AquaTechnex

"Advancing the Science of Lake Management"

Erie and Campbell Lakes
2003 Aquatic Plant Survey

P.O. Box 118 • Centralia, WA 98531 • (360) 330-0152 • Fax: (360) 330-0174 • www.aquatechnex.com

Introduction and Project Overview

Erie and Campbell Lakes are located in western Skagit County, Washington. Lake Erie is a 110 acre water body with a mean depth of 6 feet and maximum depth of 14 feet. The lake has a relatively small drainage area, the watershed is 1.62 square miles. The shoreline is a mix of residential and commercial development with large areas remaining in a natural state. Lake Erie drains to Lake Campbell located approximately one mile to the south. Lake Campbell is a 370 acre water body with a mean depth of 8 feet and a maximum depth of 16 feet. The watershed that drains to Campbell is 5.68 acres in size.

These lakes have been impacted by aquatic plant and algae problems for a number of years. This is primarily due to their shallow nature and nutrient loading from the watershed. In the early 1980's a Phase One Lake Restoration Study was performed on these lakes using grant funds from the Department of Ecology (DOE). This study resulted in additional grant funding to implement the Phase Two Lake Restoration Efforts. An Alum treatment was performed on these lakes and the County purchased an aquatic weed harvester that was used to help manage those problems. Over time, the harvester work was abandon due to the high costs of operation and the limited production capabilities of the system. By the early 2000's weed and algae growth were again posing a major problem to the residents of these lakes and the public access users. Eurasian Milfoil was discovered in these lakes in this time frame as well.

The citizens living around the lake began to work with the Skagit County Public Works Department to mitigate the impact of these weeds on their use and enjoyment of the lakes. They formed a working group and began to educate themselves on the problems and options for management. A number of public meetings were held to discuss this issue and get consensus from the community on management options.

The County Lakes staff assisted the community by developing an Integrated Aquatic Vegetation Management Plan (IAVMP). This process focused the community on developing workable solutions for the problems they face. Once adopted, the plan can also be used to request funding from DOE for implementation.

In this time frame the citizens also formed a Lake Management District (LMD) to fund the implementation of the plan. This type of special local district is set up after a vote of the landowners around the lake that benefit from the improvement of conditions. The LMD has been active for approximately 2 years. Through the County, the LMD has contracted with Aquatechnex, LLC to provide aquatic plant management services. The efforts in this regard up through 2002 are described in year end reports developed by Aquatechnex for the County.

In early 2003, these lakes were stocked with Triploid Grass Carp. This fish is a native of the Amur River in northern China/Siberia. Grass carp are biological control agents for many species of submerged aquatic weeds. They consume this plant material and thereby suppress the abundance of the problem growth.

There are regulatory hurtles to clear prior to stocking this fish. Outlets to the lakes need to be screened to insure the fish do not escape to downstream waters. This work is performed under an HPA permit from the Department of Fish and Wildlife (DFW). This permit was secured by Aquatechnex and the screens were designed and installed in the fall of 2002. The next step is to secure a stocking permit from the same department to allow the introduction of this biological control agent. DFW has to balance the desire for weed control with the potential impact this biological control agent will have on the ecosystem in the lakes under consideration. If too many grass carp are placed in a lake, they will eventually consume all aquatic vegetation, often to the detriment of other species. Aquatic plants are a key component of the aquatic ecosystem; they provide structure and cover for fish and invertebrates. If all plant life is removed, it impacts the populations of these other species.

The permit issued for this lake system allowed approximately 700 fish for Lake Erie and 2,200 fish for Lake Campbell. Generally, the department allows up to 10 fish per vegetated acre but in recent years of trended lower. The permit is good for one year after the date of issue. The Department indicated that future stocking of this biological tool would be dependent on a monitoring program that documented the need for additional fish.

Approximately 100 fish were stocked in Lake Erie and 600 fish were added to Campbell Lake. This stocking rate is lower than that allowed by the DFW. The permit allowed stocking of up to 6 fish per surface acre of each lake. Aquatic vegetation does not impact this number of acres in reality however. Lake Erie was treated in 2002 for the rapidly expanding Eurasian Milfoil problem with Sonar aquatic herbicide. This reduced the volume of aquatic plant life present because the milfoil removed made up much of the infested volume of the lake. Lake Campbell historically has had an algae bloom that limits aquatic plant growth to the shallow margins of the lake and the actual acres that support aquatic plants are much lower than the 370 surface acres of the lake.

The LMD hired Aquatechnex to implement a monitoring program on these lakes to characterize the aquatic plant communities and help determine the need for additional aquatic plant management activities over the life of the LMD. This report summarizes the monitoring performed during the summer of 2003 of the impact of the grass carp on the aquatic plant communities. It also presents protocols for ongoing monitoring.

Methods

The objectives of the field aquatic plant survey efforts for 2003 were as follows:

- To establish baseline conditions and sampling protocols to monitor the changes in the aquatic plant communities over time
- Insure that the maps and data contain the information necessary to support aquatic plant management permit applications in future years.
- To characterize the conditions present in the lakes during the summer of 2003 and make recommendations to the community regarding additional control efforts.

Our first steps were to review the previous aquatic plant mapping efforts performed on the lake. There have been a number of surveys performed on these lakes in the past few years by the County and the Lake Management District. Survey maps for 2002 showed the conditions of the aquatic plant communities prior to grass carp stocking.

Planning and assembly of equipment was the next step that was undertaken in this effort. Boats, sampling equipment and data collection equipment were mobilized to the lake for two surveys during the summer of 2003.

The survey team used a Trimble GeoXT Differential Global Positioning System (DGPS) receiver and data logger to support the data collection mission. Prior to going to the field, a data dictionary was developed for this project. Using Trimble Pathfinder software, the Data Dictionary Editor function was used to build the Erie/Campbell Data Dictionary. Three Features were entered into this system, they were:

Eurasian Milfoil, Point
Eurasian Milfoil, Area
Native Plant, Point

Default feature settings were established for each feature on the Trimble GeoXT. The logging interval was set for one second. This function directs the receiver to collect a GPS signal at one-second intervals. The accuracy default was set for "code". The default minimum number of positions collected for each feature was set for 10. Display symbols and colors for the symbols were also selected and set.

A number of attribute menus were established for the Native Plant, Point feature. These menus were set based on the types of plants that were expected in the survey area. They were:

Elodea	Coontail	Pot 1	Pot 2	Pot 3
Pot 4	Pot 5	Pot 6	Macro Algae	No Plants

Five pull down menus for native plant attributes were created for this feature, each having the species listed above. The Pot 1-6 attributes were established because a number of Potamogeton species were expected to be encountered during the survey. As these species were not known prior to the survey, each label would be assigned in the field to a particular species as the team moved around the lake.

The data dictionary (file name Erie/Campbell.ddf) was then transferred to the Trimble GeoXT using the docking station and Pathfinder Data Transfer Utility. An image of the lakes was also transferred using this utility to provide a visual reference of the survey team's location on the lake. The Coordinate System used was UTM, zone 10 North and datum NAD 1983 (Conus).

The survey team also assembled the other necessary equipment to conduct the survey. This included SCUBA dive equipment, sleds to tow divers, a polychain with one foot increments to be used to establish transects for the divers, aquatic plant sample collection equipment, aquatic plant identification keys, underwater writing equipment and a data log book. The team was then ready to move into the field.

