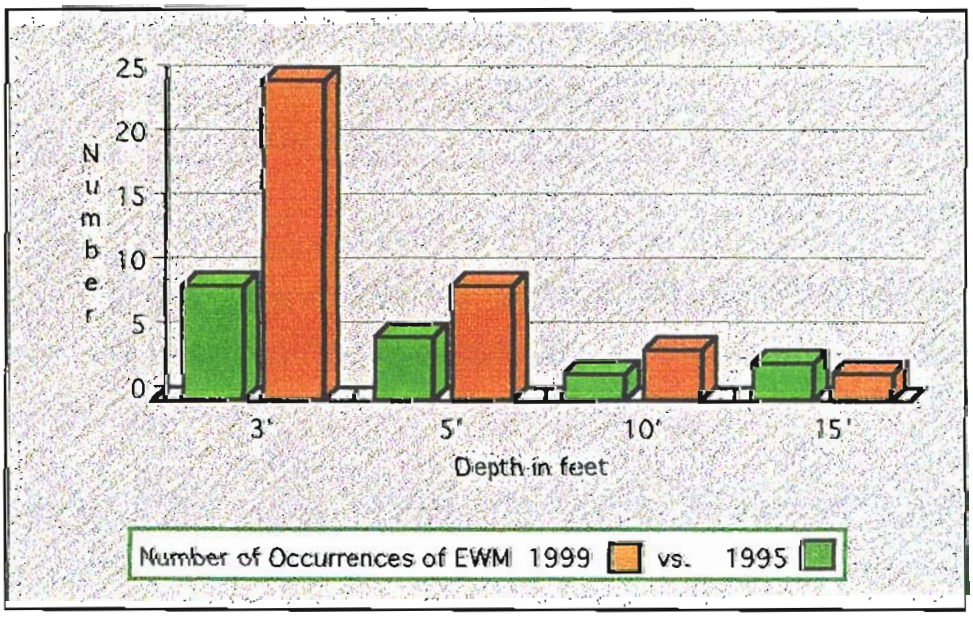


Change in density of Chara sample from 1995 to 1999

Change in density of Eurasian Water Milfoil from 1995 to 1999.

EURASIAN WATER MILFOIL

EWM has difficulty becoming established in lakes with diverse populations of native plants. In some lakes Milfoil appears to coexist with native plants with little or no impact on fish or other aquatic life. It appears that a key factor contributing to the spread of EWM is its ability to reproduce through stem fragmentation and runners. A single fragment or "floater" is capable of taking root and creating an entirely new colony. Fragments clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of aquatic plants from beaches, docks, and landings creates thousands of new stem fragments. Removing natural vegetation and or other activities that disturb the lake bottom creates a perfect habitat for the EWM to take hold. Transect points showing significant EWM concentrations and changes in the density since the 1995 study are shown on Maps 2 and 3. Also shown are the areas that received chemical treatment during the early part of 1999. All of the areas shown received routine harvesting. The following chart shows the general increase in the number of occurrences of EWM at different depths from 1995 to 1999.



WATERSHED STUDY REPORT

The recent Watershed Study completed by Earth Tech provides a database and a baseline that can be used as references for future studies. The most significant parts of the study include the discussion of the groundwater flow direction and the compilation of the lake water chemistry data. As shown by the data, the quality of Lake Beulah's water has been improving since the 1960's. The amount of dissolved oxygen found in the upper layer of the water (epilimnion) is better than the State's recommended water quality standard of 5mg../l., i.e., 5 milligrams of oxygen per liter of water. The standard is determined by the level of oxygen that will support a good fish community.

The chlorophyll-a reading is a measure of the algae biomass found in the water column. Lake Beulah's chlorophyll-a values are quite low resulting in good to very good ratings in the State's Water Quality Index.

