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A.T. Smithson: *Passages*, **1992**

Lake Management Plan for VanVliet Lake, Vilas County, Wisconsin

June 2005
Updated April 2006

Prepared by Steve McComas, Blue Water Science
with contributions from Wisconsin Department of Natural Resources
and the VanVliet Lake Association

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Lake Management Plan for VanVliet Lake, Vilas County Wisconsin

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VILAS COUNTY, WISCONSIN

Summary of the Lake Management Study

Field Work: 2004 **Report: Summer 2005**

VanVliet Lake Management Program Formulated

Natural Conditions Rated as Good

AQUATIC PLANT PROJECTS COULD BE CONSIDERED

VanVliet Lake is located in Vilas County, Wisconsin. VanVliet Lake is 220 acres in size, has an average depth of 9 feet and a maximum depth of 20 feet.

A lake study was conducted in 2004 with two primary objectives.

* to characterize existing lake conditions.
* to develop a lake management plan that protects, maintains, and enhances VanVliet Lake' water quality.

Results found that lake summer water clarity conditions of about 10 feet were slightly better than expected compared to reference lakes in the area (see page 3 for more information).

Phosphorus is the typical nutrient that has the biggest influence in algae growth. Phosphorus levels on VanVliet Lake were on the low side at 18 parts per billion. This accounts for low algae growth and good water clarity that is found in VanVliet.

VanVliet Lake, Vilas County, Wisconsin

Aquatic plants were also studied in 2004. When the plant survey results of 2004 are combined with other plant data collected in years past, an aquatic plant picture emerges.

VanVliet Lake was found to have a good diversity of plants with at least 17 plant species. Two common plants are elodea and fern pondweed, both native species. Broadleaf pondweed is found along the western side of the lake, where it grows to the water surface. A potential project to consider is cutting boat cruising lanes through the broadleaf pondweed.

VanVliet Lake Statistics

VanVliet Lake

Lake size (acre):	220
Mean depth (feet):	9
Maximum depth (feet):	20
Volume (acre-feet):	1,980
Watershed area (acre): (not including the lake)	1,370
Watershed : Lake surface ratio	7
Clarity in 2004 (feet):	10.8
Lake phosphorus in 2004 (parts per billion)	18

This special newsletter was prepared by Blue Water Science, St. Paul, Minnesota and is part of a lake management program conducted on VanVliet Lake. The program was funded by a grant from the Wisconsin DNR with volunteer assistance from the VanVliet Lake Association.

Summary of Lake and Watershed Conditions

Geology and Soils
VanVliet Lake is a glacial lake formed during the last retreat of the Wisconsin Valley glacial lobe starting about 10,000 years ago. The soils deposited by the glacier are primarily sands and loamy sands.

Watershed Characteristics
The watershed area draining to VanVliet (not including the lake) is 1,370 acres. Land use is primarily forests and wetlands, with residential use accounting for a small percent of the total watershed area.

Water Inflows and Outflows
The water inflow to VanVliet is from temporary streams and groundwater springs. The outflow is through Averill Lake and into Presque Isle Lake and out through Presque Isle Creek.

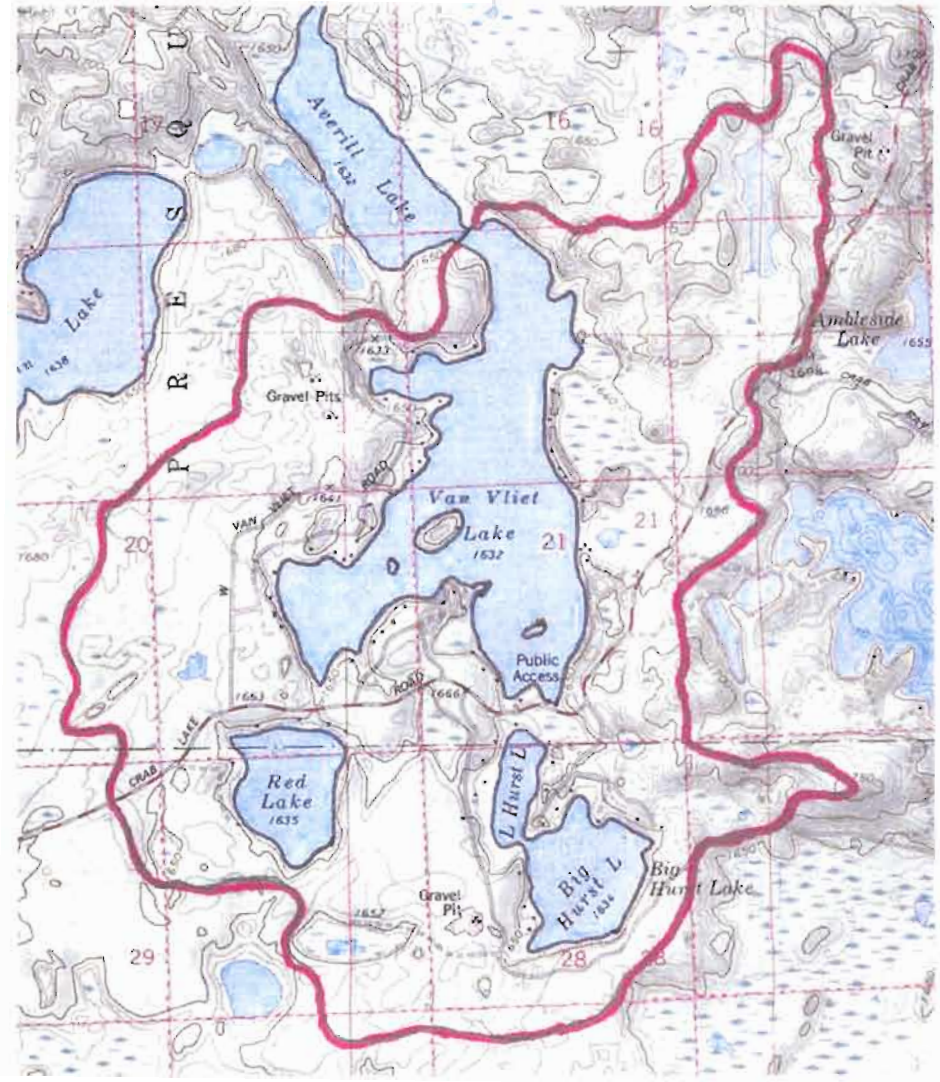
Lake Dissolved Oxygen & Temperature
VanVliet Lake thermally stratifies during the summer but weakly. This means that wind action will mix the upper lake water only during the summer. Oxygen concentrations may fall in the bottom water and become temporarily depleted in the bottom of the lake.

Lake Clarity
Lake water clarity in VanVliet Lake is good with a summer average around 10 feet.

Lake Nutrients
Phosphorus concentrations in VanVliet Lake are better then predicted when compared to other lakes in the Northern Lakes and Forest ecoregion. A growing season phosphorus average for 2004 for VanVliet Lake is 18 ppb. A predicted phosphorus concentration using ecoregion values is higher at about 24 ppb.

Lake Algae
VanVliet Lake has algae species that are common to lakes in this part of the state.

Lake Aquatic Plants
There is good coverage of submerged aquatic plants covering about 73% of the lake bottom (160 acres). Plants are beneficial as a filter for nutrients and as fish and wildlife habitat. Aquatic plant diversity is good with 17 submerged or floatingleaf plant species identified in VanVliet Lake.



The watershed drainage area to VanVliet Lake is about 1,370 acres and is outlined in red.

What is a watershed?

A watershed is the land area around the lake that captures rainfall and where all the drainage and runoff goes into the lake. It is also called a drainage basin. If the watershed has pollution sources, then the pollution will be carried into the lake with runoff. It is important to reduce the source of pollution in the watershed because this in turn will reduce the amount of pollution that gets into the lake.

Lake Assessment

Water quality of VanVliet is within range of lakes found in the Lakes and Forests Ecoregion. Water quality parameters consisted of transparency readings, phosphorus, and chlorophyll.

Lake water quality in VanVliet is about what would be expected based on it's watershed size and the ecoregion setting.

Lake management efforts should be directed to protect the existing good water quality.

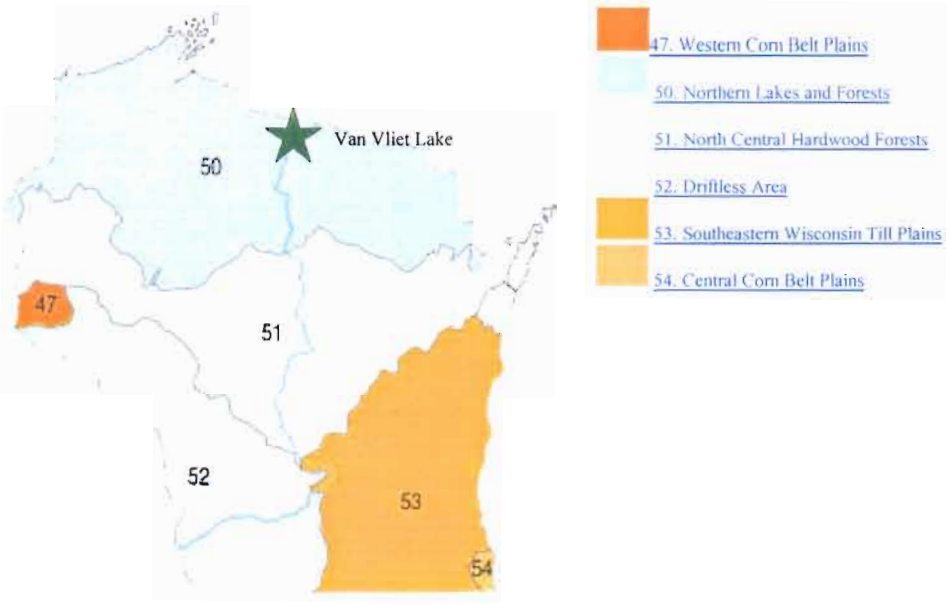
Native aquatic plants are diverse but two species present some navigational problems. In the shallow southwest bay, fern pondweed is found close to the surface or floating. In a channel along the west side, broadleaf pondweed grows to the surface and can restrict some types of navigation.