The first survey was performed on July 2nd and 3rd, 2003 with some additional data collection performed on July 23rd. The Trimble GeoXT was initialized and the Terrasync software used for data collection was opened. A rover file was created for this project (A070208a, A070308a, A072308a) and the data dictionary and background image were opened and made ready for use.

Four methods were used to map the aquatic plants present in each lake. The first method was to establish a number of data collection points throughout the littoral area of the lake and use a rake sampler to collect and identify the species of plants present at that point. The second method was to establish a number of transect lines in the lake. These lines were then surveyed by divers who recorded the species present and percent bottom cover at regular intervals. The third method was to perform visual observations between transects and points and note conditions present. The fourth method was to collect biomass samples at random points along two transect lines.

The point sampling was performed first. The boat crew established a grid across the littoral area of the lake using the GeoXT. At each survey point, the crew used a sampling rake and methodology developed by the Washington Department of Ecology to collect plant samples (Parsons, 2001). The GeoXT GPS unit has a Windows CE computer built into the system. Terrasync software allows for the display of a background aerial image of the lake, the location of the unit geographically referenced to the image and any data features collected. The boat operator used this view to navigate to the collection point. At the collection point, a sampling rake was thrown and retrieved. A double sided rake was used with a 50 foot rope. When the rake was retrieved, the species present were noted. Using the GeoXT and Terrasync software, a native plant feature was stored at the sampling location. Species attributes were then recorded for that point. The data logging system was set up to have five pull down menus with the species selection so that five species attributes could be established for each sampling point. The survey team recorded a species attribute for each species found at that point with the stylus from this menu selection. They also recorded a plant abundance rating of sparse, moderate or dense based on the amount of plant material collected on the rake.

The next task was to collect the transect data. Aquatechnex divers established each transect line by deploying a calibrated polychain. The polychain was 300 feet in length and has distances in feet displayed on the chain. A weight was attached to the deep water end of the chain. At each transect location, one diver held the chain in place as the other diver swam the chain out across the littoral area. The support crew in the boat then used the Trimble GeoXT to record the exact location of the transect by collecting a generic line feature over the length of the chain. One diver then swam the length of the transect and recorded the species present and percent bottom coverage at each twenty foot interval

on an underwater tablet. When the diver arrived at the next interval on the polychain, he reviewed a one square meter area centered on the interval marker and recorded his observations. At the conclusion of each transect, the diver gave the underwater tablet to the boat support crew where the information was transferred into a "Write in the Rain" field notebook while the divers recovered the polychain. They then moved to the next transect location and repeated this process until all ten transects were completed.

Aquatic plant biomass samples were then collected by the divers at two points along two transects. Divers placed a sampling grid on the lake bottom. They then collected and bagged the aquatic vegetation present in each site. The plants were taken back to the lab, dried and weighed for inclusion in this report.

The last step was to perform a complete visual inspection of the areas in the lake between each transect. This qualitative assessment was designed to give the survey team a better overall view of the conditions present. A number of additional GPS points were collected to establish the outside edge of the plant communities between transect if there was variation. The make up of the plant community was noted in greater detail. The team looked for other plant species that were not present on the transects or in the data collection as well.

A second sampling mission was performed on September 15th and 16th. The sampling team followed the protocols listed above.

On completion of the field efforts, the Trimble GeoXT was placed in the docking station and the Trimble Pathfinder software's data transfer utility was used to collect the rover file from the GPS receiver. Using the differential collection utility in Pathfinder, the rover file was converted to a corrected file with sub-meter accuracy. The Thurston County GIS facility community base station was used to obtain the correction file. Using the export utility in Pathfinder, the corrected data was converted to ESRI shape files and moved to Arc View GIS software for analysis.

Maps were created that document the location of the sampling sites and represent the aquatic plant communities present at the time of each survey.

Results

Erie and Campbell Lakes have different characteristics and history of aquatic weed issues. They will be discussed separately.

Lake Erie

One of the unique things about Lake Erie is that the majority of the surface area of the lake is considered the littoral zone. The littoral zone of a lake is the area that supports aquatic plant growth. It is normally determined by the depth to which light penetrates the water column with sufficient intensity for aquatic plants to survive. The littoral area of a lake is generally the shallows areas along the shorelines and out to a depth contour where

light levels are so low that plant life can not survive. As Lake Erie is shallow throughout, light reaches the lake bottom throughout and aquatic plant life can occur.

At the beginning of the 2002 season, Lake Erie was suffering from a rapidly expanding Eurasian Milfoil infestation. The treatment option selected by the LMD was a whole lake Sonar Aquatic Herbicide treatment. This treatment was performed in June and July of 2002. Whole lake Sonar treatments are generally selected when the majority of the littoral area of the lake is impacted by this noxious weed. In this case, there were extensive beds of this plant present and the remaining areas of the lake had scattered colonies. The fact that this weed was widespread and the entire lake was potential habitat factored into the decision to implement the whole lake Sonar treatment.

This type of herbicide application maintains a concentration of Sonar in the lake for 6 to 8 weeks. This generally results in 99 to 100 percent control of the target vegetation. Some native plants are also sensitive to Sonar and can be impacted in the short term by this treatment strategy. Generally, this is acceptable because the Eurasian Milfoil will also replace and remove them from the system. This had occurred in many portions of the lake. The grass carp stocking for Lake Erie comprised of 100 fish or less than one fish per vegetative acre based on 2002 conditions. It was assumed that there would be some carry over from the Sonar treatment and that higher stocking densities were not warranted at the start of this project.

During the summer of 2003, three species of submerged aquatic plants were observed using point, transect and biomass sampling procedures. They were:

Scientific Name	Common Name
Ceratophyllum demersum	Coontail
Potamogeton pusillus	Small Pondweed
Potamogeton amplifolius	Big-Leaf Pondweed

The most prevalent aquatic plant in the system was Coontail. This macrophyte was collected at 83 of 127 sampling point stations in the lake using the rake system. It was also the dominant plant observed along the transects surveyed by SCUBA divers. During the July survey, most of the plants observed were emerging from winter buds and averaged from 3 to 10 inches in length. By the September survey, these plants had grown to an average of 10 inches to three feet.

The second most prevalent species of aquatic plant observed was Small Pondweed. This species was collected at 46 of 127 sampling point stations in the lake using the rake system. This plant was not observed with this degree of frequency along the transect lines. The plants that were found were very young. In the July survey, these plants were from 2 to 5 inches long and in September had increased to 10 to 15 inches in length.

The last species detected was Big Leaf Pondweed. This plant was observed at 4 of 127 sampling point stations and not detected along transect lines.

While the sampling point data shows that there is aquatic plant life uniformly established throughout the littoral zone of the lake, the transect data and the density data indicate that the populations of the plants are low.

When the rake samples were collected, the biologists used a rating system to record the amount of vegetation retrieved from each site. A "sparse" rating indicated that plants were collected and 0 to 30 percent of the rake was covered with plant material. A "moderate" rating indicated that the plants collected covered from 30 to 60 percent of the rake. A "dense" rating indicated that plants collected covered from 60 to 100 percent of the rake. During the July survey, only 5 of 127 sampling point stations received a moderate rating. The September survey saw a slight increase in the number of moderate locations, 22 of 127 stations were rated moderate with the rest remaining sparse. Data collected along the eight transects surveyed showed similar results. The percent bottom cover along these transects at sampled intervals averaged about 10 percent. There was a trend toward a slight increase in bottom coverage between the July and September sampling events.

