WATER QUALITY AND AQUATIC PLANT UPDATE

PIGEON LAKE
MANITOWOC COUNTY, WISCONSIN

GRANT #LPL-942-04

February 17, 2005

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February 17, 2005

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1.0 EXECUTIVE SUMMARY

Pigeon Lake (the Lake) is an 80-acre drainage lake located in southern Manitowoc County, Wisconsin. Its watershed is dominated by agriculture, but residential developments, wetlands, roads, grasslands, and forested areas are also present. The Lake is ringed by residential development and subject to intense recreational use by resident and non-resident lake patrons. It has a history of good water quality and aesthetic value, and supports diverse plant and animal communities including many native and some non-natives species.

Northern Environmental Technologies, Incorporated (Northern Environmental) completed a lake water quality and aquatic plant community study during 1995. The report provided baseline data and lake management recommendations to the Pigeon Lake Association (the Association) and the Pigeon Lake Sanitary District. During subsequent years, lake residents perceived diminished water quality and reported algal blooms and winter fish kills. In response, a follow-up water quality and plant community study was completed during 2004. This study evaluated the current physiochemical conditions of the Lake and documented water quality, trophic status, and/or aquatic plant community changes that have occurred since the early 1990s.

Comparing 1995 and 2004 data revealed that the Lake has remained a mesotrophic lake that thermally stratifies throughout the summer. The volume and duration of hypoxic conditions (less than 5 milligrams per liter dissolved oxygen [mg/L DO]) and anoxic (less than 0.05 mg/L DO) in deeper parts of the Lake have increased 110 percent in recent years. This suggests that greater amounts of DO are being consumed during summer months or that stratification has been longer and/or more stable. The 1994 and 2004 surveys reveal that the Lake has a moderately diverse and productive aquatic plant community. Based on the evidence available, we believe that increased organic decomposition in deeper parts of the Lake may be resulting from increased plant growth, in particular Eurasian watermilfoil. In turn, summer decomposition of plant material is consuming more of the available oxygen. This theory is supported by 2004 data that indicates both ammonia and Kjeldahl nitrogen have increased since 1995. Ammonia typically remains reduced under anoxic conditions, and Kjeldahl nitrogen is nitrogen bound in organic matter.

Total phosphorus concentrations of the Lake water have also increased since the early 1990s. The 2004 data suggest that internal and external sources are both contributing to this increase. Increased plant decomposition near the Lake bottom is likely depleting oxygen, which can increase the size of the anoxic hypolimnion. A larger volume of anoxic water promotes increased phosphorus release from bottom sediments. External phosphorus sources are also significant. Storm-water samples collected from the East Sub-Basin of the watershed contained high phosphorus concentrations. Based on the mass influx from these flows, this sub-basin is a larger source of total phosphorus than internal loading during summer. This suggests that development and other activities in the sub-basin may be contributing to water quality changes in the Lake.

Based on these findings, Northern Environmental concludes that more of the lake volume is occupied by oxygen-deficient water during summer, and phosphorus loading has increased since the early-1990s. To address these undesirable developments, we recommend that the Association take meaningful steps to:

- Stabilize or reduce lake water nutrient concentrations
- Promote conditions desirable to native plants and animals
- Hinder the propagation of exotic plants and animals
- Monitor the Lake for further change

Northern Environmental further recommends six tactics that the Association can implement to execute these strategies.

1. Reduce phosphorus loading
2. Evaluate long-term water quality trends
3. Reduce lake sediment re-suspension
4. Evaluate methods to reduce volume of anoxic/hypoxic water
5. Monitor and manage aquatic plants
6. Maximize use of available public funds

Finally, we suggest the Association adopt a lake restoration and improvement plan that includes the six recommended tactics. For the Association's convenience, we suggest that this plan:

- Maximize use of available grant funds
  - Incorporate the Association as a non-profit entity to facilitate grant application and administration
  - Pursue multiple grant opportunities
    - Lake Management Planning
    - Lake Management Protection
    - Aquatic Invasive Species
    - Recreational Boating Facilities
    - Clean Water Grants

- Identify, quantify, and compare nutrient sources within the Lake and watershed

- Reduce nutrient influx from identified sources
  - Promote the use of phosphorus-free fertilizer in areas contributing surface-water runoff to the Lake
  - Encourage riparian buffers
  - Reduce internal phosphorus cycling by lessening the anoxic hypolimnion and decreasing the accumulation of aquatic plant detritus
  - Pass ordinance to help reduce sediment re-suspension by watercraft

- Reduce plant density and dissolved oxygen consumption, and improve aesthetics.
  - Complete an aquatic plant management plan
  - Start chemical, mechanical, and/or other treatments to remove aquatic plants

- Limit the propagation of invasive and/or non-native species (e.g., Eurasian watermilfoil) through public outreach and education

We believe implementing this plan will help the Association stem further water quality degradation in the Lake.

2.0 INTRODUCTION

Pigeon Lake (the Lake) is an 80-acre drainage lake located primarily in the western half of Section 33, Township 17 North, Range 22 East, in the Town of Liberty, Manitowoc County, Wisconsin. The Lake has a single perennial outlet located at the southwest corner of the Lake and a single inlet located in its northeast corner (Figure 1). The maximum depth is 68 feet and the average depth is 19 feet. Agriculture is the dominant land use in the Lake's approximately 1200-acre (1.9-square mile) watershed. The Lake is known to support diverse plant and animal communities including many native species and some non-natives (e.g., Eurasian watermilfoil [*Myriophyllum spicatum*] and alewife [*Alosa pseudoharengus*]) (Clarke, 2004). Approximately 70 percent of the 1.6-mile shoreline of the Lake is developed. The remaining 30 percent of shoreline includes a recreational camp, a public boat landing, and wetlands. The Lake is heavily used for recreational boating by both lake residents and visitors.

During 1992, the Pigeon Lake Sanitary District was awarded funding from the Wisconsin Department of Natural Resources (WDNR) through the Lake Management Planning Grant program to evaluate the Lake and its watershed. Northern Environmental Technologies, Incorporated (Northern Environmental) completed the 3-year study. The resultant report:

- Provided baseline water-quality data
- Evaluated non-point source pollution
- Characterized aquatic vegetation
- Corrected the bathymetric map
- Delineated the watershed
- Included a lake management plan

Area residents recently have perceived water quality deterioration and other changes in the Lake. The WDNR speculated that excessive nutrients from undetermined sources were causing this deterioration. Based on this belief, the Pigeon Lake Association (the Association) determined a need to investigate if any of the following have changed since 1995:

- Aquatic macrophyte abundance or community composition
- Nutrient sources and/or dynamics
- Summer sediment suspension due to boat traffic
- Spring algal blooms and loss of water clarity

During January 2004, Northern Environmental helped the Association apply for a Lake Management Planning Grant. The grant was applied for through the Town of Liberty Sanitary District 1 (the Sanitary District) and was awarded during March 2004. The project goals included:

- Re-evaluating nutrient sources of the Lake and their abundance and distribution
- Characterizing the current physicochemical dynamics of the Lake and contrasting it to earlier data
- Re-assessing the aquatic plant community of the Lake

Data gathered between May and November 2004 was compared to that reported during 1995. The Association provided volunteer labor and donated equipment. Northern Environmental collected data, interpreted results, and prepared this report.

3.0 INVESTIGATIVE METHODS

Several methods were employed to investigate the chemical, physical, aquatic plant community characteristics, and watershed morphology of the Lake. Whenever possible, methods used during the 1995 lake study were duplicated to ensure that 2004 data was comparable to earlier data.

3.1 Watershed Morphology and Land Use

Calculating the nutrient quantities and water balance of the Lake requires knowledge of storm-water and groundwater supplies. Lake storm-water and groundwater flows are largely dependent on watershed morphology. Because of this, the previously delineated watershed boundary was reviewed and re-defined by interpreting current U.S. Geologic Survey (USGS) topographical maps (USGS, 1973) (Figure 2).

According to the Association project coordinator (a 45-year resident of Pigeon Lake), significant watershed land-use changes have occurred in recent years (Appendix B). The provided information suggests that recent changes only occurred in discreet locations. As a result, extensive aerial photograph comparisons were not necessary to quantify the changes. However, Northern Environmental staff physically inspected the watershed to field confirm what had been reported, and casually reviewed aerial photographs for obvious change. Figure 3 illustrates the 2000 land-use conditions (MCLIO, 2000).

3.2 Bathymetry and Water Volume

Calculating the water balance of Pigeon Lake requires knowledge of the bathymetry and volume of the Lake. During 1995, a revised bathymetric map repositioned the deepest area of the Lake and identified several new lake morphologic features. The refined depth contours this map were used to estimate lake volume.

3.3 Hydrology Water Balance

The sources and amount of water that enter, are stored, and flow out of a lake can be estimated by computing a water balance. When combined with water quality data, a water balance can be used to help estimate the fate of nutrients and other compounds that affect lake water quality. A water balance has three primary factors: input, storage, and output. Contributors to each of these factors are listed below.

3.3.1 Contributing Factors

Inputs

Incident Precipitation (P)	Rain and snow that fall directly upon the lake surface.
Runoff (R)	Surface-water flow, generally resulting from storms and snow melt.
Groundwater (GW)	Springs, seeps, and dry weather stream flow

Storage

Lake volume (V)	Changes related to lake surface elevation.

Outputs

Surface-Water Outflow (O)	Outlet streams
Seepage (S)	Lake water infiltrating into the lake bottom and contributing to groundwater
Evaporation (E)	Water loss from the lake surface.

These factors relate to each other in accordance with the following equation:

$$P + R + GW = V + O + S + E$$

By making a few assumptions, the water balance of Pigeon Lake can be approximated. These assumptions include the following.

- The volume of lake water infiltrating into the lake bottom is negligible
- The volume of water entering the lake through precipitation and exiting the lake via evaporation is approximately equal
- Lake volume does not appreciably change year-to-year
- The Pigeon Lake watershed is in similar to the Meeme River watershed upstream of the USGS gaging station at South Cleveland Road, Cleveland, Wisconsin.
- Internally drained portions of the Pigeon Lake watershed contribute all water as groundwater.

The reasoning behind each of these assumptions is described in more detail in the following paragraphs.

The water elevations of ponds, wetlands, and streams are higher than Pigeon Lake in all nearby areas, except for a relatively small area abutting the southern edge of the Lake. This area is located in an area of lower permeability soil and accounts for less than 15 percent of the shoreline and adjacent lake bottom areas. Therefore, we believe little lake water infiltrates into the Lake bottom, leaving the Lake basin as groundwater.

On average, the local area receives approximately 29.24 inches of precipitation per year (USDA, 1980). Research has shown that Class A evaporation pans in the local area loose approximately 37.50 inches of water to evaporation each year (U. S. Weather Bureau, 1959). Evaporation pans loose more water than lakes, and therefore a correction (pan coefficient) must be applied. Typically, 0.75 is used in the upper Midwest. Taking this correction into account, Pigeon Lake likely looses over 28 inches of water to evaporation. Given the precision of the evaporation data, the water contribution of incident precipitation and evaporation are approximately equal, and these two terms cancel each other in the water balance equation.

The water elevation of Pigeon Lake is not known to fluctuate year to year. Since the basin morphology of the Lake also does not change, the volume of water contained within the Lake is believed to be constant year-to-year.

Stream gaging records are available for the Meeme River approximately 10 miles downstream of Pigeon Lake at South Cleveland Road near Cleveland, Wisconsin (USGS, 2004). Additionally, the USGS has estimated that the Meeme River watershed yields 0.09 cubic foot per second per square mile (USGS, 1973). These data allow us to estimate the contribution of surface water and groundwater to Pigeon Lake, if we assume the Meeme River watershed has similar hydrologic conditions throughout its extent. Soil conditions are generally consistent throughout the Meeme River watershed, except for an area of coarser-grained soils found in hummocky terrain to the west of the Lake. This area is internally drained, and likely contributes relatively less surface water and relatively more groundwater to the watershed than typical for the watershed as a whole. Given the scope of this study and the lack of more refined data, the water balance assumes the entire East Sub-Basin and Lake Sub-Basin contribute water to the Lake in a fashion identical to average Meeme River watershed conditions. In contrast, the West and Northeast Sub-Basins do not yield surface-water runoff, and are instead presumed to contribute only ground water. We have assumed that the volume of groundwater yielded by the West and Northeast Sub-Basins is equal to watershed average surface runoff rates.

3.3.2 Local Groundwater/Surface-Water Flow and Interaction

Surface topography, the elevation of nearby wetlands, streams, and springs; and other factors were evaluated to form a hypothesis regarding groundwater and surface-water flow in the local area around Pigeon Lake. The area west of the Lake is very irregular with numerous closed depressions and is underlain by fairly permeable glacially deposited sediment. This area is very conducive to surface-water infiltration and is likely a significant source of groundwater recharge. Consequently, this area contributes comparatively little surface water to Pigeon Lake. Groundwater likely radiates from this area, much of which finds its way in the subsurface to the western shore of Pigeon Lake. We would anticipate finding diffuse groundwater entry points (e.g., springs and seeps) along the Pigeon Lake western shoreline.

The area to the east of Pigeon Lake is also quite irregular with abundant closed depressions. However, soils to the east of Pigeon Lake are clayey and not particularly conducive to groundwater infiltration. Therefore, we would anticipate that perched wetlands and ponds are common in this area.

3.4 Water Quality

Water quality samples were collected from the Lake and the East Sub-Basin inlet stream several times during the study (Figure 3). These samples were analyzed to assess and contrast current water quality with that reported during 1995, to evaluate the potential input of nutrients from surface-water sources, and to evaluate current nutrient dynamics and trophic status.

3.4.1 Sample Collection

Water quality samples were collected at the same location (the deepest portion of the Lake) and during the same Lake condition (e.g., stratified and turnover) as the 1995 study to facilitate temporal comparisons. Also, congruent with the 1995 study technique, both lake surface (surface) and lake bottom (near-bottom) samples were collected. All lake water quality samples were collected by Northern Environmental staff and/or Association volunteers using a Kemmerer bottle working from an Association member's boat fitted with SONAR depth finding equipment. The boat was anchored to maintain a static position regardless of wind conditions. The accuracy of the SONAR depth finder was verified during the first sampling round using a measuring tape and steel weight to reconfirm lake depth at the deepest point of the Lake.

Four rounds of samples, including a total of eight individual samples, were collected to represent lake water quality under stratified and mixed conditions. These samples were collected.

- During early summer (stratified conditions [May 5, 2004])
- During mid summer (stratified conditions [June 17, 2004])
- During late summer (stratified conditions [August 16, 2004])
- Immediately after fall turnover (mixed conditions [November 11, 2004])

In addition to the eight time-comparative samples, four individual samples that focused on nutrient dynamics of the Lake and the East Sub-Basin inlet stream were collected (Table 1). Two of these were surface and near-bottom samples collected from the Northwest Basin of the Lake during late summer stratification. The other two were collected from the East Sub-Basin inlet stream of the watershed and represented high-flow (storm water) and base-flow (groundwater) conditions.

Table 1: 2004 Water Quality Sample Collection Dates

Sample Type	Date Collected	Sample Location		Target Condition
Temporal	5/5/04	Deepest Point	Near Bottom	Early Summer Stratification
			Surface	Early Summer Stratification
	6/7/04	Deepest Point	Near Bottom	Mid-Summer Stratification
			Surface	Mid-Summer Stratification
	8/16/04	Deepest Point	Near Bottom	Late Summer Stratification
			Surface	Late Summer Stratification
	11/11/04	Deepest Point	Near Bottom	Fall Turnover
			Surface	Fall Turnover
Nutrient Dynamics	5/17/04	Inlet Stream	High Flow	Storm water
	8/16/04	Inlet Stream	Base Flow	Groundwater
		Northwest Basin	Near Bottom	Late Summer Stratification
			Surface	Late Summer Stratification

The 1995 report included spring turnover samples but no fall turnover samples. The current study included fall turnover samples to document this phenomenon and to facilitate temporal water quality comparison under mixed-lake conditions. No prolonged (longer than a few days) water clarity loss, algae blooms, or other abnormal water quality issues were observed in the Lake during 2004. As a result, no water quality samples were collected to characterize these phenomena. Samples were collected from the East Sub-Basin stream during storm-flow and base-flow events to characterize the quality of water flowing into the Lake under those conditions.

3.4.2 Sample Preparation, Shipment, and Analysis

All water samples collected were stored in plastic sample bottles provided by the State Laboratory of Hygiene (SLOH). Samples were also preserved as prescribed by the SLOH. Sample volumes, preservatives, and analytes were as follows.

- Liter, no chemical preservative
  - Alkalinity
  - Conductivity
  - Chlorophyll *a*
  - pH
  - Total dissolved solids
- 250 ml, nitric acid preservative
  - Calcium
  - Hardness
  - Magnesium
  - Potassium
  - Sodium
- 250 ml, hydrochloric acid preservative
  - Ammonia-N
  - Nitrate + Nitrite
  - Total Kjeldahl N
  - Total phosphorus
- 60 ml, no chemical preservative
  - Dissolved reactive (soluble) phosphorus

Immediately following sample collection and preservation, all water quality samples were placed on ice in a hard plastic cooler and shipped overnight to the SLOH via courier service. Following analysis, the SLOH sent all result to the WDNR. The WDNR subsequently forwarded the results to Northern Environmental for further interpretation (Appendix A).

3.4.3 Nutrient Literature Review

Northern Environmental staff reviewed literature to help estimate internal phosphorus loading. Lehtoranta (2004) estimated benthic phosphorus release rate estimates based on soluble phosphorus concentration and lake depth. These estimates, along with the average near-bottom soluble phosphorus concentration of the Lake, the duration of hypolimnial anoxia, and the benthic surface area exposed to anoxic water were used to estimate the mass of phosphorus released by bottom sediment during 2004.

Following study initiation, the Association raised concerns about avian feces contributing nutrients to the Lake. Association members have perceived increasing numbers of Canada geese (*Branta canadensis*) and ring-billed gulls (*Larus delawarensis*) inhabiting the Lake in recent years. Collecting data to assess nutrient contribution by birds was beyond the scope of this study. However, literature was consulted to investigate the potential for geese and gulls to contribute nutrients to the Lake (Fleming, et al., 2001) (Purcell and Goldsborough, 1995).

3.4.4 Water Property Measurements

Physical and chemical characteristics of the Lake water were measured and compared to 1995 data, including:

- Dissolved oxygen (DO) concentration
- Water temperature
- Specific conductance
- Water clarity (Secchi disk)

Northern Environmental staff and/or Association volunteers measured these factors during water quality sampling events. Association volunteers collected additional DO, water temperature, and clarity measurements numerous times throughout the course of the study using equipment donated by Northern Environmental.

DO and water temperature were measured both at the deepest point and at the deepest portion of the Northwest Sub-Basin of the Lake using an YSI 550A-100 dissolved oxygen meter. The data were used to construct DO and water temperature profiles for each location. Epilimnial specific conductivity was measured at each of these locations using an Oakton® WP ECTestr High meter. Water clarity was measured with a Secchi disk. Secchi disk measurements were further used to estimate the maximum rooting depth of aquatic plants (Cole 1975).

3.5 Aquatic Vegetation Survey

Pigeon Lake supports emergent, submergent, floating-leaf, and free-floating aquatic plants. To evaluate the existing aquatic plant community, Northern Environmental staff and Association volunteers inventoried aquatic plants during June and August 2004. The data were evaluated and contrasted to that reported during 1995.

Aquatic plants were sampled using the point-transect method (Gibbons, et al., 1994). Ten 1995 transects that were roughly equally spaced around the Lake were resurveyed during 2004 (Figure 4). Latitude and longitude

coordinates at the ends of each transect were measured with a Trimble GeoXT™ global positioning system (GPS). Each transect was traversed with SONAR to determine depth. Along each transect, five 10-foot diameter circular sample areas were selected in various depth ranges (A = less than 2.5 feet, B = 2.5 to 5.0 feet, C = 5.0 to 10.0 feet, D = 10.0 to 20.0 feet, and D = greater than 20.0feet). Each circular sample area was subdivided into four quadrants. A general plant density rating was estimated for each quadrant visually or with a modified aquatic plant rake. The aquatic rake was typically used in areas where the bottom could not be clearly observed and/or plant density could not be visually estimated. In such cases, the rake was placed into each quadrant, allowed to settle, and was slowly retrieved. Observations regarding substrate type were recorded along with water depth in feet. A general density rating for rake-sampled quadrants was determined based on the following criteria.

Rake Recovery	General Density Rating
0-20 percent of rake teeth filled	1
21-40 percent of rake teeth filled	2
41-60 percent of rake teeth filled	3
61-80 percent of rake teeth filled	4
81-100 percent of rake teeth filled	5

At each sample point, the species encountered were identified, rated, and recorded. If a specimen could not be identified to the species level, it was referred to by the generic name followed by "sp."

For each transect and plant species detected during the surveys, the following statistics were calculated:

- Frequency of occurrence (the number of sample areas where a particular species was detected divided by the total number of sample areas)
- Relative frequency of occurrence (the number of sample areas where a particular species was detected divided by the number where any species was detected)
- Species mean density (the sum of all density ratings for a particular species divided by the number of sample points where it was detected)

4.0 WATERSHED MORPHOLOGY AND LAND USE

The 1995 report described land use around the Lake, delineated the watershed boundary, and identified "sensitive areas" important to lake and watershed protection. The watershed of the Lake was briefly re-examined and described below.

4.1 Watershed Boundary

Water balance and nutrient dynamics estimates were based largely on the size and characteristics of the Lake watershed. The contributing watershed delineated during 1995 was revised slightly (Figures 2 and 3). The new watershed delineation includes the following changes:

- Expands the watershed south of County Highway F
- Contracts the watershed out of two adjacent watersheds located east and northeast
- Distinguishes the Pigeon Lake watershed from the Little Pigeon Lake watershed
- Identifies internally drained sub-basins west and northwest of Pigeon Lake

The revised Pigeon Lake watershed is somewhat smaller (approximately 1200 acres) than was reported during 1995 (approximately 1600 acres). This reduced area stems from the exclusion of the watershed of Little Pigeon

Lake and two areas located east and northeast of the Lake that belong to other watersheds. The area within the refined watershed boundary area, as well as the areas of watershed components, is estimated below (Table 2).

Table 2: Revised Watershed Basin Areas

	Approximate Area (acres)
Pigeon Lake	80
Total Watershed *	1200
East Sub-Basin	110
West Sub-Basin‡	700
Northeast Sub-Basin‡	330
Lake Sub-Basin	86
Little Pigeon Lake	8.0
Total Watershed*	53

Note: * = Does not include open water areas of the Lake
‡ = Sub-basin is internally drained but likely contributes groundwater

4.2 Bathymetry and Water Volume

Pigeon Lake includes four distinct sub-basins, an island, a single perennial inlet stream, and a single outlet stream (Figures 1 and 5). The total volume of the Lake is approximately 743 acre-feet (242 million gallons), and nearly 60 percent of that volume is in areas with depths of 5 feet or less. A depth/volume nomogram is included in Figure 5.

4.3 Hydrology

The volumes of surface and groundwater entering and leaving the Lake each year directly affect the amount of sediment and nutrient delivery to Pigeon Lake. The annual water budget of the Lake is estimated below (Table 3).

Table 3: Estimated Annual Water Budget

	Estimated Annual Volume (million gallons)
Inflow	
Surface Water	320
East Sub-Basin	*23*[d]
Groundwater	41[a]
East Sub-Basin	*3.6*
Precipitation	63.52[c]
Lake Total	360[b]
East Sub-Basin Total	*27*
Outflow	
Meeme River Outlet	300
Evaporation	61
Lake Total	360

Note:

a = Includes influx from all areas suspected to contribute
b = Assumes no net lake level change or groundwater loss
c = Annual evaporation approximately equals precipitation
d = Assumes the Meeme River, the Pigeon Lake outlet, and the East Sub-Basin inlet have proportional total flows

Each italicized inflow is a components of inflows listed immediately above it

4.4 Land Use

During the early 1990s, agriculture was the largest land use within the watershed of the Lake, occupying approximately 40 percent of the total watershed area. Association member testimony and a watershed

inspection by Northern Environmental staff confirm that agriculture remains the most common land use in the watershed (Figures 6 and 7) (Appendix B).

Figure 6 Livestock Grazing in the Pigeon Lake Watershed

Figure 7 A Cultivated Field in the Pigeon Lake Watershed

Two significant land use changes have occurred in the watershed since 1995. A public golf course opened northeast of Pigeon Lake. Additional residential development has occurred around both the golf course and ringing the Lake (Appendix B, Figure 8).

Residential development appears to be the greatest land-use change around the lakeshore (Figure 8). In general, development has decreased forest cover and has increased the area of impermeable surface. Reduced pervious surface and riparian buffer likely lead to faster and increased volumes of storm water and increased nutrient and sediment delivery to the Lake.

Figure 8 Recent Residential Development Near Pigeon Lake

The Autumn Ridge Golf Course is located northeast of Pigeon Lake, and parts of it are in the East and Northeast Sub-Basins. Opened during 1995, the course itself was included in the land-use analysis of the 1995 report. Residential development has occurred around the course since the early 1990s. This development, as well as golf course management practices (e.g., fertilizer type and application, irrigation, altered storm-water flow, etc.) may have altered water quality in the East Sub-Basin.