Classification of lakes in Wisconsin is achieved through the use of a Trophic Status Index (TSI). The index is calculated by measuring spring phosphorous concentrations in the lake, average Secchi disc readings, and average chlorophyll-a amounts. Each lake is placed into one of three categories based on its TSI value. The three categories are: oligotrophic, mesotrophic and eutrophic. All lakes evolve through a natural aging process, progressing from the oligotrophic state through the mesotrophic state and finally to the eutrophic category. The amount of time required for that process can be kept under control and even extended by carefully monitoring and reducing the amount of nutrients that enter the lake from lawn care, agriculture, septic systems, storm drainage and other man-made sources. Lake Beulah has consistently fallen into the mesotrophic range, which is probably the ideal range for our type of lake. It is an indication that, to date, Lake Beulah has not experienced a significant influx of phosphorous from the surrounding watershed. The State's recommended level of phosphorous is 0.02 mg./l. Lake Beulah's reading in the 1970's was at 0.03 ml../l. and by the late 1990's it had dropped to to 0.014 mg. /l.

WATER QUALITY

Secchi readings measure water clarity and provide an indication of the amount of suspended material in the water column. As shown by the yearly averages in Table 5 and the overall average for the past four years, Lake Beulah falls within the high Mesotrophic category. Considering that Lake Beulah is in the Southeastern part of the State, surrounded by high concentrations of people, sprawling developments of homes and businesses, increasing traffic both on the highways and the lake, the quality of Lake Beulah has been well maintained. These conclusions do not mean that those people and organizations that have assumed an oversight responsibility for the Lake can afford to sit back and relax. Maintaining good water quality is an ongoing battle. The efforts of the entire lake community, including the Lake Beulah Protective and Improvement Association and the Lake Management District are being recognized. However, It is crucial that those organizations maintain their close vigilance of the Lake and its surrounding environment to be aware of changes and be prepared to implement any programs deemed necessary to maintain the high quality of the Lake.

TABLE NUMBER 5 SECCHI DEPTHS LAKE BEULAH
1996-1999

YEAR	STATION	AVERAGE DEPTH
1996	1-5	7.5 ft.
1997	1-5	12.5 ft.
1998	1-5	8.9 ft.
1999	1-5	8.7 ft.

Average for the 1996-1999 period = 9.4 ft.

Secchi readings during the summer of 1997 were considerably higher than average, reaching 12.5 feet. During normal years, average readings are closer to 8 ft. It is likely that several factors contributed to the higher 1997 average. During July and August of 1997, the surface water temperature averaged only 70 degrees F. , which is 7 degrees cooler than the average for those same months during the years just before and after 1997. Furthermore, the amount of dissolved oxygen in the water was significantly lower when the lower temperatures were observed, indicating that a reduced number of oxygen producing organisms, including algae, were present. Generally, increased water clarity results from less suspended algae growth in the water column. Another factor to consider is that cooler weather and cooler water conditions usually means a decline in recreational water activities (water skiing, jet skiing, and swimming) which reduces the disturbance of suspended particles and improves the clarity of the water column.

ZEBRA MUSSELS

Zebra mussels usually grow in clusters containing numerous individuals and are generally found in shallow, 6-30 feet of algae rich water. They are the only fresh water mollusks that can attach themselves to solid objects. They can multiply very rapidly in a single season. It is believed that after first being discovered in Lake Michigan in 1991, they were transferred to inland lakes and streams when the larvae became attached to pleasure boats, seasonal water craft and trailers. During the Fall of 1999, a very small number of zebra mussels was found on Lake Beulah's harvesting equipment which is kept at the Seminary site during the harvesting season. Although their presence is of concern, only time will tell to what extent their numbers increase. Since Lake Beulah has good water quality, that is low in algae content, it is possible that the mussels will not become prolific. However, some recommendations that should be considered are listed later in this report.

CORE SAMPLES

The preliminary results of the core samples taken from the bottom of Lake Beulah by the DNR for the summer of 1999 seem to indicate that there has been some type of increased nutrient loading during the past ten years. This data is not consistent with our own water quality data for the same time frame, but it should be noted that since the DNR's analysis is not complete for the sample, the results are not conclusive. When the analysis of that sample has been completed the District should meet with the DNR (Mr. Wakeman) and obtain a complete explanation of their results.