Ecoregions of Wisconsin

Revised April 2000

National Health and Environmental Effects Research Laboratory

U.S. Environmental Protection Agency



VanVliet Lake is located in the Northern Lakes and Forest Ecoregion. Lakes in this ecoergion have some of the best water quality n the state.

Recommended Lake Management Projects

1. Watershed projects - forests and wetlands

Maintain a photolog of typical forest and wetland areas to serve as a benchmark for future reference. Continue to take action to protect the VanVliet hemlock forest stands in the northern part of the watershed.

2. On-site system maintenance

On-site wastewater treatment systems operate satisfactorily when they are properly installed and maintained. Several activities can be implemented to assist in proper operation of the system. These activities include workshops, septic tank pumping campaigns, and ordinance implementation. However, much of the education can be conveyed through Lake Association newsletters.

There is little evidence of failing onsite systems based on shoreland setback distances and the conductivity survey. An option would be to contract with the County to randomly select 10% of the systems around the lake and conduct an onsite inspection and publish the results in a newsletter.

3. Shoreland protection and enhancement (landscaping projects)

VanVliet Lake has stretches of natural shoreline conditions but vegetative buffers and natural conditions could be improved along some of the developed parcels. The challenge is to protect the existing natural conditions and to enhance shorelands that lack native vegetative buffers. A volunteer lakescaping program should be implemented. Initially work with the UW Extension or a Planning Grant consultant to set up a VanVliet Lake Shoreland model describing how to design, install, and maintain a natural shoreland. Publish it in the lake's newsletter.

4. Aquatic plant projects

Based on the aquatic plant survey results from 2004, fern pondweed, a native aquatic plants may produce some navigational restrictions in the southwest bay. Along the western shoreline of VanVliet Lake, broadleaf pondweed grows to the water surface and may hinder boating activities.

In the southwest bay, fern pondweed is found either floating at the surface or weakly anchored in the soft sediment and extending into the water column. Because the bay is only 2 to 3 feet deep, it does not take much plant material to produce nuisance conditions.

Recommended Lake Management Projects-concluded

It appears that fern pondweed conditions in early summer are probably influenced by ice effects. In the shallow bay, ice typically reaches to the lake bottom and may entrain pondweed into the ice. When the ice goes out, some fern pondweed is brought to the surface and floats for a while although it eventually sinks.

However, later in the summer, normal growth of fern pondweed occurs and because the bay is only 2 to 3 feet deep, even average plant growth can result in plants reaching the water surface.

If plant management is considered, a mechanical harvester is recommended because it will pick up the plant material. However, because of the soft sediment, there will be come sediment resuspension and a turbid condition will persist for a few days after harvesting is completed.

Along the western shore of VanVliet broadleaf pondweed, a desirable aquatic plant can grow to the surface. A mechanical harvester could be contracted to create navigational channels to allow boat passage. Estimated cost of hiring the harvester for two days is about $2,000.

5. Fish Management Options

VanVliet Lake is a part of the Presque Isle Chain, which includes Presque Isle, Averill, and VanVliet Lakes. All three lakes are managed as a group. Boom shocking surveys indicate natural walleye reproduction is occurring in the chain and walleye stocking is probably unnecessary. Currently the plan by the WDNR is to stock muskies at one fish per two lake acres on odd numbered years.

One fishing tournament per year, usually over a weekend, is held on the chain. Fishing pressure and impacts are not considered to be excessive by the WDNR.

6. Ongoing education program

The Lake Association's newsletter should be an ongoing instrument to provide lake protection information. Abundant material is available from the WDNR on the internet and from a variety of books, including the book "Lake and Pond Management Guidebook" written by Steve McComas. This material can be inserted into newsletters.

A variety of educational opportunities are available that go beyond newsletter articles. Lake fairs and demonstration projects could be useful for advancing lake information. A good time for special events is in conjunction with the annual meeting.

7. Watershed and lake monitoring program

Ongoing lake testing should include: Secchi disk, total phosphorus, and chlorophyll a. Testing once per month from May through September is adequate to characterize lake conditions. Sampling twice per month would be better. An aquatic plant survey should be conducted every three to four years. The level of effort for a monitoring program depends on the availability of volunteers and funding levels.

In addition, winter dissolved oxygen levels could be collected to check for potential winterkill conditions caused by a lack of dissolved oxygen.

A mechanical harvester could be used to create cruising lanes through several areas of dense growth in VanVliet Lake.

1. Introduction and Project Setting

VanVliet Lake is located in Vilas County, Wisconsin (Figure 1). VanVliet Lake characteristics are shown in Table 1.

The objectives of this study were to characterize existing lake conditions and to make recommendations to protect and improve the lake environment where feasible.

Table 1. Lake statistics (WDNR 1995).

	VanVliet Lake
Size (acres)	220
Mean depth (ft)	9 estimated
Maximum depth (ft)	20

Figure 1. VanVliet Lake is located in Vilas County, Wisconsin.

2. Glaciers and Soils

VanVliet Lake was formed approximately 10,000 years ago during the last glacial retreat of the Wisconsin Valley Lobe (Figure 2). The soils deposited by the Wisconsin Valley Lobe glacier were primarily sands and loamy-sands. Beneath these soils, at depths of about 50-350 feet, is Precambrian bedrock that is over one billion years old. The bedrock is referred to as the North American shield.

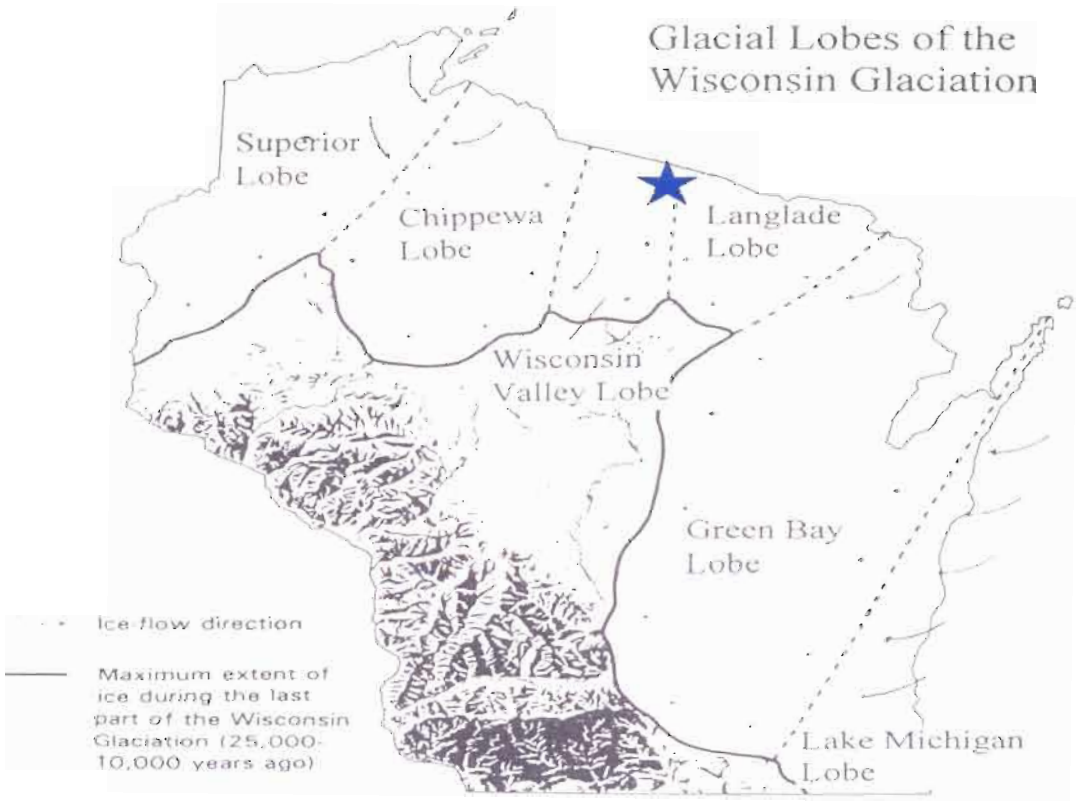


Figure 2. Glacial lobes of the Wisconsin glaciation. VanVliet Lake is located in the Wisconsin Valley lobe.

Soil composition reflects the parent material that is present. VanVliet Lake is located in an area dominated by forested silty soils and adjacent to forested loamy soils (Figure 3).