5.0 PHYSIOCHEMICAL DATA AND INTERPRETATION

A variety of factors influence or are indicative of lake water quality. Important factors are described in the following sections, and relevant data are presented, interpreted, and/or contrasted to that reported during 1995.

5.1 Water Temperature

Water temperature profoundly affects lake characteristics. Temperature influences water circulation patterns, solubility of various compounds, chemical reaction rates, and aquatic plant and animal community

composition. The temperature regimen of a lake is controlled by climatic and wind conditions, lake-basin morphology, surrounding topography and vegetation, water inflows and outflows, and water chemistry.

Most deep lakes in Wisconsin thermally stratify. In such lakes, temperature-induced water density changes cause a lake to develop three distinct temperature zones. During summer, these zones include the epilimnion (warm surface layer), metalimnion (thin transitional middle layer), and the hypolimnion (cold bottom layer). Little mixing occurs between these layers while the lake is stratified. Since the hypolimnion is not exposed at the lake surface, it does not exchange gases with the atmosphere. In eutrophic lakes, decomposing organic debris in the hypolimnion can deplete DO, leading to an anoxic hypolimnion. Anoxic water is injurious to most aquatic life and encourages phosphorus dissolution from bottom sediment (Shaw, et al., 1994).

In most lakes, thermal stratification breaks down each fall as the atmosphere cools, allowing deeper water formerly trapped in the hypolimnion to mix with surface layers. During winter, many lakes again stratify. Since water reaches its maximum density at 4° C (a temperature slightly above the freezing point of water), warmer water is found at depth, while cooler, near-freezing water is found directly below the ice. This inverse temperature stratification is easily disrupted, and lakes usually mix during spring. Mixing can bring large amounts of nutrients to the surface of a lake, enhancing productivity. Lakes that stratify and undergo two periods of mixing are termed "dimictic."

The 1995 report determined the Lake to be dimictic. Summer stratification was fully established by June and remained through at least August. Pigeon Lake was thermally stratified again during May 2004 (Figure 9). This suggests that the Lake began to stratify during April, similar to the condition reported during 1995. Both the Main and Northwest Sub-Basins of the Lake thermally stratified during summer 2004. This stratification extended considerably later into the year than did the 1995 data collection period. More specifically, stratification did not begin to significantly breakdown until October, with autumn turnover occurring during early November (Figure 10). This finding is consistent with many dimictic lakes that typically undergo autumn turnover as the atmosphere cools during late October or early November. Combined, the results reported during 1995 and 2004 provide relatively complete documentation of the summer stratification periodicity and thermal characteristics of the Lake (Table 4).

Table 4: Thermal Stratification Characteristics

		Average Water Temperature (°C)[a]			Thermocline	
Month	**Year(s) Collected**	**Surface**	**Near Bottom**	**Differential**	**Depth (Ft)**	**Temperature Range (°C)**
January	1994-1995	1.3	3.5	2.2	1.0 - 4.0	0.5 - 2.0
April	1994-1995	8.0	7.0	1.0	None Present [c]	None Present [c]
May	2004	13	6.0	7.0	17 - 21	7.0 - 11
June	1994-1995	20	7.0	13	13 - 37	7.0 - 19
	2004	19	7.0	12	8.0 -38	7.5 - 20
July	1994-1995	25	8.0	17	11 - 40	8.0 - 24
	2004	25	7.0	18	6.0 - 42	8.0- 24
August	1993-1994	23	7.5	16	12 - 43	7.0 - 23
	2004	20	7.0	13	14 - 42	8.0 - 20
October	2004	14	7.0	6.5	30 - 48	7.0 - 12
November	2004	8.0[b,d]	8.0[b,d]	0	None Present [b,d]	None Present [b,d]

Note: a = Multi-year average data reported during 1995, single-year data reported during 2004.
b = Pre-turnover November data similar to that collected during stratified October conditions
c = Measured during spring turnover
d = Measured during autumn turnover

Figure 9 Temperature Profile - Summer 2004 Stratification

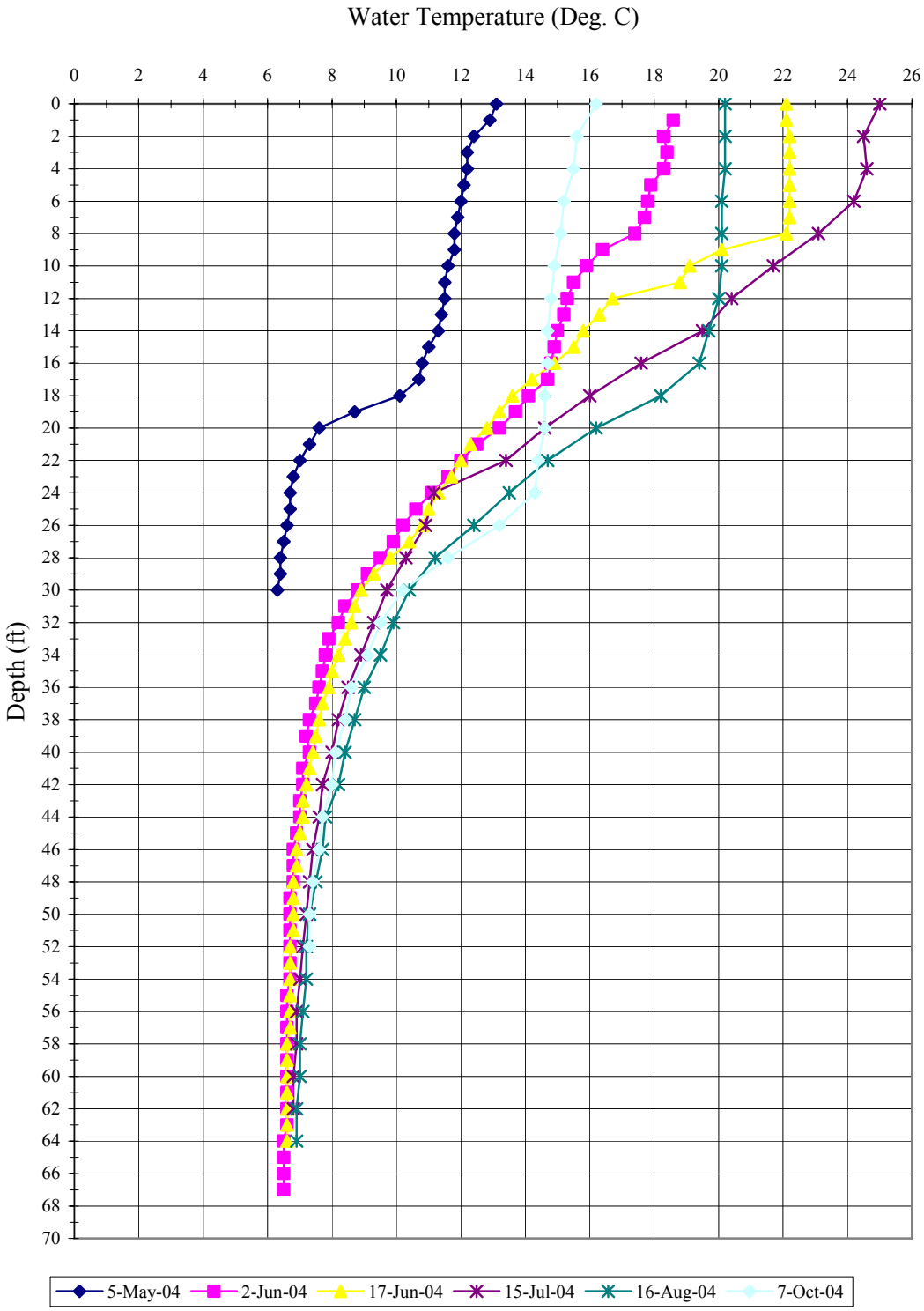
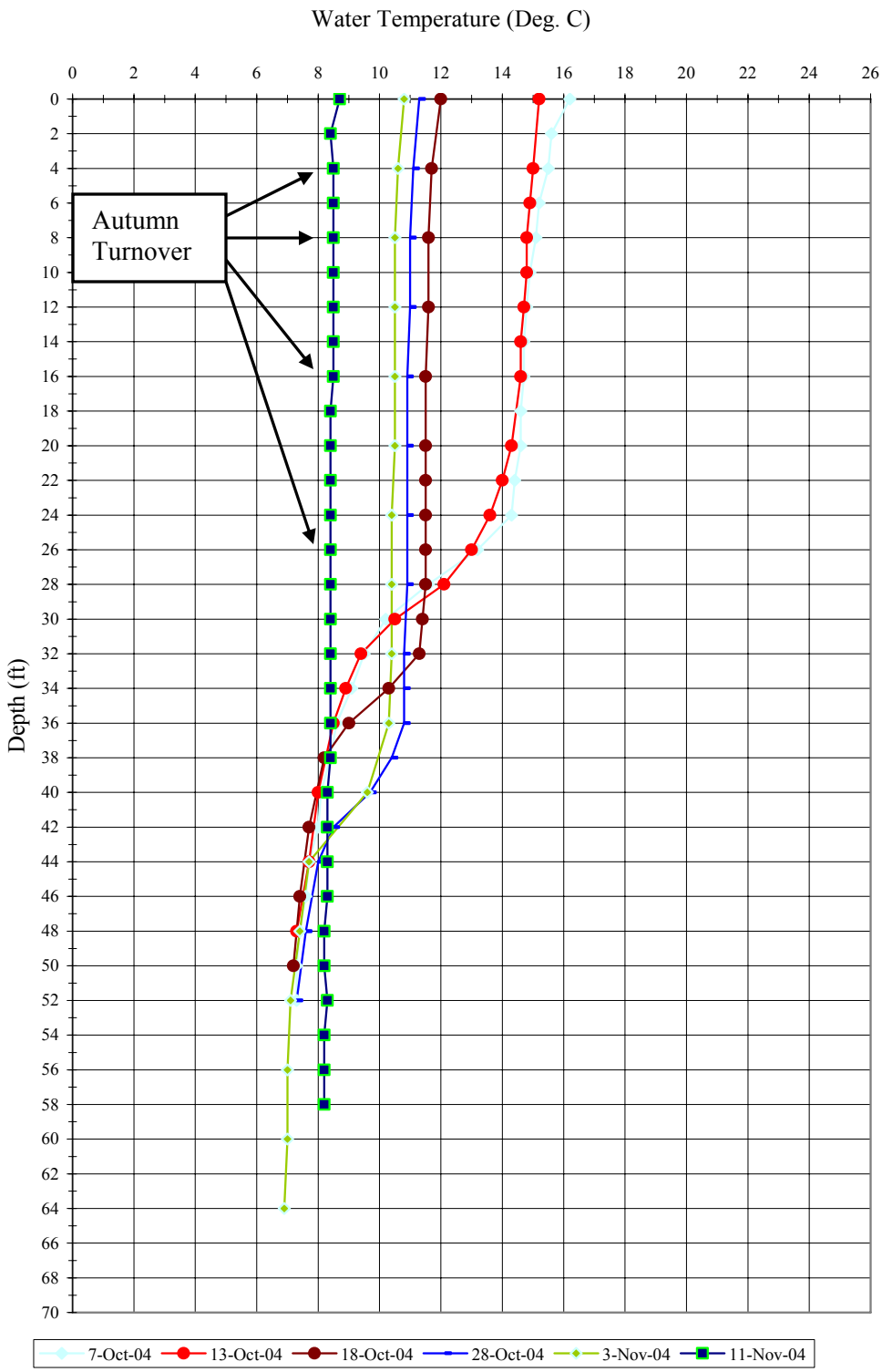


Figure 10 Temperature Profile - Autumn 2004 Destratification



The 1995 and 2004 temperature data are considerably different (Table 4). During the early 1990s, the thermocline was located 13 feet below the surface during June, and 11 feet below the surface during July. During 2004, the thermocline was 5.0 feet shallower. This means that there was approximately 4.8 percent (36 acre-feet) less epilimnial volume during June 2004 than was typical of that month during the early 1990s. Similarly, there was approximately 5.7 percent (42 acre-feet) less epilimnial volume during August 2004 than was typical of that month during the early 1990s. Air temperature and wind condition differences may influence the observed thermocline depth change.

Moyle and Cech (2000) refer to the lower-epilimnial or upper-metalimnial portion of the water column as the "aquatic plant zone" because of the aquatic macrophytes affinity for it. They note its importance for habitat for a variety of fish species include largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus)*; two game species that prefer water temperatures near the thermocline upper range and regularly observed in Pigeon Lake. The abundance and distribution of fish species inhabiting the aquatic plant zone are likely strongly influenced by changes in the volume and extent of the epilimnion.

No winter 2004 water temperature measurements were performed to confirm winter stratification. A winter walleye (*Stizostedion vitreum*) kill was recently reported by lake residents, suggesting that the Lake may stratify during winter.

5.2 Dissolved Oxygen

Dissolved oxygen is the amount of gaseous oxygen contained in water. Oxygen is needed to support respiration of aerobic organisms including fish, amphibians, aquatic invertebrates, plants, and most bacteria. Much of this oxygen originates in the atmosphere. Some oxygen is also a byproduct of photosynthesis by aquatic plants. Decomposition of detritus (dead organic matter) and respiration by other organisms removes dissolved oxygen from the water. Insufficient or depleted dissolved oxygen levels can lead to fish kills and hypolimnial anoxia. In turn, hypolimnial anoxia can encourage release of phosphorus from bottom sediments, which in turn fuels luxuriant aquatic plant growth and algal blooms.

Haggard and Green (2002) suggest that sediments typically release phosphorus when hypolimnial dissolved oxygen concentrations are at or below 0.05 milligrams per liter (mg/L). The anoxic hypolimnion of the Lake was considered the depth at which the dissolved oxygen profile becomes vertically asymptotic, and the dissolved oxygen concentration is 0.05 mg/L or less. Pigeon Lake is a warm-water fishery, a resource generally classified as requiring greater than 5.00 mg/L dissolved oxygen. Water containing less than 5.00 mg/L dissolved oxygen is inhospitable, injurious, or even lethal to warm-water aquatic life. In this report, we have used the term "hypoxic" to describe waters that contain greater than 0.05 mg/L dissolved oxygen but less than 5.00 mg/L dissolved oxygen.

5.2.1 Anoxia

The 1995 and 2004 data were used to compare the relative lake bottom area exposed to anoxic conditions, the volumes of anoxic and hypoxic water, and the periodicity of hypolimnial anoxia and hypoxia during each study period (Table 5).

Table 5: Extent and Volume of Oxygen-Deficient Water

		Vertical Extent and Volume of Hypoxic/Anoxic Water (Feet below Lake Surface/Percent of Total Lake Water Volume)[a]	
Month	**Year(s) Collected**	**Hypoxic (0.05 to 5.00 mg/L DO)**	**Anoxic (less than 0.05 mg/L DO)**
January	1994-1995	None Present [e]	None Present [e]
April	1994-1995	None Present [c]	None Present [c]
May	2004	*Greater than 30 [f]- 68 (Less than 16%)*	*Greater than 30 [f] – 68 (Less than 16%)*
June	1994-1995	*43 – 68 (7.1%)*	*Greater than 50 [f] – 68 (Less than 3.6%)*
	2004	*19 – 68 (26%)*	*45 – 68 (5.6%)*
July	1994-1995	*31 – 68 (16%)*	*41 – 68 (8.5%)*
	2004	*12 – 68 (34%)*	*28 – 68 (18%)*
August	1993-1994	*25 – 68 (20%)*	*41 – 68 (8.5%)*
	2004	*17 – 68 (29%)*	*28 – 68 (18%)*
October	2004	*30 – 68 (16%)*	*37 – 68 (12%)*
November	2004	None Present [b,d]	None Present [b,d]

Note: a = Multi-year average data reported during 1995, single-year data reported during 2004.
b = Pre-turnover November data similar to stratified October conditions
c = Measured during spring turnover
d = Measured during autumn turnover
e = Measured during winter stratification
f = Available DO meter limited to measurements to an insufficient depth

The 1995 Pigeon Lake DO profile reveals that an anoxic hypolimnion existed in the Lake during July and August below an average depth of approximately 41 feet below the Lake surface. This depth means that approximately 8.5 percent of the total lake water volume (63 acre-feet) was anoxic and that 14 acres of the lake bottom was exposed to conditions conducive to phosphorus release.

An anoxic hypolimnion was probably present during other summer months. However, it either occurred at depths greater than 50 feet (the greatest depth monitored during June) or during months when no monitoring occurred (i.e., September and October). If anoxic conditions occurred only during July and August, lake bottom sediments were exposed to conditions conducive to phosphorus release for a 60-day period. This time period almost certainly underestimates the length of summer stratification. Summer stratification and associated hypolimnial anoxia more likely began during early summer and lasted through late fall. Under this more realistic timeframe, the anoxic hypolimnion would have persisted for between 120 and 135 days.

An anoxic hypolimnion was present in Pigeon Lake between June and October 2004 (Figures 11 and 12). During that period, the average depth to the hypolimnion was 35 feet. It made up approximately 14 percent of the total water volume of the Lake (100 acre-feet) and exposed approximately 20 acres of lake bottom sediments to phosphorus-releasing conditions for about 135 days (mid-June through early-November [Figures 11 and 12]). To allow comparison to the 1995 study, removing June 2004 from these calculations decreases the anoxic hypolimnial depth to 31 feet and increases its volume to 120 acre-feet; results considerably different to those of the earlier study. More specifically, our results indicate that:

- The anoxic hypolimnion occurred at a depth 38 percent deeper during June 2004 than during subsequent summer 2004 months.
- Ten more acres of the lake bottom were exposed to conditions conducive to phosphorus release during 2004 than during the early 1990s.
- The volume of anoxic water was 6.6 percent more during 2004 than during the early 1990s.

Figure 11 Dissolved Oxygen Profile - Summer 2004 Stratification

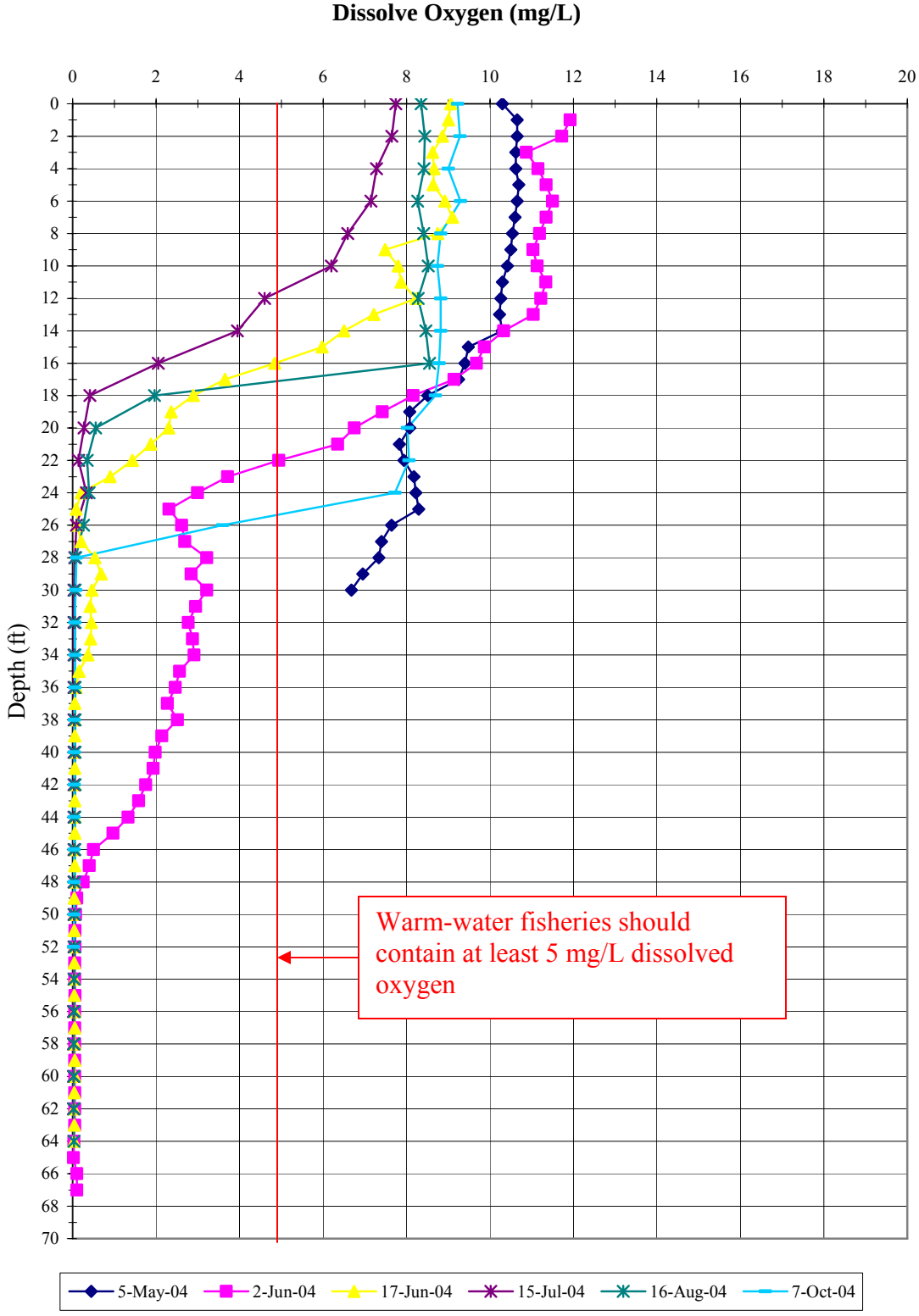
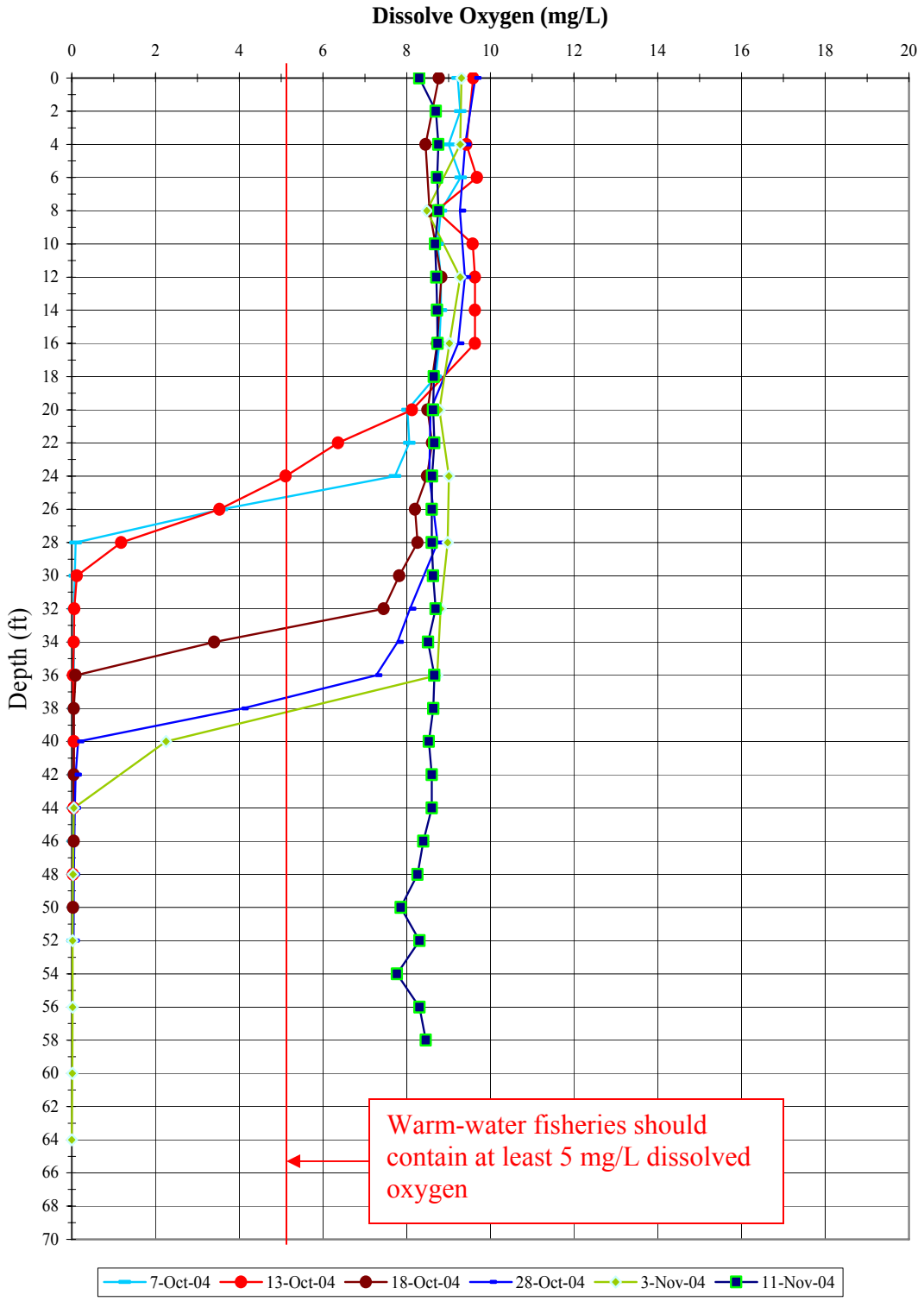


Figure 12 Dissolved Oxygen Profile - Autumn 2004 Destratification



An anoxic hypolimnion formed in both the Main and Northwest Sub-Basins and the Lake during 2004. The volume of anoxic water, duration of summer stratification, and the lake bottom surface area exposed to anoxic conditions in the Lake increased considerably between 1995 and 2004. Alone, these data suggest that changes in the phosphorus balance of the Lake are at least partially the result of increased dissolution from lake bottom sediments. If detritus decomposition also increased within the anoxic hypolimnion, internal phosphorus loading would further increase. Similarly, if a winter anoxic hypolimnion forms, then increased phosphorus loading during that season could potentially increase net annual internal loading.

