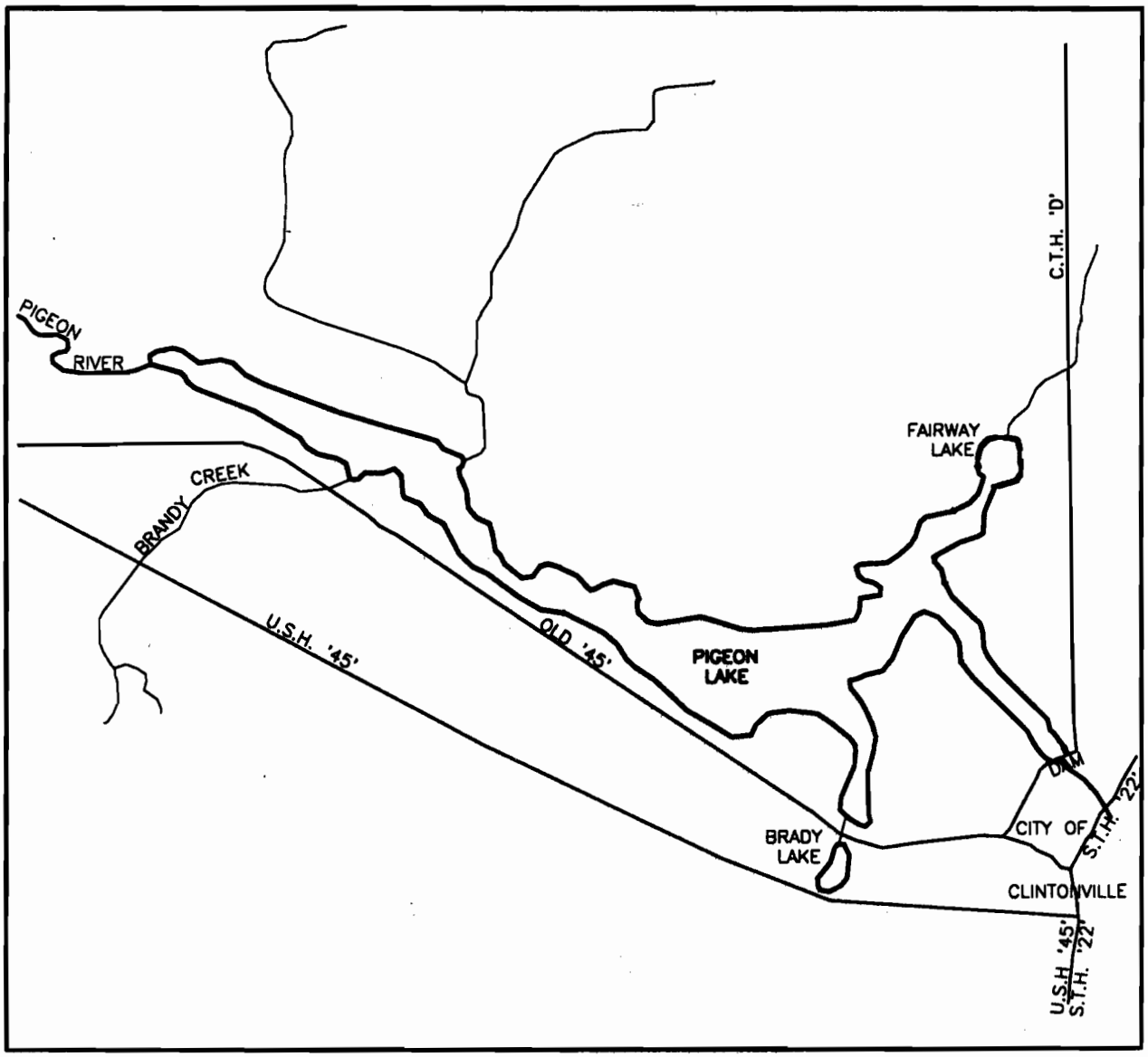
PIGEON LAKE MANAGEMENT STUDY

WAUPACA COUNTY, WISCONSIN



PREPARED FOR:
PIGEON LAKE PROTECTION & REHABILITATION DISTRICT

OCTOBER 1997

PREPARED BY:

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The Pigeon Lake Protection and Rehabilitation District Committee members took the initiative to seek and provide funds to develop this plan for the Pigeon Lake community. Throughout the planning, the committee members provided valuable insight and guidance for development of this management plan for their lake community.

This plan was made possible with funds provided from the Wisconsin Department of Natural Resources, the Waupaca County Land and Conservation Department, and the Pigeon Lake Protection and Rehabilitation District.

A special thanks goes out to the following individuals that provided information from their education and experience in their respective fields:

Tim Rasman, Limnologist - Wisconsin Department of Natural Resources
Bruce Bushweiler, Waupaca County Conservationist
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Greg Blonde, Agricultural Agent - UW Cooperative Extension - Waupaca Co.
Greg Bloom, Director - USDA Farm Service Agency - Waupaca County
Kevin Erb, Nutrient Management Specialist - UW Cooperative Extension - Northeast Wisconsin Region
Thomas Wilson, Community Resource Development Agent - UW Cooperative Extension - Waupaca County

INTRODUCTION

In May of 1995, the Pigeon Lake Protection and Rehabilitation District (PLPRD) passed a resolution to seek funds from the Wisconsin Department of Natural Resources to develop a lake management plan through the "Lake Management Planning Project Grant Program". The PLPRD contacted Nordin-Pedersen Associates, Inc. from Shawano, Wisconsin to help apply for the grant. In October of 1995, the PLPRD received the grant to develop this management plan for Pigeon Lake. The purpose of this plan is to provide management recommendations to protect and improve the lake ecosystem for public use and the enjoyment of its natural beauty.

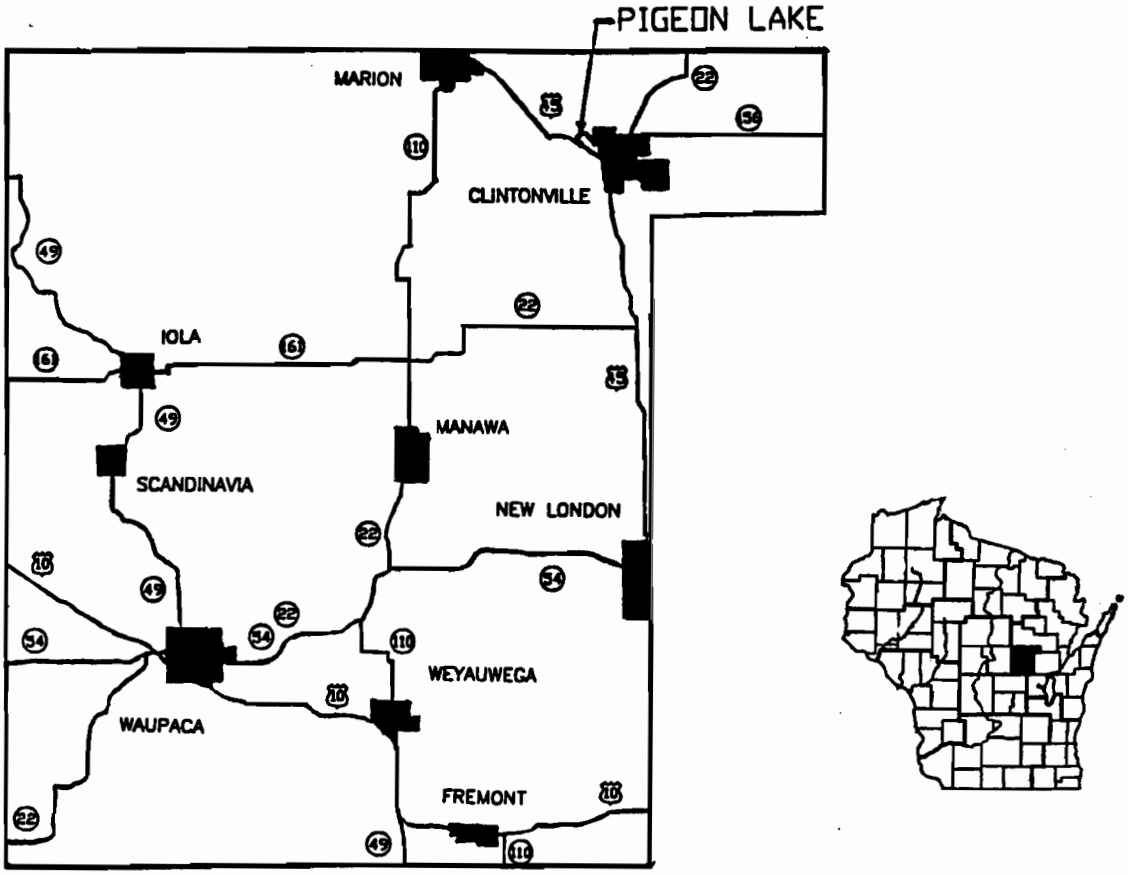
Pigeon Lake is a 165-acre impoundment of the Pigeon River by the dam located in the City of Clintonville in northeastern Waupaca County, Wisconsin. The lake has a direct drainage basin of approximately 33,640 acres, most of which is of agricultural land-use. The primary use of the lake is for fishing, boating, and simply enjoying its natural beauty.