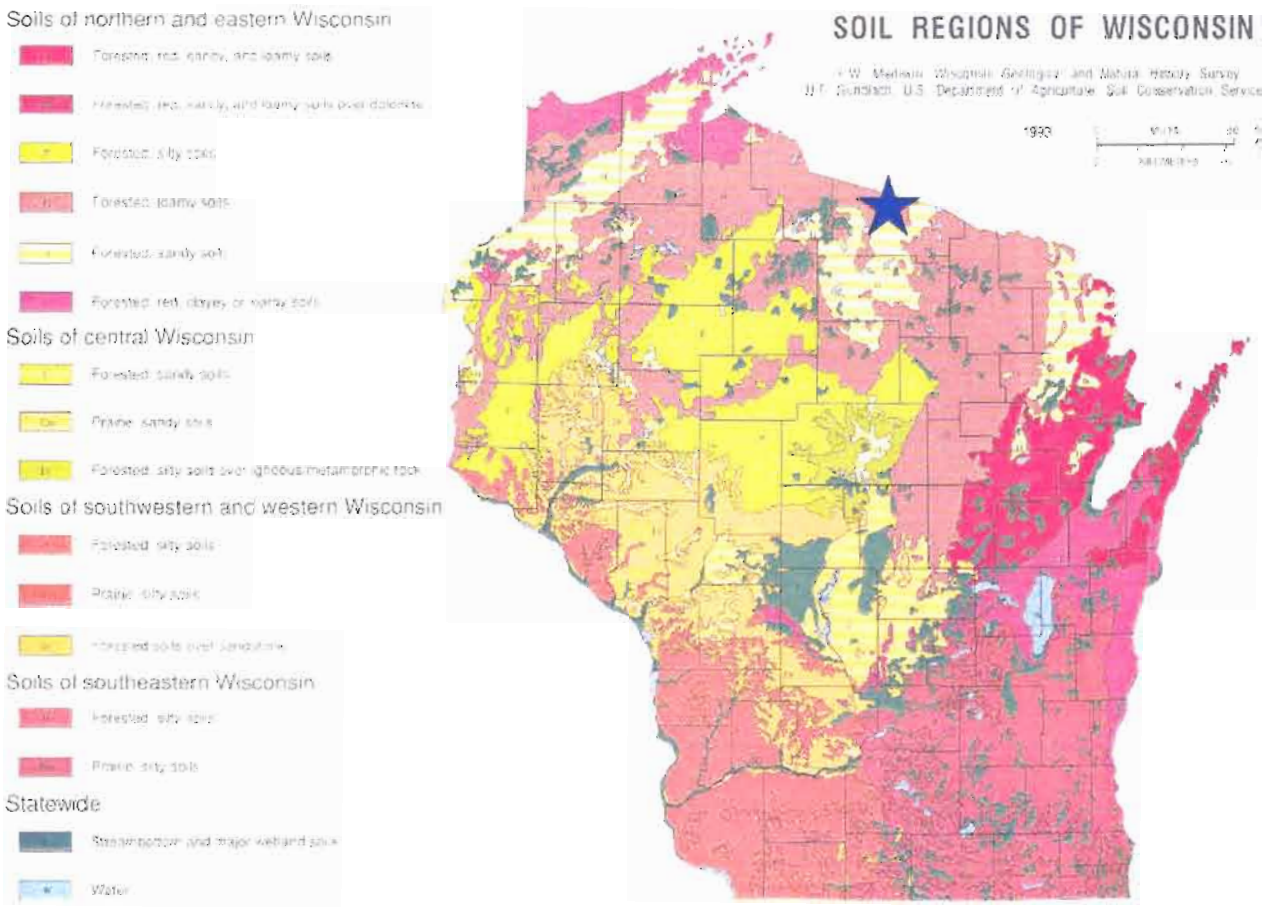


Figure 3. VanVliet Lake is located within a soils group characterized as forested silty soils.

3. Watershed Features

3.1. Drainage Area and Land Use of VanVliet Lake

Drainage area to VanVliet Lake is 1,370 acres (based on a USGS maps) and the delineation is shown in Figure 4.

VanVliet Lake and its watershed is located within Vilas County and forested land is the dominant land use. VanVliet lake drains to Presque Isle Lake to the north.

The watershed to lake ratio of VanVliet Lake is 6 to one. VanVliet Lake has good water clarity, but not as good as Presque Isle Lake to the north. To preserve good water quality in years to come, conservation measures in the watershed and on the lakeshore of VanVliet Lake should be considered.

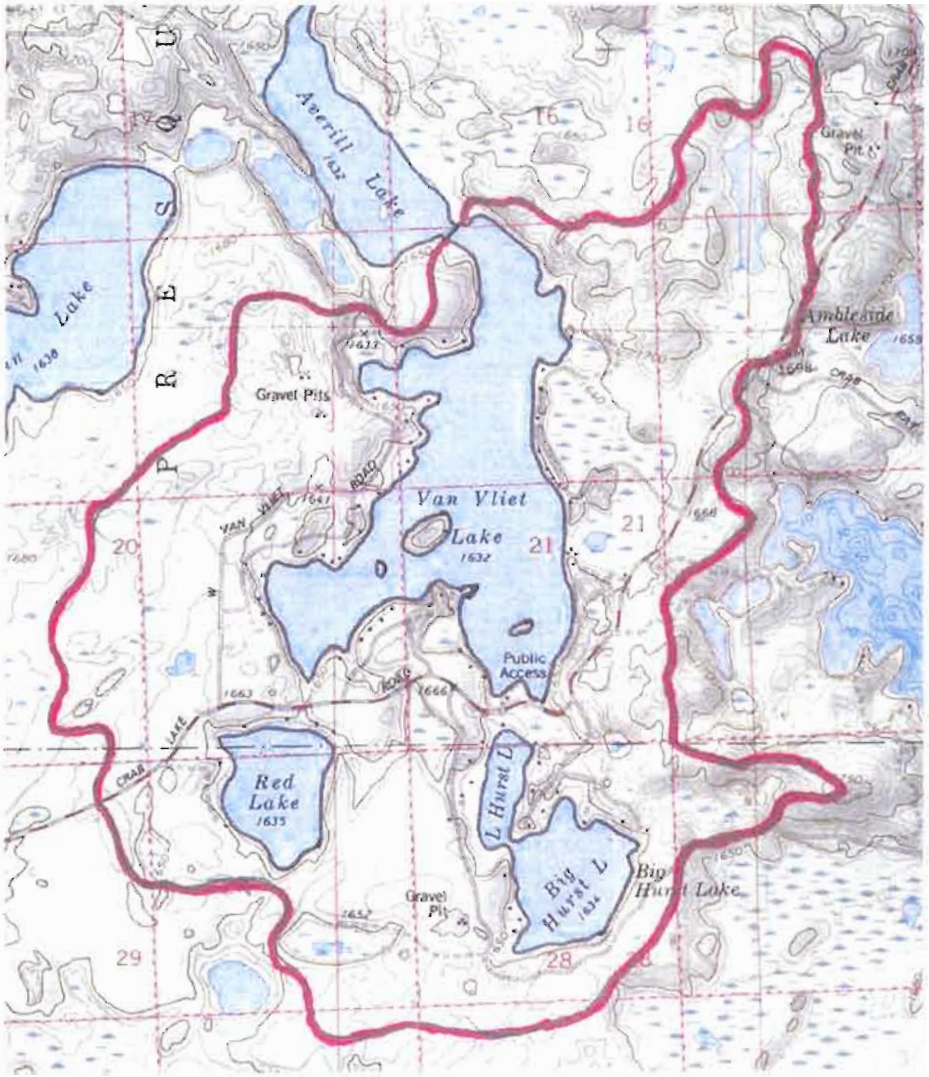


Figure 4. Watershed area for VanVliet Lake (delineation was made by Blue Water Science, 2004).

3.2. Source of Water and Nutrients to VanVliet Lake

Water: Source of water to VanVliet Lake is from a combination of surface runoff, rainfall, and groundwater. The amount of water flowing into and out of VanVliet Lake is estimated to be about 2 cubic feet per second. Flows were estimated based on runoff amounts listed for Vilas County in the Wisconsin Spreadsheet Lake Model (Table 2). Much of the flow is through groundwater springs with the remainder from overland runoff and precipitation.

Table 2. Average annual water flow into VanVliet Lake.

Drainage area (not including the lake) (acre)	1,370
Average yearly runoff for Vilas County (feet)(from WDNR WILMS Model)	1.17
Total water inflow (acre-feet)	1,603

The estimated 1,603 acre-feet of water flowing into VanVliet Lake in one year would be enough water to fill a swimming pool the size of a football field to a depth of 1,550 feet. It would also be enough drinking water to supply a town of 22,000 for a year.

Although this is a lot of water coming into VanVliet Lake, the volume of VanVliet Lake is 1,980 acre-feet. If VanVliet Lake completely dried up, it would take 1.2 years to fill.

Watershed Nutrients: The primary source of phosphorus from the watershed of VanVliet Lake is from forested areas. There are no known land uses such as row crops or agricultural lands contributing excess phosphorus to VanVliet Lake. Phosphorus in rainfall and snowfall is the largest single source of phosphorus to VanVliet Lake. Phosphorus contributions to VanVliet Lake were estimated. Watershed sampling was not conducted. Additional information on watershed nutrients is presented in Section 5.3.

3.3. Shoreland Inventory

The shoreland area encompasses three components: the upland fringe, the shoreline, and shallow water area by the shore. A photographic inventory of the VanVliet Lake shoreline was conducted in August of 2004 by lake resident volunteers and Blue Water Science. The objectives of the survey were to characterize existing shoreland conditions which will serve as a benchmark for future comparisons.