5.2.2 Hypoxia

Water that is not anoxic, but is not adequately oxygenated, can cause hypoxia in fish and other aquatic organisms. Chapter NR 102, Wisconsin Administrative Code sets water quality standards for lakes and rivers. Water bodies with warm-water species should contain at least 5 mg/L dissolved oxygen, while water bodies inhabited by trout and other cold-water species should contain 6 to 7 mg/L dissolved oxygen. While many species can tolerate significantly lower dissolved oxygen concentrations (e.g., 2 mg/L) for various lengths of time, healthy and productive aquatic ecosystems are promoted if sufficient dissolved oxygen is always present.

Pigeon Lake is a warm-water fishery, and lake water should contain at least 5 mg/L dissolved oxygen to promote ecosystem health. For the purpose of this study, we have termed water containing 5 mg/L dissolved oxygen or greater as "hospitable." In contrast, water-promoting hypoxia (containing 2 to 5 mg/L dissolved oxygen) is labeled "inhospitable," while water containing less than 2 mg/L dissolved oxygen is labeled "uninhabitable."

Hypoxic water is generally found in the upper portion of the Pigeon Lake hypolimnion. The depth at which hypoxic water is found, and the volume of hypoxic water present, varies depending on the season. Data collected during the mid-1990s revealed that entire water column of Pigeon Lake contained greater than 5 mg/L dissolved oxygen during mid-winter. The 2004 study did not extend into the winter. However, after the fall turnover during November 2004, the water column of the entire Lake contained greater than 5 mg/L dissolved oxygen. This homogeneity does not guarantee that oxygen deficient conditions will not form later during winter. In fact, a recent winter walleye kill suggests that hypoxia is reforming when the Lake is ice-covered. Data to test this theory has not yet been collected.

As can be seen from the available data, water in the deep basins of the Lake does not contain enough oxygen to support desirable aquatic life. Fortunately, the deep basins do not account for most of the water volume of the lake. The volume of hypoxic water enlarges as summer progresses, demonstrating that oxygen continues to be depleted in the hypolimnion after the Lake stratifies.

The volume of summer season hypoxic water in Pigeon Lake more than doubled between 1995 and 2004. During June to August of the early 1990s, hypoxic water was found at an average depth of 33 feet. This means that on average, 110 acre-feet (or 15 percent of the total water volume of the lake) was not conducive to desirable aquatic life during summer of the early 1990s. In contrast, the average depth where hypoxic water was encountered during the June to August 2004 period was 16 feet. Therefore, during summer 2004, 230 acre-feet (or 30 percent of the lake volume) did not contain sufficient oxygen to support desirable aquatic life.

The growing volume of hypoxic water is only part of the story. The 2004 data reveals that hypoxic water conditions developed much earlier during 2004 than past years. When combined with the growth in hypoxic water volume, these data demonstrate that less aquatic habitat is available in Pigeon Lake to support desirable aquatic organisms.

5.3 Nutrients

Nitrogen and phosphorus are macronutrients essential to plant growth. While plants require many compounds to live, most are readily available in sufficient quantities to allow growth. Nitrogen and phosphorous are typically not as readily available, and the concentration of one or the other usually limits aquatic plant growth. Consequently, knowing the concentration of these compounds in lake water can help us understand the factors currently and potentially limiting plant growth. Nutrients were similar in the Main and Northwest Sub-Basins of the Lake during 2004.

5.3.1 Nitrogen/Phosphorus Ratio

When the ratio of total nitrogen to total phosphorous is greater than 15 to 1, plant and algal growth in a lake is controlled by the amount of phosphorous available and is considered "phosphorus limited." When the ratio is below 10 to 1, nitrogen is the limiting nutrient for plant and algae growth, values between 10 to 1 and 15 to 1 are considered transitional (Shaw, et al., 1993). Most Wisconsin lakes are phosphorus limited. The 1995 and 2004 nitrogen/phosphorus ratios of the Lake are summarized and compared below (Table 6).

Table 6: Nitrogen/Phosphorus Ratio

Year	Parameter	Mean Concentration (mg/L)	N:P Ratio	Limiting Nutrient
1995	Total N	1.019	46:1	Phosphorus
	Total P	0.022		
2004	Total N	1.292	52:1	Phosphorus
	Total P	0.025		

The nitrogen/phosphorus ratio of the Lake was approximately 50:1 during 1995 and 2004. Based on this information, the phosphorus remains the limiting nutrient in the Lake.

5.3.2 Phosphorus

Phosphorous is nutrient-limiting aquatic plant growth in 80 percent of Wisconsin lakes (Shaw, et al., 1994). Lake water phosphorous concentrations are usually measured as soluble phosphorous and total phosphorous. Soluble phosphorous is readily available to plants. Consequently, its concentration can vary widely over short periods of time. A potentially better measure of lake water phosphorous level is total phosphorous, which measures soluble phosphorous as well as organic-bound phosphorous in plants and animal fragments suspended in lake water.

Phosphorous is very reactive in the environment, being absorbed by plants and attaching itself tightly to sediments. Consequently, sediments carried by surface water are typically the largest external source of phosphorous to lakes. Sediments that have settled on a lake bottom can become suspended if they are disturbed by watercraft or current. Phosphorus attached to disturbed sediment particles is also suspended, but in well-oxygenated water, it remains particle bound. It remains bound because phosphorous does not readily dissolve in well-oxygenated lake water. Instead, it forms insoluble precipitates with iron, calcium, and aluminum. Consequently, most fully oxygenated lakes have a net flux of phosphorous to the lake bottom. However, if lake water lacks oxygen, iron-phosphorus precipitates become unstable and release phosphorous to the overlying water. The hypolimnia in thermally stratified lakes are often devoid of oxygen during summer, increasing the concentration of soluble phosphorous available to plant growth.

Lakes with soluble phosphorus concentrations below 0.01 mg/L and total phosphorous levels between 0.02 and 0.03 mg/L will generally have good water quality and will not have nuisance algae blooms (Shaw, et al., 1994). The median total phosphorous concentration measured in 61 southeastern Wisconsin lakes is 0.03 mg/L (Lillie and Mason, 1983).

The concentration of total and soluble phosphorus from both surface and near-bottom water from Pigeon Lake were determined. The 1995 and 2004 average phosphorus concentrations are summarized and compared below (Table 7).

Table 7: Phosphorus Concentrations

Parameter	Year Reported	Mean Concentration (mg/L)	Min. Concentration for Summer Algae Bloom (mg/L)	Nuisance Algae Bloom Conducive?	More Conducive to Algal Blooms?
Average Annual Total Phosphorus	1995	0.022	0.02	Yes	No
	2004	0.025		Yes	
Average Spring Soluble Phosphorus	1995	0.002	0.01	No	No
	2004	0.002		No	

Total lake water phosphorus concentrations were slightly higher than previous years and remained conducive to nuisance algal blooms. Mean soluble phosphorus concentrations, on the other hand, remained unchanged and below the nuisance algal threshold. These results suggest that the average phosphorus concentrations of the Lake have not changed significantly since the early 1990s.

Storm-water runoff and base flow samples were collected from the small creek entering the northeast corner of Pigeon Lake. Storm-water samples contained considerably higher total and soluble phosphorus concentrations than lake water (Table 8). This is undoubtedly due to high sediment loads in storm-water runoff. Base flow samples, representing groundwater quality, did not contain elevated soluble phosphorus concentrations. Nevertheless, base flow did contain total phosphorus concentrations greater than did those of the Lake.

While concentration data are interesting, the mass of phosphorus contributed by the inlet stream compared to other sources are more informative. The following mass evaluation can be used for this purpose (Table 8).

Table 8: Phosphorus Sources and Fates

Parameter			Mean Concentration (mg/L)	Mean Concentration (lbs/Million Gal)	Estimated Volume (Million Gal)	Annual Mass (lbs)
Total Phosphorus	Sources	East Sub-Basin Storm Water	0.097	*0.81*	23	19
		East Sub-Basin Groundwater [a]	0.043	*0.36*	3.6	1.3
		Atmospheric Deposition	Not Sampled	Not Sampled	N/A	15[f]
		Internal Lake Loading	Not Sampled [d]	Not Sampled [d]	33	18
		Total	**N/A**	**N/A**	**N/A**	**59**
	Summer Lake Storage		0.03	*0.21*	240	50
	Fates	Pigeon Lake Discharge	0.018[b]	*0.15*	300	46
		Other Fates [g]	Not Sampled	Not Sampled	Not Quantified	13[e]
		Total	**N/A**	**N/A**	**N/A**	**59**
Soluble Phosphorus	Sources	East Sub-Basin Storm Water	0.027	*0.23*	23	5.2
		East Sub-Basin Groundwater [a]	0.002	*0.017*	3.6	0.060
		Internal Lake Loading	Not Sampled [c]	Not Sampled [c]	33	18[c]
		Total	**N/A**	**N/A**	**N/A**	**23**
	Summer Lake Storage		0.002	*0.017*	240	4.0
	Fates	Pigeon Lake Discharge	0.002[b]	*0.017*	300	5.0
		Other Fates [d,g]	Not Sampled	Not Sampled	Not Quantified	18[e]
		Total	**N/A**	**N/A**	**N/A**	**23**

Note: a = Assumes East Sub-Basin base flow is groundwater
b = Assumes lake surface and lake discharge soluble phosphorus concentrations are equal
c = Based on Lehtoranta (2004) anoxic phosphorus release rate estimate of 0.75 $mg/m^2/day$
d = Includes soluble phosphorus absorbed by aquatic plants
e = Calculated as the difference between the summed sources and the lake discharge
f = Based on Robertson (1996) atmospheric deposition rate estimate of 0.18 pounds per acre
g = Includes precipitation of soluble phosphorus to lake the lake bottom
N/A = Not applicable

Flowing storm water typically entrains sediment particles, and phosphorus is often bound to those particles. The East Sub-Basin storm water appears to have been a larger source of total phosphorus than release from lake bottom sediments (internal loading) during 2004 (Table 8). Although contributing only slightly more total phosphorus mass than internal loading, this result underscores the potential significant influence the inlet stream has on the phosphorus dynamics of the Lake.

Unlike total phosphorus, internal loading generated over three times more soluble phosphorus mass than the East Sub-Basin storm-water flow during 2004. Despite not being the greatest source of soluble phosphorus, the East Sub-Basin still contributed considerable amounts of it to the Lake (Table 9).

A land-use/watershed area model was used to estimate phosphorus loading to Pigeon Lake as part of the 1995 report. The model classified land use over the entire watershed and assumed that the entire watershed contributes phosphorus to the Lake. This is not likely to be an accurate assumption. Most phosphorus is delivered from a watershed to a lake attached to particulate matter such as sediment. Areas that cannot contribute surface water to the lake (i.e., closed depressions) will not likely deliver phosphorus from the watershed. Since a large portion of the Pigeon Lake watershed is internally drained, much of the watershed is incapable of delivering sediment to the Lake. Only approximately 12 percent (190 acres) of the watershed defined during 1995 contribute surface water to the Lake. Furthermore, much of the area that does contribute surface water is occupied by wetlands and woodlands. Therefore, we believe only 10 percent of the computed 1995 watershed phosphorus yield (54 pounds) actually enters the Lake. This is still greater than that estimated

by the concentration and flow data but does compare favorably. Another factor potentially further attenuating phosphorus delivery to Pigeon Lake is wetlands trapping particulates transported by the inlet stream before water enters the Lake.

Phosphorus can leave lake water volumes by surface water discharge, precipitation to bottom sediments, and by absorption by plants. The available data does not allow us to quantify the mass of phosphorus precipitated to bottom sediments or bound by plants. Phosphorus can leave the Pigeon Lake water column through surface-water discharge or precipitation to bottom sediments. The mass of phosphorus residing in the water column can be computed from lake volume and water quality data.

Available information allows us to compare 1995 to 2004 phosphorus dynamics (Table 9). The mass of phosphorus internally generated, residing in, and leaving the Lake can each be estimated.

Table 9: Phosphorus Mass Comparison

Parameter	Year	Source/Fate	Mean Concentration (mg/L)	Mean Concentration (lbs/Million Gal)	Volume (Million Gal)	Annual Mass (lbs)	Mean WI Concentration (mg/L)
Total Phosphorus	1995	Internal Loading	NA	NA	22	13***	0.031**
		Summer Water Column	0.022	0.2	240	44	
		Pigeon Lake Discharge	0.016*	0.1	300	41	
	2004	Internal Loading	NA	NA	33	18***	
		Summer Water Column	0.025	0.2	240	50	
		Pigeon Lake Discharge	0.018*	0.2	300	46	
Soluble Phosphorus	1995	Internal Loading	NA	NA	22	13***	0.017**
		Summer Water Column	0.002	0.02	240	4.0	
		Pigeon Lake Discharge	0.003*	0.03	300	8.0	
	2004	Internal Loading	NA	NA	33	18***	
		Summer Water Column	0.002	0.02	240	4.0	
		Pigeon Lake Discharge	0.002*	0.02	300	5.0	

Note: * = Assumes lake surface and lake discharge soluble phosphorus concentrations are equal
** = State-wide averages provided by Lillie and Mason, 1983
*** = Based on Lehtoranta (2004) anoxic phosphorus release rate estimate of 0.75 $mg/m^2/day$
NA = Not applicable

The estimated mass of total phosphorus in the water column of the Lake was approximately 14 percent greater during summer 2004 than summers during the early-1990s (Table 9). Similarly, approximately 12 percent more total phosphorus left the Lake as surface discharge during 2004 than during the early-1990s.

Approximately 38 percent more soluble phosphorus was generated by internal loading during summer 2004 than summers during the early-1990s (Table 9). Despite this increase, the estimated summer mass of soluble phosphorus in the water column of the Lake has not changed since the early-1990s, and the mass discharged from the Lake has declined approximately 38 percent. This possibly suggests that greater amounts of soluble phosphorus are being absorbed by aquatic plants or precipitating to the lake bottom during unstratified conditions. Greater aquatic plant absorption in recent years could have increased plant density and decay, and phosphorus bound in flocculent aquatic plant detritus would increase total phosphorus concentrations. Additional organic decay may also explain the increased volume of hypoxic water during 2004.

5.3.3 Nitrogen

Nitrogen can also limit aquatic plant growth, and is typically second in importance to phosphorous. Nitrogen can be found in lakes in many forms including nitrate, nitrite, ammonia, and organic nitrogen. Nitrite is usually present in only trace quantities since it is readily transformed to nitrate in oxygenated water. Sources from which nitrogen can enter a lake include precipitation (which can have concentrations of nitrogen as high as 0.5 mg/L), breakdown of organic compounds, and human-induced sources of nitrogen such as fertilizers, sewage effluent, and animal waste.

Even though nitrogen demand in vegetated terrestrial soils is high during active growing periods, nitrogen can move through soil and reach ground water if:

- Vegetation is not actively growing
- Nitrogen supply exceeds vegetative demand
- Nitrogen is injected directly to subsurface sediment (e.g., septic system drain fields)

Nitrogen levels are typically measured as ammonia, nitrate, nitrite, Kjeldahl nitrogen, and total nitrogen. Inorganic nitrogen (nitrate, nitrite, and ammonia) can be readily used by aquatic plants and algae. If spring inorganic nitrogen levels are below 0.3 mg/L, summer algae blooms are unlikely (Shaw, et al., 1993).

Organic nitrogen is often contained in suspended organic matter. Breaking down (i.e., digesting) the organic matter in lake water releases organic nitrogen and allows it to be measured. Water is often tested for organic nitrogen and ammonia combined; these two forms are expressed as "Kjeldahl nitrogen." Total nitrogen is calculated by adding nitrate and nitrite to Kjeldahl nitrogen. The median total nitrogen concentration measured in 61 southeastern Wisconsin lakes is 1.18 mg/L (Lillie and Mason, 1983). Pigeon Lake 1995 and 2004 nitrogen data are summarized below (Table 10).

Table 10: Nitrogen Summary and Historical Comparison

Parameter	Year Reported	Mean Concentration (mg/L)	Min. Concentration for Summer Algal Bloom (mg/L)	Nuisance Conducive to Algal Blooms?	Changed Between Studies?	Mean WI Concentration (mg/L)***
Total Inorganic Nitrogen**	1995	0.374	0.3	Yes	Increased	0.26
	2004	0.469	0.3	Yes		
Total Nitrogen**	1995	1.019	Does Not Apply	Does Not Apply	Increased	0.86
	2004	1.292	Does Not Apply	Does Not Apply		
Nitrate + Nitrite*	1995	0.106	Does Not Apply	Does Not Apply	Reduced	Not Available
	2004	0.077	Does Not Apply	Does Not Apply		
Total Kjeldahl - N*	1995	0.913	Does Not Apply	Does Not Apply	Increased	Not Available
	2004	1.215	Does Not Apply	Does Not Apply		
Ammonia - N*	1995	0.268	Does Not Apply	Does Not Apply	Increased	Not Available
	2004	0.392	Does Not Apply	Does Not Apply		

Note: * = Annual Average
** = Spring Average
*** = Statewide averages provided by Lillie and Mason (1983)

The data reveal that forms of nitrogen related to plant detritus and oxygen-deficient water conditions have increased between 1995 and 2004. This finding is concordant with the increasing volume of oxygen-depleted water and suspected increase in the density of aquatic plant life.

5.3.4 Management Implications

Phosphorus has remained the limiting nutrient of the Lake since 1995. Summer season total phosphorus mass has increased considerably (approximately 14 percent) since the early 1990s, and it appears that both internal and external source are responsible. Increased internal loading is typically the result of increased anoxia. The size of the anoxic hypolimnion in the Lake has increased during recent years. Greater hypoxic occurrence suggests that there may be more decaying detritus on the lake bottom than during past years. If the amount of decaying detritus in the anoxic hypolimnion has increased, this too may be increasing internal soluble phosphorus loading. The increased availability of soluble phosphorus has likely facilitated the algal blooms and increased macrophytic growth reported by lake residents. In addition, winter-season anoxia could also be contributing to internal phosphorus loading. We recommend that the Association collect data to determine if winter hypolimnial anoxia and/or increased organic decay are contributing to the nutrient budget of the Lake.

External sources (e.g., the East Sub-Basin) also have contributed to the phosphorus mass increase. During 2004, the East Sub-Basin contributed more total phosphorus than internal loading. Most of this phosphorus was entrained in storm-water runoff passing though the sub-basin and into the Lake. This finding suggests that increased phosphorus in the Lake resulted from changes within both the Lake and its watershed. One notable change to the East Sub-Basin is the recent and ongoing residential development in it. Its current major land uses include:

- Residential development
- Agriculture
- A public golf course

Additional residential development has also occurred within the Lake sub-basin. This has reduced the forested riparian buffer of the Lake and decreased that amount of pervious surface around the Lake. Reduced riparian buffering/filtering capacity, increased surface runoff volume and/or intensity, and increased lawn and/or golf course fertilization can all increase the quantity of nutrients entering the Lake from its watershed. Maintaining a riparian buffer through increased minimum house setback distances is one way to both reduce and filter surface runoff. Others include diverting storm water to sediment detention basins and/or requiring native vegetation along lakeshore property. We recommend that the Association:

- Complete a watershed-level nutrient study to quantify/compare known sources
- Initiate a volunteer water quality monitoring program to track long-term trends in the Lake
- Pursue local ordinances that protect and/or restore the shoreline and riparian buffer

Replacing native lakeshore vegetation with lawns can attract some bird species. Nuisance geese and gulls are becoming increasingly common in many areas of Wisconsin and the Midwest. They are often found around golf courses, residential developments, cultivated fields, and other open areas. Pigeon Lake residents have reported large flocks of ring-billed gulls (Larus delawarensis) and Canada geese (Branta canadensis) regularly inhabiting the Lake during recent years. These flocks have been anecdotally documented by Northern Environmental staff as constituting several hundred birds. The flocks appear to use the Lake as resting habitat after feeding in local agricultural fields. They may be using the Lake on an increasing basis for a variety of reasons, the replacement of dense lakeside vegetation with open lawns likely being one of them. Regardless, avian feces can be a significant source of external nutrients to surface water (Fleming, et al., 2001) (Purcell and Goldsborough, 1995).

The available data suggest that internal and external nutrient sources are causing changes to the water quality of the Lake. The best way to assess the influence of internal and external sources is by completing a watershed-level nutrient study. Quantifying and comparing nutrient sources, storage, and fates will facilitate complete nutrient balance for the Lake. This information can be used to identify and reduce nutrient contribution to the Lake through proper watershed management.

5.4 Chlorophyll *a*

Chlorophyll *a* concentrations correspond to the abundance of microscopic algae in lake water. Chlorophyll *a* concentrations respond to seasonal light changes, lake water nutrient content, transparency, aquatic macrophyte growth, temperature, and zooplankton abundance. High chlorophyll *a* concentrations relate to algal blooms. Algal blooms most often occur after spring and fall turnovers in lakes with anoxic hypolimnia. Algal blooms can also occur when other events liberate nutrients into the lake system or otherwise upset nutrient equilibrium. Examples of events that could cause algal blooms are:

- Severe thunderstorms washing nutrient-laden water or sediment into a lake
- Mid-season hypolimnial circulation caused by storms, flood flows, etc.
- Decreased zooplankton abundance
- Significant macrophyte community manipulation

If macrophytes are destroyed, nutrients are returned to the water from decomposing plant remains and the root aquatic plant for limiting nutrients is decreased. This chain of events can cause algae blooms.

The average annual chlorophyll *a* concentration of the Lake was 4.7 micrograms per liter (µg/L) during 1995 and 5.3 µg/L during 2004. Chlorophyll *a* readings less than 5.0 µg/L indicate very good water quality, while values of 10 µg/L or higher are associated with algal blooms (Lillie and Mason, 1983). The 2004 chlorophyll *a* average was somewhat higher than that reported during 1995. Much of this difference, however, was due to an anomalously high concentration (20.1 µg/L) in one hypolimnial sample collected in the Northwest Sub-Basin of the Lake. This atypical chlorophyll *a* concentration was likely caused by the inadvertent inclusion of aquatic plant material in the sample. Other laboratory results for that sample were consistent with another near-bottom sample collected the same day in another part of the Lake. If the anomalous result is disregarded, the average 2004 chlorophyll *a* concentration is reduced to 3.5 µg/L. Microscopic algal abundance does not seem to have changed significantly since the mid-1990s.

5.5 Alkalinity and pH

Lake water alkalinity is largely attributable to bicarbonate and carbonate, compounds typically released from dissolution of calcite and dolomite. Dissolution of calcite and dolomite also releases calcium and magnesium, producing hard water. Median alkalinity concentration in 61 southeastern Wisconsin lakes is 160 mg/L. Alkalinity buffers the effects of acidic rainfall by neutralizing low pH rainfall.

Lakes with abundant plant growth and high alkalinity water often have marl deposits. Marl is composed primarily of calcium carbonate, but also includes phosphorous. Plant growth fosters marl formation by removing carbon dioxide from the water, increasing pH. Marl in often visible on the leaves of certain aquatic macrophytes.

The average alkalinity of Pigeon Lake was 201 mg/L during 1995. The average alkalinity of the Lake during 2004 remained fairly consistent at approximately 193 mg/L. This indicates that no major acid-buffering capacity has been lost in the Lake.

pH is an exponential index of hydrogen ion concentration used to measure acidity. pH is represented on a logarithmic scale from 1 to 14, with 7 being neutral. Readings greater than 7 have less hydrogen ions and are basic (alkaline), readings less than 7 have more hydrogen ions and are considered acidic. The median pH of 61 southeastern Wisconsin lakes is 8.0. Rainfall in southeastern Wisconsin is acidic, having a pH of about 4.4. The average pH of the Lake was reported as 8.3 during 1995 and 8.2 during 2004. The 2004 pH readings range from 7.6 to 8.7, which is reasonable given the high alkalinity of the water and abundant aquatic plant growth. Based on the available data, no significant lake pH changes appear to have occurred in recent years.

5.6 Transparency

Transparency is a function of water color and turbidity and commonly measured with a Secchi disk. A Secchi disk is an 8-inch circular plate with alternating black and white quadrants fixed to a length of graduated cord. During the middle of the day, the disk is lowered on the shaded side of the boat until an observer can no longer see the Secchi disk. The depth is noted, the disk is then raised until it is just again visible, and the depth is again recorded. The two measurements are averaged to give a reading. The deeper the Secchi disk reading, the clearer the water. High concentrations of algae or suspended sediment usually account for shallow Secchi disk readings. In some instances, colored water can also account for low Secchi readings.