The major concern of the PLPRD was to address the nuisance weed growth, soft sediment build-up, and the effect these have on the fishery and recreational usage of the lake. To propose management recommendations for these concerns, the water quality of the lake and its tributaries was tested to determine its existing conditions. The PLPRD chose Northern Lake Service , Inc. of Crandon, Wisconsin to assist them with the water sampling, water testing, and weed survey. Sampling began in April of 1996 and continued throughout the year. A survey of the soft sediments on the lake bottom was conducted through the ice in March 1997.

The results of these tests and surveys along with recommendations for management alternatives follow in this report. In addition, this report makes comparisons to a similar Pigeon Lake study conducted in 1977.

BACKGROUND INFORMATION

Pigeon Lake is located in Sections 22 & 23 in the Town of Larrabee (T25N, R14E) in Waupaca County WI. Approximately half of the lake is located within the limits of the City of Clintonville. Below is location map showing Pigeon Lake in Waupaca County, Wisconsin.

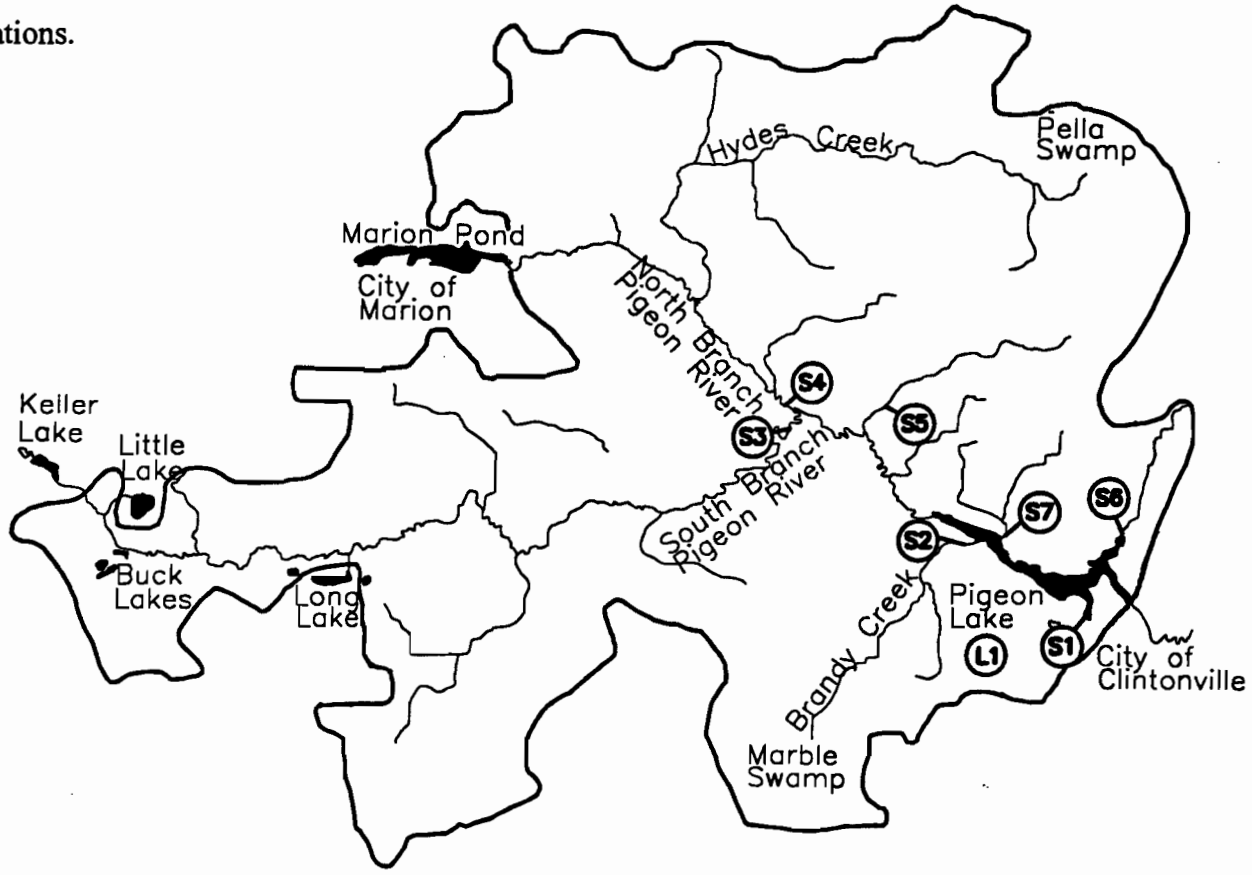


Pigeon Lake was formed in 1855 when a timber and earth dam was built on the Pigeon River in Clintonville for the purpose of running a grist mill. The dam has been reconstructed and modified several times over the years to its present state which now holds a head of approximately 12 feet of water. The Pigeon Lake impoundment covers 165 acres and has an average depth of 4 feet. The bottom composition consists of soft sediments, also known as muck. On the following page a hydrographic map provides a detailed summary and location of the characteristics of Pigeon Lake.

The direct drainage basin (watershed) is approximately 33,640 acres consisting mainly of farmland with gentle to moderate sloping topography. The basin is drained by the North and South Branch of the Pigeon River, Brandy Creek, Hydes Creek, and several other small tributaries.

LAKE & TRIBUTARY ANALYSIS

The water quality of Pigeon Lake and its tributaries was sampled and tested in 1972 and 1977. Since a substantial quantity of data already existed for the lake and its major tributaries, the emphasis of the water sampling was to collect current data to compare to the data from previous studies and also to find out more information about the other minor tributaries entering Pigeon Lake. One lake sampling site was chosen along with seven tributary sites. The map below shows the sampling locations.



L1 - Pigeon Lake Sample located in the large lobe of the lake.

S1 - Brady Lake Inlet at culvert located on Old 45.

S2 - Brandy Creek at bridge located on Old 45.

S3 - S. Branch Pigeon River at bridge located on USH 45.

S4 - N. Branch Pigeon River at bridge located on Knitt Road.

S5 - Stream in Section 9, Town of Larrabee at bridge located on Knitt Road.

S6 - Stream inlet to Fairway Lake at culvert on Greentree Road.

S7 - Stream entering Pigeon Lake at the end of River Road.

Water Quality of Pigeon Lake

The water quality of a lake is categorized by its ability to produce plant life and its clarity. A lake that exhibits high plant growth and low clarity is considered a lake that has low water quality. The reason for high plant growth results from high phosphorus and nitrogen nutrient levels that are used by the plant life. Pigeon Lake is highly susceptible to nutrient inflow from the predominantly agricultural watershed and urban development of its shoreline.

Lakes samples were taken in the middle of the large lobe of the lake on April 9, May 23, June 27, July 31, and November 2 of 1996 by Northern Lake Service of Crandon, Wisconsin. A water sample was collected using a 6 foot by 2 inch PVC pre-cleaned and rinsed column sampler. The water from the column was then placed in a mixing container. From the mixing container, the water was poured into vials where pH and conductivity were measured on site. Additional vials were filled and transported to the lab in Crandon where the water was analyzed for chloride, nitrogen, and phosphorus. Additionally, the clarity of the water was measured using a secchi disc (20 cm in diameter) which was lowered to a depth until it was no longer visible.