For analysis, each photograph was evaluated by Blue Water Science staff for shoreline and upland conditions. Our criteria for natural conditions were the presence of 50% native vegetation in the understory and at least 50% natural vegetation along the shoreline in a strip at least 15 feet deep. Although the shoreline recommendations for new development is a 35-foot deep buffer, a 15-foot deep buffer is about the minimum needed to achieve some degree of runoff water quality treatment. We evaluated shorelines and uplands at the 75% natural level as well (Figure 5 illustrates the methodology).

A summary of the inventory results is shown in Table 3. Based on our subjective criteria about 82% of the parcels in the VanVliet Lake shoreland area meet the natural ranking criteria for shorelines and upland areas. This is slightly above average for "northern Wisconsin lakes" where 50% of the parcels meet the "natural" criteria. Country lakes are defined as lakes found about 1 to 2 hours driving time outside of a major Metropolitan area such as Minneapolis/St. Paul or Milwaukee.

In the next 10 years proactive volunteer native landscaping could improve the natural aspects of a number of parcels.

A comparison of VanVliet Lake conditions to other lakes in Minnesota and Wisconsin is shown in Table 4 and in Figure 6.

Table 3. Summary of shoreline buffer and upland conditions in the shoreland area of VanVliet Lake. Approximately 100 parcels were examined.

VanVliet Lake	Natural Shoreline Condition		Natural Upland Condition		Undevel. Photo Parcels	Shoreline Structure Present	
	>50%	>75%	>50%	>75%		riprap	wall
TOTALS (no. of parcels = 100)	82% (82)	68% (68)	93% (93)	65% (65)	20% (20)	10% (10)	1% (1)

Figure 5. [top] This parcel would rate as having a shoreline with a buffer greater than 50% of the lot width and an understory with greater than 50% natural cover.
[bottom] This is an example of a parcel from another lake that would not qualify as having a natural shoreline buffer greater than 50% of the lot width. Also understory in the upland area would be rated as having less than 50% natural cover.

Table 4. Summary of shoreland inventories from VanVliet Lake and 35 other lakes in Minnesota and Wisconsin.

Lake	Eco-region	Date of Survey	Total Number of Parcels (#)	Undevel. Parcels % (#)	Natural Upland Condition		Natural Shoreline Condition		Parcels with Erosion % (#)	Parcels with Shoreline Revetment % (#)
					> 50% % (#)	>75% % (#)	> 50% % (#)	>75% % (#)		
NORTHWOODS LAKES										
Ballard chain Vilas Co, WI	LF	7.23.99	110	--	98 (108)	96 (106)	96 (106)	95 (105)	--	0
Pike Chain Price & Vilas Co, WI	LF	2001	722	380	92 (633)	87 (626)	95 (684)	91 (654)	--	5 (34)
Bear Oneida Co, WI	LF	6.8.99	115	6 (7)	93 (107)	78 (90)	84 (97)	77 (89)	1 (1)	8 (9)
VanVliet Vilas Co, WI	LF	6.04	100	20 (20)	93 (93)	65 (65)	82 (82)	68 (68)	8 (8)	11 (11)
Muskellunge Vilas Co, WI	LF	8.7.04	129	8 (10)	81 (104	62 (80)	88 (114)	76 (98)	2 (2)	18 (23)
Big Bear Lake Burnett Co, WI	LF	9.11.02	87	13 (11)	82 (71)	62 (54)	86 (75)	76 (66)	0	9 (8)
Nancy Lake Washburn Co, WI	LF	9.21.00	217	19 (41)	77 (167)	65 (141)	80 (174)	72 (156)		5 (11)
Plum Lake Vilas Co, WI	LF	7.26.01	225	13 (30)	75 (169)	58 (130)	81 (182)	708(158)	--	9(4)
Big Bearskin Oneida Co, WI	LF	8.10.99	130	--	73 (95)	63 (82)	80 (104)	67 (87)	--	0
COUNTRY LAKES										
North Pipe Lake Polk Co, WI	CHF	8.03	80	45 (36)	100 (80)	96 (77)	94 (75)	91 (73)	0	1 (1)
Upper Turtle Lake Baron Co, WI	CHF	7.23-24.02	309	28 (85)	72 (224)	58 (178)	76 (234)	68 (209)	0	20 (63)
Lower Turtle Barron Co, WI	CHF	7.23.04	127	9 (12)	43 (54)	29 (37)	82 (104)	71 (90)	1 (1)	6 (8)
Pipe Lake Polk Co, WI	CHF	8.03	217	8 (17)	67 (144)	50 (108)	63 (137)	56 (121)	0	22 (48)
Little Pelican Otter Tail Co, MN	CHF	9.16.04	119	33% (39)	55% (65)	61% (51)	66% (79)	61% (73)	33 (39)	23 (27)
Comfort Chisago Co, MN	CHF	10.9-11.2.98	100	--	62 (62)	--	50 (50)	--	--	12 (12)
Lake Volney Le Sueur Co, MN	CHF	9.21.02	79	25 (20)	54 (43)	42 (33)	56 (44)	47 (37)	0	30 (24)
Rush Lake Chisago Co, MN	CHF	9.16.00	524	11 (58)	48 (253)	28 (147)	51 (267)	38 (201)	1 (3)	18 (92)
West Rush Lake, Chisago Co, MN	CHF	9.16.00	332	12 (40)	52 (171)	31 (103)	55 (184)	43 (142)	1 (2)	15 (50)
East Rush Lake, Chisago Co, MN	CHF	9.16.00	192	9 (18)	43 (82)	23 (44)	43 (83)	31 (59)	1 (1)	22 (42)
Fish Otter Tail Co, MN	CHF	9.16.04	95	21% (20)	38% (36)	36% (34)	43% (41)	36% (38)	48 (46)	7 (7)
Big Round Lake, Polk Co, WI	CHF	8.03	74	14 (10)	27 (20)	24 (18)	39 (29)	34 (25)	1 (1)	14 (10)
Bass Otter Tail Co, MN	CHF	9.16.04	22	0% (0)	6% (27)	3% (14)	41% (9)	41% (9)	68 (15)	2 (2)
Pelican Otter Tail Co, MN	CHF	9.16.04	881	14% (2)	21% (183)	14% (123)	21% (181)	16% (142)	2 (14)	80 (706)
Green Lake Kandiyohi Co, MN	CHF	9.19.01	721	1 (9)	20 (146)	12 (88)	19 (140)	14 (100)	0	62 (446)
Diamond Lake Kandiyohi Co, MN	CHF	8.13 & 14.02	344	2 (7)	13 (44)	11 (39)	16 (56)	12 (42)	1 (5)	49 (168)

Lake	Eco-region	Date of Survey	Total Number of Parcels (#)	Undevel. Parcels % (#)	Natural Upland Condition		Natural Shoreline Condition		Parcels with Erosion % (#)	Parcels with Shoreline Revetment % (#)
					> 50% % (#)	>75% % (#)	> 50% % (#)	>75% % (#)		
METROPOLITAN LAKES										
Ravine Lake Washington Co, MN	CHF	7.19.01	9	100 (9)	100 (9)	100 (9)	100 (9)	100 (9)	0	0
Pike Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	9	56 (5)	100 (9)	100 (9)	100(9)	100 (9)	0	0
Powers City of Woodbury, MN	CHF	1998	30	90 (27)	90 (27)	90 (27)	97 (29)	97 (29)	0	0
Lake Edward, City Maple Grove, MN	CHF	9.30 - 10.12.99	34	12 (4)	91 (31)	88 (30)	76 (26)	71 (24)	6 (2)	3 (1)
Rice Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	137	33 (45)	71 (97)	64 (87)	81 (111)	74 (102)	0	19 (25)
Lee Lake Dakota Co, MN	CHF	5.31.02	30	37 (11)	73 (22)	50 (15)	77 (23)	67 (20)	0 (0)	10 (3)
Fish Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	170	7 (12)	74 (126)	44 (75)	57 (97)	41 (70)	1 (1)	20 (34)
Alimagnet Lake Dakota Co, MN	CHF	8.6.03	108	37 (40)	54 (58)	47 (51)	69 (75)	61 (66)	0	16 (17)
Eagle Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	90	14 (13)	64 (58)	52 (47)	47 (42)	41 (37)	0	35 (32)
Cedar Island Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	93	5 (5)	62 (58)	35 (33)	55 (51)	39 (36)	0	22 (21)
Orchard Lake Dakota Co, MN	CHF	9.17.01	109	4 (4)	47 (51)	30 (33)	53 (58)	32 (35)	0	54 (59)
Lac Lavon Dakota County, MN	CHF	9.9.03	110	7 (8)	54 (59)	44 (48)	42 (46)	30 (33)	0	8 (9)
Upper Prior Scott Co, MN	CHF	9.30 - 10.12.99	366	10 (37)	51 (187)	36 (132)	35 (128)	31 (113)	4 (15)	46 (168)
Weaver Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	111	5 (5)	47 (52)	28 (31)	44 (49)	29 (32)	0	14 (16)
Lower Prior Scott Co, MN	CHF	9.24-30.99	691	10 (66)	36 (249)	24 (166)	22 (152)	17 (117)	5 (35)	54 (373)
Maple Grove Lake Summary, MN	CHF	9.30 - 10.12.99	644	14 (89)	67 (431)	48 (312)	60 (385)	48 (310)	1 (3)	20 (129)