The average Secchi disk depth of the Lake was reported as 9.1 feet during 1995 (a depth that indicates good water clarity). According to 2004 data, the average Secchi of the Lake has been reduced to 8.23 feet. This depth indicates fair water quality.

No algae blooms were observed in the Lake during 2004 to explain decreased water clarity. However, Association members and Northern Environmental staff noted that water clarity decreased considerably during periods of heavy boat traffic. For instance, many lake patrons spent the Fourth-of-July weekend boating and water skiing. Secchi disk measurements collected on July 5, 2004 revealed that the clarity of the Lake was reduced to 3.25 feet after being 5.50 feet on June 30, 2004. Further, by July 15, 2004, the water clarity had recovered to 8.50 feet. In general, it was very common for the clarity of the Lake to fluctuate in response to heavy boat traffic. The benthic sediments of the Lake are easily disturbed by these activities, and there are no ordinances to limit agitation of lake bottom sediment.

5.7 Chloride and Specific Conductance

Under natural conditions, surface-water chloride concentrations in Wisconsin should be quite low. For example, in sparsely populated northern Wisconsin, median lake water chloride concentrations are between 1 and 2 mg/L. The presence of high chloride levels usually is accountable to human pollutants like road salt, fertilizers (potash), septic system effluent, and animal wastes. Septic effluent commonly contains 50 to 100 mg/L chloride (Shaw, et al., 1994).

Southeastern Wisconsin is home to extensive agriculture and a large human population. Additionally, bedrock aquifers in some portions of southeastern Wisconsin have brackish water. Therefore, lakes in southeastern Wisconsin typically contain more chlorides than those in other parts of the state. Median chloride concentration of 61 southeastern Wisconsin lakes is 16 mg/L.

The chloride concentrations of the lake water averaged 6.8 mg/L during the early 1990s and 10 mg/l chloride during 2004. While the change is significant, Pigeon Lake still contains less chloride than average for southeastern Wisconsin lakes. The low concentrations of chloride detected during 1995 appear more unusual than the modest concentrations detected during 2004. The lower chloride concentrations of the mid-1990s may be an artifact of the heavier than normal precipitation that occurred during many consecutive years of the early-1990s.

Specific conductance relates to the amount of dissolved solids in lake water. Lakes with high conductivity readings are often eutrophic. Conductivity readings are commonly twice the alkalinity levels (Shaw, et al., 1994). The Lake conductivity was reported during 1995 to average 355 micromhos (µmhos). During 2004, it averaged 413 µmhos. Since these values are roughly two times higher than the reported alkalinity values, and are therefore not indicative of water quality degradation related to human activity.

5.8 Trophic Status

Trophic status is an indicator of lake water quality. Total phosphorous, chlorophyll *a*, and Secchi disk depths are used to classify the trophic status of a lake (Table 11).

Table 11: Trophic Status

Parameter	Year	Concentration	Units	Trophic Status Indicated	Conclusion
Average Total Phosphorus	1995	22	µg/L	Mesotrophic	1995 = Mesotrophic
	2004	25	µg/L	Mesotrophic	
Average Chlorophyll *a*	1995	4.7	µg/L	Oligotrophic	
	2004	5.3	µg/L	Oligotrophic	
Average Secchi Depth	1995	9.1	ft	Oligotrophic	2004 = Mesotrophic
	2004	8.2	ft	Oligotrophic	

The available data suggest that the Lake has remained a mesotrophic. Nevertheless, all of the parameters used to classify the water quality of the Lake demonstrate slightly more eutrophic conditions. The condition of the Lake was more closely investigated by contrasting the Carlson Trophic Status Index (TSI) values from 2004 and the early 1990s. TSI values are calculated from total phosphorus, chlorophyll *a*, and Secchi disk depth data (Lillie and Mason, 1983). The Lake was reported to be mesotrophic with a 46 Carlson TSI value in 1995. During 2004, the TSI value of the Lake increased slightly to 47, but the Lake remained mesotrophic. Transparency plays a key role in determining TSI values. Water clarity diminishment resulting from suspended lake sediments during and after periods of heavy boat traffic has been observed and documented in the Lake. These reductions may be partly responsible for the increased TSI value during 2004. Small total phosphorus and chlorophyll *a* increases during 2004 do suggest some level of eutrophication in recent years. Regardless, the Lake has remained in a mesotrophic state. Mesotrophic lakes have occasional algal blooms, medium productivity, internal phosphorus cycling, accumulated organic debris, fair to good water quality, and diverse fish communities.

5.9 Aquatic Plant Community

5.9.1 Ecology

Aquatic plants are vital to the health of a water body. Unfortunately, they can also grow so profusely as to become a nuisance, particularly in nutrient-enriched water bodies. In general, aquatic plants can be divided into two major groups: microphytes (phytoplankton) composed mostly of single-celled algae, and macrophytes that include macroalgae, flowering vascular plants, and aquatic mosses and ferns. A wide variety of phytoplankton co-inhabits all hospitable areas of a lake. Their abundance depends solely on light, nutrient availability, and other environmental factors. In contrast, macrophytes are predominantly found in distinct habitats in the littoral (shallow near shore) zone where sufficient light can penetrate to the lake bottom. The littoral zone is subdivided into four distinct transitional zones: the eulittoral, upper littoral, middle littoral, and lower littoral (Figure 13) (Wetzel, 1983).

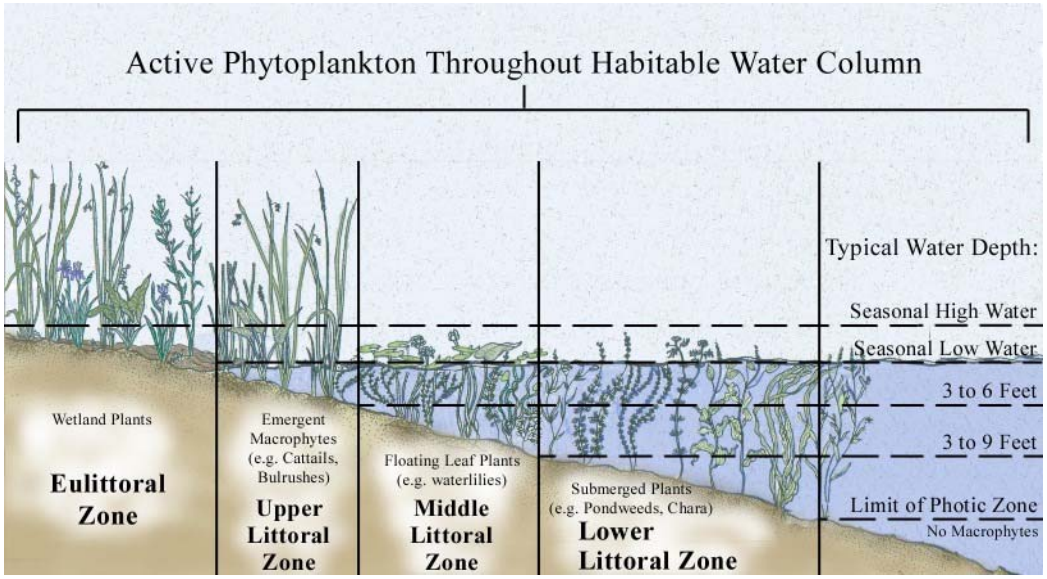
Eulittoral Zone: Includes the area between the highest and lowest seasonal water levels, and often contains many wetland plants.

Upper Littoral Zone: Dominated by emergent macrophytes and extends from the water edge to water depths between 3 and 6 feet.

Middle Littoral Zone: Occupies water depths of 3 to 9 feet, extending lake-ward from the upper littoral zone. The middle littoral zone is dominated by floating leafed plants.

Lower Littoral Zone: Extends to a depth equivalent to the limit of the photic zone, which is defined as 1 percent of surface light intensity.

Figure 13 Phytoplankton and Macrophyte Community Relationships



The abundance and distribution of aquatic macrophytes are controlled by factors other than dissolved nutrient availability. These factors include light availability, lake trophic status as it relates to nutrients and water chemistry, sediment characteristics, and wind energy. Lake morphology and watershed characteristics relate to these factors independently and in combination (NALMS, 1997).

Aquatic macrophytes grow in lake areas with sufficient light availability and suitable substrate materials. The bottom of Pigeon Lake is composed mostly of fine-grained sediment, sediments capable of supporting large aquatic macrophyte populations. The littoral zone of the Lake (the shallow area where light penetration is greatest and aquatic macrophytes grow) typically ranges from 0 to 15 feet in depth. Even though water quality and turbidity changes can cause the size of the littoral zone to fluctuate, data indicate that the maximum rooting depth was approximately 25 feet during 2004. This corresponds closely to the maximum rooting depth (27 feet) of the Lake during the early-1900s and suggests that factors controlling the growth of aquatic plants have not significantly changed since then.

In many instances, aquatic plants serve as indicators of water quality due to their sensitivity to water clarity and nutrient level changes. To grow, aquatic plants must have adequate nutrient supplies. Rooted aquatic

plants can normally grow in nutrient-poor water if lake sediments contain adequate nutrients. Nutrients removed by rooted macrophytes from the lake bottom may be returned to the water column when the plants die. Consequently, killing aquatic macrophytes may increase the nutrients available for algal growth.

In general, a direct relationship exists between water clarity and macrophyte growth. That is, water clarity is usually improved with increasing abundance of aquatic macrophytes. Two possible explanations are postulated. The first is that the macrophytes and epiphytes out-compete phytoplankton for available nutrients. Epiphytes derive essentially all of their nutrient needs from the water column. The other explanation is that aquatic macrophytes stabilize bottom sediment and limit water circulation, preventing re-suspension of solids and nutrients (NALMS, 1997).

If aquatic macrophytes are reduced in abundance, water clarity can suffer. Water clarity reductions can further reduce the vigor of macrophytes by restricting light penetration, reducing the size of the littoral zone, and further reducing water clarity. Studies have shown that if 30 percent or less of the area of a lake occupied by aquatic plants is controlled, water clarity will generally not be affected. However, lake water clarity will likely be reduced if 50 percent or more of the macrophytes are controlled (NALMS, 1997).

Aquatic plants also play a key role in the ecology of a lake system. Aquatic plants provide food and cover for fish, wildlife, and invertebrates. Plants also improve water quality by protecting shorelines and the lake bottom, improving water quality, adding to the aesthetic quality of the Lake and impacting recreational activities.

5.9.2 Identified Species and Relative Abundance

The Lake exhibited medium aquatic plant diversity and moderate productivity in the early 1990s. The following seventeen aquatic plants were detected during an August 1994 survey:

- Hard-Stem Bulrush (*Scirpus acutus*)
- Three-Square Rush (*Scirpus Americanus*)
- White Water Lily (*Nymphaea odorata*)
- Yellow Water Lily (*Nuphar variegata*)
- Broad Leaved Cattail (*Typha latifola*)
- Large Leaved Pondweed (*Potamogeton amplifolius*)
- Richardson's Pondweed (*Potamogeton richarsonii*)
- Sago Pondweed (*Potamogeton pectinatus*)
- Curly-Leaf Pondweed (*Potamogeton crispus*)
- Common Pondweed (*Potamogeton natans*)
- Northern Watermilfoil (*Myriophyllum exalbescens*)
- Eurasian Watermilfoil (*Myriophyllum spicatum*)
- Water Celery (*Valliseria Americana*)
- Slender Naiad (*Najas flexilis*)
- Filamentous Algae (Cladophora, Spirogyra)
- Muskgrass (*Chara julgaris*)
- Stonewort (*Nitella flexilis*)

The most abundant genus reported during 1995 was pondweeds (*Potamogeton*). Watermilfoils were present at all sampling points; however, of these, only 33 percent had Eurasian watermilfoil. Muskgrass was the second most abundant plant, occurring at 83 percent of the sampling points. No species-specific plant densities were calculated during 1995.

The aquatic plants of the Lake were re-surveyed during June and August 2004 (Appendix C). Ten 1995 transects that were roughly equally spaced around the Lake were resurveyed (Figure 4). Surveys were completed to assess both early-summer and late-summer plant communities. The results of this survey are presented in detail in Appendix D and summarized below.

Table 12: Aquatic Plants Identified During 2004

Genus	Species	Common Name	When Detected		Category	Detected during 1995?
			June	August		
Chara spp.		Muskgrass / Chara	X	X	Submersed	Yes
Lemna	*minor*	Small duckweed	X		Free Floating	No
Myriophyllum	*spicatum*	Eurasian watermilfoil	X	X	Submersed	Yes
Myriophyllum	*sibiricum*	Northern watermilfoil	X	X	Submersed	Yes
Najas	*flexilis*	Slender naid/bushy pondweed	X	X	Submersed	Yes
Nitella spp.		Nitellas	X	X	Submersed	Yes
Nuphar	*variegata*	Spatterdock	X	X	Floating-Leaf	Yes
Nymphaea	*odorata*	White water lily	X	X	Floating-Leaf	Yes
Potamogeton sp.		Pondweed	X	X	Submersed	No
Potamogeton	*amplifolius*	Large-Leaf Pondweed	X	X	Submersed	Yes
Potamogeton	*natans*	Floating-Leaf Pondweed	X	X	Submersed	Yes
Potamogeton	*pectinatus*	Sago Pondweed		X	Submersed	Yes
Potamogeton	*pusillus*	Small Pondweed		X	Submersed	No
Scirpus	*acutus*	Hardstem Bulrush	X	X	Emergent	No
Typha	*latifolia*	Broad-Leaf Cattail	X	X	Emergent	Yes
Vallisneria	*americana*	Wild Celery	X	X	Submersed	Yes

The 2004 data revealed that the Lake has moderate species diversity and a relatively low amount of biomass as compared to other Wisconsin lakes. Twelve free-floating, floating leaved and submerged aquatic species, two emergent, and two algal species were identified during the surveys.

During June 2004, *Chara sp.* (muskgrass) was the most abundant macrophyte, having a 58 percent frequency of occurrence and a 33 percent relative frequency. This means that muskgrass was growing in 58 percent of the sampled areas and 33 percent of the areas where any plant species were growing. *Myriophyllum spicatum* (Eurasian watermilfoil) was the second most abundant species during June 2004, with a 31 percent frequency of occurrence and an 18 percent relative frequency. *Myriophyllum sibiricum* (northern watermilfoil) was the third-most abundant species during June with a 24 percent frequency of occurrence and a 14 percent relative frequency.

The species with the highest mean density rating (the average density rating for all sample points where a species was present) during June 2004 was Eurasian watermilfoil. This means that on average, Eurasian watermilfoil was growing more densely than any other species. The second and third highest were northern watermilfoil and muskgrass, respectively. June 2004 frequency of occurrence, relative frequency, and mean density ratings are summarized in Appendix D.

During the August 2004 survey, muskgrass was, again, the most abundant species with a 60 percent frequency of occurrence and a 31 percent relative frequency (Appendix D). Eurasian watermilfoil was the second most abundant species with a 36 percent frequency of occurrence and a 19 percent relative frequency. *Potamogeton amplifolius* (Large-Leaf Pondweed) was the third most abundant species with a 31 percent frequency of occurrence and a 16 percent relative frequency.

Muskgrass was the most densely growing species during August 2004. The second and third densest were Nitella (*Nitella sp.*) and northern watermilfoil, respectively. August 2004 frequency of occurrence, relative frequency, and mean density ratings are summarized in Appendix D.

Comparing 1995 and 2004 aquatic plant data shows that the average frequency occurrence of the Eurasian watermilfoil has not significantly changed (0.50 percent) during recent years. It was the second-most abundant species in the Lake during both the early- and late-summer 2004 surveys. More importantly, it was the most densely growing species in the Lake during early-summer 2004 (Appendix D). These results suggest that Eurasian watermilfoil is not colonizing new areas of the Lake but is growing early during the summer and more densely than other plant species.

5.9.3 Management Implications

People often refer to all rooted aquatic plants as "weeds" and ultimately desire to eradicate them. This perception is unfortunate and often must be corrected in order to manage a lake ecosystem effectively. Rooted macrophytes are extremely important for the well being of lake communities. They have many positive attributes and make littoral areas the most productive aquatic habitat in freshwater lakes.

Aquatic macrophytes can become a nuisance when exotics plant species (e.g., Eurasian watermilfoil) occupy large portions of a lake or when eutrophication significantly increases growth. Under these circumstances, excessive aquatic plant growth often negatively affects water quality and recreational activities. To be effective, aquatic plant management in most lakes must maintain a plant community that is:

- Stable
- Species rich
- Diverse
- Mostly native

The increased plant productivity of the Lake in recent years has reduced its aesthetic beauty and recreational value. In particular, the dense beds of Eurasian watermilfoil (*Myriophyllum spicatum*) in the Lake:

- Make swimming and water skiing less enjoyable
- Inhibit fish predation on aquatic snails that cause "swimmer itch"
- Likely generate excess organic detritus that causes anoxia, hypoxia, and fish kills

We recommend that the Association complete an aquatic plant management (APM) plan and begin chemical or mechanical plant control (e.g., Eurasian watermilfoil) in the Lake. The WDNR requires an accepted APM plan before issuing an aquatic plant management permit. The permit is required before initiating chemical treatment, mechanical harvesting, or any other plant management strategy. Completing an APM plan would provide the Association with long-term guidance for managing and improving Pigeon Lake and its aquatic plant community.

6.0 SUMMARY AND RECOMMENDATIONS

Pigeon Lake is subjected to heavy recreational use, hosts non-native plants and animals, receives phosphorus-laden storm runoff, is surrounded by increasing residential development, and displays water quality degradation resulting from these factors. The mass of total phosphorus in the Lake has increased since the early 1990s. Although it is beyond the scope of this study to pinpoint reasons for the change, the newly available data reveals several important findings.

Most of the Pigeon Lake watershed does not contribute surface water to the Lake. Consequently, approximately nine-tenths of the watershed should not contribute sediment to the Lake. Since most

phosphorus is typically tightly bound to particulate matter, surface-water runoff from most of the watershed should not be a significant contributor of phosphorus to Pigeon Lake. The only areas likely to contribute phosphorus in the form of surface-water runoff are the residential areas ringing the Lake and the direct drainage basin of the inlet stream entering Pigeon Lake in its northeast corner. Although this is a limited area, available data reveal that it is the largest contributor of phosphorus to the Lake.

Pigeon Lake residents have wondered about the nutrient contribution of gulls and geese. Available data suggests that gulls and geese could contribute. Water quality data reveal that the volume of anoxic water in the Pigeon Lake hypolimnion has appreciably changed since the 1990s. Additionally, the duration of the period when anoxic water exists has also not appreciably changed. This means that the portion of the lake bottom covered by anoxic water has also not appreciably changed, and the time sediments are exposed to conditions conducive to phosphorus release has also not changed. Consequently, the flux of phosphorus from bottom sediments into the water column has likely remained the same.

During the past 10 years, the volumes of anoxic (devoid of oxygen) and hypoxic (inhospitable) water have each expanded in the Lake. Recent data show that only the uppermost 16 feet of the Lake are hospitable to desirable aquatic life during summer. Approximately 30 percent of the summer water volume of the Lake does not contain enough dissolved oxygen to support a healthy aquatic ecosystem, up from 15 percent during the early-1990s. Similarly, the volume of anoxic water has increased 6.6 percent in recent years. Six additional acres of the Lake bottom were exposed to phosphorus-releasing conditions during summer 2004 than summers during the early-1990s. Even with recent changes, the trophic status of the Lake has remained consistent since the early 1990s.

The Lake currently supports invasive, non-native, plant and fish species (e.g. Eurasian watermilfoil and alewife). In addition, other nearby lakes support zebra mussels (*Dreissena polymorpha*). The best way to prevent the spread of these extremely damaging species to other lakes is by educating lake patrons. We recommend that the Association complete a public outreach project to educate lake residents and patrons on how to prevent the spread of invasive species to and from the Lake.

Despite recent changes, the Lake has retained much of its recreational and aesthetic value. To prevent serious deterioration of recreational and aesthetic values, we recommend that meaningful and active steps be taken. These steps include:

- Stabilizing or reducing Lake water nutrient concentrations
- Promoting conditions desirable to native plants and animals
- Hindering the propagation of exotic plants and animals
- Monitoring the Lake for further change

Northern Environmental further recommends six tactics that the Association can implement to execute these strategies.

1. Reduce phosphorus loading
2. Evaluate long-term water quality trends
3. Reduce lake sediment re-suspension
4. Evaluate methods to reduce volume of anoxic/hypoxic water
5. Monitor and manage aquatic plants
6. Maximize use of available public funds

Finally, we suggest the Association adopt a Lake restoration and improvement plan that includes the six recommended tactics. For the Association's convenience, we suggest that this plan:

- Maximize use of available grant funds
  - Incorporate the Association as a non-profit entity to facilitate grant application and administration
  - Pursue multiple grant opportunities
    - Lake Management Planning
    - Lake Management Protection
    - Aquatic Invasive Species
    - Recreational Boating Facilities
    - Clean Water Grants

- Identify, quantify, and compare nutrient sources within the Lake and watershed

- Reduce nutrient influx from identified sources
  - Promote the use of phosphorus-free fertilizer in areas contributing surface-water runoff to the Lake
  - Encourage riparian buffers
  - Reduce internal phosphorus cycling by lessening the anoxic hypolimnion and decreasing the accumulation of aquatic plant detritus
  - Pass ordinance to help reduce sediment re-suspension by watercraft

- Reduce plant density and dissolved oxygen consumption, and improve aesthetics
  - Complete an aquatic plant management plan
  - Start chemical, mechanical, and/or other treatments to remove aquatic plants

- Limit the propagation of invasive and/or non-native species (e.g., Eurasian watermilfoil) through public outreach and education

We believe implementing this plan will help the Association and/or Sanitary District to refine lake and watershed management, and to stem further water quality degradation.

Grants are available to fund most of the recommended work. We suggest that the Association begin by incorporating as a non-profit organization under Wisconsin Statutes 181. This would qualify the Association to be a grant project sponsor and would remove administrative burden from the Sanitary District. In essence, it would simplify project funding. If needed, a small-scale lake management planning grant could be obtained to fund 75 percent of the work required to incorporate. The Association could provide the remaining 25 percent through in-kind labor contributions.

The recommended watershed-level nutrient study could be funded in large part by the WDNR. Large-scale lake management planning grants fund up to 75 percent of the work needed to complete accepted projects. The Association could use in-kind donations of labor and equipment to cover the remaining costs. This study is highly recommended because it would provide a relatively complete picture of the nutrient sources and sinks in Pigeon Lake and its watershed. Further, it could be used to facilitate nutrient management throughout the watershed to benefit Pigeon Lake.

The WDNR also has programs available to fund APM plans and plant management activities. Aquatic Invasive Species (AIS) Grants provide a total of $500,000 annually to local groups interested in studying ways

to control and/or eradicate their invasive species. Awarded grants fund 50 percent of project costs and the Association could secure the remaining 50 percent through in-kind labor and equipment donations. Actual plant management activities, such as chemical treatment and mechanical harvesting, qualify for similar funding through the state's Recreational Boating Facilities (RBF) program. Like AIS grants, the RBF program provides funding for 50 percent of accepted projects. In-kind donations by the Association could again be used to cover the remaining 50 percent of project costs.

A project to educate lake patrons regarding the spread of invasive and or exotic species could receive funding through a WDNR Lake Management Planning Grant. The Boat U.S. Foundation's Clean Water Grants Program will also fund public outreach. Small grants (up to $4,000) from the Clean Water Grants Program are regularly awarded to local groups for public outreach projects. Similarly, AIS grants are awarded to pay for volunteer training through Wisconsin's Clean Boats, Clean Waters program. Clean Boats, Clean Waters teaches volunteers to conduct boater-education programs, perform boat and trailer inspections, and report new invasive species infestations.

Finally, the training and equipment needed to initiate volunteer lake monitoring is available through Wisconsin's Self-Help Lake Monitoring program. This WDNR program teaches local groups how to collect water-quality data and monitor long-term lake trends. Lake monitoring is valuable for detecting water-quality degradation or change in its early stages.

We recommend that the Association and/or Sanitary District immediately begin considering these grant sources for work during 2005. Northern Environmental will be happy to both assist the Association with free grant writing and to the provide services needed to complete any funded projects. For the Association's convenience, application deadlines for potential funding sources are listed below (Table 13). If the Association is interested taking advantage of Northern Environmental's free grant writing services, we recommend they contact us at least 1 month before deadline.

Table 13: Lake Management Grant Programs and Application Deadlines

Grant Program	Application Deadline
Lake Management Planning	February 1 and August 1
Lake Management Protection	May 1
Aquatic Invasive Species	February 1 and August 1
Recreational Boating Facilities	Established Quarterly
Clean Water Grants	February 1

7.0 GLOSSARY

The following section is largely adapted from a University of Wisconsin Extension Publication entitled *Understanding Lake Data* (Shaw, et al., 1994).

Algae: One-celled (phytoplankton) or multi-cellular plants either suspended in water (plankton) or attached to rocks, rooted aquatic plants, and other substrates (epiphytes). Their abundance, as measured by the amount of chlorophyll *a* (green pigment) in an open water sample, is commonly used to help classify the trophic status of a lake. Algae are essential to the lake ecosystems and provide the food base for most lake organisms, including fish.

Phytoplankton abundance and specie distribution vary widely from day to day, as life cycles are short.