Aquatic plant Biomass data again reflected this trend. Four sites were surveyed. The results for these are as follows.

	July	September
Transect 2, Station One	12.04 g/sq m	15.15 g/sq m
Transect 2, Station Two	10.85 g/sq m	13.75 g/sq m
Transect 6, Station One	No plants	7.25 g/sq m
Transect 6, Station Two	7.45 g/sq m	9.94 g/sq m

These biomass levels document the trend toward sparse aquatic plant coverage within Lake Erie. No plants were present in the Transect 6, Station One July sampling event. Portions of the lake bottom were free of vegetation and this sampling station is a result of that condition.

One map was prepared for Lake Erie. This map shows the survey point locations, the transect line locations and presents a polygon around those areas with sparse to moderate levels of aquatic plants dominated by Coontail. The bands along the shoreline were generally free from aquatic plant growth, with spotty very small patches of either Coontail or Small Pondweed.

No Eurasian Milfoil was observed in Lake Erie by the divers or the boat survey team. It appears that the Sonar treatment was successful in targeting and removing that noxious aquatic weed from this lake system. The aquatic plant communities found in the lake do not currently pose a problem to the identified beneficial uses found in the Integrated Aquatic Vegetation Management Plan. They are not impacting boating, swimming or fishing activities. At this point, there is no need to target this lake with additional aquatic plant management activities.

Lake Campbell

While Lake Campbell is similar to Erie with respect to the shallow nature of the system, this lake has been impacted by a heavy algae bloom in many of the past few years. Excessive amounts of algae cells that are present during these summer long blooms restrict light penetration. This has limited the littoral zone to the margins or shallow areas along the shoreline of the lake.

This lake also had some Eurasian Milfoil present during the 2002 summer season. These plants were targeted where they existed with AquaKleen, a 2,4-D based herbicide. AquaKleen is target specific for plants that are members of the broad leaf family, it does not target many of the native aquatic plants that are members of the narrow leaf family. This herbicide can be used to spot treat locations where Eurasian Milfoil is present and the treatments were not as wide spread as the application made to Lake Erie.

Two maps were prepared for Lake Campbell documenting the condition of the aquatic plant communities in the system. The first shows the point sampling and transect locations on the lake. It should be noted that in many areas of the lake, such as the north shore and southeastern shore, dropped off to depths beyond the littoral zone rapidly. When sampling indicated that the crew had moved beyond the edge of the plant beds, additional points were not collected as there were no plants present. The second map describes the plant communities present in the lake during the summer of 2003.

There were a number of species of submerged aquatic plants observed in the survey of Campbell Lake. They were:

Scientific Name	Common Name
Potamogeton richardsonii	Richardson's Pondweed
Potamogeton amplifolius	Big-leaf Pondweed
Potamogeton filiformis	Slender-Leaved Pondweed
Elodea canadensis	Common Waterweed or Elodea
Ceratophyllum demersum	Coontail
Myriophyllum verticillatum	Whorled Milfoil
Chara sp.	Chara

The distribution of these plants is presented in the Survey map. Light limited aquatic vascular plant growth beyond the five foot contour in the lake. Chara, a macro-algae with a lower tolerance for light, grew beyond this depth in some cases.

There are four basic zones or areas of the lake with respect to species makeup of the plant beds.

The first of these zones is depicted in green on the Survey map. This area is the west end of the lake. This section was dominated by a combination of Coontail and the macro

algae Chara. The point survey, the transect survey and visual observation of the plant communities between 40 and 50 percent of the lake bottom occupied by these two species. While other aquatic plants did not turn up in the sampling for this area, small stands of Richardson's Pondweed were observed. The Coontail was dense from the shoreline to the midway point of this polygon. There was a gradual shift to Chara dominance near the outside (deep water) edge of the polygon.

The second of these zones was the near shore area of the southern shoreline. This area is depicted in Red on the Survey map. Our biologists noted a variety of submerged aquatic plants along this section of the lake shore. Richardson's Pondweed was well distributed from the shoreline to the four foot contour throughout this region. Stands of Big-Leaf and Slender-Leaved Pondweed were also distributed throughout this area making up approximately 20 percent of the community. Our team also noted the presence of Whorled Milfoil (a native species) along the deep water margin of this plant community. The population of the milfoil present expanded between the July and September surveys. In the deeper water off the southern shoreline, the aquatic plant communities shifted to Chara dominated in the deeper water sections as depicted in the Purple polygon.

The eastern shore of the lake was dominated by sparse stands of Chara. This area had no vascular plants present at any of the sampling points with the exception of two locations where Coontail was collected in the northeast portion of the polygon where it boarders with the next Red Polygon (points 57 and 58).

The northern shoreline was another area that displayed a variety of aquatic plant species in a moderate to dense level. The nearshore areas were dominated with a combination of Elodea and Richardson's Pondweed. Our biologists also observed Whorled Milfoil and Slender-leaved Pondweed mixed in with the plants present. Chara was the dominant species at the outside edge of these plant beds.

When the rake samples were collected, the biologists used a rating system to record the amount of vegetation retrieved from each site. A "sparse" rating indicated that plants were collected and 0 to 30 percent of the rake was covered with plant material. A "moderate" rating indicated that the plants collected covered from 30 to 60 percent of the rake. A "dense" rating indicated that plants collected covered from 60 to 100 percent of the rake. During the July survey; 30 of 88 sampling point stations recorded a density of "Sparse". 55 of 88 sampling point stations recorded a density of "Moderate" and 3 of 88 sampling point stations recorded a density of "Dense". Contrasting that to the September Survey; 23 of 88 sampling point stations recorded a density of "Sparse", 45 of 88 sampling point stations recorded a density of "moderate" and 20 of 88 sampling point stations recorded a density of "Dense".

There was no observed reduction in the plant communities between the July and August surveys. In some cases, there was a slight expansion in the aquatic plants present in various areas of the lake. Much of this expansion was due to a noted increase in the presence of Whorled Milfoil along the south and to a more limited extent along the north shorelines.

Aquatic plant Biomass data again reflected this trend. Four sites were surveyed. The results for these are as follows.

	July	September
Transect 1, Station One	88.25 g/sq m	93.35 g/sq m
Transect 1, Station Two	76.54 g/sq m	83.54 g/sq m
Transect 3, Station One	112.54 g/sq m	139.25 g/sq m
Transect 3, Station Two	83.35 g/sq m	94.65 g/sq m

It should also be noted that no Eurasian Milfoil was observed by our biologists during either survey event. At the end of last season, there were some Eurasian Milfoil plants remaining in the lake. These areas were examined in detail and no milfoil was found.

Discussion

Both of these lakes have benefited from the implementation of aquatic plant management activities. Eurasian Milfoil was the primary focus of efforts in 2002 and this plant was not observed in either lake in the summer of 2003. Native aquatic plant life is a critical component of lake ecosystems. Aquatic plant management activities are generally applied when plant populations impact the beneficial uses of the lake system. A separate discussion for each of these lakes is presented here.

Lake Erie has recovering native aquatic plant communities that were impacted by the milfoil infestation. The plant levels in this lake remain low growing and sparse throughout the system. A combination of techniques have been applied to Lake Erie in the past two year, a whole lake Sonar aquatic herbicide treatment and the introduction of 100 triploid grass carp. The aquatic plant populations in the lake (in our opinion) are not currently impacting the beneficial uses outlined in the Integrated Aquatic Vegetation Management Plan and no further aquatic plant management activities are warranted at this time. Ongoing monitoring in the coming years will document the changes in this system and if plants become problematic, additional aquatic plant management activities may be necessary. There should also be ongoing efforts to locate any new introductions of Eurasian Milfoil.