* CHF = Central Hardwood Forest Ecoregion
** LF = Lake and Forests Ecoregion

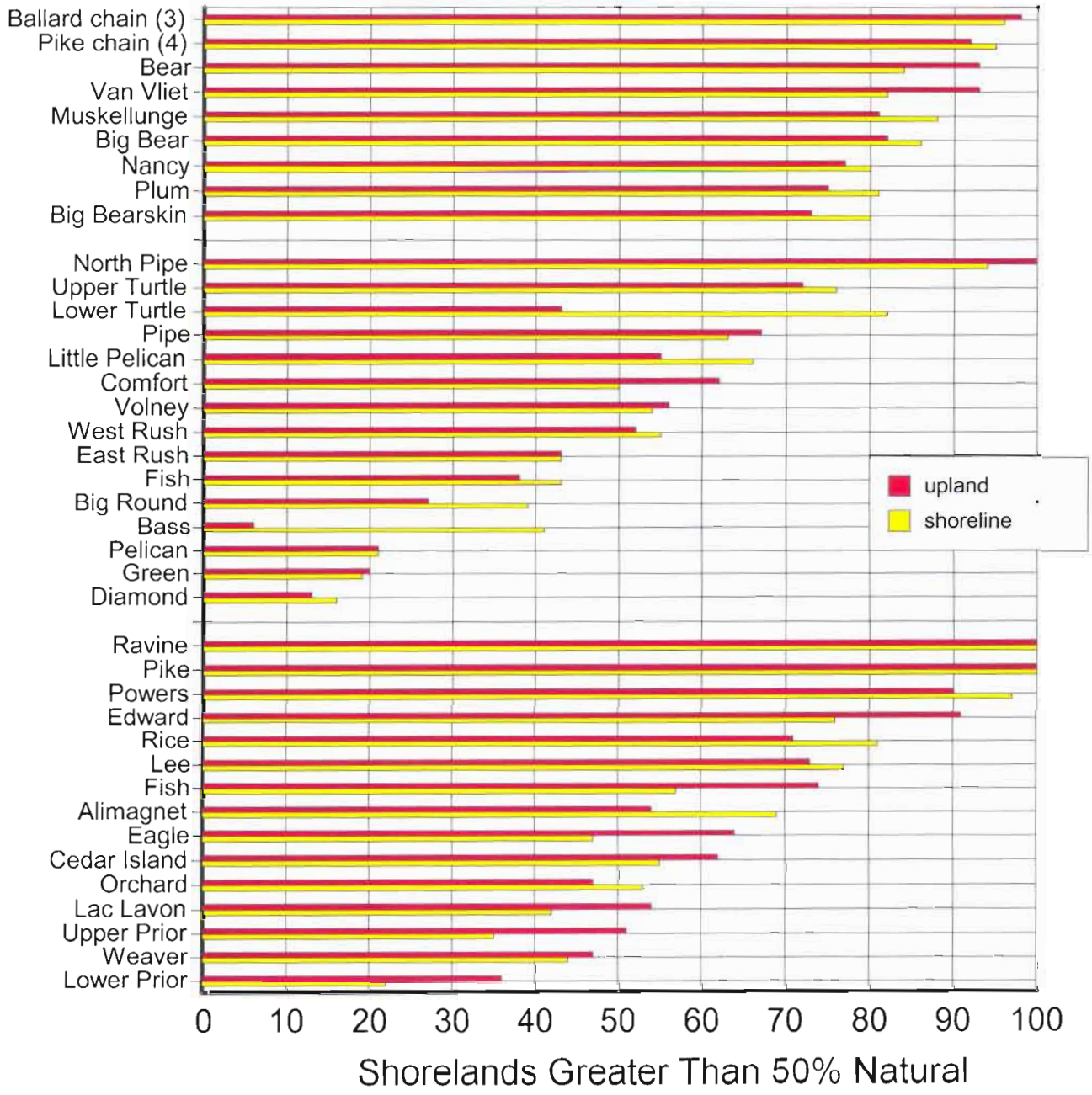


Figure 6. A summary of shoreland inventory results for lakes using an evaluation based on shoreland photographs. For each lake the percentage of shoreline and upland conditions with greater than 50% natural conditions is shown. The first tier of lakes are located in northern Wisconsin. The lower tier of lakes are in the Twin City Metropolitan area and are considered urban lakes. Although several lakes are "urban" lakes most of the shoreland is owned by the city and there is a high percentage of natural conditions. The middle tier of lakes are about an hour or two drive from the Twin Cities, and are not considered to be urban lakes, but are referred to as "country" lakes.

VanVliet Lake is in the northern Wisconsin tier of lakes. It's natural shoreland conditions are slightly above average compared to the other northern Wisconsin lakes.

3.4. VanVliet Lake Wildlife Inventory - 2004

Wildlife were observed in the VanVliet Lake shoreland area through 2004 and results were compiled by the VanVliet Lake Association.

3.5. Groundwater and On-site Wastewater Treatment Systems

Groundwater inflow was evaluated indirectly by measuring lake water conductivity in the shallow nearshore area. The objective was to see if there was any change in conductivity. An increase or decrease in conductivity could indicate the inflow of groundwater. The groundwater could be coming from natural flows or from septic tank drainfields.

Specific conductance or conductivity is a measure of dissolved salts in the water. The unit of measurement is microSiemans/cm^2 or micro umhos/cm^2 . . . both are used. The saltier the water the higher the conductivity. For example oceans which are salty have much higher conductivity than fresh water lakes. For the conductivity survey on VanVliet Lake we used a YSI (Yellow Springs Instruments) probe attached to the end of an eight-foot pole. The survey used two people. One person held the probe under the surface of the water and recorded the reading off of a conductivity meter while the other person maneuvered the boat around the perimeter of VanVliet Lake.

Results are shown in Figure 7. The background or base conductivity was 100 umhos/cm. Several areas around VanVliet Lake had a conductivity reading above background. The elevated conductivity readings could be an indicator of septic tank effluent inputs or groundwater spring. Just because a conductivity reading is elevated, it does not mean it is a phosphorus source. Additional testing is necessary. More than likely, the elevated conductivity readings suggest that VanVliet Lake may be receiving groundwater inflows in several areas (Figure 7). It is not surprising that springs are found in VanVliet Lake. This was an active glacial area is the past and often leads to subsurface groundwater inflows.

It appears that the conductivity survey conducted in 2004 was able to discern areas of groundwater inflow comparable to the more rigorous approach of using monitoring wells. These conductivity surveys are a handy tool to help illustrate active groundwater areas in lakes.

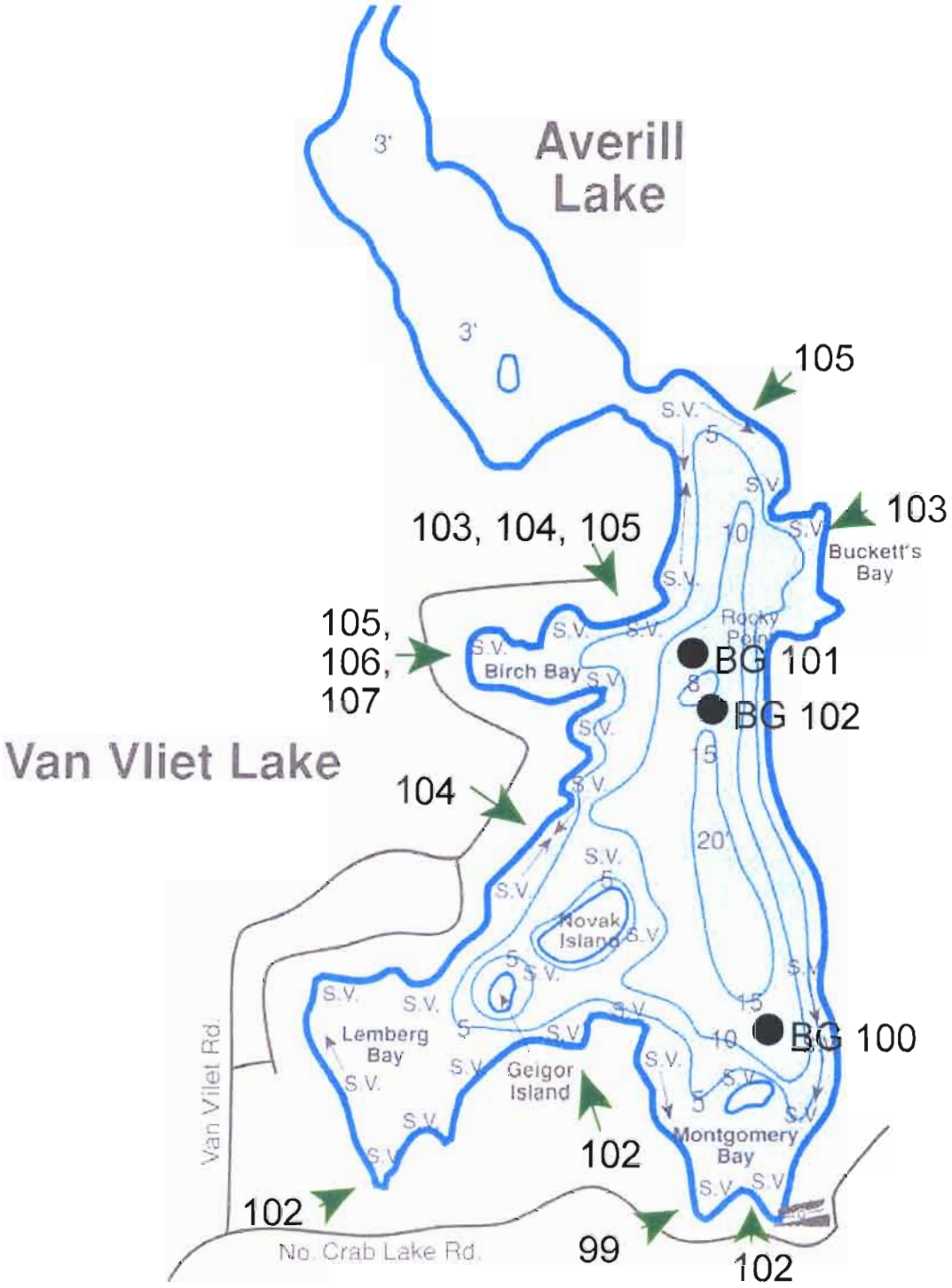


Figure 7. VanVliet Lake conductivity survey. Numbers on map represent conductivity readings in umhos/cm². BG represents background readings which were 100 - 102. Conductivity readings greater than background could indicate areas of groundwater inflow.