To establish where Pigeon Lake is in terms of water quality, the results must be compared to a set of predefined standards. The following list of criteria shall be used in determination of the water quality of Pigeon Lake :

Water Quality Index	Total Phosphorus (mg/l)	Secchi Disc Depth (ft.)
Excellent	<0.001	>19.7
Very good	.001-.010	9.8-19.7
Good	.010-.030	6.6-9.8
Fair	.030-.050	4.9-6.6
Poor	.050-.150	3.3-4.9
Very Poor	>.150	<3.3

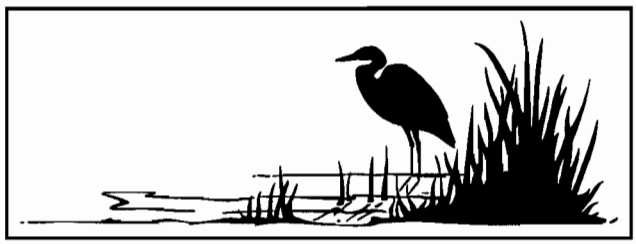
(Source: Lille, R. A., and Mason, J. W., 1983. Limnological Characteristics of Wisconsin Lakes. WDNR Technical Bulletin No. 138.)

The following table shows the phosphorus levels and the secchi disk depths from sampling on the large lobe of Pigeon Lake in 1996:

Date	Total Phosphorus (mg/l)	Secchi Depth (ft.)
April 9, 1996	0.095	no depth - ice on lake
May 23, 1996	0.079	3.7
June 27, 1996	0.120	2.8
July 31, 1996	0.100	2.1
November 2, 1996	0.077	2.4
Average	**0.094**	**2.8**

Using the Water Quality Index on the previous page, the average total phosphorus level is rated as poor water quality and the average secchi depth falls in the very poor category. The sampling results show that Pigeon Lake is very nutrient rich and it is no surprise that the lake is supporting a large weed population. The complete analytical results of the water sampling are provided in Appendix A at the back of this report.

The water quality of Pigeon Lake was also analyzed in 1972 resulting with an average total phosphorus level of 0.083 mg/l and an average secchi depth of 2.9 feet. In comparing these values to the 1996 data, the water quality of Pigeon Lake has not changed and is still considered poor.



Water Quality of Tributaries

The water quality of Pigeon Lake is a result of the incoming stream waters, storm sewer waters, and shoreline runoff waters. These waters transport the nutrients and sediment that settle out into Pigeon Lake causing nuisance weed growth and soft sediment buildup. If these waters can be made "cleaner", the water quality of Pigeon Lake will increase.

Stream sampling was conducted during two storm events on April 12 and May 20, 1996 to determine the quality of the water coming into Pigeon Lake. These spring storms provided favorable sampling conditions when runoff was presumed high in the watershed. Grab samples were taken in the middle of each stream or river with a sampling bottle. From the sampling bottle, separate vials were filled and sent to Northern Lakes Service for analysis of nitrogen, phosphorus and suspended solids. The following table shows the average nutrient and sediment levels for the two storm events at the seven locations:

Location	Average Nitrogen NO2 + NO3 (mg/l)	Average Total Phosphorus (mg/l)	Average Total Suspended Solids (mg/l)
S1	0.15	0.17	6.0
S2	0.26	0.19	23.5
S3	0.53	0.22	14.0
S4	0.78	0.08	8.5
S5	2.10	0.11	14.0
S6	0.28	0.20	14.0
S7	1.30	0.14	3.5

The results of the storm event sampling show that the tributaries have high levels of nitrogen and phosphorus. Phosphorus levels in particular are all above the poor water quality level given on the Water Quality Index Table previously shown on Page 5. The levels of total suspended solids were highest on Brandy Creek with high levels also recorded on the inlet to Fairway Lake, the stream at the end of River Road, and the South Branch of the Pigeon River.

Sediment Depths in Pigeon Lake

The depth of soft sediments (muck) is a result of solids being carried to the lake by the tributaries and the decay of plants that grow in the lake. The buildup of soft sediments decreases the water depth of the lake and hinders its recreational value. In the case of Pigeon Lake, the sedimentation process is of great concern because of the shallow water depth.

In 1977, the thicknesses of the soft sediments in Pigeon Lake were measured as part of the lake study performed by Northern Lake Service and are shown on the lake map on the following page. This data was extremely valuable for determining the rate of soft sediment buildup by comparing the 1977 values to the 1997 values.

In March of 1997, the thicknesses of soft sediments were measured by Nordin-Pedersen personnel in the 19 locations shown on the following page. The measurements were taken through the ice by lowering an 8 inch, white, PVC disk to the top of the soft sediment. This depth was recorded and then a 1 inch metal sounding rod was pushed into the sediment until refusal to record the bottom of the soft sediments. The difference of these depths is the thickness of the soft sediments. The table and graph on the following page compares the thicknesses measured for 1977 and 1997.

By comparing the two sets of data, the sediment thicknesses are increasing but at different rates depending on the location on the lake. The greatest increase was 4.5 feet on the northeast bay of Pigeon Lake that is referred to as Fairway Lake. Moreover, the southern finger bay along Old 45 also has substantially large increases of sediment. The average increase of soft sediment thickness throughout Pigeon Lake is 1.2 feet from 1977 to 1997. This twenty year average equates to approximately 3/4 of an inch per year of sediment buildup over the entire area of the lake.

The thicknesses measured can be considered somewhat subjective because different personnel and methods were used by the two different companies. However, the overall trend of the data indicates that sediment thicknesses are increasing which is resulting in shallower water depths.

Macrophyte (Weed) Survey

A macrophyte (weed) survey was conducted by Northern Lake Service, Inc. on July 31, 1996 to determine the condition of the aquatic plant growth and furthermore to make comparisons to the study performed in 1977. The complete macrophtye survey is provided in Appendix B at the end of this report. The baseline conclusions of the report are as follows:

1) Aquatic plant growth remains extensive and quite dense throughout Pigeon Lake.
2) The harvesting program seems to be keeping the problem in check to the point that recreation has been improved.
3) Most aquatic plant growth is less dense than it was 20 years ago.
4) Diversity and native species may be suffering from the harvesting program and/or the advance of exotic species.
5) Urban runoff, which is usually much easier and cheaper to control than agricultural runoff, has probably increased over the years.

C. demersum

L. minor

P. crispus

LAND USE INFORMATION

The water quality of Pigeon Lake is a direct result of the land use practices taking place within its watershed. The urban development near the shoreline and the predominant agricultural land use within the watershed "sets the stage" for runoff to occur into Pigeon Lake. The key for increasing the water quality of the lake is not to change the major land use within the watershed, but rather to implement best management practices that combat the runoff of nutrients and sediments into the waters. To take a closer look, information for both shoreline and watershed land use was gathered by reading maps, by collecting land conservation materials, and by advising with key individuals that have valuable knowledge of shoreline, agricultural, and conservation practices.

Shoreline Land Use

The shoreline of Pigeon Lake is approximately 90% developed into residential lots. There are 87 homes, 1 apartment complex, and 1 motel along the shore of the lake. The properties on the east side of the lake are in the City of Clintonville and properties on the west side are in the Town of Larrabee. The residents along the lake have constructed 52 docks which are used for a variety of water recreation activities. The public has access to the lake through Pickerel Point Park and 5 boat landings.

By observing the shoreline practices, the majority of the shoreline landscape is mowed lawns. The mowed areas adjacent to the lake provide easy thoroughfares for rainwater to runoff into the water. Contained in the water are lawn fertilizers (nitrogen and phosphorus) along with soil and grass sediments. These nutrients and sediments directly decrease the water quality of Pigeon Lake.

The best way to combat the sheet runoff of rainwater into the lake is by establishing a vegetative protection area. This area is made by leaving a strip of land unmowed (usually 20-60 feet in width) along the shoreline. Many areas retain remnants of a seed bank that will reestablish native vegetation if left undisturbed for a few seasons. Many native species have square, triangular or round stems (i.e. mint, sedge, and reed families) that remain erect during rainstorms and persist through the winter to slow spring runoff and trap sediment and associated nutrients. In comparison,

flat stemmed turf grasses bend during runoff and are much less effective sediment traps. For more information, the "Waupaca County Shoreland Protection Manual" is an excellent guide for developing and caring for waterfront property and may be obtained from the UW Cooperative Extension in Waupaca County at tel. (715)258-6230.

Waupaca County also has established Shoreland Zoning Ordinances for lakes, rivers, and streams that apply to all lands adjacent to navigable waterways. To obtain a copy of these ordinances, contact the Waupaca County Zoning Office at tel.(715)258-6255. A summary of the major provisions is given in the following two tables. Pigeon Lake is classed in the Group 3 Lakes category.