Lake Campbell is also recovering from an infestation of Eurasian Milfoil. The lake has healthy populations of native aquatic plants throughout the majority of the littoral area. As the lake is not extensively populated, the majority of these plant beds are not impacting beneficial uses lake wide. There may be areas adjacent to individual docks or water fronts where aquatic plants remain a problem for individual lake residents. Grass carp were stocked at a rate of 600 fish in the spring of 2003. These fish will over time graze on and thin the population of aquatic plants in the lake. They may or may not provide the level of control that is necessary to clear individual properties in the short term. Grass carp do not focus their efforts in one particular area of a lake, they roam freely and consume vegetation along the way. In order to insure complete control of

aquatic vegetation in areas adjacent to individual docks, they would have to be stocked at rates that provide that level of control system wide.

This is the first year quantitative data has been collected for either of these lakes. We have noted the absence of Widgeon Grass that has been present in previous years. The large beds of this plant that were located along the northern shoreline in previous years is not present now. This could be a result of grass carp feeding, changing light conditions in the lake or a combination of each. As this survey is repeated over time using these protocols, trends in control will become more obvious. At this point, we feel that the aquatic plant communities present in the lake are well distributed and provide a good balance between weed control and the need to maintain aquatic plants as habitat. Individual residents may have issues with the plants immediately adjacent to their properties however. A public meeting should be held in the near future to present this information to the public and discuss the need for local control of aquatic vegetation. It may be appropriate to target plants locally. We feel that the grass carp should be given another year or so to look at their impact on both lakes prior to stocking any additional fish based on our observations and the results of this survey.

References

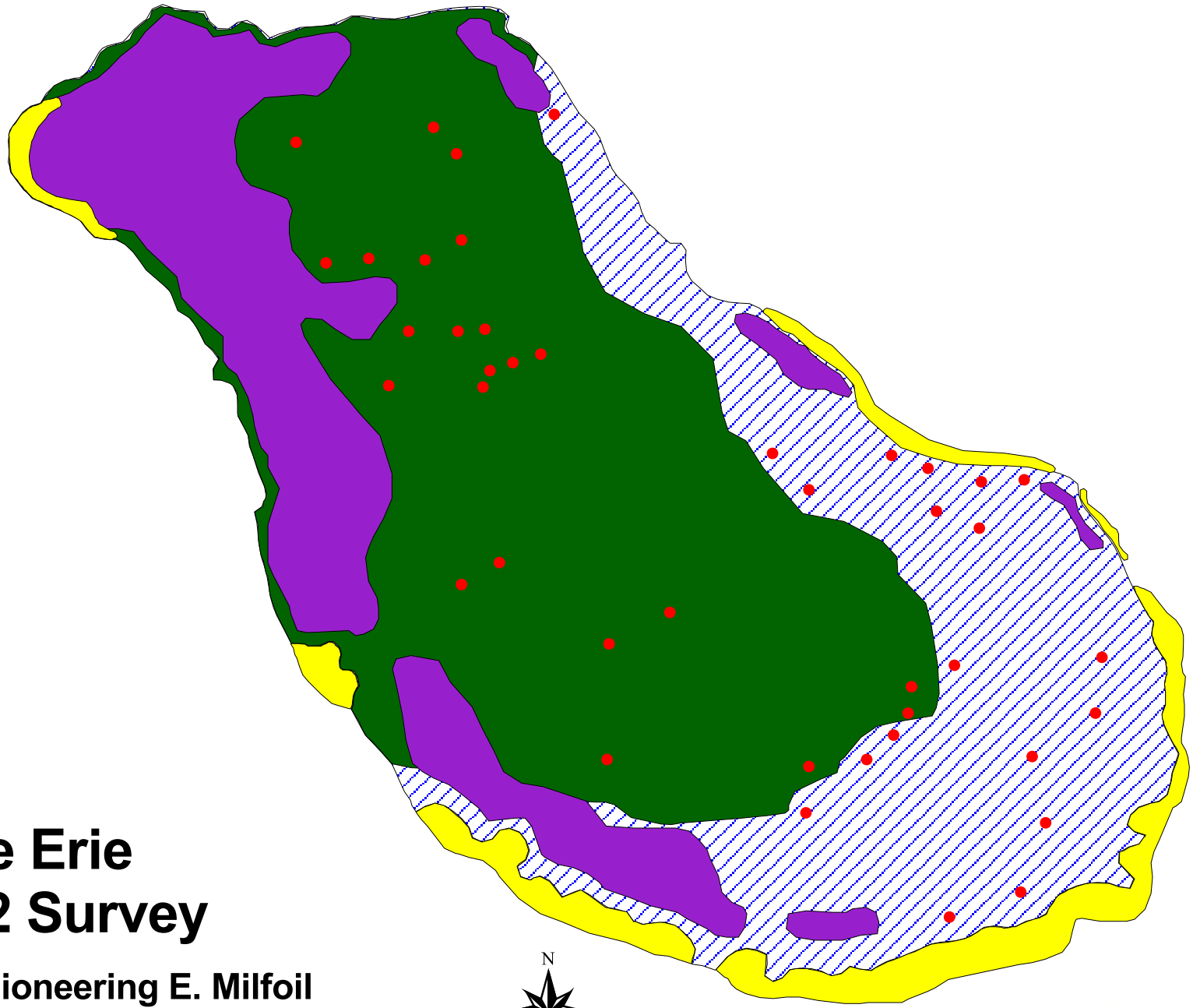
Fasset, Wayne, 1969. A Manual of Aquatic Plants. University of Wisconsin Press. Madison, WI.

Parsons, Jennifer 2001. Aquatic Plant Sampling Protocols, Washington Department of Ecology Publication No. 01-03-017.

Washington Department of Ecology, 2001. An Aquatic Plant Identification Manual for Washington's Freshwater Plants, Washington Department of Ecology Publication No. 01-10-032.

Appendix

Lake Erie Map
Lake Campbell Sampling Points Map
Lake Campbell Aquatic Plant Community Map
Lake Erie Transect and Point Data
Lake Campbell Transect and Point Data