Alkalinity: A measure of the amount of carbonates, bicarbonates, and hydroxide present in water. Low alkalinity is the main indicator of susceptibility to acid rain. Increasing alkalinity is often related to increased algae productivity. Expressed as mg/L of calcium carbonate ($CaCO_3$) or as microequivalents per liter (µeq/L). 20 µeq/L = 1 mg/L of $CaCO_3$.

Ammonia: A form of nitrogen found in organic materials and many fertilizers. It is the first form of nitrogen released when organic matter decays, can be used by most aquatic plants, and is, therefore, an important nutrient. Ammonia converts rapidly to nitrate (NO_3^-) if oxygen is present. The conversion rate is related to water temperature. Ammonia is toxic fish at relatively low concentrations in pH-neutral or alkaline water. Under acidic conditions, non-toxic ammonium ions (NH_4^+) form, but at high pH values, the toxic ammonium hydroxide (NH_4OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/L of NH_4OH. At a pH of 7 and a temperature of 68˚F (20˚C), the ratio of ammonium ions to ammonium hydroxide is 250:1; at pH of 8, the ratio is 26:1.

Anion: Refers to the chemical ions present that carry a negative charge in contrast to cations, which carry a positive charge. There must be equal amounts of positive and negative charged ions in any water sample. Following are the common anions in decreasing order of concentration for most lakes: bicarbonate (HCO_3^-), sulfate $SO_4^=$), chloride (Cl^-), carbonate ($CO_3^=$), nitrate (NO_3^-), nitrate (NO_2^-), and phosphates ($H_2PO_4^-$, $HPO_4^=$, and $PO_4^=$).

Anoxia: A condition in which dissolved oxygen is depleted to 0.05 mg/L or less.

Aquatic invertebrates: Aquatic animals without an internal skeletal structure, such as insects, mollusks, and crayfish.

Blue-green algae: Algae that is often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans. They often form floating scum as the die. Many can fix atmospheric nitrogen (N_2) to provide their own nutrient source.

Calcium: The most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-baring minerals in the lake watershed, and reported in mg/L as calcium carbonate ($CaCO_3$) or mg/L as calcium ion (Ca^{++}).

Cation: Refers to chemical ions present that carry a positive charge. The common cations present in lakes in normal order of decreasing concentrations follow: calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+), sodium (Na^+), ammonium (NH_4^+), ferric iron (Fe^{+++}) or ferrous iron (Fe^{++}), manganese (Mn^{++}), and hydrogen (H^+).

Chloride: Chlorine in the chloride ion (Cl^-) form has very different properties from chlorine gas (Cl_2), which is used for disinfecting. The chloride ion (Cl^-) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

Chlorophyll *a*: Green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae, and therefore is commonly used as a water-quality indicator.

Color: Measured in color units that relate to a standard. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. The average color value for Wisconsin lakes is 39 units, with the color of state lakes raging from zero to 320 units. Color also affects light penetration, and therefore, the depth at which plants can grow.

Concentration units: Express the amount of a chemical dissolved in water. The most common ways chemical data are expressed is in mg/L and micrograms per liter (µg/L). One mg/L is equal to one part per million (ppm). To convert µg/L to mg/L, divide by 1000 (e.g., 30 µg/L = 0.03 mg/L). To convert mg/L to µg/L, multiply by 1000 (e.g., 0.5 mg/L = 500 µg/L). Microequivalents per liter (µeq/L) is also sometimes used, especially for alkalinity; it is calculated by dividing the weight of the compound by 1000 and then dividing that number into the mg/L.

Conductivity (specific conductance): Measures the ability of water to conduct an electric current. Conductivity is reported in micromhos per centimeter (µmhos/cm) or an equivalent in microsiemens (µs), and is directly related to the total dissolved inorganic chemicals in the water. Values are commonly two times the water hardness unless the water is receiving high concentrations of contaminants introduced by humans.

Drainage basin: The total land area that drains toward the lake.

Drainage lakes: Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter residence times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

Epiphyte: See "Algae"

Filamentous algae: Algae that forms filaments or mats attached to sediment, weeds, piers, etc.

Food chain: The sequence of algae being eaten by small aquatic animals (zooplankton) that in turn are eaten by small fish that are then eaten by larger fish, and eventually by people or predators. Certain chemicals, such as polychlorinated biphenyls (PCBs), mercury, and some pesticides, can be concentrated from very low levels in the water to toxic levels in animals through this process.

Groundwater discharge lake: Often referred to as a spring-fed lake; has large amounts of groundwater as its source, and a source outlet. Areas of high groundwater inflow may be visible as springs or sand boils. Groundwater drainage lakes often have intermediate retention times with water quality dependent on groundwater quality.

Hardness: The quantity of multivalent cations, primarily calcium (Ca^{++}) and magnesium (Mg^{++}) in the water, expressed as mg/L of $CaCO_3$. Amount of hardness relates to the presence of soluble minerals, especially limestone and dolomite, in the lake watershed.

Hypolimnion: see "Stratification"

Hypoxia: A low dissolved oxygen condition that makes water inhospitable to aquatic life.

Ion: A charged atom or group of atoms that have separated from an ion of the opposite charge. In water, some chemical molecules separate into cations (positive charge) and anions (negative charge). Thus, the number of cations equals the number of anions.

Insoluble: Incapable of dissolving in water.

Kjeldahl nitrogen: The most common analysis run to determine the amount of organic nitrogen in water. The test includes ammonium and organic nitrogen.

Limiting factor: The nutrient or condition in shortest supply relative to plant growth requirements. Plants will grow until stopped by this limitation; for example, phosphorous in summer, temperature, or light in fall or winter.

Macrophytes: see "Rooted aquatic plants."

Marl: White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ($CaCO_3$) in hard water lakes. Marl may contain many snail and clamshells, which also are $CaCO_3$. While it gradually fills in lakes, marl also precipitates phosphorous, resulting in low algae populations and good water clarity. In the past, marl was recovered and used to lime agricultural fields.

Metalimnion: see "Stratification."

Nitrate: An inorganic form of nitrogen important for plant growth. Nitrogen is in this stable form when oxygen is present. Nitrate (NO_3^-) often contaminates groundwater when water originates from manure pits, fertilized fields, lawns, or septic systems. High levels of nitrate-nitrogen (over 10 mg/L) are dangerous to infants and expectant mothers. A concentration of nitrate-nitrogen (NO_3^-N) plus ammonium-nitrogen (NH_4^-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorous is present.

Nitrite: a form of nitrogen that rapidly converts to nitrate (NO_3^-) and is usually included in the NO_3^- analysis.

Overturn: Fall cooling and spring warming of surface water increases density and gradually makes temperature and density uniform from top to bottom. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the oxygen content of the water. However, warming may occur too rapidly in the spring for mixing to be effective, especially in small sheltered kettle lakes.

Phosphorous: Key nutrient influencing plant growth in more than 80 percent of Wisconsin lakes. Soluble reactive phosphorous is the amount of phosphorous in solution that is available to plants. Total phosphorous includes the amount of phosphorous in solution (reactive) and in particulate form.

Photosynthesis: Process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a food base for a lake and is an important source of oxygen for many lakes.

Phytoplankton: see "Algae."

Precipitate: A solid material that forms and settles out of water as a result of certain negative ions (anions) combining with positive ions (cations).

Retention time: The average length of time water resides in a lake, ranging from several days in small impoundments to many years in large seepage lakes. Retention time (turnover rate or flushing rate) is important in determining the impact of nutrient inputs. Long retention times result in recycling and greater nutrient retention in most lakes. Calculate retention time by dividing the volume of water passing through the lake per year by the lake volume.

Respiration: The process by which aquatic organisms convert organic material to energy. It is the reverse of photosynthesis. Respiration consumes oxygen (O_2) and releases carbon dioxide (CO_2). It also takes place as organic matter decays.

Riparian area: Refers to the margin of a river or other water bodies where sufficient soil moisture supports the growth of mesic vegetation that requires a moderate amount of moisture.

Rooted aquatic plants: Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

Secchi disc: An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. For best results, the readings should be taken on sunny, calm days.

Sedimentation: Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, marl, and soil and organic matter eroded from the watershed of the lake.

Seepage lakes: Lakes without a significant inlet or outlet and fed by rainfall and ground water. Seepage lakes lose water through evaporation and groundwater moving on a downgradient. Lakes with little groundwater inflow tend to be naturally acidic and most susceptible to the effects of acid rain. Seepage lakes often have long residence times, and lake levels fluctuate with local groundwater levels. Water quality is affected by groundwater quality and the use of land on the shoreline.

Soluble: Capable of being dissolved.

Stratification: The layering of water due to differences in density. The greatest density of water occurs at 39˚F (4˚C). As water warms during the summer, cool water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 feet. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion or thermocline.

Suspended solids: A measure of the particulate matter in a water sample expressed in mg/L. When measured on inflowing streams, it can be used to estimate the sedimentation rate of lakes or impoundments.

Thermocline: see "Stratification."

Transparency: see "Secchi disc."

Trophic state: The degree to which a lake is enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Watershed: see "Drainage basin."

Zooplankton: Microscopic or barely visible animals that often eat algae. These suspended plankton are an important component of the lake food chain and ecosystem. For many fish, they are the primary source of food.

8.0 REFERENCES

Borman, S., R. Korth, and J. Temte, *Through the Looking Glass … a Field Guide to Aquatic Plants,* Wisconsin Lakes Partnership, 1997.

Clarke, Jack (Lake resident), conversation with Ryan L. McCone (Northern Environmental Technologies, Incorporated), May 5, 2004.

Cole, G. A., *Textbook of Limnology,* 1975.

Fleming, R., P. Eng, and H. Fraser, *The Impact of Waterfowl on Water Quality*, Literature Review, 2001.

Gibbons, M. V., H. L. Gibbons Jr., M. D. Sytsma, *A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plan,* http://www.ecy.wa.gov/programs/wq/plants/management/manual/, 1994

Haggard, B. and W. Green, *Simulation of Hydrodynamics, Temperature, and Dissolved Oxygen in Beaver Lake, Arkansas, 1994-1995*, 2002.

Lehtoranta, J, *Benthic Phosphorus Release from Sediment to Water, Drainage Basin Nutrient Inputs and Eutrophication: An Integrated Approach*, 2004.

Lillie, R. and J. Mason, "Limnological Characteristics of Wisconsin Lakes," *Wisconsin Department of Natural Resources Technical Bulletin No. 138*, 1983.

Manitowoc County Land Information Office, Manitowoc County aerial photograph, 2000.

Moyle, P. and J. Cech Jr., *Fishes: An Introduction to Ichthyology*, 2000.

North America Lake Management Society, *Aquatic Plant Management in Lakes and Reservoirs*. Aquatic Plant Management Society and the North America Lake Management Society, 1997.

Purcell, S. L. and L.G. Goldsborough, *The Significance of Waterfowl Feces as a Source of Nutrients to Algae in a Prairie Wetland*. University Field Station (Delta Marsh) Annual Report 30:43-51, 1995.

Robertson, D., "Sources and Transport of Phosphorus in the Western Lake Michigan Drainages," Fact Sheet FS-208-96, U.S. Geologic Survey, 1996.

Shaw, B., C. Mechenich, and L. Klessig, *Understanding Lake Data*, University of Wisconsin Extension Publication G3582, 1994.

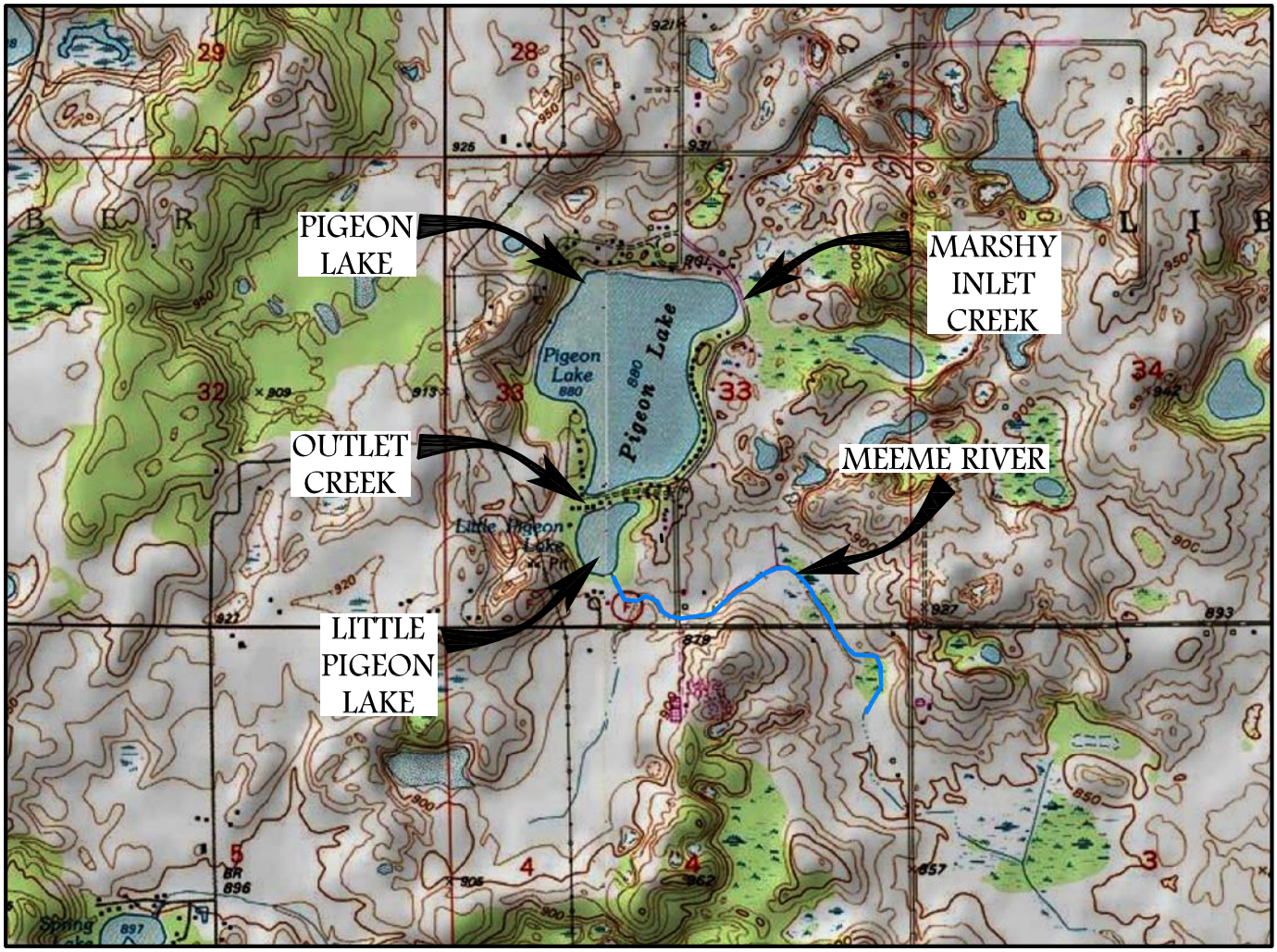
Skinner, E. and R. Borman, *Water Resources of Wisconsin, Lake Michigan Basin,* Hydrologic Investigations Atlas HA-432, 1973.

U.S. Geologic Survey, *Cleveland West Quadrangle, Wisconsin 7.5 Minute Series Topographic, Geologic Survey,* 1973.

U.S. Geologic Survey, *Daily Stream Flow for Wisconsin*, *USGS 040854555 Meeme River at South Cleveland Road near Cleveland, WI,* http:nwis.waterdata.usgs.gov/wi/nwis/discharge/?site_no=040854555, 2004.

Weather.com., monthly averages for Valders, Wisconsin, www.weather.com/activities/other/weather/climo-monthly-graph.html?locid=USWI0704&from=search. The Weather Channel Interactive, Incorporated, 2004.

Wetzel, R. G, *Limnology*, 1983.



SCALE IN FEET

1" = 2000'

0 1000 2000 3000 4000 5000 6000 7000 8000

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

N

QUADRANGLE LOCATION

BASE MAP SOURCE: USGS 7.5 MINUTE QUADRANGLE, SCHOOL HILL, WISCONSIN, 1992 (NATIONAL GEOGRAPHIC HOLDINGS, INC.)

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Phone: 800-776-7140 Fax: 262-241-8222

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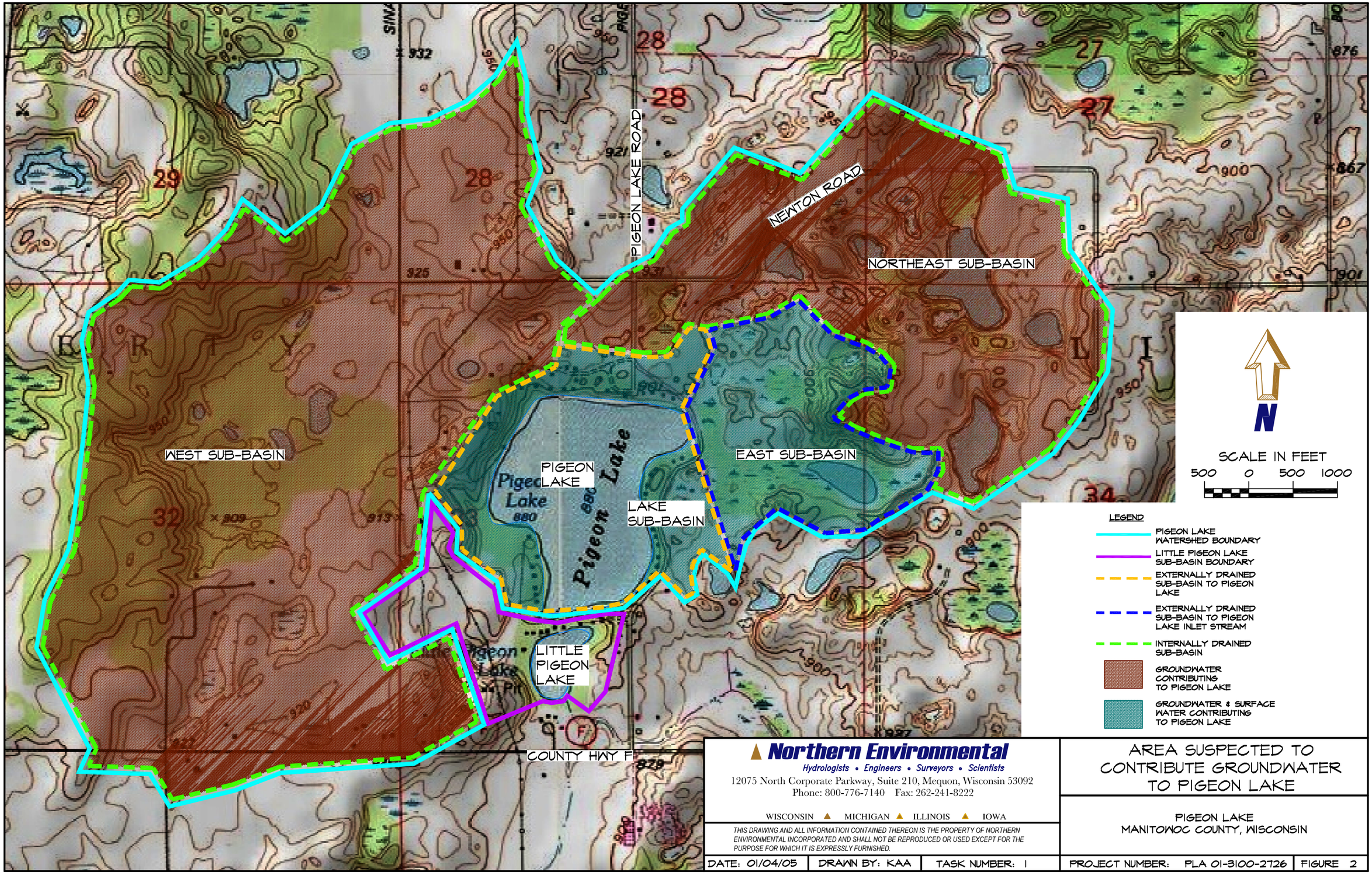
SITE LOCATION & LOCAL TOPOGRAPHY

PIGEON LAKE
MANITOWOC COUNTY, WISCONSIN

DATE: 01/04/05	DRAWN BY: KAA	TASK NUMBER: 1	PROJECT NUMBER: PLA 01-3100-2726	FIGURE 1

S:\CAD\Mequon\PROJECTS\PLA\2726\05_0121_1.dwg, Figure 1, 1/31/2005 2:14:10 PM



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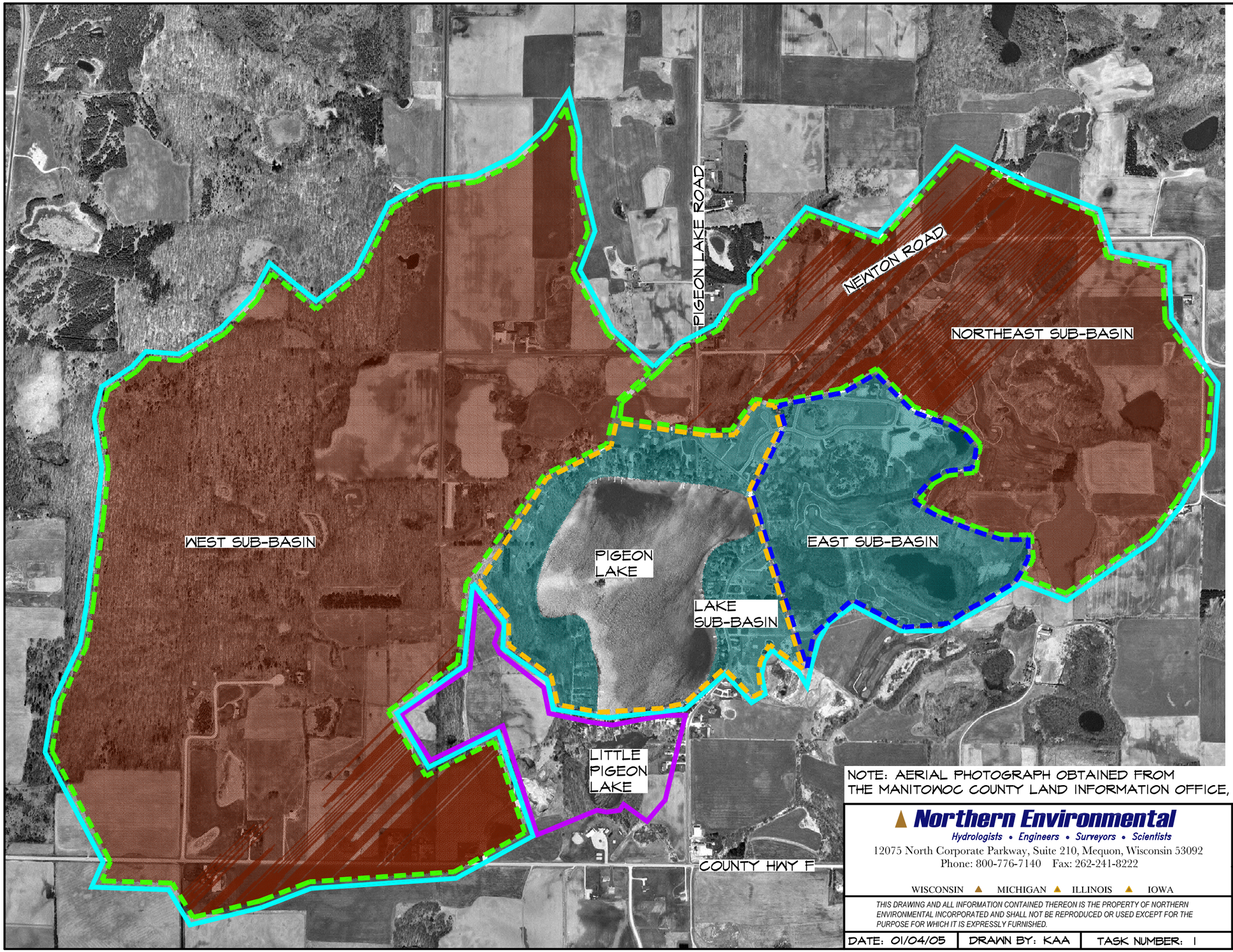
AREA SUSPECTED TO CONTRIBUTE GROUNDWATER TO PIGEON LAKE

PIGEON LAKE
MANITOWOC COUNTY, WISCONSIN

DATE: 01/04/05	DRAWN BY: KAA	TASK NUMBER: 1	PROJECT NUMBER: PLA 01-3100-2726	FIGURE 2

S:\CAD\Mequon\PROJECTS\PLA\2726\05_0121_2.dwg, Figure 2, 1/31/2005 1:55:00 PM



LEGEND

- PIGEON LAKE WATERSHED BOUNDARY
- LITTLE PIGEON LAKE SUB-BASIN BOUNDARY
- EXTERNALLY DRAINED SUB-BASIN TO PIGEON LAKE
- EXTERNALLY DRAINED SUB-BASIN TO PIGEON LAKE INLET STREAM
- INTERNALLY DRAINED SUB-BASIN
- GROUNDWATER CONTRIBUTING TO PIGEON LAKE
- GROUNDWATER & SURFACE WATER CONTRIBUTING TO PIGEON LAKE