WAUPACA COUNTY SHORELAND ZONING REQUIREMENTS
SUMMARY OF MAJOR PROVISIONS
(see attached list of lake, river & stream classes)

Standard	Location	Group 1 Lakes	Group 2 Lakes	Group 3 Lakes	Rivers & Streams	Trout Streams
Min. lot size	7.2-5 p. 21-24	5 acres	2 acres	20,000 sq. ft.	40,000 sq. ft.	40,000 sq. ft.
Min. lot width & water frontage	7.2-5 p. 21-24	400 ft.	200 ft.	100 ft.	200 ft.	200 ft.
Shore setback [1]	7.2-5 p. 21-24	300 ft.	100 ft.	75 ft.	100 ft.	125 ft.
Shore setback averaging	5.4 p. 12	If an undeveloped lot is less than 150 ft. deep, the average of setbacks of existing principle structures on adjacent lots within 200 ft. may be used. However, a setback of at least 50 ft. is required.				
Wetland & drainageway setback	5.3 p. 12	25 ft.				
Side & rear yards	4.2 p. 11	Lots > 100 ft. wide = min. 10 ft. & total of 30 ft. Lots < 100 ft. wide = min. 7.5 ft. & total of 20 ft.				
Structures	4.3&4 p. 11	• No more than 1 dwelling may occupy a lot in single family residential district. • A principal structure must be constructed prior to or concurrent with any accessory structure.				
Vegetation protection area [2]	7.2-5 p. 21-24	Within 275 ft. from shore (OHWM)	Within 75 ft. from shore	Within 50 ft. from shore	Within 75 ft. from shore	Within 100 ft. from shore
Land disturbing activities	6.15 p. 14	Limited to 50% of lot or 25,000 sq. ft. whichever is less. A conditional use permit is required for most activities within 300 ft. of shore (OHWM).				
Impervious surfaces [3]	6.16 p. 14	Limited to 25% of lot or 10,000 sq. ft. whichever is less (total of all roofs, patios, walkways, paving, etc.).				
Shore protection structures (seawalls, riprap, sheet piling, etc.)	7.2-5 p. 21-24	All except bioengineered are prohibited.	All with state permit are allowed.			All except riprap & bioengineered are prohibited.
Boathouses	7.2-5 p. 21-24	New boathouses are prohibited. Existing boathouses (as of 6/5/97) are limited to ordinary maintenance & repair.				

Wetland protection	7.1 p. 16-21	In mapped shoreland and contiguous wetlands of 2 acres or more the following uses are permitted: open space uses, forestry, ag. drainage maintenance, fencing, piers & walkways, public highway maintenance, limited private road construction, limited development of natural & recreation areas, habitat improvement projects & limited utility & railroad construction. Other development requires a demonstration that listed significant public interest values do not exist in the wetland & that an alternative project site is not available. Map amendment process is required.
Planned residential unit development	3.2 p. 7-10	Custom tailored residential development guidelines provide an alternative to class standards for lot size & width. 50% density bonus. 40 acre min. parcel size. 50% dedicated open space required with multiple ownership options. Flexible design standards for roads, building envelopes & infrastructure. Authorized as a conditional use.
Nonconforming uses [4]	8.2 p. 24	No expension is permitted. If discontinued for 12 mos., future use must conform. Nuisances not permitted to continue.
Nonconforming structures [4]	8.3 p. 25	Accessory structures are limited to ordinary maintenance & repair. Principal structures: • 0-50 ft. from shore = internal improvement only • 50-75 ft. from shore = may expand by 50% of footprint or to total of 1500 sq. ft. whichever is less. • Mitigation is required (consult Mitigation Manual): - upgrade sanitary system - abandon minor nonconformities - restore shore buffer functions - control runoff - make visually inconspicuous • Limited conversion of seasonal residences permitted. Structures damaged in excess of 50% of fair market value must comply if rebuilt.
Nonconforming lots [4]	8.4 p. 27	Lots served by sanitary sewer - Single family dwelling permitted if: a) at least 7,500 sq. ft. in area & 50 ft. width & water frontage b) residential use permitted c) lot recorded prior to ordinance d) ownership separate from abutting lands e) compliance with all other requirements Lots not served by sanitary sewer - Single family dwelling permitted if: a) at least 10,000 sq. ft. in area & 65 ft. width & water frontage & b-e above, or b) at least 20,000 sq. ft. in area & 100 ft. water frontage & b,c & e above.

[1] Measured from the ordinary highwater mark (OHWM) to the nearest point of a building or structure.

[2] No vegetation removal or land disturbance except for pier or wharf construction, a walkway to access the shore, approved shoreline protection activities, removal of dead, diseased or dying trees which are a hazard & establishment of a 30 ft. wide view corridor by selective pruning and removal.

[3] Surfaces which do not permit water to infiltrate through the ground.

[4] Nonconforming uses, structures or lots are those which predate current regulations, were legal when constructed but do not comply with current requirements.

Watershed Land Use

The general land use in the watershed was determined by taking the United States Geological Survey Quadrangle Maps and dividing the watershed into 40 acre parcels. The parcels were then categorized into either agricultural, forested, swamps, or urban based on the majority land use within the 40 acre parcel. The number of parcels were counted in each group and a summary of the land uses in the Pigeon Lake Watershed is provided in the table below:

LAND USE	ACRES	PERCENT
Agricultural	23,548	70
Forested	4,710	14
Swamps	5,046	15
Urban	336	1
Total	33,640	100

Whenever rain falls or snow melts, runoff water washes over farm fields and city streets into the tributaries and storm sewers. This water eventually discharges into Pigeon Lake carrying soil, fertilizer, pesticides, bacteria, toxic compounds, and other pollutants. The poor water quality of Pigeon Lake is a direct result of these pollutants being added to the lake ecosystem over the years.

To combat runoff pollution, land management practices have been developed and proven to substantially decrease the transport of pollutants into receiving waters. Implementation of the following land management practices would be beneficial to the water quality in the Pigeon Lake watershed.

conservation tillage - A farming practice that leaves stalks or stems and roots intact in the field after harvest. Its purpose is to reduce water runoff and soil erosion compared to conventional tillage where the topsoil is mixed and turned over by a plow.

street cleaning - Streets and parking lots are cleaned by sweeping which removes large dust and dirt particles. Sweeping actually removes solids so pollutants do not reach receiving waters.

streamside buffer strips - Maintaining the natural vegetation along a stream, limiting livestock access to a stream, and where vegetation has been removed, planting strips of grass, trees and shrubs. Buffer strips act as a filter between the stream and an area being disturbed by human activity that protects the stream from erosion and nutrient impacts.

nutrient and pesticide management - Managing the application of fertilizer and pesticides on cropland to improve profitability and protect water quality. A nutrient/pest management plan is developed for farm fields by a consultant and approved by the Natural Resources Conservation Service (NRCS).

construction site erosion control - Installation of silt fence, straw bale barriers, vegetative cover, and other devices to prohibit transport of sediment from disturbed areas and spoil piles.

The Continuous Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP) have been developed to provide funding to offset the cost involved in implementing such practices. Information on these two programs is presented in Appendix C and sign up is at the Farm Service Agency in Waupaca at tel.(715)258-7162.

CONCLUSIONS BASED ON STUDIES & OBSERVATIONS

1.) The water quality of Pigeon Lake is classified as poor and has not changed drastically in the last twenty years. Phosphorus levels in the lake are on average 6 times higher than that needed to produce nuisance weed growth.

2.) Tributary phosphorus levels from storm event sampling are high in all seven locations with no real stand-out indicating that nutrient concentrations are relatively uniform in the watershed. Brandy Creek has the highest sediment levels with high levels also showing on the South Branch, the inlet to Fairway Lake, and the creek on the end of River Road.

3.) Sediment depths in the lake have increased an average of 1.2 feet in the past twenty years. Sediment carried from incoming storm sewers and streams along with the decomposition of weeds are the major reasons for this increase. The southeastern finger bay to Brady Lake and the northeastern finger bay to Fairway lake show large increases.

4.) The weed survey showed that aquatic plant growth remains extensive and quite dense throughout the lake. The harvesting program is keeping the weed problem in check to the point that recreation has been improved compared to 1977. Most aquatic growth is less dense than it was 20 years ago. Diversity and native species may be suffering from the harvesting program and/or the advance of exotic species.

5) Since 1977, the shoreline has been developed in several areas. This urban development without the use of vegetative protection areas between the shore and mowed lawns/disturbed areas creates nutrient/sediment loading from runoff.