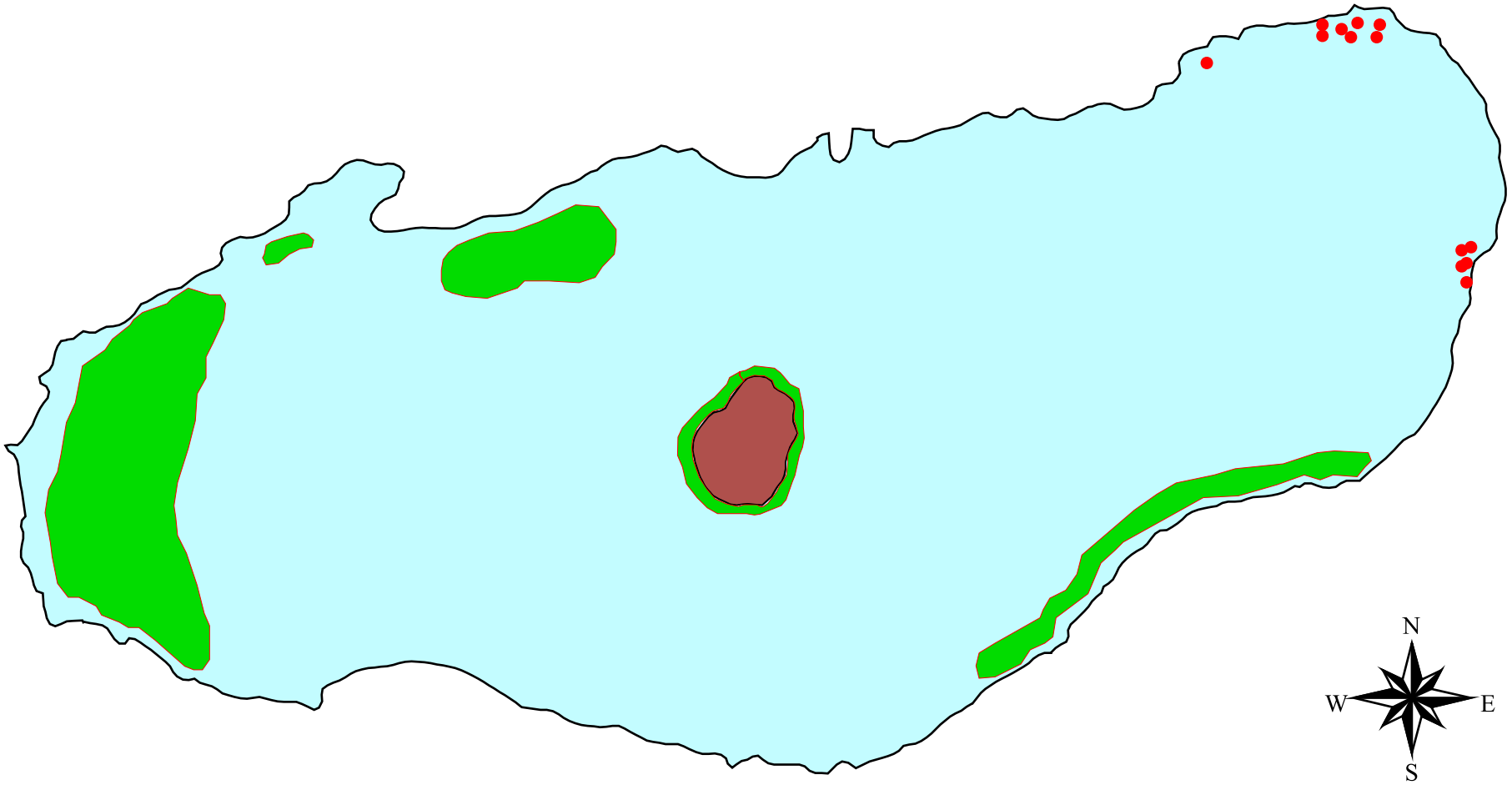
Lake Erie
2002 Survey

- Pioneering E. Milfoil
- Nuphar
- Established E. Milfoil
- Moderate to dense Coontail
- Mixed Coontail/N. Milfoil/elodea/pondweed spp.

N
W E
S

AquaTechnex
"Advancing the Science of Lake Management."

Lake Campbell 2002 Survey



Island
Eurasian Milfoil Plants
Eurasian Milfoil Areas
Lake Campbell

AquaTechnex
"Advancing the Science of Lake Management."