N

SCALE IN FEET
500 0 500 1000

NOTE: AERIAL PHOTOGRAPH OBTAINED FROM THE MANITOWOC COUNTY LAND INFORMATION OFFICE, 2000

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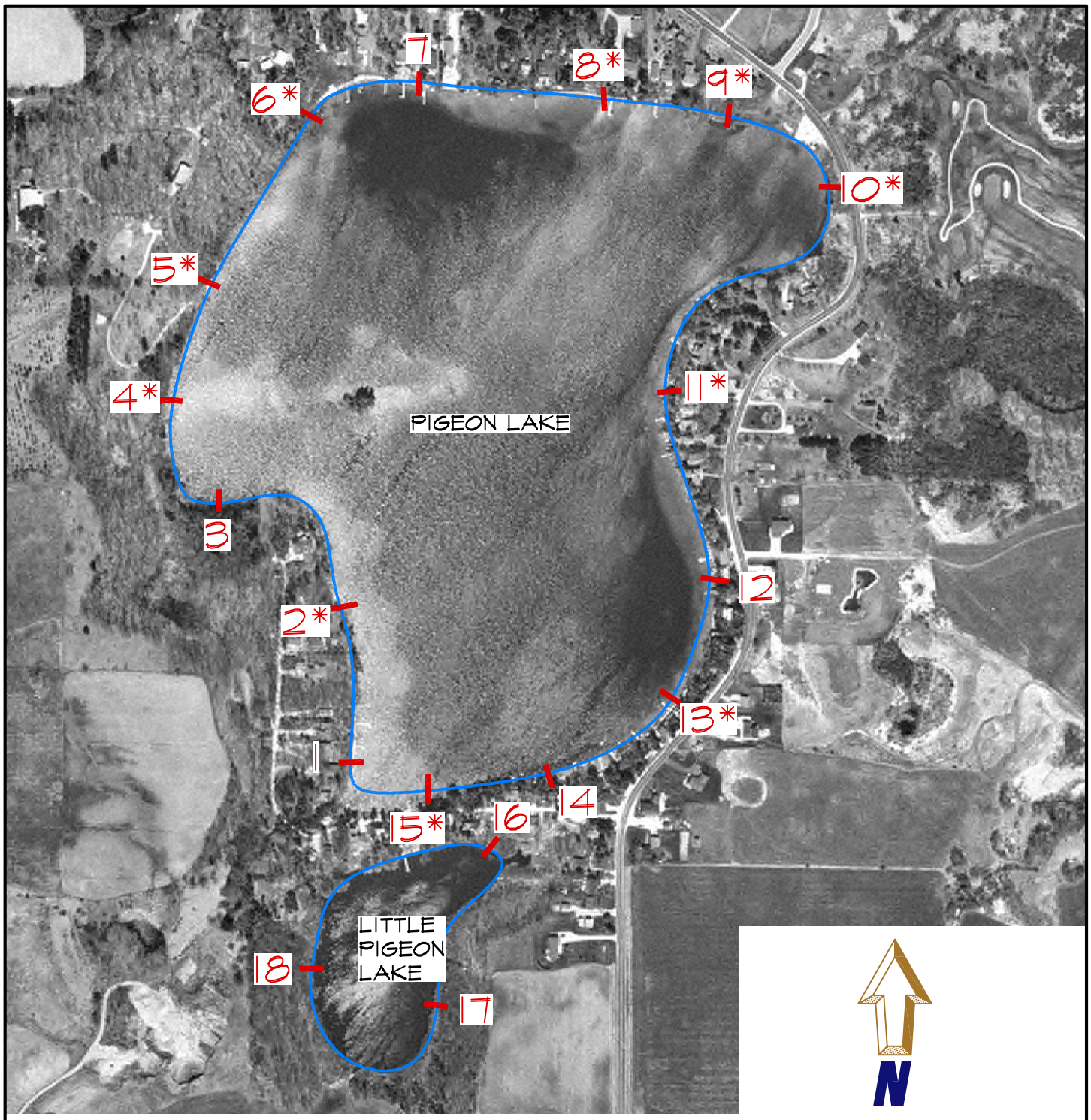
PIGEON LAKE AERIAL PHOTOGRAPH & WATERSHED BOUNDARY

PIGEON LAKE
MANITOWOC COUNTY, WISCONSIN

DATE: 01/04/05	DRAWN BY: KAA	TASK NUMBER: 1	PROJECT NUMBER: PLA 01-3100-2726	FIGURE 3



*PLANTS SURVEYED AGAIN IN 2004

NOTE: AERIAL PHOTOGRAPH OBTAINED FROM
THE MANITOWOC COUNTY LAND INFORMATION OFFICE, 2000

SCALE IN FEET

250 0 250 500

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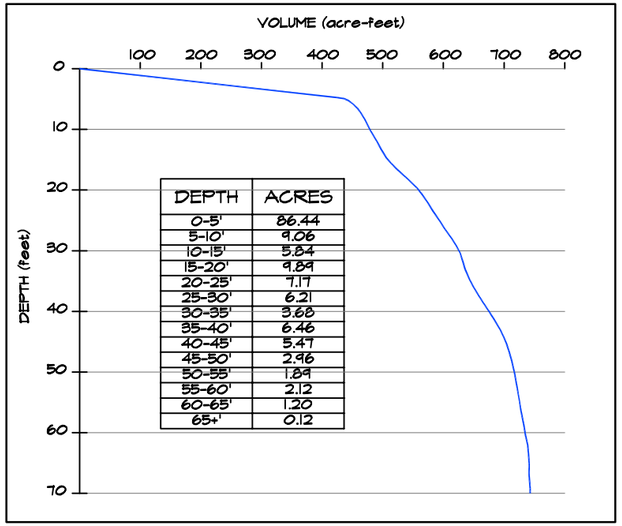
1995/2004 AQUATIC MACROPHYTE SAMPLE TRANSECTS

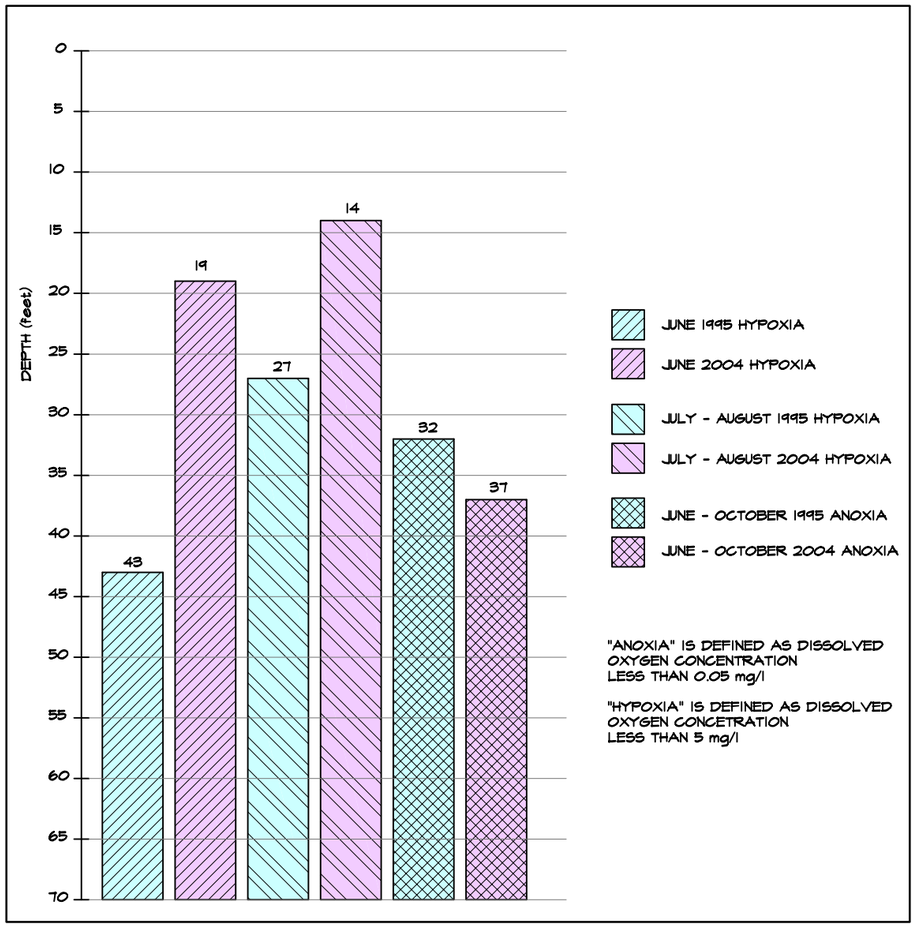
TOWN OF LIBERTY SANITARY DISTRICT #1
PIGEON LAKE
MANITOWOC COUNTY, WISCONSIN

DATE: 01/04/05	DRAWN BY: KAA	TASK NUMBER: 1	PROJECT NUMBER: PLA 01-3100-2726	FIGURE 4

S:\CAD\Mequon\PROJECTS\PLA\2726\05_0121_4.dwg, Figure 4, 1/31/2005 2:09:32 PM

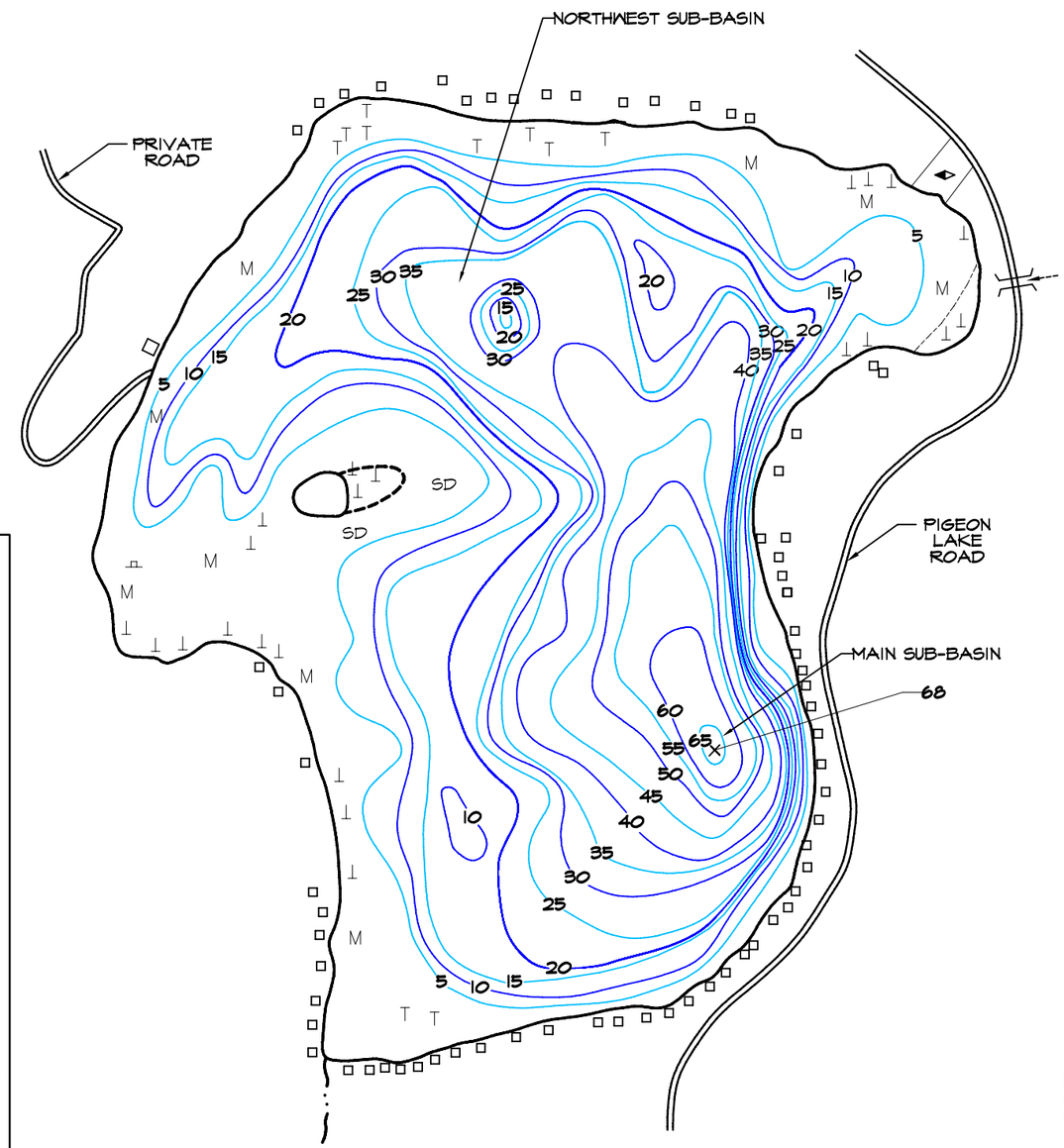


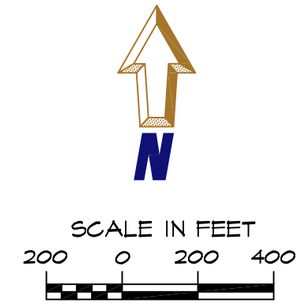
DEPTH	ACRES
0-5'	86.44
5-10'	9.06
10-15'	5.84
15-20'	9.89
20-25'	7.17
25-30'	6.21
30-35'	3.68
35-40'	6.46
40-45'	5.47
45-50'	2.96
50-55'	1.89
55-60'	2.12
60-65'	1.20
65+'	0.12



"ANOXIA" IS DEFINED AS DISSOLVED OXYGEN CONCENTRATION LESS THAN 0.05 mg/l

"HYPOXIA" IS DEFINED AS DISSOLVED OXYGEN CONCETRATION LESS THAN 5 mg/l





LEGEND

- DWELLING
- ACCESS WITH PARKING
- INDEFINITE SHORELINE
- INTERMITTENT STREAM
- INTERMITTENT CULVERT

LAKE FEATURES

- M MARL
- SD SAND
- ROCK DANGER TO NAVIGATE
- T SUBMERGED VEGETATION
- ⊥ EMERGENT VEGETATION
- FLOATING VEGETATION

NOTE: BATHYMETRY REVISED USING DUAL SONAR BY NORTHERN ENVIRONMENTAL, JUNE 12, 1995

NOTE: LAKE SURVEY DATA OBTAINED FROM THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES, 1974

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BATHYMETRY & WATER VOLUME

PIGEON LAKE
MANITOWOC COUNTY, WISCONSIN

DATE: 01/04/05	DRAWN BY: KAA	TASK NUMBER: 1	PROJECT NUMBER: PLA 01-3100-2726	FIGURE 5

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APPENDIX A

LABORATORY REPORTS

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: 1D050504
Collection Start: 05/05/2004 02:45 pm
Collected by: GANSBERG
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - BOTTOM
Sample Source: SU
Date Reported: 06/08/2004
Project No: LPL942

Sample #: IO020660
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM010
Sample Depth:
Sample Status: COMPLETE

Analyses and Results:

Analysis Method: HARDNESS (AS CACO3), TOTAL REC, CALC — Analysis Date: — Lab Comment:

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
899	HARDNESS TOTAL RECOVERABLE CALCULATION	E1643592	216.	MG/L	1.4		4.6

Analysis Method: MAGNESIUM, TOTAL REC, ICP (EPA 200.7) — Analysis Date: 05/11/2004 — Lab Comment:

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
921	MAGNESIUM TOTAL RECOVERABLE	7439954	32.1	MG/L	0.2		0.7

Analysis Method: AMMONIA (AS N), DISS (EPA 350.1) — Analysis Date: 05/10/2004 — Lab Comment:

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.286	MG/L	0.015		0.048

Analysis Method: NITRATE+NITRITE (AS N), DISS (EPA 353.2) — Analysis Date: 05/18/2004 — Lab Comment:

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	0.154	MG/L	0.019		0.061

Analysis Method: TOTAL KJELDAHL NITROGEN (AS N) (EPA — Analysis Date: 05/11/2004 — Lab Comment:

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.15	MG/L	0.14		0.4

Wisconsin Department of Natural Resources
Laboratory Report

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	05/20/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.023	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	05/07/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	ND	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment
POTASSIUM, TOTAL REC, ICP (EPA 200.7)	05/11/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
50245	POTASSIUM TOTAL RECOVERABLE	7440097	1.	MG/L	1		3

Analysis Method	Analysis Date	Lab Comment
SODIUM, TOTAL REC, ICP (EPA 200.7)	05/11/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
923	SODIUM TOTAL RECOVERABLE	7440235	4.6	MG/L	0.1		0.3

Analysis Method	Analysis Date	Lab Comment
TOTAL DISSOLVED SOLIDS, 180 C (SM 2540C	05/10/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
134	TOTAL DISSOLVED SOLIDS 180 C	E1642222	248.	MG/L	50		167

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	05/07/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	TEMPERATURE AT LAB	E1645696	ICED	C		0	

Analysis Method	Analysis Date	Lab Comment
CALCIUM, TOTAL REC, ICP (EPA 200.7)	05/11/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
918	CALCIUM TOTAL RECOVERABLE	7440702	33.7	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
CHLORIDE (EPA 325.2)	05/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
940	CHLORIDE	16887006	10.5	MG/L	0.6		2.0

Analysis Method	Analysis Date	Lab Comment

Wisconsin Department of Natural Resources
Laboratory Report

VOLUME LAB FILT FOR CHLOROPHYLL A (05/17/2004

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	**SAMPLE SIZE LITERS**		**200**	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (WELS	**05/18/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	**CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)**	479618	**2.73**	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
CONDUCTIVITY PH & ALK (SM2510B/EPA 1	**05/13/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
410	**ALKALINITY TOTAL CACO3**	E1640192	**196.**	MG/L		1.	
95	**CONDUCTIVITY AT 25C**	E1640291	**423.**	UMHOS/CM		1	
403	**PH LAB**	E1644285	**8.08**	SU		1	

Analysis Method	Analysis Date	Lab Comment
DIG, TOTAL REC, ICP, LIQUIDS (SW846 3005	**05/10/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99404	**DIG TOTAL REC SW846 3005A**		**COMPLETE**				

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: 1S050504
Collection Start: 05/05/2004 02:00 pm
Collected by: GANSBERG
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - SURFACE
Sample Source: SU
Date Reported: 06/08/2004
Project No: LPL942

Sample #: IO020661
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM010
Sample Depth: M1
Sample Status: COMPLETE

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
TOTAL DISSOLVED SOLIDS, 180 C (SM 2540C	05/10/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
134	TOTAL DISSOLVED SOLIDS 180 C	E1642222	236.	MG/L	50		167

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	05/07/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	TEMPERATURE AT LAB	E1645696	ICED	C		0	

Analysis Method	Analysis Date	Lab Comment
CALCIUM, TOTAL REC, ICP (EPA 200.7)	05/11/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
918	CALCIUM TOTAL RECOVERABLE	7440702	32.7	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
CHLORIDE (EPA 325.2)	05/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
940	CHLORIDE	16887006	10.5	MG/L	0.6		2.0

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A (	05/17/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		200	ML			

Analysis Method	Analysis Date	Lab Comment

Wisconsin Department of Natural Resources
Laboratory Report

CHLOROPHYLL A, FLUORESCENCE (WELS 05/18/2004

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	4.33	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
CONDUCTIVITY PH & ALK (SM2510B/EPA 1	05/13/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
410	ALKALINITY TOTAL CACO3	E1640192	192.	MG/L		1.	
95	CONDUCTIVITY AT 25C	E1640291	410.	UMHOS/CM		1	
403	PH LAB	E1644285	8.46	SU		1	

Analysis Method	Analysis Date	Lab Comment
DIG, TOTAL REC, ICP, LIQUIDS (SW846 3005A)	05/10/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99404	DIG TOTAL REC SW846 3005A		COMPLETE				

Analysis Method	Analysis Date	Lab Comment
HARDNESS (AS CACO3), TOTAL REC, CALC		

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
899	HARDNESS TOTAL RECOVERABLE CALCULATION	E1643592	213.	MG/L	1.4		4.6

Analysis Method	Analysis Date	Lab Comment
MAGNESIUM, TOTAL REC, ICP (EPA 200.7)	05/11/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
921	MAGNESIUM TOTAL RECOVERABLE	7439954	31.9	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	05/10/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.030	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	05/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	0.175	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment

Wisconsin Department of Natural Resources
Laboratory Report

TOTAL KJELDAHL NITROGEN (AS N) (EPA :05/11/2004

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	**NITROGEN KJELDAHL TOTAL**	E1644079	**0.93**	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	**05/20/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	**PHOSPHORUS TOTAL**	7723140	**0.021**	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	**05/07/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	**PHOSPHATE ORTHO DISS**	7723140	**ND**	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment
POTASSIUM, TOTAL REC, ICP (EPA 200.7)	**05/11/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
50245	**POTASSIUM TOTAL RECOVERABLE**	7440097	**1.**	MG/L	1		3

Analysis Method	Analysis Date	Lab Comment
SODIUM, TOTAL REC, ICP (EPA 200.7)	**05/11/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
923	**SODIUM TOTAL RECOVERABLE**	7440235	**4.7**	MG/L	0.1		0.3

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #:	8S051804	Sample #:	IO021482
Collection Start:	05/17/2004 06:00 am	Collection End:	
Collected by:		Waterbody/Outfall Id:	64000
ID #:		ID Point #:	
County:	Manitowoc	Account #:	LM010
Sample Location:	MARSHY INLET @ NORTHEAST CORNER OF PIGEON LAKE (VALDEZ WI)		
Sample Description:	SURFACE WATER FROM LAKE INLET		
Sample Source:	SU	Sample Depth:	
Date Reported:		Sample Status:	PARTIAL
Project No:	LPL942		

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	05/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	TEMPERATURE AT LAB	E1645696	ICED	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene DNR ID 113133790
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

Sample:

Field #: 8S051804 Sample #: IO021482
Collection Start: 05/17/2004 06:00 am Collection End:
Collected by: Waterbody/Outfall Id: 64000
ID #: ID Point #:
County: Manitowoc Account #: LM010
Sample Location: MARSHY INLET @ NORTHEAST CORNER OF PIGEON LAKE (VALDEZ WI)
Sample Description: SURFACE WATER FROM LAKE INLET
Sample Source: SU Sample Depth:
Date Reported: 06/22/2004 Sample Status: COMPLETE
Project No: LPL942

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	05/26/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.024	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	05/26/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	ND	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	06/07/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.47	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	05/28/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.097	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	05/19/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	0.027	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment

Wisconsin Department of Natural Resources
Laboratory Report

TEMPERATURE ON RECEIPT-ICED **05/18/2004**

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: ID061704
Collection Start: 06/17/2004 10:00 am
Collected by:
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - BOTTOM
Sample Source: SU
Date Reported: 07/16/2004
Project No: LPL942

Sample #: IO025364
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM010
Sample Depth:
Sample Status: COMPLETE

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
CALCIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
918	CALCIUM TOTAL RECOVERABLE	7440702	35.0	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
CHLORIDE (EPA 325.2)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
940	CHLORIDE	16887006	10.2	MG/L	0.6		2.0

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A (	06/21/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		200	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (WELS	06/22/2004	DUPLICATE QC EXCEEDED, RESULT AVG OF 4.573 & 2.67

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	*3.62	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
CONDUCTIVITY PH & ALK (SM2510B/EPA 1	06/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ

Wisconsin Department of Natural Resources
Laboratory Report

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
410	ALKALINITY TOTAL CACO3	E1640192	203.	MG/L		1.	
95	CONDUCTIVITY AT 25C	E1640291	437.	UMHOS/CM		1	
403	PH LAB	E1644285	7.98	SU		1	

Analysis Method	Analysis Date	Lab Comment
DIG, TOTAL REC, ICP, LIQUIDS (SW846 3005A)	06/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99404	DIG TOTAL REC SW846 3005A		COMPLETE				

Analysis Method	Analysis Date	Lab Comment
HARDNESS (AS CACO3), TOTAL REC, CALC		

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
899	HARDNESS TOTAL RECOVERABLE CALCULATION	E1643592	220.	MG/L	1.4		4.6

Analysis Method	Analysis Date	Lab Comment
MAGNESIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
921	MAGNESIUM TOTAL RECOVERABLE	7439954	32.1	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.742	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	ND	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	06/21/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.89	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	06/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ

Wisconsin Department of Natural Resources
Laboratory Report

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.043	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	06/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	ND	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment
POTASSIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
50245	POTASSIUM TOTAL RECOVERABLE	7440097	1.	MG/L	1		3

Analysis Method	Analysis Date	Lab Comment
SODIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
923	SODIUM TOTAL RECOVERABLE	7440235	4.3	MG/L	0.1		0.3

Analysis Method	Analysis Date	Lab Comment
TOTAL DISSOLVED SOLIDS, 180 C (SM 2540C	06/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
134	TOTAL DISSOLVED SOLIDS 180 C	E1642222	242.	MG/L	50		167

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	06/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	TEMPERATURE AT LAB	E1645696	ICED	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: IS061704
Collection Start: 06/17/2004 10:00 am
Collected by:
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - SURFACE
Sample Source: SU
Date Reported: 07/16/2004
Project No: LPL942

Sample #: IO025363
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM010
Sample Depth: M1
Sample Status: COMPLETE

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
CONDUCTIVITY PH & ALK (SM2510B/EPA 1	06/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
410	ALKALINITY TOTAL CACO3	E1640192	176.	MG/L		1.	
95	CONDUCTIVITY AT 25C	E1640291	378.	UMHOS/CM		1	
403	PH LAB	E1644285	8.70	SU		1	

Analysis Method	Analysis Date	Lab Comment
DIG, TOTAL REC, ICP, LIQUIDS (SW846 3005A)	06/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99404	DIG TOTAL REC SW846 3005A		COMPLETE				

Analysis Method	Analysis Date	Lab Comment
HARDNESS (AS CACO3), TOTAL REC, CALC		

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
899	HARDNESS TOTAL RECOVERABLE CALCULATION	E1643592	199.	MG/L	1.4		4.6

Analysis Method	Analysis Date	Lab Comment
MAGNESIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
921	MAGNESIUM TOTAL RECOVERABLE	7439954	30.2	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	06/24/2004	

Wisconsin Department of Natural Resources
Laboratory Report

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.016	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	0.057	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA :	06/21/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	0.84	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	06/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.018	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	06/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	ND	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment
POTASSIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
50245	POTASSIUM TOTAL RECOVERABLE	7440097	ND	MG/L	1		3

Analysis Method	Analysis Date	Lab Comment
SODIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
923	SODIUM TOTAL RECOVERABLE	7440235	4.4	MG/L	0.1		0.3

Analysis Method	Analysis Date	Lab Comment
TOTAL DISSOLVED SOLIDS, 180 C (SM 2540C	06/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
134	TOTAL DISSOLVED SOLIDS 180 C	E1642222	216.	MG/L	50		167

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	06/18/2004	

Wisconsin Department of Natural Resources
Laboratory Report

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	TEMPERATURE AT LAB	E1645696	ICED	C		0	

Analysis Method	Analysis Date	Lab Comment
CALCIUM, TOTAL REC, ICP (EPA 200.7)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
918	CALCIUM TOTAL RECOVERABLE	7440702	29.9	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
CHLORIDE (EPA 325.2)	06/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
940	CHLORIDE	16887006	9.7	MG/L	0.6		2.0

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A (	06/21/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		200	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (WELS	06/22/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	5.90	UG/L	0.26		0.87

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #:	1B081604	Sample #:	IP004539
Collection Start:	08/16/2004 08:45 am	Collection End:	
Collected by:	MCCONE/GRUENEWALD	Waterbody/Outfall Id:	64000
ID #:	363078	ID Point #:	
County:	Manitowoc	Account #:	LM011
Sample Location:	PIGEON LAKE		
Sample Description:	DEEP SPOT - BOTTOM		
Sample Source:	SU	Sample Depth:	
Date Reported:	09/09/2004	Sample Status:	COMPLETE
Project No:	LPL942		

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
CALCIUM, TOTAL REC, ICP (EPA 200.7)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
918	CALCIUM TOTAL RECOVERABLE	7440702	38.1	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
CHLORIDE (EPA 325.2)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
940	CHLORIDE	16887006	10.0	MG/L	0.6		2.0

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		100	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (EPA 445.0)	08/27/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	1.95	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
CONDUCTIVITY PH & ALK (SM2510B/EPA 1	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
410	ALKALINITY TOTAL CACO3	E1640192	217.	MG/L		1.	