Figure 8. [top] VanVliet Lake Association volunteers assisted with collecting data for the conductivity survey.
[bottom] Much of the water input to VanVliet Lake is from groundwater flow. Water infiltrates in areas like this, in the southern end of the lake, and travels to the lake through the peat and sand in the subsurface.

Onsite Systems Status: Onsite systems appear to be in mostly good condition based on the conductivity survey results, the surrounding soils, and the setback of the cabins and homes. A conventional onsite system is shown in Figure 9. With proper maintenance (such as employing a proper pumping schedule) onsite systems are an excellent wastewater treatment option. The challenge is to maintain systems in good working condition.

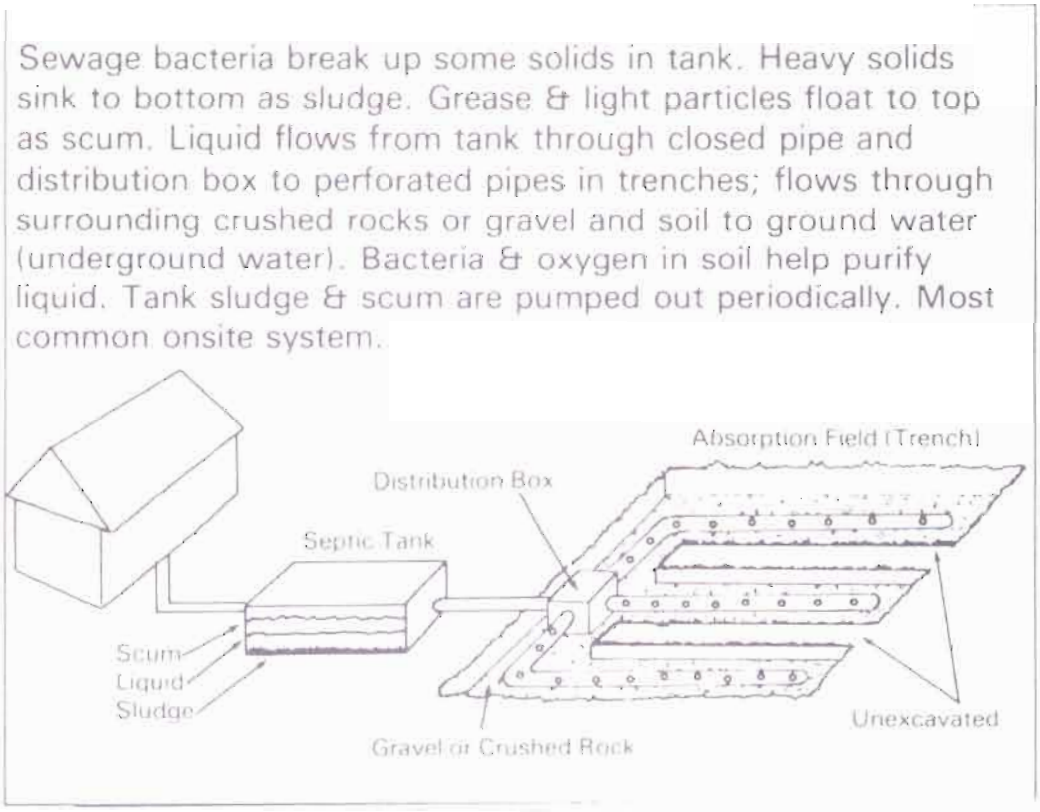


Figure 9. Typical onsite wastewater treatment system found in the VanVliet Lake watershed.

4. Lake Features

4.1. Lake Map and Lake Statistics

VanVliet Lake is approximately 220 acres in size, with a watershed of 1,370 acres. The average depth of VanVliet Lake is 3 meters (9 feet) with a maximum depth of 6 meters (20 feet) (Table 7). A lake contour map is shown in Figure 10. VanVliet Lake is located in an area of Wisconsin that is dominated by forests.

Figure 10. VanVliet Lake, Vilas County, Wisconsin.

Table 7. VanVliet Lake Characteristics

Area (Lake):	220 acres (89 ha)
Mean depth:	9 feet (3 m)
Maximum depth:	20 feet (6 m)
Volume:	1,980 acre-feet (267 Ha-M)
Watershed area (not including lake area):	1,370 acres (554 ha)
Watershed: Lake surface ratio	6:1
Public accesses (#):	1
Inlets:	intermittent
Outlets: Presque Isle	outflow ungaged

Figure 11. Presque Isle outlet area, July 2004. The water level of Presque Isle will influence the water level of VanVliet Lake.

4.2. Dissolved Oxygen and Temperature

Temperature profiles for VanVliet Lake are shown in Figure 12.

A profile was obtained each month from June through September, 2004. By examining the profiles, one can learn a great deal about the condition of a lake and the habitat that is available for aquatic life.

For example, the July profile shows that the lake was thermally stratified. **Thermally stratified** means that the water column of the lake is segregated into different layers of water based on their temperature. Just as hot air rises because it is less dense than cold air, water near the surface that is warmed by the sun is less dense than the cooler water below it and it "floats" forming a layer called the *epilimnion*, or *mixed layer*. The water in the epilimnion is frequently mixed by the wind, so it is usually the same temperature and is saturated with oxygen.

Below this layer of warm, oxygenated surface water is a region called the *metalimnion*, or *thermocline* where water temperatures decrease precipitously with depth. Water in this layer is isolated from gas exchange with the atmosphere. The oxygen content of this layer usually declines with depth in a manner similar to the decrease in water temperature.

Below the thermocline is the layer of cold, dense water called the *hypolimnion*. This layer is completely cut off from exchange with the atmosphere and light levels are very low. So, once the lake stratifies in the summer, oxygen concentrations in the hypolimnion progressively decline due to the decomposition of plant and animal matter and respiration of benthic (bottom-dwelling) organisms. Because VanVliet Lake is relatively shallow, it appears the lake can mix over the summer.

The July profile indicates that the epilimnion extended to a depth of about 12 feet. In the future, routine dissolved oxygen measurements will be collected as well.

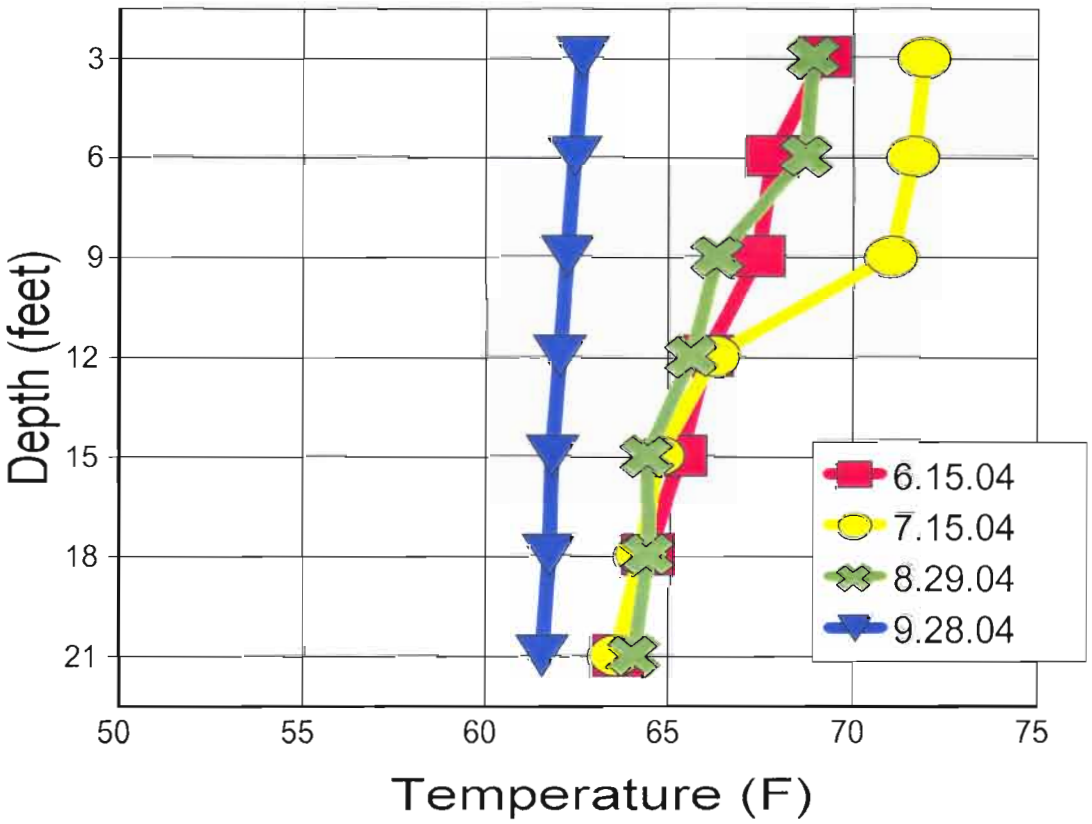


Figure 12. Temperature profiles for the summer of 2004.