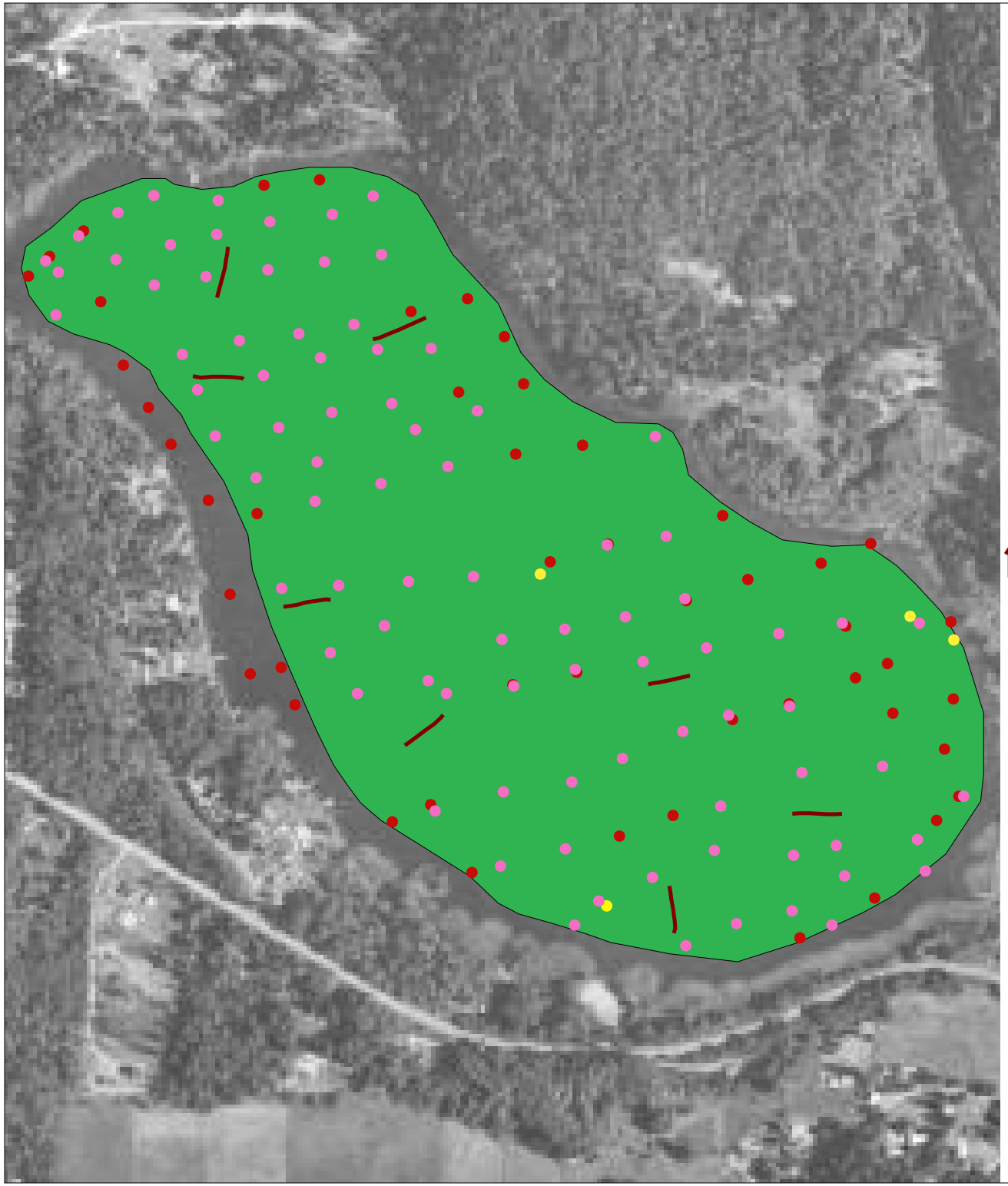


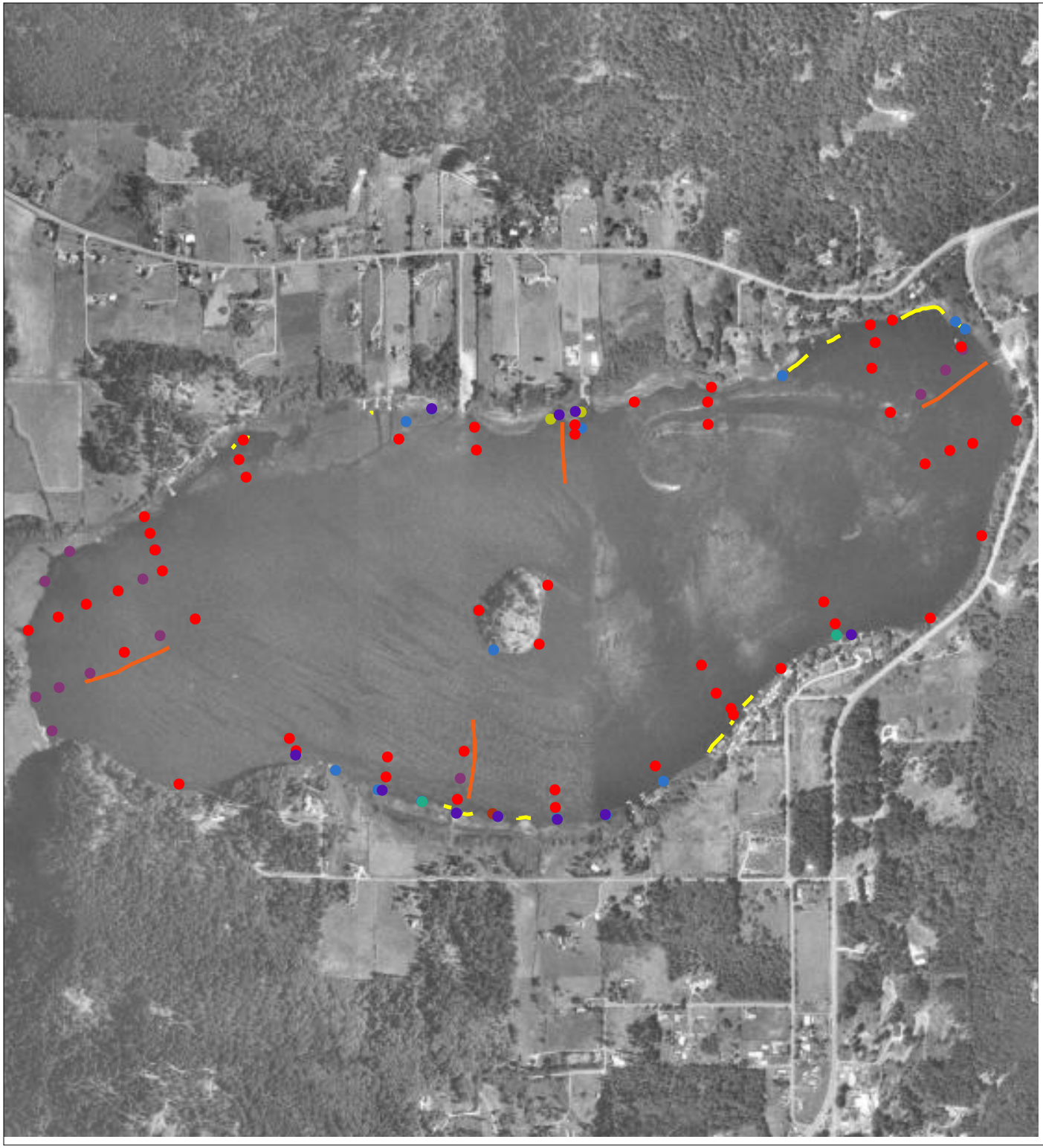
Figure 1. Lake Erie 2003 Survey

- Surveyed Potamogeton amplifolius locations
- Surveyed Ceratophyllum demersum locations
- Surveyed Potamogeton pusillus locations
- Transect Lines
- Sparse to Moderate Coontail

N
W E
S

AquaTechnex
"Advancing the Science of Lake Management"

100 0 100 200 Meters



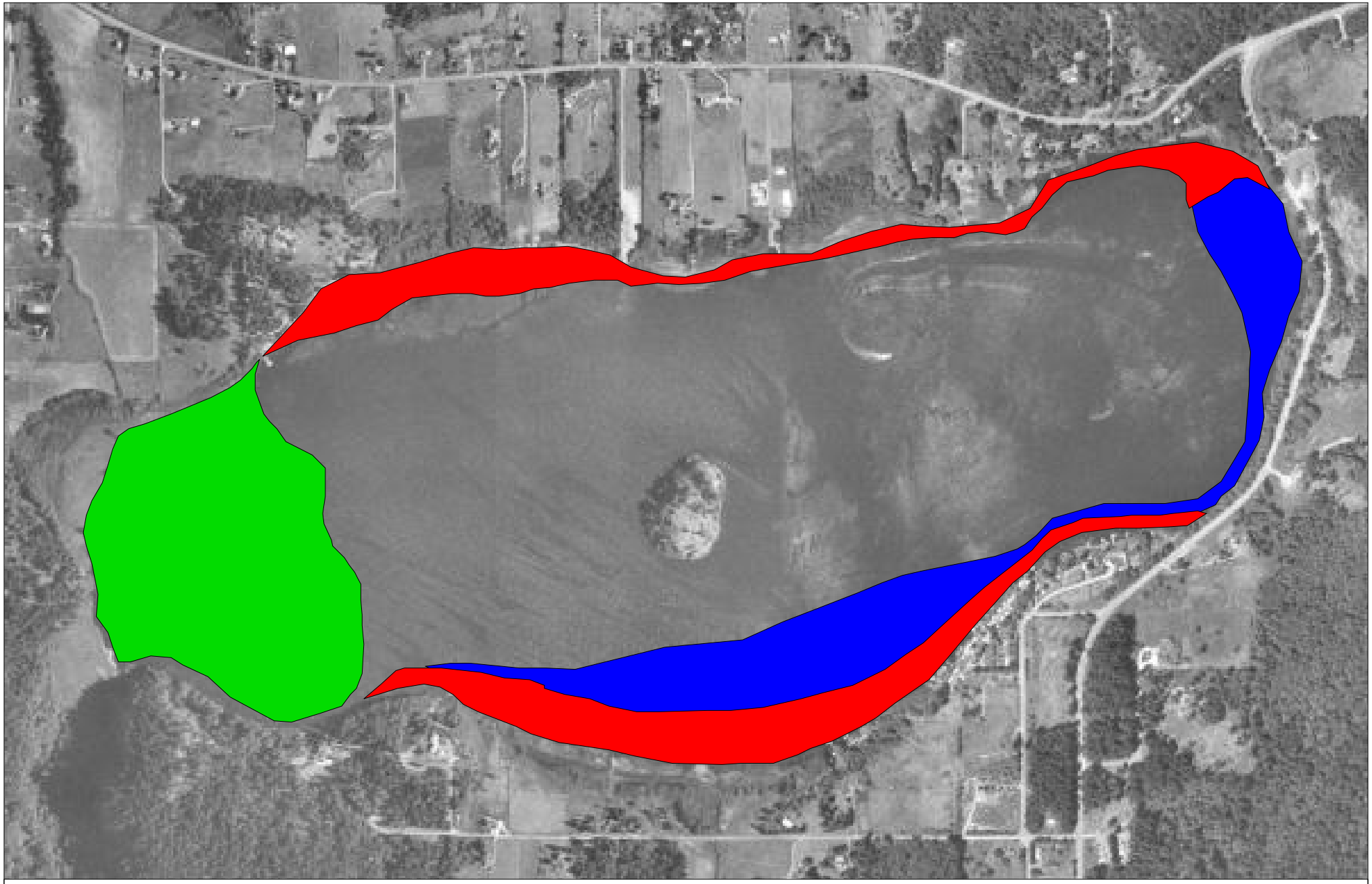
Campbell Lake
2003 Survey

- Potamogeton richardsonii
- Potamogeton amplifolius
- Potamogeton filiformis
- Elodea canadensis
- Chara
- Myriophyllum verticillatum
- Nymphaea spp.
- Ceratophllum demersum
- Transect Line