Wisconsin Department of Natural Resources
Laboratory Report

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
95	CONDUCTIVITY AT 25C	E1640291	456.	UMHOS/CM		1	
403	PH LAB	E1644285	7.60	SU		1	

Analysis Method	Analysis Date	Lab Comment
DIG, TOTAL REC, ICP, LIQUIDS (SW846 3005A)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99404	DIG TOTAL REC SW846 3005A		COMPLETE				

Analysis Method	Analysis Date	Lab Comment
HARDNESS (AS CACO3), TOTAL REC, CALC		

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
899	HARDNESS TOTAL RECOVERABLE CALCULATION	E1643592	234.	MG/L	1.4		4.6

Analysis Method	Analysis Date	Lab Comment
MAGNESIUM, TOTAL REC, ICP (EPA 200.7)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
921	MAGNESIUM TOTAL RECOVERABLE	7439954	33.8	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	1.49	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	ND	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	08/30/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.98	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.046	MG/L	0.005		0.016

Wisconsin Department of Natural Resources
Laboratory Report

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	**08/18/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	**PHOSPHATE ORTHO DISS**	7723140	**ND**	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment
POTASSIUM, TOTAL REC, ICP (EPA 200.7)	**08/25/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
50245	**POTASSIUM TOTAL RECOVERABLE**	7440097	**1.**	MG/L	1		3

Analysis Method	Analysis Date	Lab Comment
SODIUM, TOTAL REC, ICP (EPA 200.7)	**08/25/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
923	**SODIUM TOTAL RECOVERABLE**	7440235	**4.5**	MG/L	0.1		0.3

Analysis Method	Analysis Date	Lab Comment
TOTAL DISSOLVED SOLIDS, 180 C (SM 2540C	**08/18/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
134	**TOTAL DISSOLVED SOLIDS 180 C**	E1642222	**268.**	MG/L	50		167

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	**08/17/2004**	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: 1S081604
Collection Start: 08/16/2004 08:45 am
Collected by: MCCONE/GRUENEWALD
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - SURFACE
Sample Source: SU
Date Reported: 09/09/2004
Project No: LPL942

Sample #: IP004538
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM011
Sample Depth: M1
Sample Status: COMPLETE

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
CALCIUM, TOTAL REC, ICP (EPA 200.7)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
918	CALCIUM TOTAL RECOVERABLE	7440702	27.3	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
CHLORIDE (EPA 325.2)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
940	CHLORIDE	16887006	10.2	MG/L	0.6		2.0

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A (	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		100	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (EPA 44	08/27/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	2.30	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
CONDUCTIVITY PH & ALK (SM2510B/EPA 1	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
410	ALKALINITY TOTAL CACO3	E1640192	176.	MG/L		1.	

Wisconsin Department of Natural Resources
Laboratory Report

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
95	CONDUCTIVITY AT 25C	E1640291	371.	UMHOS/CM		1	
403	PH LAB	E1644285	8.55	SU		1	

Analysis Method	Analysis Date	Lab Comment
DIG, TOTAL REC, ICP, LIQUIDS (SW846 3005A)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99404	DIG TOTAL REC SW846 3005A		COMPLETE				

Analysis Method	Analysis Date	Lab Comment
HARDNESS (AS CACO3), TOTAL REC, CALC		

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
899	HARDNESS TOTAL RECOVERABLE CALCULATION	E1643592	200.	MG/L	1.4		4.6

Analysis Method	Analysis Date	Lab Comment
MAGNESIUM, TOTAL REC, ICP (EPA 200.7)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
921	MAGNESIUM TOTAL RECOVERABLE	7439954	32.0	MG/L	0.2		0.7

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.040	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	0.036	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	08/30/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	0.83	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.017	MG/L	0.005		0.016

Wisconsin Department of Natural Resources
Laboratory Report

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	08/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	ND	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment
POTASSIUM, TOTAL REC, ICP (EPA 200.7)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
50245	POTASSIUM TOTAL RECOVERABLE	7440097	1.	MG/L	1		3

Analysis Method	Analysis Date	Lab Comment
SODIUM, TOTAL REC, ICP (EPA 200.7)	08/25/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
923	SODIUM TOTAL RECOVERABLE	7440235	4.6	MG/L	0.1		0.3

Analysis Method	Analysis Date	Lab Comment
TOTAL DISSOLVED SOLIDS, 180 C (SM 2540C	08/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
134	TOTAL DISSOLVED SOLIDS 180 C	E1642222	234.	MG/L	50		167

Analysis Method	Analysis Date	Lab Comment
TEMPERATURE ON RECEIPT-ICED	08/17/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
136	TEMPERATURE AT LAB	E1645696	ICED	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene DNR ID 113133790
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

Sample:

Field #: 8S081604 Sample #: IP004540
Collection Start: 08/16/2004 08:00 am Collection End:
Collected by: MCCONE/GRUENEWALD Waterbody/Outfall Id: 64000
ID #: 363347 ID Point #:
County: Manitowoc Account #: LM011
Sample Location: MARSHY INLET @ NORTHEAST CORNER OF PIGEON LAKE
Sample Description: SURFACE WATER FROM INLET CULVERT
Sample Source: SU Sample Depth:
Date Reported: 09/09/2004 Sample Status: COMPLETE
Project No: LPL942

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.022	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	ND	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	08/30/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.71	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.043	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	08/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	0.002	MG/L	0.002		0.006

Analysis Method	Analysis Date	Lab Comment

Wisconsin Department of Natural Resources
Laboratory Report

TEMPERATURE ON RECEIPT-ICED **08/17/2004**

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #:	2B081604	Sample #:	IP004542
Collection Start:	08/16/2004 09:05 am	Collection End:	
Collected by:	MCCONE/GRUENEWALD	Waterbody/Outfall Id:	64000
ID #:	363359	ID Point #:	
County:	Manitowoc	Account #:	LM011
Sample Location:	PIGEON LAKE - NORTHWEST BASIN		
Sample Description:	BOTTOM		
Sample Source:	SU	Sample Depth:	
Date Reported:	09/09/2004	Sample Status:	COMPLETE
Project No:	LPL942		

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		100	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (EPA 445.0)	08/27/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	20.1	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.451	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	ND	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	08/30/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.56	MG/L	0.14		0.4

Wisconsin Department of Natural Resources
Laboratory Report

Analysis Method	*Analysis Date*	*Lab Comment*
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	**08/24/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
665	**PHOSPHORUS TOTAL**	7723140	**0.045**	MG/L	0.005		0.016

Analysis Method	*Analysis Date*	*Lab Comment*
DISS REACTIVE PHOSPHORUS AS P (ORTH	**08/18/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
671	**PHOSPHATE ORTHO DISS**	7723140	**ND**	MG/L	0.002		0.006

Analysis Method	*Analysis Date*	*Lab Comment*
TEMPERATURE ON RECEIPT-ICED	**08/17/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #:	2S081604	Sample #:	IP004541
Collection Start:	08/16/2004 09:05 am	Collection End:	
Collected by:	MCCONE/GRUENEWALD	Waterbody/Outfall Id:	64000
ID #:	363359	ID Point #:	
County:	Manitowoc	Account #:	LM011
Sample Location:	PIGEON LAKE - NORTHWEST BASIN		
Sample Description:	SURFACE		
Sample Source:	SU	Sample Depth:	
Date Reported:	09/09/2004	Sample Status:	COMPLETE
Project No:	LPL942		

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		100	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (EPA 445.0)	08/27/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	2.33	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	0.049	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	08/24/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	ND	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	08/30/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	0.82	MG/L	0.14		0.4

Wisconsin Department of Natural Resources
Laboratory Report

Analysis Method		Analysis Date	Lab Comment				
TOTAL PHOSPHORUS (AS P) (EPA 365.1)		**08/24/2004**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
665	**PHOSPHORUS TOTAL**	7723140	**0.016**	MG/L	0.005		0.016

Analysis Method		Analysis Date	Lab Comment				
DISS REACTIVE PHOSPHORUS AS P (ORTH		**08/18/2004**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
671	**PHOSPHATE ORTHO DISS**	7723140	**ND**	MG/L	0.002		0.006

Analysis Method		Analysis Date	Lab Comment				
TEMPERATURE ON RECEIPT-ICED		**08/17/2004**					
Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: 1B111104
Collection Start: 11/11/2004 10:30 am
Collected by: MCCONE
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - BOTTOM
Sample Source: SU
Date Reported: 12/02/2004
Project No: LPL942

Sample #: IP013638
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM011
Sample Depth:
Sample Status: COMPLETE

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	11/17/2004	SPIKE Q.C. EXCEEDED, SPIKE RECOVERY 88.7%, 82.5%

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	*0.256	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	11/17/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	0.073	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	11/22/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
625	NITROGEN KJELDAHL TOTAL	E1644079	1.04	MG/L	0.14		0.4

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	11/18/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
665	PHOSPHORUS TOTAL	7723140	0.014	MG/L	0.005		0.016

Analysis Method	Analysis Date	Lab Comment
DISS REACTIVE PHOSPHORUS AS P (ORTH	11/12/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
671	PHOSPHATE ORTHO DISS	7723140	ND	MG/L	0.002		0.006

Wisconsin Department of Natural Resources
Laboratory Report

Analysis Method	*Analysis Date*	*Lab Comment*
TEMPERATURE ON RECEIPT-ICED	**11/12/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: Wisconsin State Laboratory of Hygiene
2601 Agriculture Dr.
Madison WI 537077996
Phone : 800-442-4618 Fax Phone : 608-224-6276

DNR ID 113133790

Sample:

Field #: 1S111104
Collection Start: 11/11/2004 10:30 am
Collected by: MCCONE
ID #: 363078
County: Manitowoc
Sample Location: PIGEON LAKE
Sample Description: DEEP SPOT - SURFACE
Sample Source: SU
Date Reported: 12/02/2004
Project No: LPL942

Sample #: IP013637
Collection End:
Waterbody/Outfall Id: 64000
ID Point #:
Account #: LM011
Sample Depth:
Sample Status: COMPLETE

Analyses and Results:

Analysis Method	Analysis Date	Lab Comment
VOLUME LAB FILT FOR CHLOROPHYLL A (	11/23/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
32000	SAMPLE SIZE LITERS		200	ML			

Analysis Method	Analysis Date	Lab Comment
CHLOROPHYLL A, FLUORESCENCE (EPA 445.0)	11/24/2004	DUPLICATE QC EXCEEDED, RESULT AVG OF 4.925 & 3.916

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
99717	CHLOROPHYLL A, FLUORESCENCE (WELSCHMAYER 1994)	479618	*4.42	UG/L	0.26		0.87

Analysis Method	Analysis Date	Lab Comment
AMMONIA (AS N), DISS (EPA 350.1)	11/17/2004	MATRIX SPIKE Q.C. EXCEEDED

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
608	NITROGEN NH3-N DISS	7664417	*0.276	MG/L	0.015		0.048

Analysis Method	Analysis Date	Lab Comment
NITRATE+NITRITE (AS N), DISS (EPA 353.2)	11/17/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ
631	NITROGEN NO3+NO2 DISS (AS N)	E701177	0.079	MG/L	0.019		0.061

Analysis Method	Analysis Date	Lab Comment
TOTAL KJELDAHL NITROGEN (AS N) (EPA	11/22/2004	

Code	Description	Cas No	Result	Units	LOD	Report Limit	LOQ

Wisconsin Department of Natural Resources
Laboratory Report

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
625	**NITROGEN KJELDAHL TOTAL**	E1644079	**1.06**	MG/L	0.14		0.4

Analysis Method	*Analysis Date*	*Lab Comment*
TOTAL PHOSPHORUS (AS P) (EPA 365.1)	**11/18/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
665	**PHOSPHORUS TOTAL**	7723140	**0.018**	MG/L	0.005		0.016

Analysis Method	*Analysis Date*	*Lab Comment*
DISS REACTIVE PHOSPHORUS AS P (ORTH	**11/12/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
671	**PHOSPHATE ORTHO DISS**	7723140	**ND**	MG/L	0.002		0.006

Analysis Method	*Analysis Date*	*Lab Comment*
TEMPERATURE ON RECEIPT-ICED	**11/12/2004**	

Code	*Description*	*Cas No*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	E1645696	**ICED**	C		0	

Northern Environmental℠
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APPENDIX B

LAKE ASSOCIATION MEMBER
LAND-USE CHANGE TESTIMONIAL

Ryan L McCone

From: Jack Clarke [jclarke@lsol.net]
Sent: Monday, November 22, 2004 4:33 PM
To: Ryan McCone
Subject: Land Use

Ryan,

You are right, there have been many changes since 1995. The most noticeable is the development of the Autumn Ridge Golf Course and the Autumn Ridge subdivision with about 12 new homes, this development will continue. There has been some extensive land filling and leveling of new home lots in that area.

The construction of new homes around the lake is also continuing. During the time period since 1995 the whole north shore area has been rebuilt and only one or two buildings are original and predate "95. Currently, there are three new homes completed this summer and another in early phase of construction. The current home construction in the northeast corner involved clearing some very large pine trees and most of those built in that area involved tree removal. The new homes in the southwest corner of the lake also involved significant tree removal. Also currently, in the last month, there is a mobile home on the east side which has been removed to make room for more development, but this should require setback variances because the lot is probably too narrow to conform to County setback from Pigeon Lk Rd. One of the concerns of the Lake Association is the willingness of the Manitowoc Park and Planning Board to grant variances that could affect the lake quality.

There is a remodeling project currently going at the house where the boat house we use as a landmark for depth is located. There has been brush and tree removal there also. This is mentioned just as an example of how each change of ownership usually results in some sort of "improvement".

The tree removal around Pigeon Lake has been extensive since 1995 and it would be very difficult to make an exact count, but I think almost every property has lost trees in the last 10 years. Some trees were lost in the 2001 storm (tornado) which did the most damage on the north side of the lake. I have lost three trees in the last year due to age and storm damage and both neighbors to the north have lost or removed several. The estimate of trees lost in the shoreline area in the last 10 years would be in excess of 100.

There has not been a significant increase or decrease in wetland area. There were attempts to fill some wetlands but this was stopped and no further filling of wetlands has been noted.

Our concerns as a lake association is that more bigger homes and additional blacktop and concrete involved in this new construction could increase the run-off into the lake.

I have not been very specific in the numbers and owners of the new homes but if that is needed we could do a count, with more specific details., but think you wanted an overall view. It seems that there isn't much room for further expansion but you never know which direction it could go in the future.

If you would like more detail or further information we would be pleased to give what we can. There certainly has been a dramatic change since we have owned property here.

Jack

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APPENDIX C

2004 AQUATIC PLANT STUDY

Northern Environmental℠
Hydrologists • Engineers • Surveyors • Scientists

APPENDIX C1

FIELD DATA

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	A	0-2.5	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1		1	
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	B	3.5-5	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Nalad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	1	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	C	5-10	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	2	2	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	D	10-20'	M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				1
Myriophyllum spicatum	EWM	3	4	3	1
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	E	20+	M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail	X	X	X	
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				2
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	A	0-25	S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	3	2	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	B	2.5-5	S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	3	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	C	3-10	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM		1		
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	4	1
Nitella spp.	Nitellas	1			
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	D	10-200	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				1
Nitella spp.	Nitellas	3	1	2	4
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	E	20+	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	2	2	1	1
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
5	A	2.5	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1	1	1	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	1	1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
1	3	[illegible]	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	1	1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
5	6	5-10	S/9

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	3	4	2	5
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1			2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
5	D	10-20	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	4	4	4	4
Myriophyllum spicatum	EWM	1			
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	A	0-3.5	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	1	1		
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	3	1	3
Nitella spp.	Nitellas				
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	B	3.5'	S/6

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	3	1	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	C	5-10'	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	5	5	5	5
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	D	10-20	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	2	3	2	2
Myriophyllum spicatum	EWM	1		1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				5
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	E	20' +	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
3	A	0-2.5'	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1			
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1 (20%)	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	B	2.5' [illegible]	2/6

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil		1		
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	1	1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	C	5-10'	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	1	1	1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	2	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	D	[illegible]	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	1	1	1	5
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	E	20' plus	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed	X	X	X	
Floating Leaf					
Nuphar variegata	Spatterdock	X	X	X	X
Nymphaea odorata	White Water Lilly	X	X	X	X
Submersed					
Certatophyllum demersum	Coontail	X	X	X	X
Myriophyllum sibiricum	Northern Watermilfoil	X	X	X	
Myriophyllum spicatum	EWM	X	X	X	
Najas flexilis	Slender Naiad	X	X	X	
Potamogeton crispus	Curlyleaf	X	X	X	X
Potamogeton diversifolius	Water-thread Pondweed	X	X	X	X
Potamogeton pectinatus	Sago Pondweed	X	X	X	X
Potamogeton zosteriformis	Flat-stem Pondweed	X	X	X	X
Zosterella dubia	Water Stargrass	X	X	X	X
Potamogeton amplifolius	Large-leaf Pondweed	X	X	X	X
Potamogeton richardsonii	Clasping Leaf Pondweed	X	X	X	X
Potamogeton natans	Floating leaf Pondweed	X	X	X	X
Valliseria americana	wild celery	X	X	X	X
Urticularia valgaris	Bladderwort	X	X	X	X
pontederia cordata	Pickerelweed	X	X	X	X
Algae					
Chara spp.	Muskgrass, stonewart	X	X	X	X
Nitella spp.	Nitellas	X	X	X	X
Emergent					
Scirpus acutus	Hard-stem Bulrush	X	X	X	X
Scirpus americanus	Three-square rush	X	X	X	X
Typha latifolia	Broad Leaved Cattail	X	X	X	X
Lythrum salicaria	Purple Loosestrife	X	X	X	X
Sagitaia engelmanniana	Short-beaked arrowhead	X	X	X	X

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	A	0-2.5	M/S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	2	1	2	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	5	5	5	5
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush	1		1	
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail	+			
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	13	2.5-5.0	M/S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	4	4	4	4
Najas flexilis	Slender Naiad		1		1
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
E 1		1			
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	C	5.0 - 10.0	m/s

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	2	1	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	D	10.0-20.0	m/s

14.8

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	2	2
Nitella spp.	Nitellas	2		4	
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	A	0-2.5	M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed	1		1	
Floating Leaf					
Nuphar variegata	Spatterdock	2	2	2	2
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	1		1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	2	1	2	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed	1	2	1	2
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	1	2	1
Nitella spp.	Nitellas				
[illegible]		1		1	
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail	?			
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	B	2.5-5.0	M/S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	1		1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	2	2	1	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	2	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	C	5.0 - 10.0	M/S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	4	5	4	5
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad	1		1	
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed		1		1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart		1		1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	D	10-20.0	H · S?