4.3. Lake Water Quality Summary

Summer water clarity data were collected in 1993, 1994, 2002, 2003, and 2004. In 2003 and 2004 total phosphorus (TP), and chlorophyll a (Chl a) data were also collected (Table 8). Overall, the three water quality indicators (Secchi disc, total phosphorus, and chlorophyll a) in 2003 and 2004 indicate VanVliet is in fair shape.

Table 8. Summary of water quality data collected through the Citizen Self-Help Monitoring Program.

Date	Secchi Disc (ft)	TP - top (ppb)	Chlorophyll a (ppb)
1993 (Forbes Taylor)			
6.17.93	11.5		
6.24.93	9.0		
7.3.93	10.5		
Jun - Jul Avg	***10.3***		
1994 (Forbes Taylor)			
5.2.94	8.5		
5.18.94	8.0		
5.26.94	6.0		
6.27.94	10.0		
7.24.94	5.0		
8.28.94	4.5		
11.14.94	5.5		
May - Sept Avg	***7.0***		
2002 (Jeff Burke)			
6.2.02	7.25		
6.15.02	9.5		
7.3.02	9.0		
7.22.02	5.0		
8.2.02	5.25		
8.20.02	4.75		
9.15.02	6.5		
Jun - Sept Avg	***6.8***		
2003 (Jeff Burke)			
5.25.03	11.0	20	
6.11.03	11.0		
6.15.03		18	2.3
7.12.03	6.0		
7.17.03		19	8.0
8.15.03		20	4.9
9.30.03	4.75		
10.15.03		22	
May - Sept Avg	***8.2***	***20***	***5.1***
2004 (Jeff Burke)			
5.28.04	14.0	17	
6.15.04	11.5		
6.28.04		20	3.2
6.29.04	11.5		
7.9.04		17	4.1
7.15.04	10.5		
8.29.04	8.5		
8.31.04		17	5.8
9.9.04	9.25		
9.28.04	10.5		
May - Sept Avg	***10.8***	***18***	***4.4***

4.3.1. Secchi Disc Transparency

Water clarity is commonly measured with a Secchi disc. A typical seasonal pattern in lakes shows good clarity in May and June with a drop off in July and August. The low water clarity in late summer is usually due to algae growth. This pattern is also found in VanVliet (Figure 13). Water clarity summer averages from 1993 through 2004 are shown in Figure 13. Clarity in 2004 was good with a 10.8 foot average.

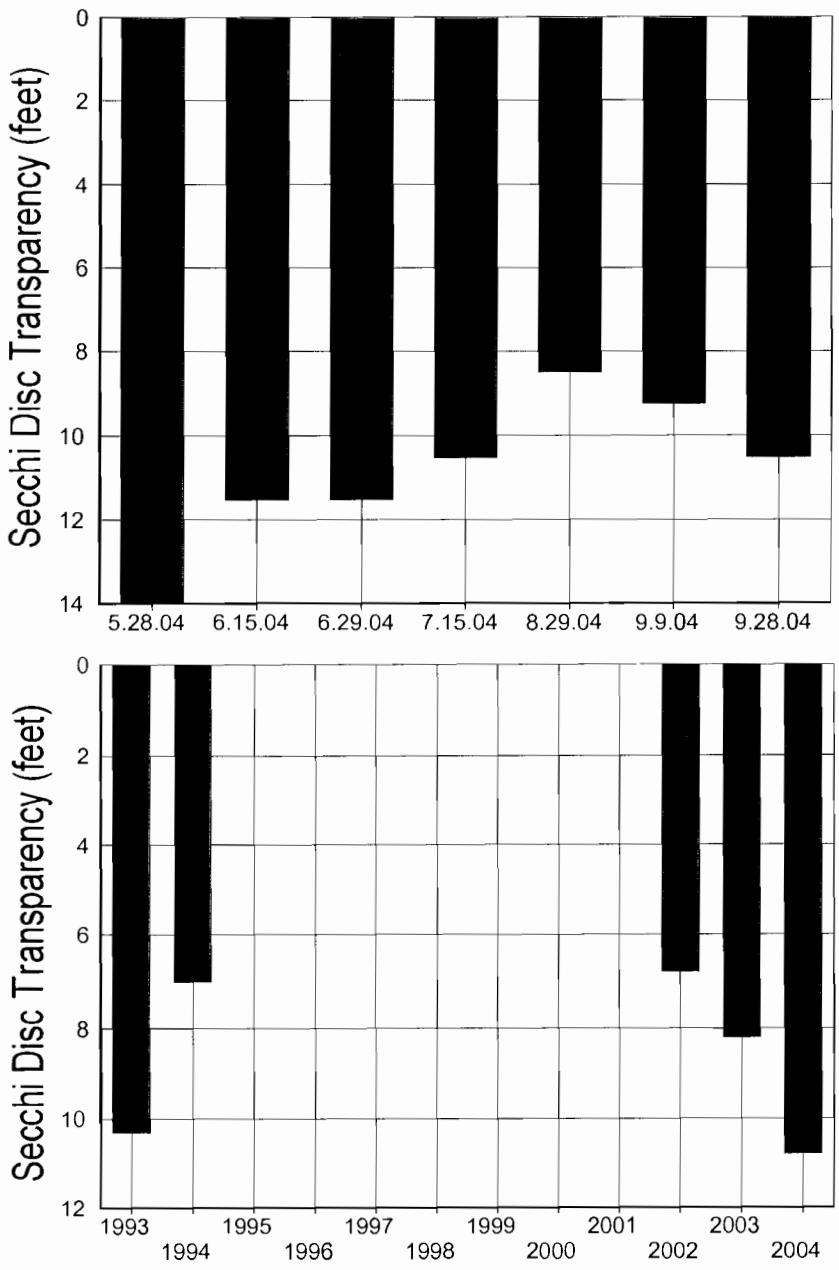


Figure 13. [top] Monthly Secchi disc readings in VanVliet Lake in 2004. [bottom] Yearly Secchi disc readings for VanVliet Lake.

4.3.2. Total Phosphorus

Phosphorus is the nutrient more often associated with stimulating nuisance algae growth. Lake phosphorus concentrations for the summer of 2003 and 2004 are shown in Figure 14. Phosphorus concentrations in VanVliet Lake are fairly low.

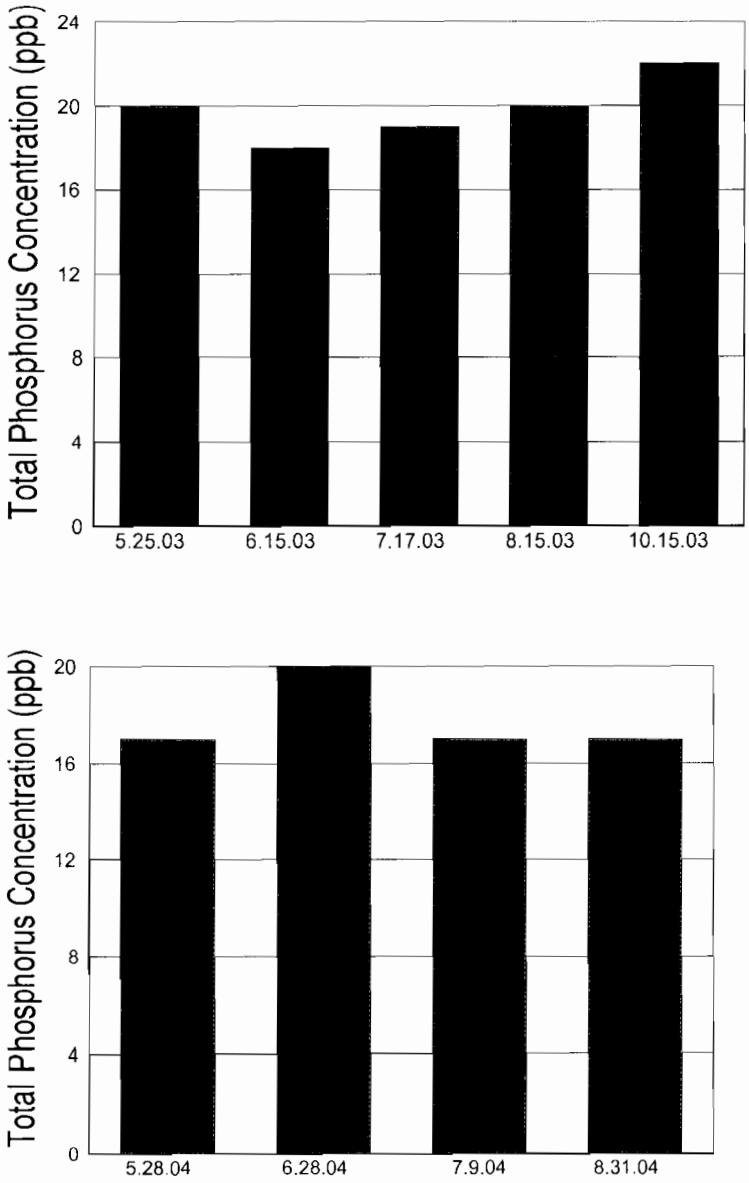


Figure 14. Monthly surface total phosphorus concentrations for 2003 and 2004.