N
W E
S

AquaTechnex
"Advancing the Science of Lake Management"

70 0 70 140 Meters



Campbell Lake 2003 Survey

- Moderate to Dense Mixed Potamogeton spp. w/ M. verticillatum
- Chara
- Moderate C. demersum mixed w/Chara

N
W E
S

AquaTechnex
"Advancing the Science of Lake Management"

200 0 200 400 Meters

Lake Erie Point Data

Key: Aquatic Plants
Ceratophyllum demersum=C
Potamogeton pusillus=Pp
Potamogeton amplifolius=Pa
No Plants Present=N

Density Ratings
S=Sparse
M=Moderate
D=Dense

Point Number	July Plants	July Density	September Plants	September Density
1	Pp	S	Pp	S
2	Pp,C	S	Pp,C	S
3	Pp,C	S	Pp,C	S
4	C	S	C	S
5	C	S	C	S
6	C	S	C	S
7	Pp	S	Pp	S
8	Pp	S	Pp	S
9	C	S	C	S
10	C	M	C	M
11	C	S	C	M
12	C	S	C	S
13	C	S	C	S
14	C	S	C	M
15	C	S	C	S
16	C	S	C	M
17	Pp	S	Pp	S
18	C	M	C	S
19	C	S	C	M
20	C	S	C	M
21	C	S	C	M
22	C	S	C	S
23	Pp	S	Pp	S
24	C	S	C	M
25	C	S	C	M
26	C	M	C	S
27	C	S	C	S
28	Pp	S	Pp	M
29	Pp	S	Pp	S
30	Pp	S	Pp	S

31	C	S	C	S
32	C	S	C	M
33	C	S	C	M
34	C	S	C	S
35	C	S	C	S
36	Pp	S	Pp	M
37	Pp	S	Pp	S
38	C	S	C	S
39	C	S	C	S
40	C	S	C	S
41	C	S	C	S
42	Pp	S	Pp	S
43	Pp	S	Pp	S
44	Pp	S	Pp	S
45	C	S	C	S
46	C	S	C	S
47	C	S	C	M
48	C	S	C	M
49	Pp	S	Pp	S
50	Pp	S	Pp, C	S
51	C	S	C	S
52	C	S	C	S
53	C	S	C	S
54	Pp	S	Pp, C	S
55	Pp	S	Pp	S
56	C	S	C	S
57	Pp	S	Pp	S
58	C	S	C	S
59	C	S	C	M
60	C	S	C	S
61	C	S	C	M
62	Pp, Pa	S	Pp, Pa	M
63	C	S	C	M
64	C	S	C	S
65	Pp	S	Pp	S
66	Pp	S	Pp	S
67	Pp	S	Pp	S
68	C	S	C	S
69	C	S	C	S
70	Pp	S	Pp	S
71	C	S	C	S
72	C	S	C	S
73	C	S	C	S
74	C	S	C	S
75	C	S	C	S

76	C	S	C	S
77	Pp	S	Pp	S
78	Pp	S	Pp	S
79	Pp	S	Pp	S
80	C	M	C	S
81	C	S	C	S
82	C	S	C	S
83	C	S	C	M
84	C	S	C	M
85	C	S	C	S
86	Pp, C	S	Pp, C	S
87	C, Pa	S	C, Pa	S
88	Pp	S	Pp	S
89	Pp	S	Pp	S
90	Pp, C	S	Pp, C	S
91	C	M	C	M
92	C	S	C	S
93	C	S	C	S
94	C	S	C	S
95	Pp, C	S	Pp, C	S
96	Pp, C	S	C	S
97	Pp	S	Pp	S
98	Pp	S	Pp	S
99	Pa	S	Pa	S
100	Pp	S	Pp	S
101	C	S	C	S
102	C	S	C	S
103	Pp	S	Pp	S
104	Pp	S	Pp	S
105	C	S	C	S
106	C	S	C	S
107	Pp	S	Pp	S
108	Pp	S	Pp	S
109	C	S	C	S
110	C, Pa	S	C	S
111	C	S	C	S
112	C	S	C	S
113	C	S	C	S
114	C	S	C	S
115	C	S	C	S
116	Pp	S	Pp	S
117	C	S	C	S
118	C	S	C	S
119	C	S	C	S
120	C	S	C	S

121	C	S	C	S
122	Pp	S	Pp	S
123	Pp, C	S	Pp, C	S
124	Pp	S	Pp	S
125	C	S	C	S
126	Pp	S	Pp	S
127	C	S	C	S

Lake Erie Transect Data

Key: Aquatic Plants
Ceratophyllum demersum=C
Potamogeton pusillus=Pp
Potamogeton amplifolius=Pa
No Plants Present=N

Bottom Coverage number is percent covered at that location
First Plants or Percent is for July Survey
Second (behind /) Plants or Percent is for September Survey

Transect One

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	C/C	10/10	40	C/C	5/10
60	C/C	10/15	80	C/C	10/15
100	C/C	10/10	120	C/C	10/15
140	C/C	10/10	160	C/C	5/10
180	C/C	10/15	200	C/C	10/10
220	C,PP/C,PP	10/10	240	C/C	10/15
260	C/C	10/15	280	C/C	10/15
300	C/C	15/20			

Transect Two

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	C/C	5/10	40	C/C	10/10
60	C/C	10/15	80	C/C	10/15
100	C/C	10/10	120	C/C	10/15
140	C,PP/C	10/15	160	C/C	10/20
180	C/C	10/15	200	C/C	10/15
220	C/C	10/15	240	C/C	10/15
260	C/C	10/15	280	C/C	10/15
300	C/C	10/15			

Transect Three

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	C/C	5/5	40	C/C	5/5
60	C/C	10/15	80	C/C	10/15
100	C/C	10/15	120	C/C	10/20
140	C/C	10/10	160	PP/PP	10/10
180	C/C	10/15	200	C/C	10/15
220	C/C	10/10	240	C/C	5/10
260	C/C	5/10	280	C/C	5/10
300	C/C	5/10			

Transect Four

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	N		40	C/C	5/5
60	C/C	10/10	80	C/C	10/10
100	C/C	10/15	120	C/C	10/15
140	C/C	10/15	160	C/C,PP	10/15
180	C/C	10/15	200	C/C	10/15
220	C/C	5/10	240	C/C	10/10
260	C/C	10/10	280	C/C	10/10
300	C/C	10/10			

Transect Five

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	N		40	C/C	5/10
60	C/C	10/10	80	C/C	10/15
100	C/C	10/15	120	C/C	10/15
140	C/C	10/10	160	C/C	10/15
180	C/C	10/15	200	C/C	10/15
220	C/C	10/15	240	C/C	10/15
260	C/C	5/5	280	C/C	5/10
300	C/C	5/15			