RECOMMENDATIONS

1. Existing harvesting techniques are good, but need be refined or improved to eliminate the disturbance of beneficial bottom plants, such as Chara, and to minimize the distribution of EWM floaters produced during the harvesting process. It is the spreading of these floaters, especially to areas where the lake bottom has been disturbed, that is a major contributor to the growth of EWM.

2. Consider working with the harvesting equipment manufacturer to develop a mechanized means for collecting floaters created during harvesting.

3. Consider using part of the harvesting day to manually collect floaters along the shoreline; paying special attention to areas of high EWM concentration, especially immediately after cutting and taking wind direction into account.

4. Continue to educate and encourage residents to remove EWM from their water front and put in their gardens, use it as a mulch away from the lake or place it so that it can be picked up by the harvester. Establish a regular schedule for dried plant pickup and post it so residents know when they should have their collections ready.

5. Establish a zebra mussel alert using newsletters and placing warning signs at all appropriate locations. Perhaps a local version of the program recently introduced in Waukesha County should be developed for Lake Beulah. Students from several high schools in Waukesha County's Lake Country region have been recruited to participate in a pilot environmental program designed to teach fourth and fifth grade students about the problems associated with the zebra mussel invasion and what they can do to help reduce the spread of this invasive aquatic animal. The program is being conducted by officials from the Department of Natural Resources, the Waukesha County Department of Parks and Land Use, the Fox River Partnership and the Wisconsin Sea Grant Program. An appropriation of $50, 000 was included in the State budget for an anti-zebra mussel education program.

6. Monitor zebra mussel activity by establishing and maintaining a set of traps at specific locations that are considered to be the most likely places for the zebra mussels to become established, e.g. boat launch sites, the Seminary.

7. Maintain involvement with the Lake Beulah Protective and Improvement Association, the Town of East Troy and the Department of Natural Resources on issues pertaining to the lake and the surrounding areas, i.e., watershed studies, land use studies, zoning requirements, agricultural developments, land conservation, waterway protection, etc.

8. Explore the possibility of developing an ordinance prohibiting the burning of residences along the immediate lakeshore and/or areas close enough that would result in the ashes, soot and other debris falling directly into the Lake or be washed into the lake by surface water runoff, thereby reducing the phosphorous loading into the Lake.

9. Develop a process to update the water quality database that has been created by Earth Tech. The data for 1999 is still on paper and needs to be put in the data base.

10. Encourage and support the idea of establishing wash stations at all launch sites, where practical, such as the Yacht Club so that all boats, including sail boats, can be cleaned prior to entering or exiting the lake.

11. Although Purple Loosestrife was not found in the lake at one of the designated transect points at this time, residents need to be continually educated that, even though considered to be pretty, it does exist in the immediate area and it can be devastating to the health of the lake, especially in smaller bays and secluded inlets. It needs to be treated and/or removed when as it appears.

CONCLUSIONS

The overall plant community of the lake has remained fairly static since the survey in 1995. There are some exceptions as indicated in Table 4. The spread of EWM continues most noticeably in the 3' to 5' depths. This most likely isn't the result of the natural spreading of the plants but more likely is caused by "floaters" as they move to the shoreline areas. Floaters generally originate from one of four sources: (1) boating activity, (2) transmission from external sources on marine equipment, (3) water fowl and (4) harvesting operations. Although harvesting may be the major factor contributing to these floaters, the other sources cannot be ignored. People must continue to be reminded about the dangers of EWM and zebra mussels(as well as all other exotic invaders that can be detrimental to the health of the Lake.) Removal of plant fragments from boat trailers from other lakes needs to be constantly emphasized

Wild celery has become very prolific in selected areas. It is not known at this time whether the wild celery moved into the treated areas after the EWM was treated, or whether it was present before the EWM existed and then reappeared after the competitive EWM was killed. Wild celery is considered to have greater wildlife value than EWM.

Chara is doing very well and in areas where EWM has been treated there seems to be an increase in the density of the chara. Evidence also shows that in shallow areas where chara has been disturbed, EWM will take its place. Because Chara is an excellent bottom stabilizer that inhibits the establishment and spread of EWM extra care must be exercised to avoid disturbing existing beds (it is often removed from swimming areas because it is a little rough to walk on and it has a somewhat disagreeable odor) and to encourage its growth whenever open or disturbed areas are spotted. Its benefits far out weigh its small inconvenience.