6) The land use in the watershed has undergone little change with the majority use being open/agricultural. Storm events are causing nutrients and sediments to runoff into tributaries which are then transported to the lake system. Since 1977, agricultural practices have been improved through programs and awareness of the effect of runoff on surface receiving waters.

7) Procedures for decreasing urban and agricultural runoff have been developed and are called "Best Management Practices". The implementation of these practices by volunteer efforts and local, state, and federal programs is the best avenue to improving the water quality of Pigeon Lake.

MANAGEMENT RECOMMENDATIONS

1.) To combat the nuisance weed growth, continue harvesting as desired for recreational purposes. The areas where tributaries enter the lake should not be harvested to filter the inflowing water. After the fish survey has been completed in 1998, develop a weed harvesting plan to avoid spawning and high fish population areas.

2.) Purchase a manual weed cutting device for weed cutting along the shoreline. The device could be used by any PLPRD member. Consider hiring adolescents in the summer to help with the weed cutting for shoreline residents.

3.) Redefine the Pigeon Lake Protection and Rehabilitation District to include every property within the watershed regardless of the land use or the location to streams or the lake.

4.) To help create and maintain interest, distribute a semi-annual newsletter to district members or place it in the local newspaper to provide information of current happenings and ideas of the PLPRD.

Urban Recommendations

5.) To combat the sediment transport from urban streets, request that the city frequently clean streets that have storm sewers which discharge into Pigeon Lake. Also request that the City decrease the use of sand/salt on these streets and to clean these streets first in the spring. Consider funding extra street cleaning on streets with storm sewers that discharge into Pigeon Lake.

6.) Contact the Tomorrow Valley Co-Op to mix a low-phosphorus fertilizer mixture for lawns and call it the "Pigeon Lake Blend". The district could contact the riparian property owners to promote use of this blend to help the water quality of Pigeon Lake. Also encourage all City of Clintonville residents to use this blend. Advertise the fertilizer by using signs in the local co-ops and department stores.

7.) Hold lawn fertility meetings through a cooperative effort between the UW Agricultural Extension Office in Waupaca and the PLPRD for all residents interested in lawn care.

8.) Start a Pigeon Lake shoreline program that would encourage construction of a vegetative protection area between the shoreline and the mowed lawn area. Consider purchasing and distributing the "Waupaca County Shoreland Protection Manual" to shoreline residents. A vegetative protection area plan could be submitted to the district and when approved the shoreline owner would receive a flat rate payment for implementation of a protection area project.

9.) Discourage feeding waterfowl on the shoreline because it adds nutrients to the lake.

10.) Request the City of Clintonville to adopt the Waupaca County Shoreland Zoning Ordinances.

Watershed Recommendations

11.) Request in writing to the Waupaca County Land & Conservation Committee to form a proposal to obtain funding through the USDA Environmental Quality Incentives Program (EQIP) for the Pigeon Lake Watershed. This funding would provide technical, financial and educational assistance to help farmers in the watershed establish conservation practices that protect soil, water, and other natural resources.

12.) Contact the local USDA Farm Service Agency office for the possibility of providing additional funding to the rental rates of the Continuous Conservation Reserve Program (CRP). This additional funding would provide extra incentive for sign-up in this conservation program in the Pigeon Lake Watershed.

13.) Implement a stream/river bank erosion program. A qualified individual through the Waupaca County Land & Conservation Department could be hired to inventory the stream and river banks in the watershed which would identify areas of high erosion. The PLPRD could riprap these stream or river banks to stop the erosion and subsequent transport of sediment into Pigeon Lake.

14.) Contact the UW Agricultural Extension Office in Waupaca County for information on the Monsanto High School Vo-Ag Program. This Monsanto Program works with a local Future Farmers of America (FFA)Chapter by donating $100 to the chapter for sign-up of a riparian buffer strip implemented along a stream bank in an agricultural field. The FFA chapter can have up to 5 sign-ups in one year through the Monsanto Program. The PLPRD could consider donating a number of the same $100 sign-ups within the Pigeon Lake Watershed.

Macrophyte Survey of

Pigeon Lake, Waupaca County

July 31 1996

Prepared by:

Northern Lake Service, Inc.

400 North Lake Avenue

Crandon, Wisconsin 54520

INTRODUCTION

On July 31, 1996 a general macrophyte survey was performed on Pigeon Lake in Waupaca County, WI. The survey methodology and site map were the same as those used in 1977, so comparisons to that earlier study could be made. The site map is contained in this report. This survey is a portion of a management study currently being performed for the Pigeon Lake Association by Nordin Pedersen of Shawano, WI and Northern Lake Service of Crandon, WI.

METHODOLOGY

As stated above, the site map used for this survey was developed as part of an earlier study. Sample sites represent intersection points on a grid superimposed on a lake map. This grid contains 78 points.

Once on the lake, the map, a compass and visual estimations are used to locate each site.

At each site a 10 feet circle is visualized and divided into quadrants. Macrophytes (plants) from within that circle are collected and identified and ranked as follows: 1 if present in one quadrant; 2 if present in two quadrants; etc. If a species occupies the entire water column at a station it is given a rank of

5. A "p" is used to indicate that a species has been noted in the lake but does not fall into a specific sample station. Species receiving only this designation are not considered when relative frequency, and average density are calculated, but are included on the species list.

Specimens that cannot be identified to species are referred to by the generic name followed by "sp". ("spp" indicates more than one unidentified species within the same genus.)

Water depth, depth to vegetation, percent open water and bottom type (if depth permits) are also recorded at each station.

FINDINGS

Seventeen different taxa of aquatic plants were collected during this survey. These were represented by 10 submerged species, 6 floating-leaf species and an emergent.

Submergents

The species list was quite similar to that generated from the 1977 study, although there seems to be a slight loss of diversity since then.

The predominant submergent remains *Ceratophyllum demersum* or coontail, but it was much less common than in 1977. In 1977 it was

present at nearly all sample station at an average density of 4.0. In 1996 it was collected at 47 stations (60%) at an average density of only 2.6.

Two of the next three most common submerged species in 1977 were not collected at all in 1996. These are *Potamogeton praelongus* or white-stem pondweed which was present at over half the stations and *Myriophyllum exalbescens* a native water milfoil. *Potamogeton zosterformis* or flat-stem pondweed was present at half the sample station in 1977 but only 11% in 1996.

Heteranthera dubia (water stargrass) and *Potamogeton nodosus* (American pondweed) which were collected at 11 and 9% of the sample stations respectively in 1977 were not collected during this survey.

Two submerged species have made rather dramatic increases in relative frequency. *Elodea canadensis* or american waterweed increased from 17% to 35% and *Potamogeton crispus* or curly-leaf pondweed, a noxious exotic increased from 11% to 36%.

Myriophyllum spicatum or Eurasian water milfoil which often exhibits rapid population explosions has remained quite stable over the last 20 years.

Most average densities are similar to those recorded during the earlier study.

Floating-leaf vegetation

The 1977 macrophyte reports that "a severe bloom of duckweed and watermeal formed a thick mat over at least 60% of the total lake in June but this coverage had declined to about 40% by August." While these plants are still predominant, the density of the coverage seems to be decreasing. *Lemna minor* was present at 70 stations but at an average density of 1.9 compared to 3.9 in 1977. *Wolffia* dropped from 4.1 to 1.5 and *Spirodella* from 2.8 to 1.4. (This last species, known as giant duckweed, was much more common this time than in 1977.) At lower densities these tiny plants do very little to hamper recreation.

Field sheets are used to record the "percentage open water" were there is vegetation at the surface or "depth to vegetation" where vegetation does not reach the surface. This does not paint the full picture however. Where duckweed was present in low densities and submerged vegetation was well below the surface the recreational value and general "usability" of Pigeon Lake has been improved significantly. This is the case in much of the central channel where harvesting is occurring. Unfortunately, in a system as productive as this it is a battle that will not be won and possibly may not improve the lake any more than it has.