Transect Six

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	C/C	5/10	40	C/C	5/10
60	C/C	10/10	80	C/C	10/10
100	C/C	10/15	120	C/C	10/15
140	C/C	10/15	160	C/C	10/15
180	C/C	10/15	200	C/C	10/15

220	C/C	10/10	240	C/C	10/15
260	C/C	10/15	280	C/C	10/15
300	C/C	10/15			

Transect Seven

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	N		40	N	
60	C/C	5/10	80	C/C	5/5
100	C/C	5/15	120	C/C	5/10
140	C/C	5/10	160	C/C	10/15
180	C/C	10/15	200	C/C	10/15
220	C/C	10/15	240	C/C	10/15
260	C/C	10/15	280	C/C	10/10
300	C,PP/C,PP	10/15			

Transect Eight

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	C/C	5/5	40	C/C	5/5
60	N		80	C/C	5/10
100	C/C	5/10	120	C/C	10/15
140	C/C	10/15	160	C/C	10/15
180	C/C	10/15	200	C/C,PP	10/15
220	C/C,PP	10/15	240	C/C	10/15
260	C/C	5/10	280	C/C	10/10
300	C/C	5/10			

Lake Campbell Point Data

Key: Aquatic Plants
Ceratophyllum demersum=C
Potamogeton filiformis=Pf
Potamogeton amplifolius=Pa
Potamogeton richardsonii=Pr
Elodea canadensis=E
Myriophyllum verticillatum=Mv
Chara=Ch
No Plants Present=N

Density Key
S=Sparce
M=Moderate
D=Dense

Point Number	July Plants	July Density	September Plants	September Density
1	Ch,E	M	Ch,E	M
2	Ch,E	M	Ch,E	M
3	Ch	M	Ch	M
4	Ch,E	D	CH,E	D
5	Ch,E	M	Ch,E	M
6	Ch,E	M	Ch,E	M
7	Ch	M	Ch	M
8	C	M	C	M
9	C	M	C	M
10	Ch,C	M	Ch,C	M
11	Ch,	M	Ch	M
12	Ch	M	Ch,C	M
13	Ch	S	C	S
14	C,Ch	M	C,Ch	M
15	Ch	S	Ch	S
16	C	M	C	M
17	C	S	C	M
18	C	M	C	M
19	Ch,C	M	Ch,C	M
20	C	S	C	M
21	Ch	S	Ch	S
22	C	M	C	M
23	C	M	C	M
24	Pr,Ch,Mv	M	Pr,Ch,Mv	M

25	Pr,Mv,Ch	M	Pr,Mv,Ch	M
26	Ch,Mv	M	Ch,Mv	M
27	Pa,Mv	M	Pa,Mv	D
28	Pr,Mv	M	Pr,Mv	D
29	Ch,Mv	M	Ch,Mv	D
30	Ch,Mv	M	Ch,Mv	D
31	Pa	M	Pa,Mv	M
32	Pr,Mv	M	Pr,Mv	D
33	Ch,Mv	M	Ch,Mv	D
34	C,Mv	M	C,Mv	D
35	Ch,Mv	M	Ch.Mv	D
36	Pf, Mv	D	Pf,Mv	D
37	Pr,Mv	M	Pr,Mv	D
38	Ch,Mv	M	Ch,Mv	D
39	Ch,Mv	D	Ch,Mv	D
40	Pr	M	Pr	M
41	Mv,	M	Mv	D
42	Ch,Mv	M	Ch,Mv	D
43	Ch,Pr	M	Ch,Pr	M
44	Ch	M	Ch	M
45	Ch	M	Ch	M
46	Ch	M	Ch	M
47	Ch	M	Ch	M
48	Mv	M	Mv	M
49	Ch	M	Ch	M
50	Ch	M	Ch	M
51	Pr	M	Pr	M
52	Ch	S	C	S
53	Ch	S	C	S
54	Ch	S	Ch	S
55	Ch	S	Ch	S
56	Ch	S	Ch	S
57	Ch	S	Ch	S
58	Ch	S	Ch	S
59	Ch,C	M	Ch,C	M
60	Ch,C	M	Ch,C	M
61	Ch	S	Ch	S
62	Pa	S	Pa	M
63	Pa	S	Pa	M
64	Ch	S	Ch	S
65	Ch	S	Ch	S
66	Ch	S	Ch	S
67	Ch	S	Ch	S
68	Mv	M	Mv	M
69	Ch	S	Ch	S

70	Ch	S	Ch	S
71	Ch	S	Ch	S
72	Ch	S	Ch	S
73	Pr,E	M	Pr,E	D
74	Pr,E	M	Pr,E	D
75	Ch,Mv	M	Ch,Mv	D
76	Ch,Mv	M	Ch,Mv	D
77	Pr,E	M	Pr,E	D
78	Pr,E	M	Pr,E	M
79	Ch	S	Ch	S
80	Ch	M	Ch	M
81	Pr,E	M	Pr,E	M
82	Pr	S	Pr	M
83	Mv	M	Mv	M
84	Ch	S	Ch	M
85	Ch	S	Ch	S
86	Ch	S	Ch	S
87	Mv	S	Mv	M
88	Ch	S	Ch	S

Lake Campbell Transect Data

Transect One

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	C/C	40/50	40	C/C	50/50
60	C/C	40/40	80	C/C	30/40
100	C,Ch/C,Ch	30/30	120	C,Ch/C,Ch	30/30
140	C,Ch/C,Ch	30/40	160	C,Ch/C,Ch	30/30
180	C,Ch/C,Ch	40/40	200	C,Ch/C,Ch	40/40
220	CH/CH	30/30	240	CH/CH	30/40
260	CH/CH	25/25	280	CH/CH	25/25
300	CH/CH	30/40			

Transect Two

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	E,PR/E,PR	75/75	40	E,PR/E,PR	75/75
60	E,PR/E,PR	50/60	80	Pr,HC/Pr,Ch	50/50
100	Pr,HC/Pr,Ch	50/40	120	Ch/Ch	25/25
140	Ch/Ch	25/30	160	Ch/Ch	25/25
180	Ch/Ch	10/15	200	Ch/Ch	10/15
220	Ch/Ch	10/15	240	N	

260	N		280	N	
300	N				

Transect Three

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	Pr,Mv/Pr/MV	75/100	40	Pr,Mv/Pr/MV	75/100
60	Pr,Mv/Pr/MV	75/75	80	Pr,Mv/Pr/MV	50/75
100	Pr,Mv/Pr/MV	50/75	120	Pr,Mv/Pr/MV	50/75
140	Ch,Mv/Ch/MV	30/40	160	Ch/Ch	30/30
180	Ch/Ch	30/30	200	Ch/Ch	30/30
220	Ch/Ch	20/20	240	Ch/Ch	20/20
260	Ch/Ch	20/20	280	Ch/Ch	20/20
300	Ch/Ch	20/20			

Transect Four

Distance	Plants	Bottom Coverage	Distance	Plants	Bottom Coverage
20	Ch/Ch	20/20	40	Ch/Ch	20/20
60	Ch/Ch	20/20	80	Ch/Ch	20/20
100	C/C	5/15	120	C/C	5/10
140	Ch/Ch	5/10	160	Ch/Ch	10/15
180	Ch/Ch	10/10	200	Ch/Ch	10/10
220	Ch/Ch	10/15	240	Ch/Ch	10/10
260	Ch/Ch	10/15	280	Ch/Ch	10/10
300	Ch/Ch	10/15			