The generally, good health of the aquatic plant community is related to two major factors. The careful harvesting techniques employed by the Lake Management District and the low amount of nutrients entering the water column. Since most nutrients entering the lake come from the immediate shoreline and the surrounding watershed, education is the best method for dealing with this problem. Because the Lake Management District and the Lake Beulah Protective and Improvement Association work closely together, the development of educational programs should continue to be developed and made available to the public.

The Management District has done an excellent job maintaining and improving the water quality and the overall desirability of Lake Beulah. Since the old Sanitary District (now the lake Management District) was formed in the late 1960's the water quality has improved. This can be verified by viewing the newly organized water quality data included in the Earth Technology Watershed Report. And, perhaps more importantly, the District has implemented nearly all of the the suggestions made in the 1995 Aquatic Plant Management Plan.

An Aquatic Plant Survey update should be considered every 2 to 3 years or sooner if major changes are observed. The ongoing survey, as well as other water quality parameters (Secchi Disc readings, Dissolved Oxygen content, etc.) will provide the Management District with a historical background to refer to when making future lake management decisions.

RECOMMENDATIONS FROM 1995 STUDY	STATUS
1. Retain as primary objective the protection of Lake Beulah and the surrounding watershed.	1. Ongoing- Watershed Study and updated Aquatic Plant Management Plan, are results of the earlier recommendations.
2. The LBPIA, LMD, DNR, and Town of East Troy should continue to work as partners to promote the well being of Lake.	2. Manage District and citizens attend local and state meetings.
3. Develop job description for Harvesting Supervisor, hire someone full time from May to September for the position.	3. Management District prepared job description and harvesting supervisor was hired for the summer harvesting period.
4. Purchase new harvester and trailer, modify existing elevator as needed, sell existing equipment	4. Completed
5. Apply for grant to assist with purchase of new equipment.	5. Completed
6.Modify existing harvesting procedures to make them more effective.	6. Completed
7. Continue practices described in 1995 report to continue to maintain control of EWM.	7. Ongoing
8. Follow recommendations presented in Sensitive Area study: a. Avoid harvesting in sensitive areas. b. Prohibit all dredging in the Lake c. Use chemical treatment only in well controlled areas. d. Continue mechanical harvesting but only in predetermined areas and at prescribed depths to avoid bottom disturbance.	8. Ongoing
9. Participate regularly in various external educational programs sponsored by the DNR and other lake associations.	9. Representatives do attend workshops and meetings.
10. Continue water testing program as recommended /modified by the DNR.	10. Ongoing

RECOMMENDATIONS FROM 1995 STUDY	STATUS
11. Have historical data organized and displayed or made accessible in a more user-friendly format than currently exists.	11. The Earth Tech Report established a data base.
12. Monitor existing publications, public education materials and other informational media for ideas and suggestions about plant management techniques and progress elsewhere.	12. This is being done in conjunction with the LBPIA.
13. Be alert for new exotic nuisances while maintaining vigilance over known potential problems such as Purple Loosestrife and zebra mussels.	13. Ongoing.
14. Update Aquatic plant Management Plan , including update of plant inventory and progress made using other techniques to control EWM, i.e., Herbivore Weevil program.	14. This report is the result of this recommendation.
15. Inspect all water craft entering and leaving Lake Beulah. Install signs at launch sites describing this requirement. Install a power wash station at the upper level parking facility at the boat launch.	15. Not known whether boat launch attendant does inspections at this time. Signs have been placed at launch sites. Washing station has been considered but may not be practical at this time.
16. Monitor all shore line development, including new construction and other activities that could modify or impact the shoreline.	16. Some efforts are in place to monitor this activity.
17. Conduct a review of construction and building permit requirements that impact on the Lake and determine how effective existing requirements are and whether new or clarified regulations might be warranted.	17. There needs to be more discussion between the Management District, the LBPIA, the Town of East Troy and the County regarding these matters. More coordination is required.

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