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1	1	1	
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	5	4	5	4
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	E	>20.0	A S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	A	0-2.5	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail	X	X		
Myriophyllum sibiricum	Northern Watermilfoil	X	X		
Myriophyllum spicatum	EWM	X	X		
Najas flexilis	Slender Naiad	X	X		
Potamogeton crispus	Curlyleaf	X	X		
Potamogeton diversifolius	Water-thread Pondweed	X	X		
Potamogeton pectinatus	Sago Pondweed	X	X		
Potamogeton zosteriformis	Flat-stem Pondweed	X	X		
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart			1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	B	2.5-3.0	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad	X			
Potamogeton crispus	Curlyleaf		X		
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart			1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	C	5.0 - 10.0	5

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail	X			
Myriophyllum sibiricum	Northern Watermilfoil	X			
Myriophyllum spicatum	EWM	X			
Najas flexilis	Slender Naiad	X			
Potamogeton crispus	Curlyleaf	X			
Potamogeton diversifolius	Water-thread Pondweed	X			
Potamogeton pectinatus	Sago Pondweed	X			
Potamogeton zosteriformis	Flat-stem Pondweed	X			
Zosterella dubia	Water Stargrass	X			
Potamogeton amplifolius	Large-leaf Pondweed	X			
Potamogeton richardsonii	Clasping Leaf Pondweed	X			
Potamogeton natans	Floating leaf Pondweed	X			
Valliseria americana	wild celery	X			
Urticularia valgaris	Bladderwort	X			
pontederia cordata	Pickerelweed	X			
Algae					
Chara spp.	Muskgrass, stonewart		2	1	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	D	10.0-20.0	M/S

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1			1
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas		1	1	
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	E	720.0	N/A

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail	X	X	X	X
Myriophyllum sibiricum	Northern Watermilfoil	X	X	X	X
Myriophyllum spicatum	EWM	X	X	X	X
Najas flexilis	Slender Naiad	X	X	X	X
Potamogeton crispus	Curlyleaf	X	X	X	X
Potamogeton diversifolius	Water-thread Pondweed	X	X	X	X
Potamogeton pectinatus	Sago Pondweed	X	X	X	X
Potamogeton zosteriformis	Flat-stem Pondweed	X	X	X	X
Zosterella dubia	Water Stargrass	X	X	X	X
Potamogeton amplifolius	Large-leaf Pondweed	X	X	X	X
Potamogeton richardsonii	Clasping Leaf Pondweed	X	X	X	X
Potamogeton natans	Floating leaf Pondweed	X	X	X	X
Valliseria americana	wild celery	X	X	X	X
Urticularia valgaris	Bladderwort	X	X	X	X
pontederia cordata	Pickerelweed	X	X	X	X
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	A	0-2.5	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort		X	X	X
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	I			
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	B	2.5-5.0	S/G

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM			1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed			1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	1	1	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	C	5.0 - 10.0	M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1	2	1	1
Myriophyllum spicatum	EWM	1			2
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	D	10.0-20.0	M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil			1	1
Myriophyllum spicatum	EWM	2	2	2	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	E	>20.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				2
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
15	A	0-2.5	S/M

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	I	I	I	I
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: June 17, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
15	B	2.5-5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	2	1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	A	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	13	2.5-5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	3	2	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	C	5-10	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad			3	3
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	2	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	D	6-20	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	2	3	2	3
Myriophyllum spicatum	EWM	2	3	2	3
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
2	E	20+	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	A	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	3	2	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	B	2.5-5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	?	?	?	?
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	C	5.0-10.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	4	4	4	4
Nitella spp.	Nitelias				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	D	10.0-12.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	1	1		
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas			4	4
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	5	7.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail			X	X
Myriophyllum sibiricum	Northern Watermilfoil	X	X		
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
5	A	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly	1	2	1	2
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2			
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				
	Unknown	1			

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
E	B	2.5-5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1	2	1	2
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	2	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
5	c	5.2-12.4	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1	1	3	3
Myriophyllum spicatum	EWM	2	2	3	3
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
5	D	10-10.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail	X	X	X	X
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	A	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	3	4	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
4	B	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	3	2	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	C	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad	1		1	
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1		1	
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	D	10'-20'	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil			3	3
Myriophyllum spicatum	EWM	1	1		
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	1		
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
6	E	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	A	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				X
Potamogeton diversifolius	Water-thread Pondweed		X	X	
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass		X	X	
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	B	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil		1		
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1		1	
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	C	5.0-12.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	4	5	4	5
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery	1		1	
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	3	2	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	D	10.0 - 14.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	4	4	4	4
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	4	4	4	4
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
8	E	720.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	2	2	2	2
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	A		

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed		1	2	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	2	3	4
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush	1			
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail	2			
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Page ____ of ____

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	B	2.5-5?	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	2	1	2	2
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad	1		1	
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1			
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	C	5.0-10.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	2	2	3	3
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	3	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
9	D	10.0 - 10.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1		1	
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	5	4	5	4
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	A		

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock	2	2	2	2
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1		1	
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	2	1	2	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed	1		1	
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	3	4	3	4
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	8	1.5-5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	1		1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	2	1	2	1
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	4	4	4	4
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
10	C	5.0-12.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	9	5	9	5
Myriophyllum spicatum	EWM	1		1	
Najas flexilis	Slender Naiad	1		1	
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	1		1	
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	D	10-20.2	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	I	✓	I	
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	U	U	U	U
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
1D	E	7?0.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas	5	5	5	5
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	1	0-2	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	3	3	3	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	B	2.5 - 5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	3	3	3	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	C		

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	2		1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	3	3	3	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	D	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1		1	
Myriophyllum spicatum	EWM	1		1	
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	3	2	3	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Page ____ of ____

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
11	5	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1		1	
Nitella spp.	Nitellas		1		1
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	9	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Ceratophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	3	2	3
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	1	2.5-3.1	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly	1			
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	2	2	3	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
15	C	[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil	1		1	
Myriophyllum spicatum	EWM	1			
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed	1		1	
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery	1		1	
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	[illegible]	[illegible]	[illegible]	[illegible]
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	D	10-[illegible]	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM	3	4	3	4
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
13	E	7.25	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart				
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitala engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
15	A	0-2.5	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad				
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	1	1	1
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

Aquatic Vegetation Stratified Random Sampling Data Sheet

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Site Information

Lake: Pigeon Lake
County: Manitowoc
Date: August 16, 2004

Subsampling Area Information

Transect	Sampling Point	Depth	Substrate
15	B	2.5-5.0	

Species Information

Scientific Name	Common Name	Quad 1	Quad 2	Quad 3	Quad 4
Free Floating					
Lemna minor	Duckweed				
Floating Leaf					
Nuphar variegata	Spatterdock				
Nymphaea odorata	White Water Lilly				
Submersed					
Certatophyllum demersum	Coontail				
Myriophyllum sibiricum	Northern Watermilfoil				
Myriophyllum spicatum	EWM				
Najas flexilis	Slender Naiad	1		1	
Potamogeton crispus	Curlyleaf				
Potamogeton diversifolius	Water-thread Pondweed				
Potamogeton pectinatus	Sago Pondweed				
Potamogeton zosteriformis	Flat-stem Pondweed				
Zosterella dubia	Water Stargrass				
Potamogeton amplifolius	Large-leaf Pondweed				
Potamogeton richardsonii	Clasping Leaf Pondweed				
Potamogeton natans	Floating leaf Pondweed				
Valliseria americana	wild celery				
Urticularia valgaris	Bladderwort				
pontederia cordata	Pickerelweed				
Algae					
Chara spp.	Muskgrass, stonewart	1	2	1	2
Nitella spp.	Nitellas				
Emergent					
Scirpus acutus	Hard-stem Bulrush				
Scirpus americanus	Three-square rush				
Typha latifolia	Broad Leaved Cattail				
Lythrum salicaria	Purple Loosestrife				
Sagitaia engelmanniana	Short-beaked arrowhead				

- Wild Celery
- Sago Pondweed
- Sago
- Nitella
- Eurasian

Northern Environmental℠
Hydrologists • Engineers • Surveyors • Scientists

APPENDIX C2

SURVEY RESULTS

Pigeon Lake - 2004 Aquatic Macrophyte Survey (June summary <2.5' depth zone)

Survey Date: June 17, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*				*Najas flexilis*				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*				*Potamogeton sp.*				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*				*Potamogeton pusillus*				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2	1		1																																																																	
Transect 4	2	3	2	3																																																															
Transect 5	1	1	1	1																																	1	1	1	1																												
Transect 6	4	3	4	3					1	1																																																							
Transect 8													1																								1		1																													
Transect 9	5	5	5	5																																	2	1	2	1													1	1	1	1	1	1	1	1				
Transect 10	2	1	2	1	1		1		1		1														2	2	2	2									2	1	2	1	1	2	1	2													1	1	1	1				
Transect 11			1	1																																																											
Transect 13	1																																																													
Transect 15	1	1	1	1																																																										
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	87.5				12.5				25.0				12.5				0.0				0.0				12.5				0.0				0.0				50.0				12.5				0.0				0.0				12.5				25.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	35.0				5.0				10.0				5.0				0.0				0.0				5.0				0.0				0.0				20.0				5.0				0.0				0.0				5.0				10.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	2.21				1.00				1.00				1.00				0.0				0.0				2.00				0.0				0.0				1.25				1.50				0.0				0.0				1.00				1.00				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(June summary 2.5' - 5.0' depth zone)**

Survey Date: June 17, 2004

	Species Density Rating															
	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2	2	2	1	2												
Transect 4	2	2	3	2												
Transect 5	1	1	1	1												
Transect 6	1	3	1	2												
Transect 8	1	1	1	1										1		
Transect 9									4	4	4	4				
Transect 10	2	2	2	2					1		1					
Transect 11			1	1												
Transect 13	1	1	1	3							1					
Transect 15	1	2	1	1												
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	87.5				0.0				25.0				12.5			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	50.0				0.0				14.3				7.1			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	1.57				0.0				2.50				1.00			

	Najas flexilis				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9		1		1												
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	12.5				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	7.1				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	1.00				0.0				0.0				0.0			

	Potamogeton sp.				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9	1				1		1									
Transect 10					2	2	1	1								
Transect 11																
Transect 13							1									
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	12.5				25.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	7.1				14.3				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	1.00				1.25				0.0				0.0			

	Potamogeton pusillus				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey (June summary 5.0' - 10.0' depth zone)

Survey Date: June 17, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*				*Najas flexilis*				*Nitella spp.*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2	1	2	2	1																				
Transect 4	2	2	4	1						1											1			
Transect 5	1			2					3	4	2	5												
Transect 6									5	5	5	5	1	1										
Transect 8	2	2	2	2					1	1	1													
Transect 9	1	2	1	2																				
Transect 10													4	5	4	5								
Transect 11																								
Transect 13									1			2	1	2	1	1								
Transect 15																								

	Nuphar variegata				*Nymphaea odorata*				*Potamogeton sp.*				*Potamogeton amplifolius*				*Potamogeton natans*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																				
Transect 4																				
Transect 5																				
Transect 6													1							
Transect 8																1				
Transect 9													1		1					
Transect 10														1		1				
Transect 11																				
Transect 13																				
Transect 15																				

	Potamogeton pectinatus				*Potamogeton pusillus*				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																				
Transect 4																				
Transect 5																				
Transect 6																				
Transect 8																				
Transect 9																				
Transect 10																				
Transect 11																				
Transect 13																				
Transect 15																				

	Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	**Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)**	**Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])**
Chara spp.	62.5	31.3	1.75
Lemna minor	0.0	0.0	0.0
Myriophyllum spicatum	50.0	25.0	2.63
Myriophyllum sibiricum	25.0	12.5	2.75
Najas flexilis	0.0	0.0	0.0
Nitella spp.	12.5	6.3	1.00
Nuphar variegata	0.0	0.0	0.0
Nymphaea odorata	0.0	0.0	0.0
Potamogeton sp.	0.0	0.0	0.0
Potamogeton amplifolius	50.0	25.0	1.00
Potamogeton natans	0.0	0.0	0.0
Potamogeton pectinatus	0.0	0.0	0.0
Potamogeton pusillus	0.0	0.0	0.0
Scirpus acutus	0.0	0.0	0.0
Typha latifolia	0.0	0.0	0.0
Vallisneria americana	0.0	0.0	0.0

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(June summary 10.0' - 20.0' depth zone)**

Survey Date: June 17, 2004

	Species Density Rating															
	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2									3	4	3	1				1
Transect 4				1												
Transect 5									1				4	4	4	4
Transect 6									1		1		4	3	2	2
Transect 8																
Transect 9	2	2	2	2												
Transect 10													1	4	1	
Transect 11		1	1										1		1	
Transect 13									2	2	2				1	1
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	25.0				0.0				37.5				50.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	14.3				0.0				21.4				28.6			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	1.50				0.0				1.58				2.44			

	Najas flexilis				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4					3	1	2	4								
Transect 5																
Transect 6								5								
Transect 8					1	1	1	5								
Transect 9					2		4									
Transect 10					5	4	5	4								
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				62.5				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				35.7				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				3.40				0.0				0.0			

	Potamogeton sp.				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

	Potamogeton pusillus				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(June summary >20.0' depth zone)**

Survey Date: June 17, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

	Najas flexilis				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2								2								
Transect 4					2	2	1	1								
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10					1											
Transect 11																
Transect 13								2								
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				37.5				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				100.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				1.50				0.0				0.0			

	Potamogeton sp.				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

	Potamogeton pusillus				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(August summary <2.5' depth zone)**

Survey Date: August 16, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2	2	3	2	3												
Transect 4	2	3	2	3												
Transect 5	2															
Transect 6	4	3	4	3					1		1					
Transect 8																
Transect 9	4	4	4	4												
Transect 10	3	4	3	4									1		1	
Transect 11	3	3	3	3												
Transect 13	2	3	2	3												
Transect 15	1	1	1	1												
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	87.5				0.0				12.5				12.5			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	38.9				0.0				5.6				5.6			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	2.71				0.0				1.00				1.00			

	Najas flexilis				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5													1	2	1	2
Transect 6																
Transect 8																
Transect 9																
Transect 10									2	2	2	2				
Transect 11																
Transect 13																
Transect 15	1		1													
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	12.5				0.0				12.5				12.5			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	5.6				0.0				5.6				5.6			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	1.00				0.0				2.00				1.50			

	Potamogeton sp.				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8					1											
Transect 9					2	1	2	1								
Transect 10					2	1	2	1	1		1					
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				37.5				12.5				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				16.7				5.6				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				1.33				1.00				0.0			

	Potamogeton pusillus				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9					1	1	1	1	1	1	1	1				
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				12.5				12.5				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				5.6				5.6				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				1.00				1.00				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(August summary 2.5' - 5.0' depth zone)**

Survey Date: August 16, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*				*Najas flexilis*				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*				*Potamogeton sp.*				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*				*Potamogeton pusillus*				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2	2	3	2	3																																																															
Transect 4	2	3	2	3																																																														
Transect 5	2	2	2	2																																	1	2	1	2																											
Transect 6	2	3	2	3																																																													
Transect 8	1		1												1																						1		1																											
Transect 9									2	2	2	2					1		1																		1																											
Transect 10	4	4	4	4					1		1																										2	1	2	1																										
Transect 11	3	3	3	3																																																												
Transect 13	3	2	3	2																									1																																			
Transect 15																																													1	1	1	1	1	1	1	1												
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	75.0				0.0				25.0				12.5				12.5				0.0				0.0				0.0				0.0				50.0				0.0				12.5				12.5				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	37.5				0.0				12.5				6.3				6.3				0.0				0.0				0.0				0.0				25.0				0.0				6.3				6.3				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	2.42				0.0				1.50				1.00				1.00				0.0				0.0				0.0				0.0				1.25				0.0				1.00				1.00				0.0				0.0				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(August summary 5.0' - 10.0' depth zone)**

Survey Date: August 16, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*				*Najas flexilis*				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*				*Potamogeton sp.*				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*				*Potamogeton pusillus*				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2	2	2	2	2							3	3																									1		1																									
Transect 4	4	4	4	4																																	1		1																							
Transect 5									2	2	3	3	4	4	3	3																																														
Transect 6	1		1						4	4	4	4					1																				1		1																							
Transect 8	2	2	2	2					4	5	4	5																									1		1																				1		1	
Transect 9	2	2	2	2					2	2	3	3																									1		1																							
Transect 10										1		1	4	5	4	5	1		1		1		1														1		1																							
Transect 11	3	3	3	3						2		2																																																	
Transect 13	4	4	4	4					2		2		1		1																							1		1																					1		1
Transect 15																																																													
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	62.5				0.0				75.0				25.0				25.0				12.5				0.0				0.0				0.0				75.0				0.0				0.0				0.0				0.0				0.0				12.5			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	21.7				0.0				26.1				8.7				8.7				4.3				0.0				0.0				0.0				26.1				0.0				0.0				0.0				0.0				0.0				4.3			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	2.20				0.0				2.92				4.00				1.00				1.00				0.0				0.0				0.0				1.00				0.0				0.0				0.0				0.0				0.0				1.00			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(August summary 10.0' - 20.0' depth zone)**

Survey Date: August 16, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2									4	4	3	3	2	3	2	3
Transect 4									4	2						
Transect 5																
Transect 6	1	1							1	1					3	3
Transect 8	4	4	4	4									4	4	4	4
Transect 9													1		1	
Transect 10													1	2	1	
Transect 11	3	2	3	2					1		1		1		1	
Transect 13									3	4	3	4		1		1
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	25.0				0.0				37.5				62.5			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	15.4				0.0				23.1				38.5			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	2.50				0.0				2.50				2.37			

	Najas flexilis				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4							4	4								
Transect 5																
Transect 6																
Transect 8																
Transect 9					5	4	5	4								
Transect 10					4	4	4	4								
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				37.5				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				23.1				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				4.17				0.0				0.0			

	Potamogeton sp.				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
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Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

	Potamogeton pusillus				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

Pigeon Lake - 2004 Aquatic Macrophyte Survey **(August summary >20.0' depth zone)**

Survey Date: August 16, 2004

Species Density Rating

	Chara spp.				*Lemna minor*				*Myriophyllum spicatum*				*Myriophyllum sibiricum*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11	1		1													
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

	Najas flexilis				*Nitella spp.*				*Nuphar variegata*				*Nymphaea odorata*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8					2	2	2	2								
Transect 9																
Transect 10					5	5	5	5								
Transect 11						1		1								
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				25.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				100.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				3.50				0.0				0.0			

	Potamogeton sp.				*Potamogeton amplifolius*				*Potamogeton natans*				*Potamogeton pectinatus*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

	Potamogeton pusillus				*Scirpus acutus*				*Typha latifolia*				*Vallisneria americana*			
	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density	Toss #1 Density	Toss #2 Density	Toss #3 Density	Toss #4 Density
Transect 2																
Transect 4																
Transect 5																
Transect 6																
Transect 8																
Transect 9																
Transect 10																
Transect 11																
Transect 13																
Transect 15																
Frequency of Occurrence =(# of sampling sites in which species occurs / total # of sample sites; [within depth interval])	0.0				0.0				0.0				0.0			
Relative Frequency= (# of sampling sites in which species occurs / total number of occurances of all species)	0.0				0.0				0.0				0.0			
Species Mean Density = (Sum of density ratings for species / # of sites were present; [within depth interval])	0.0				0.0				0.0				0.0			

Northern Environmental℠
Hydrologists • Engineers • Surveyors • Scientists

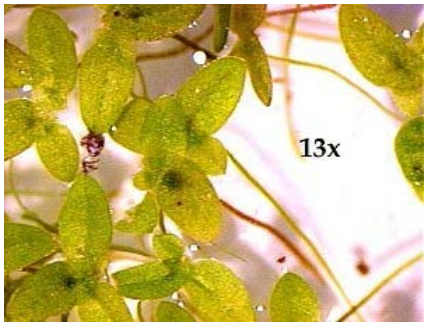
APPENDIX C3

PLANT DESCRIPTIONS

AQUATIC PLANT COMMUNITY MEMBER DESCRIPTIONS

Free-Floating Plants

Free-floating aquatic plant species were identified during the 2004 aquatic plant surveys. A brief description of free-floating plants follows.



Small Duckweed

Lemna minor (Small Duckweed)

Small Duckweed is a common free-floating aquatic plant. Duckweed has round oval-shaped leaf bodies called fronds. These fronds float individually or in groups on the waters surface. Duckweed commonly reproduces by budding. The plants absorb nutrients from the water through their leaves and dangling roots. Duckweed is a nutritious food source for a variety of waterfowl. Duckweed reproduces at tremendous rates and can double in number in 3 to 5 days (Borman, et al., 1997).

Floating-Leaf Plants

Submerged aquatic plant species were identified during 2004 aquatic plant surveys. A brief description of these plants follows.

Nuphar variegata (Spatterdock)

Spatterdock was found in Pigeon Lake. Spatterdock shows a preference for soft sediment and water that is 6 feet or less in depth. Floating leaves emerge in early summer from rhizomes that are actively growing in the soft sediments. Yellow flowers occur throughout the summer. Floating leaves provide cover and shade for fish as well as habitat for invertebrates (Borman, et al., 1997).

Spatterdock

White Water Lily

Nymphaea odorata (White Water Lily)

White Water Lily has a flexible stalk with a round floating leaf. Most of its leaves float on the water surface. White Water Lily is typically found growing in a variety of sediment types in less than 6 feet of water. Floating leaves emerge in early summer from rhizomes that are growing in the soft sediments. White flowers occur throughout the summer. The floating leaves provide shelter and shade for fish as well as habitat for invertebrates (Borman, et al., 1997).

Submergent Plants

Submerged aquatic plant species were identified during 2004 aquatic plant surveys. A brief description about these plants follows.

Myrionphyllum spicatum (Eurasian watermilfoil)

Eurasian watermilfoil

Eurasian watermilfoil (EWM) is a submersed aquatic plant native to Europe, Asia and northern Africa. It was introduced to the United States by early European settlers. EWM has proliferated in waterways across North America. EWM was first detected in Wisconsin lakes during the 1960s. In the past three decades, this exotic species has significantly expanded its range to about 310 lakes in 54 of Wisconsin's 72 counties. The range of EWM continues to expand in Wisconsin between 1994 and 2001 (DNR, 2002). Because of its potential for explosive growth and its incredible ability to regenerate, EWM can successfully out-compete most native aquatic plants, especially in disturbed areas.

EWM shows no substrate preference, and can grow in water depths greater than 4 meters (Nichols, 1999). It does not rely on seed for re-production as its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried down or up the Lake by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist. Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the substrate).

As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help it claim the water column early in spring, photosynthesize, reproduce, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM threaten the integrity of aquatic communities.

Northern watermilfoil

Myriophyllum sibiricum (Northern watermilfoil)

Northern watermilfoil has light colored stems that emerge from rootstalks and rhizomes. Stems are sparingly branched and fairly erect in water. Leaves are divided like a feather, with five to twelve pairs of thread-like leaflets. Leaves are arranged in whorls. Northern watermilfoil can also reach nuisance levels posing problems for recreational and navigational patron. Waterfowl eat the foliage and fruit of northern watermilfoil, while beds of this plant provide cover and foraging opportunities for fish and invertebrates. Northern watermilfoil is usually found growing in soft sediment in fairly clear-water lakes.

*Potamogeton amplifolius (*Large-leaf Pondweed)

Large-leaf Pondweed

Large-leaf Pondweed has robust stems that emerge from black-scaled rhizomes. The submersed leaves are the broadest of any pondweed and are slightly folded. The blade is also lined with many veins (25 to37). Floating leaves are oval and on long stalks. Stipules of both submersed and floating leaves are

large and are free. Large-leaf pondweed is most frequently found in soft sediments in water 1 to several feet deep. It is sensitive to increased turbidity. Large-leaf pondweed is commonly grazed by waterfowl. It offers habitat for invertebrates and offers foraging opportunities for fish (Borman, et al., 1997).

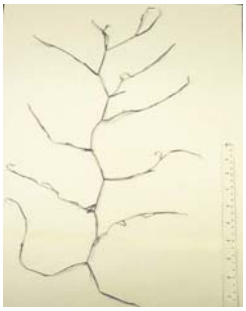
Potamogeton natans (Floating-Leaf Pondweed)

Floating-leaf Pondweed

Floating-Leaf Pondweed has stems that emerge from red-spotted rhizomes. Submersed leaves are stalk-like, with no obvious leaf blade. Floating leaves are heart-shaped at their base. Floating-leaf pondweed is usually found in water less than 1.5 meters deep. Fruit of floating-leaf pondweed is held on the stalk until late in the growing season. It provides valuable grazing opportunities for ducks and geese. It may also be consumed by muskrat, beaver and deer (Borman et al. 1997).

Potamogeton pectinatus (Sago Pondweed)

Sago Pondweed resembles two other pondweeds with needle-like leaves, but sago pondweed tends to be much more common. The fruit and tubers of sago pondweed are very important food sources for waterfowl, while leaves and stems provide shelter for small fish and invertebrates (Borman, et al., 1997).



Sago Pondweed

Small Pondweed

Small Pondweed(*Potamogeton pusillus*)

Small pondweed has small slender stems, emerges from a slight rhizome, and branches repeatedly near its ends. Small pondweed over winters as rhizomes and winter buds. There is some limited reproduction by seed. Small pondweed can be locally important as a food source for a variety of wildlife. Waterfowl tend to feed on small pondweed as well as deer, muskrat, and some small fish (Borman, et al., 1997).

Najas flexilis (Slender Naiad)

Slender Naiad is sometimes called bushy pondweed and has fine branched stems that emerge from a slight rootstalk. Leaves are paired and sometimes smaller leaves are bunched. Slender Naiad can grow in very shallow and very deep. Waterfowl, marsh birds, and muskrats consume the stems, leaves, and seeds of naiad. The foliage produces forage and shelter opportunities for fish and invertebrates (Borman, et al., 1997).

Slender Naiad

Wild Celery

Valinsneria americana (Wild Celery)

Wild Celery, also known as eel-grass or tape-grass, was not observed in our most recent aquatic plant survey but was identified in past aquatic plant surveys (Mosinee Paper Corporation, 2002). Wild Celery has ribbon-like leaves that tend to grow till they emerge in clusters along the waters surface. Wild celery is a premiere source of food for waterfowl. All portions of the plant are consumed. This plant is an extremely important food source for canvasbacks that feed on the tubers of this plant. Beds of wild celery are also considered good fish habitat providing shade, shelter and feeding opportunities (Borman, et al., 1997).

Chara, sp. (Muskgrass / Chara)

Although *Chara, sp.* (Muskgrass / Chara) looks like a higher plant, it actually is a multi-celled algae. Muskgrass is usually found in hard waters and prefers muddy or sandy substrate and can often be found in deeper water than other plants. Muskgrass beds provide valuable habitat for small fish and invertebrates. Muskgrass is also a favorite waterfowl food. Its rhizoids slow the movement and suspension of sediments and benefit water quality in the ability to stabilize the lake bottom (Borman, et al., 1997).

Chara sp.

Nitella sp.

Nitella sp. (Nitella)

Nitella is another type of algae that looks like a higher plant. This plant has no conductive tissue and has simple anchoring structures called rhizoids rather than true roots. Nitella is similar in appearance to muskgrass and is often found in similar habitats. However, Nitella can be distinguished from muskgrass by its stems and branches, which are smooth (Borman, et al., 1997).

Emergent Plants

Emergent aquatic plant species were identified during the 2004 aquatic plant surveys. A brief description of these plants follows.

Scirpus acutus. (Hardstem Bulrush)

Hardstem Bulrush has tall, sturdy stems that emerge from a shallow rhizome. The cylindrical, olive green stems are firm when pressed between your fingers. Hardstem bulrush can be found in wetlands, lakes, ponds and streams. It usually grows in water less than 2 meters deep, but it has been found considerably deeper. Hardstem shows a preference for firm substrate with good water movement in the root zone. Hardstem bulrush offers habitat for invertebrates and shelter for young fish, especially northern pike. The nutlets are

Hardstem Bulrush

consumed by a wide variety of waterfowl, marsh birds and upland birds. It also provides nesting material and cover for waterfowl, marsh birds, and muskrats (Borman, et al., 1997).

Typha latifolia. (Broad-leaf Cattail)

Broad-leaved cattail has pale green, sword-like leaves that emerge from a robust, spreading rhizome. The leaves are sheathed around on another at the base and junction of the leaf sheath and blasé the sheath is usually tapered. Broad-leaved cattail can be distinguished from narrow-leaved cattail by having male and female flower spikes immediately adjacent to each other and the leaves that are wider and flatter. Cattails provide nesting habitat for many marsh birds and cover for small fish (Borman, et al., 1997).

Broad-leaved Cattail