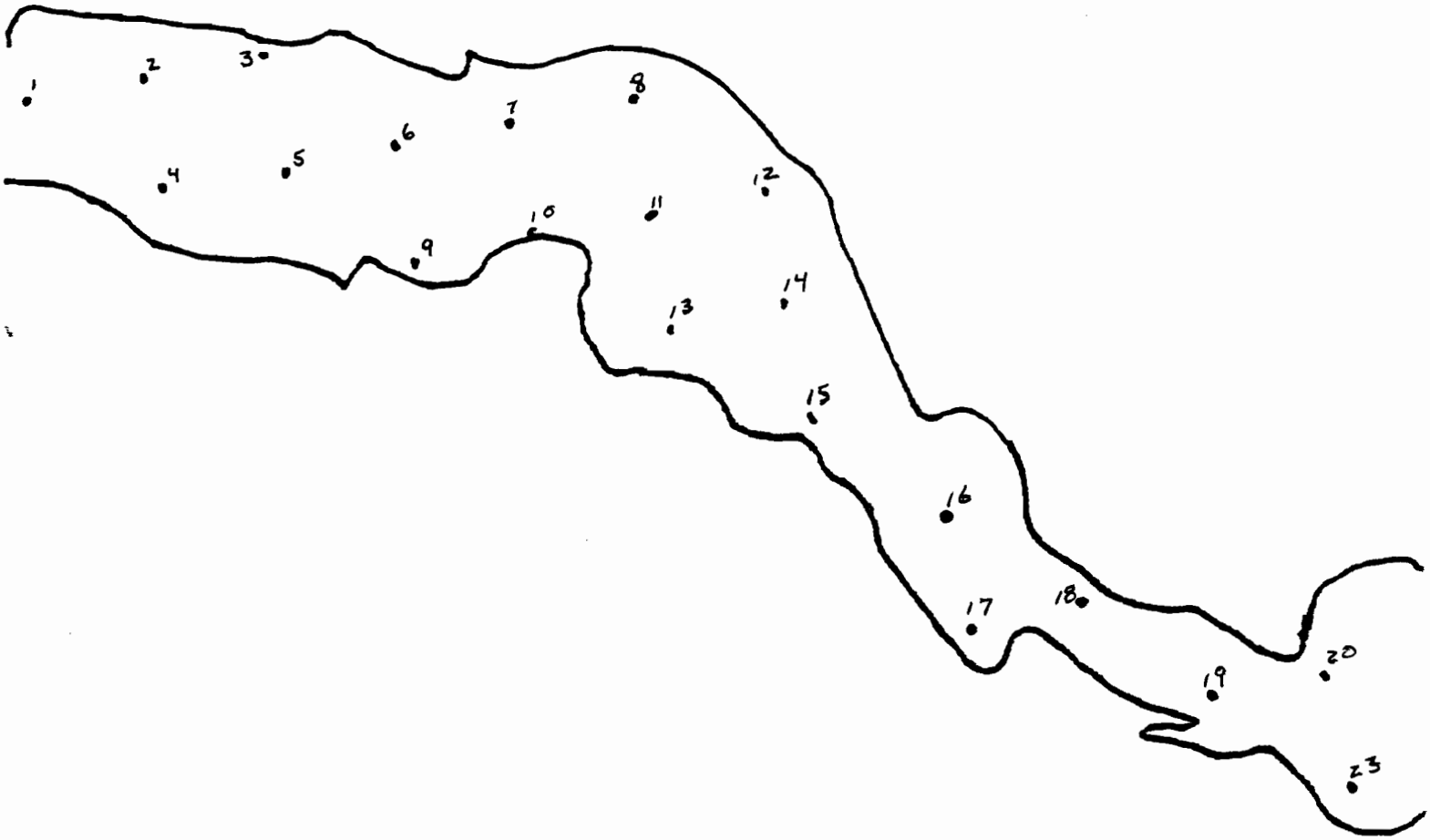
Where harvesting can not be done the situation has probably not improved over the last twenty years. While the agricultural

nutrient load from the river may have been targeted and decreased to some extent, the urban load to the lake directly has probably increased through development in several areas. This effect, if it is occurring, would be most prominent in the two finger bays toward the east end of the lake.

CONCLUSIONS

It is important to remember that aquatic plant populations can be very dynamic from one year to the next, therefore it is difficult to make "apples to apples" comparisons. However, based solely on the information gathered in 1977 and again in 1996 the following appears to be occurring:

1. Aquatic plant growth remains extensive and quite dense throughout Pigeon Lake.
2. The harvesting program seems to be keeping the problem in check to the point that recreation has been improved.
3. Most aquatic growth is less dense than it was 20 years ago.
4. Diversity and native species may be suffering from the harvesting program and/or the advance of exotic species.
5. Urban runoff, which is usually much easier and cheaper to control the agricultural loading, has probably increased over the years.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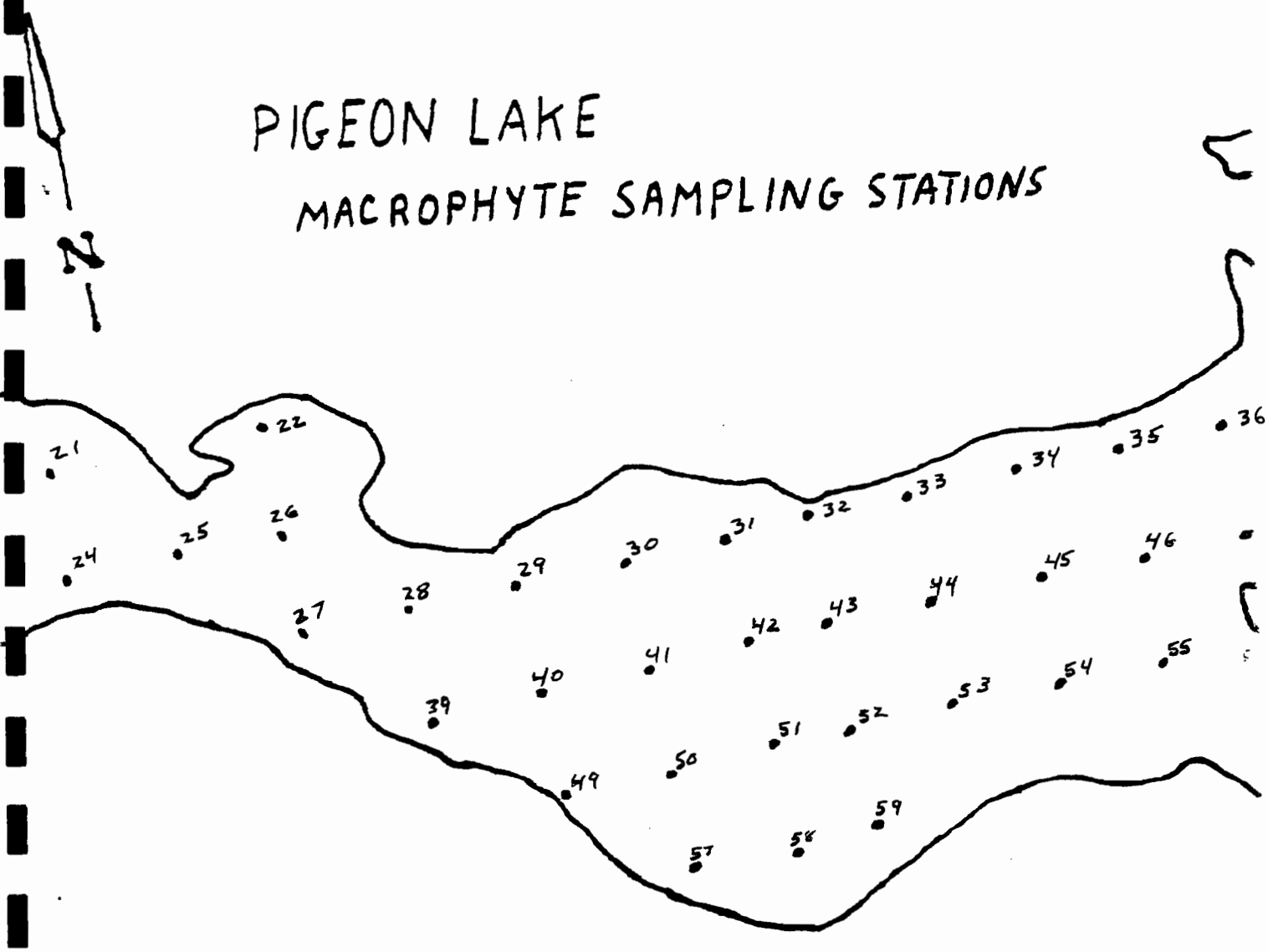
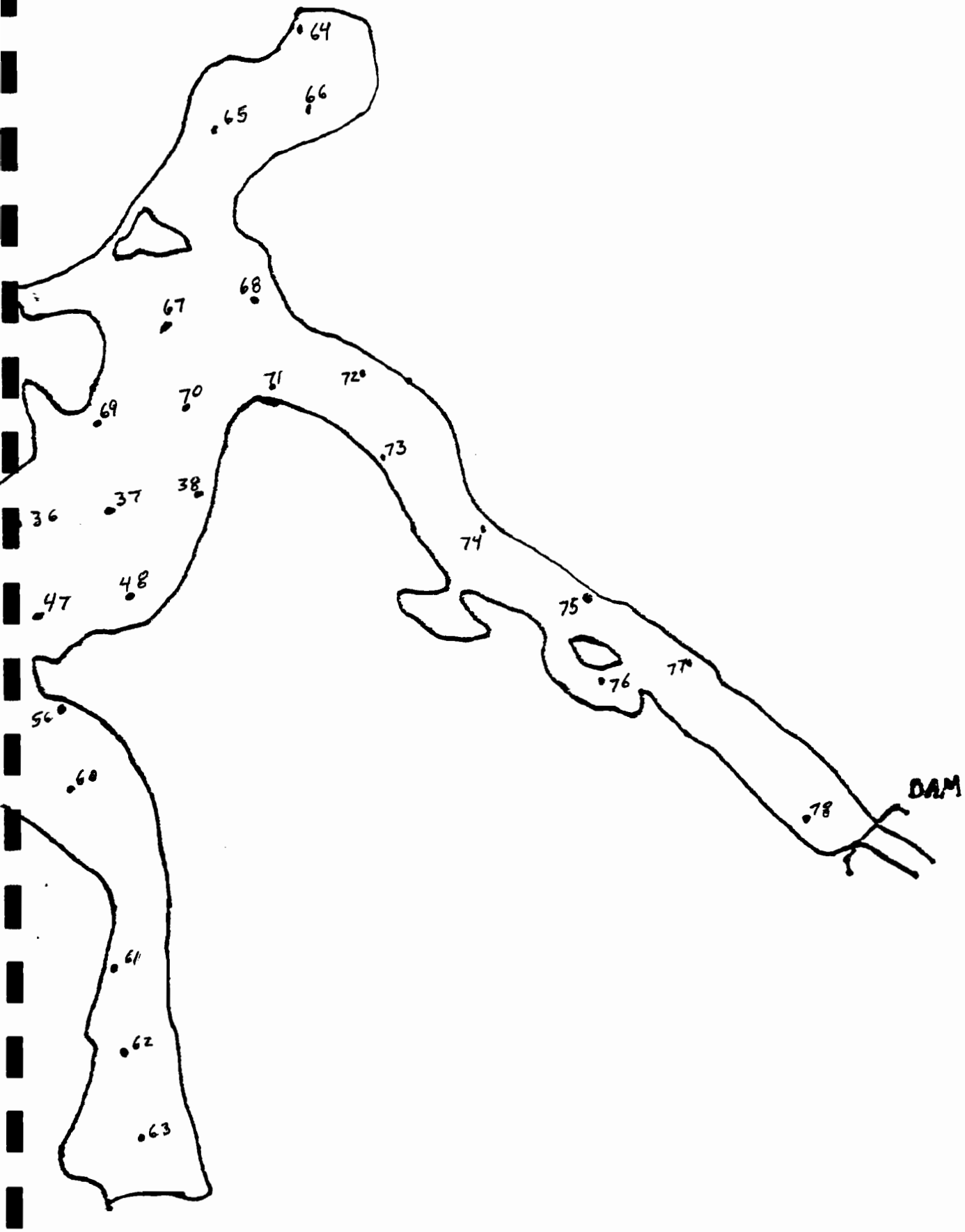
PIGEON LAKE

MACROPHYTE SAMPLING STATIONS

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PIGEON LAKE MACROPHYTE SPECIES LIST

Species (common name)	Relative Frequency (%)	Average Density	Depth of Growth (ft.)
Ceratophyllum demersum (coontail)	60.3	2.6	2 - 9
Elodea canadensis (American elodea)	34.6	2.5	2 - 7
Lemna minor (small duckweed)	88.5	1.9	-
Lemna trisulca (star duckweed)	12.8	1.0	-
Myriophyllum spicatum (Eurasian water milfoil)	9.0	1.1	4.5 - 6.5
Nitella (nitella)	19.2	2.8	4 - 7
Nuphar variegatum (yellow pond lily, spatterdock)	1.3	1.0	2.5
Nymphaea tuberosa (white water lily)	12.8	2.4	2 - 3.5
Potamogeten amplifolious (large-leaf pondweed)	1.3	2.0	3.5
P. crispus (curly-leaf pondweed)	35.9	2.5	2 - 7
P. pectinatus (Sago pondweed)	7.7	1.5	2 - 2.5
P. zosteriformes (flatstem pondweed)	10.3	1.6	2 - 7
Ranunculus longirostris (water crowfoot)	1.3	2.0	2.5
Spirodella polyrhiza (giant duckweed)	30.8	1.4	-
Typha latifolia (cattail)	p		

Vallisneria americana (eelgrass, wild celery)	10.3	2.4	3.5 - 6.5
Wolffia columbiana (watermeal)	56.4	1.5	-

Note: p=present, but not found at any numbered station.

SPECIES GLOSSARY

Ceratophyllum demersum - Coontail; leaves 1 - 3.5 cm long, whorled on stems, palmately divided and serrated on one side; leaves crowded at tips of stems giving "coontail" effect.

Elodea canadensis - American elodea; leaves 1-2 cm long by 1.5-3 mm whorled on stems in groups of 3's or 4's; whorls about 0.5-1 cm apart; stem thin, light colored and brittle; flowers, with extremely thin white petiole, float on surface.

Lemna minor - Lesser Duckweed; consists of only small floating leaf with tiny white root. Leaf ≈ 3 mm diameter.

Lemna trisulca - Star Duckweed; small (≈ 7 mm) spatula-shaped segment connected to one another by "stalk" portion; each segment with one tiny root; plants often form large, tangled, sinking mats.

Myriophyllum spicatum - Eurasian milfoil, more branching than other members of this genus, leaves drooping, each with more than 11 pairs of leaflets.

Nitella sp. - Large limp algae; dark green, almost transparent; "leaves" whorled on stems, with forked tips.

Nuphar variegatum - Yellow pond lily, spatterdock; leaves large (to 50 cm) oval, basal lobes <u>rounded</u>; stem stout, attached to leaf between basal lobes; flowers large (to 10 cm), yellow spherical.

Nymphaea odorata - White water lily; leaves large (to 40 cm) nearly circular; basal lobes <u>pointed</u>; stem stout attached to leaf between basal lobes; flower large (to 20 cm) with 25-50 waxy white petals surrounding yellow center.

Potamogeton americanus - Submerged and floating leaves similar, 8-15 cm long, tapering at both ends,with long petioles (to 20cm.) floating leaves thicker, stems with few branches; stipules thick, 5-10 cm.

Potamogeten amplifolius - Large-leaf pondweed; leaves to 20 cm,

folded along midrib and recurved (banana-shaped); plants often turning brown; flowers on dense spike (to 8 cm) held above the water; stipules rigid, persistent (to 4 cm); often with elliptical floating leaves.

P. crispus - Curly leaf pondweed; leaves ≈ 10 cm x 1 cm, crispy with rounded tips and wavy, serrated margins; stems brittle and slightly flattened.

P. pectinatus - Sago pondweed; leaves all submerged coarsely thread-like, with sharp tips, to 10 cm; stipules ≈ 2 cm attached to leaves for half their length; stem much-branched; fruits in interrupted spikes; plants appear fan-like in the water.

P. zosteriformis - Flat-stem pondweed; leaves linear to 20 cm x 5 mm; stem to 5 mm wide, strongly flattened slightly winged, limp; stipules to 3 cm; peduncle to 5 cm often curved.

Ranunculus longirostris - white water buttercup or crowfoot; leaves finely dissected; petiole absent or very short with clasping sheath at base; flowers 1-2 cm wide with white pedals surrounding yellow center.

Spirodella polyrhiza - Duckweed; tiny floating plant consisting of oval leaves about 3 - 10 mm with many whitish roots hanging from aech leaf. Leaves are usually green on top and reddish underneath.

Typha latifolia - Cattail; leaves sword-like to 2 m, stiff; stem to 3 m stiff, erect; flowers tiny crowed into large (to 20 x 5 cm) cigar-like spike.

Vallisneria americana - Eel grass, wild celery; leaves ribbon-like to 1 m x ≈ 1.5 cm wide; flowers, white ≈ 1 cm, floating on long, slender, spirally stem.

Wolfia columbiana - Watermeal: Tiny floating plant consisting of only a green bean-shaped leaf.

(These definitions have been written with regard to the species and variations of species found in Pigeon Lake, Waupaca County. It should not be relied upon as a key, especially on other lakes.)

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Fassett, Norman C., A Manual of Aquatic Plants, 1957, Revision appendix by Eugene C. Ogden, pp. 405, University of Wisconsin Press, Madison.

Lopinot, Alvin C. and Glen S. Winterringer, Aquatic Plants of Illinois, 1966, pp. 140, Department of Registration and Education, Illinois State Museum Division and Department of Conservation, Division of Fisheries.

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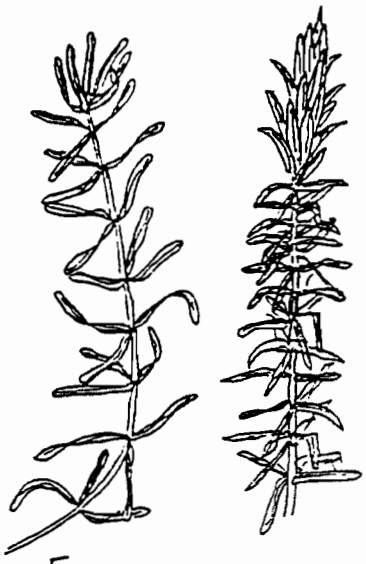
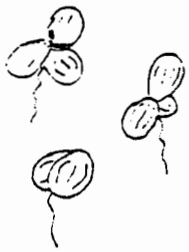
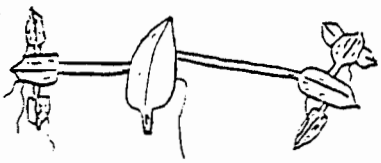
C. demersum



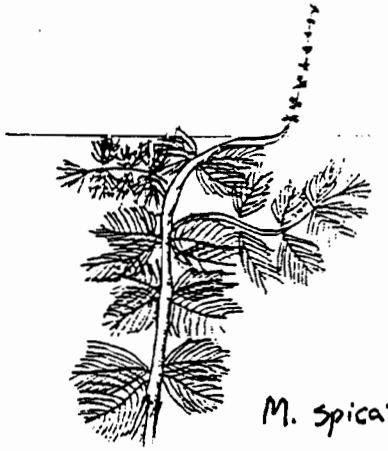
E. americana



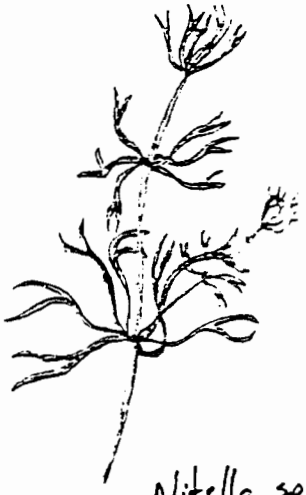
L. minor



L. trisulca

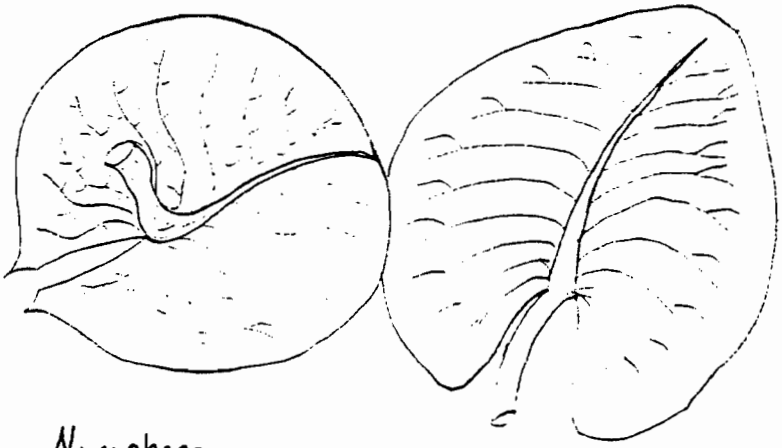


M. spicatum



Nitella sp.

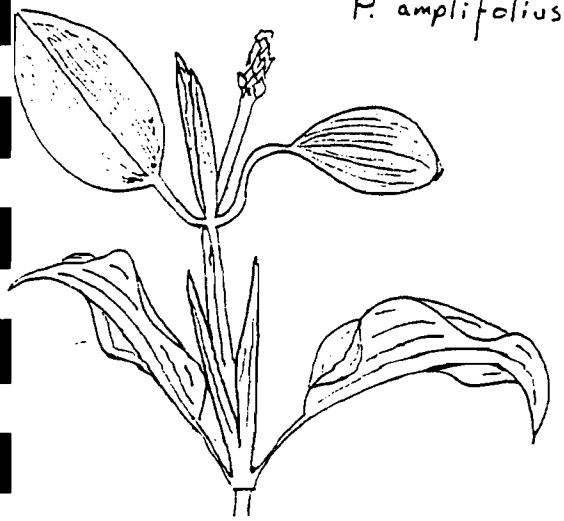
Underside of Leaves



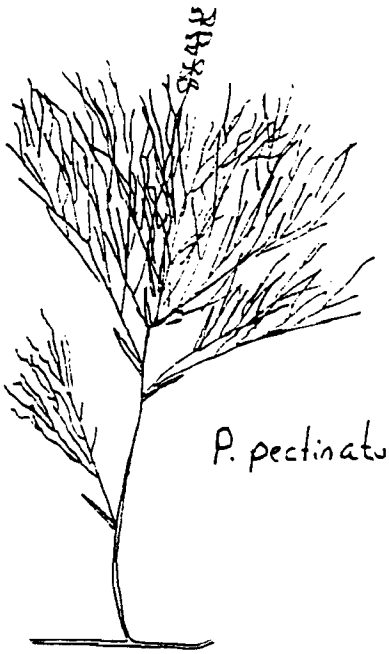
Nymphaea

Nuphar

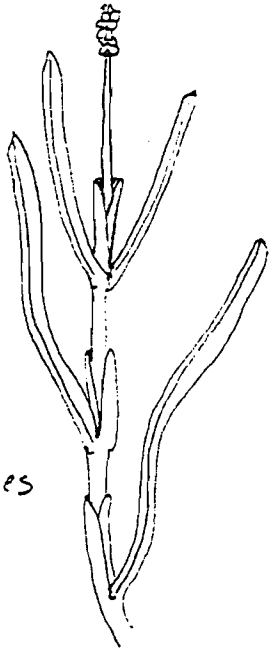
P. amplifolius



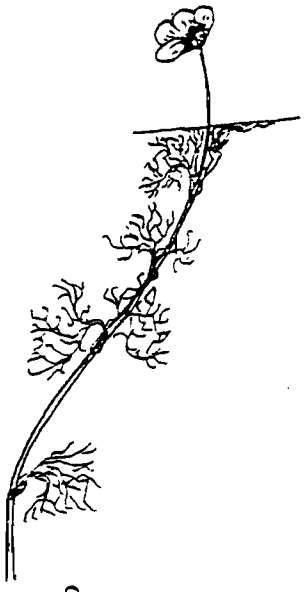
P. crispus



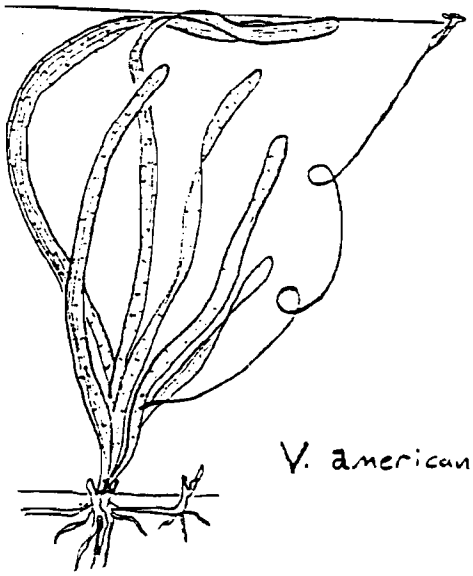
P. pectinatus



P. zosterformes

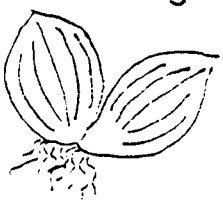


R. longirostris



V. americana

S. polyrhiza



W. columbiana