4.3.3. Chlorophyll (a measure of algae)

Algae are small green plants, often consisting of single cells or grouped together in filaments (strings of cells). The amount of algae can be characterized by measuring the chlorophyll content in lake water. Chlorophyll results in 2003 and 2004 are shown in Figure 15. Chlorophyll concentrations are relatively low.

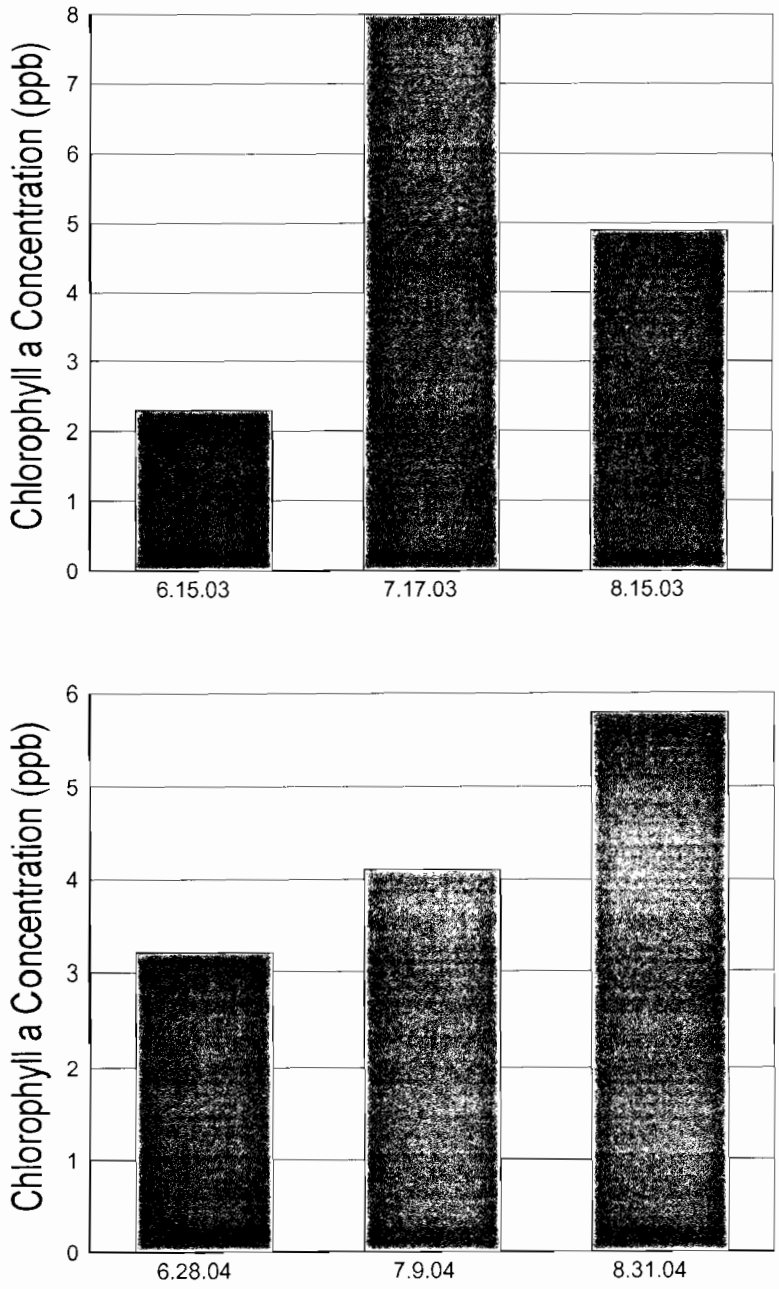


Figure 15. Monthly chlorophyll concentrations in VanVliet Lake for 2003 and 2004.

4.4. Algae

In mid to late summer, algae numbers increase and reduce transparency in VanVliet Lake. The dominant late summer algal species in VanVliet Lake in 2004 was *Spirogyra* (Figure 16). This can be a bloom forming species in some lakes.

Figure 16. *Spirogyra* algae from VanVliet Lake in August 2004.
[top] *Spirogyra*, is the dominant algal species.
[bottom] Two species of *Spirogyra*, are present in VanVliet Lake.

4.5. Zooplankton

Zooplankton are microscopic crustaceans that can feed on algae. A variety of different zooplankton are commonly found in lakes. An example of a large-sized zooplankton species from VanVliet Lake is shown in Figure 17. The zooplankton community in VanVliet Lake is typical for lakes in Northern Wisconsin. In the photo, the image is magnified 150 times.

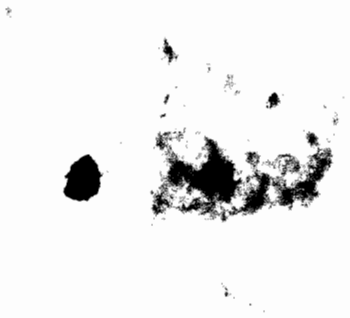


Figure 17. The animal in the middle of the picture is a *Bosmina*, a cladoceran zooplankton that feeds on algae (June 5, 2004).

Zooplankton in VanVliet Lake were sampled on two dates in 2004 and results are shown in Table 10. Bosmina were dominant in June and declined in July. This is a common pattern in many lakes.

Table 10. Zooplankton counts for VanVliet Lake (organisms/liter).

Date	**6.5.04 (#/l)**	**7.9.04 (#/l)**
Depth (ft)	10 ft	10 ft
Big Daphnids	0	4
Little Daphnids	0	23
Ceriodaphnia	0	0
Bosmina	74	0
Chydorus	1	5
Cladoceran	**75**	**32**
Calonoids	3	19
Cyclopoids	26	5
Nauplii	31	21
Copepods	**60**	**45**
Rotifers	**115**	**6**
Total Zooplankton	**250**	**83**

4.6. Aquatic plant status

Aquatic plants are very important to lakes. They act as nurseries for small fish, refuges for larger fish, and they help to keep the water clear. Currently VanVliet Lake has a fair diversity of aquatic plants.

Aquatic plants were monitored in the summer of 2004. The dominant plant was elodea, followed by fern pondweed.

In July and August of 2004, aquatic plant distribution was estimated to be at 160 acres or about 73% of the lake bottom (Figure 18). Of that coverage, several acres grew to nuisance conditions where plants topped out at the lake surface primarily on the west side of the lake.

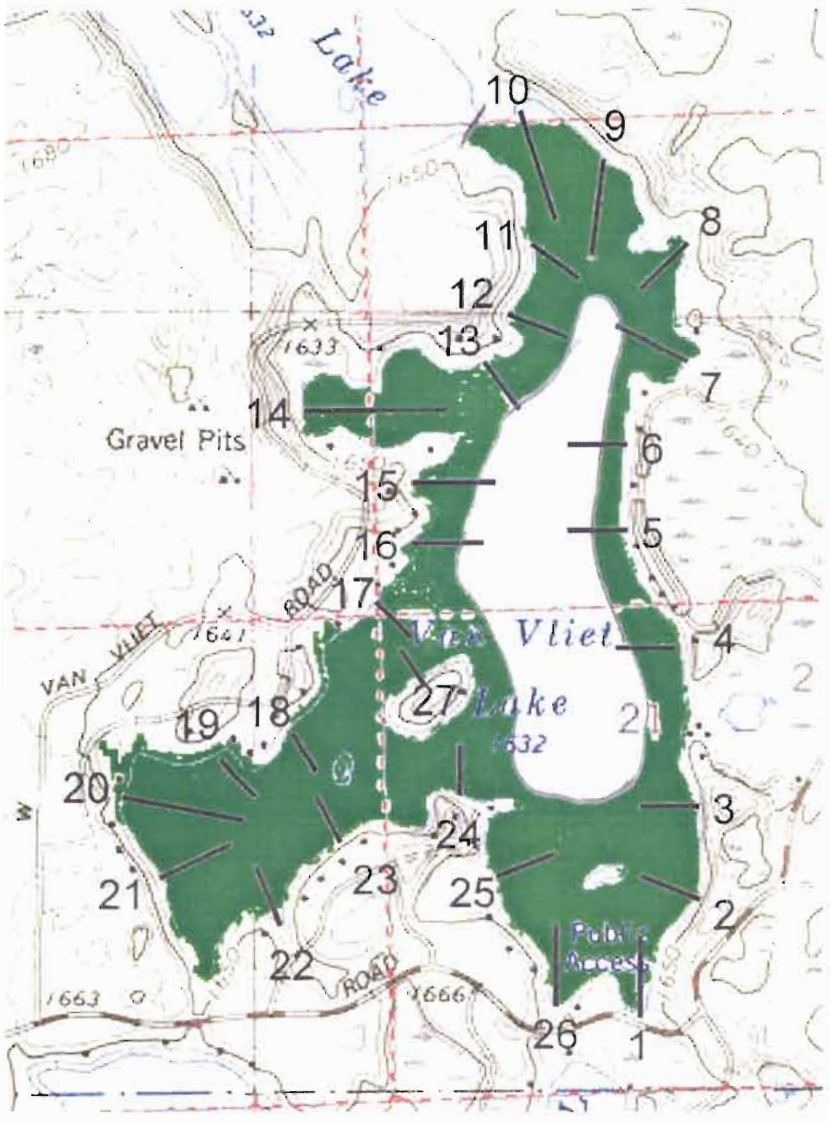


Figure 18. Aquatic plant coverage on VanVliet Lake on July and August, 2004.

A summary of aquatic plant statistics is shown in Table 11 and line drawings of common VanVliet Lake aquatic plants are shown on the next page.

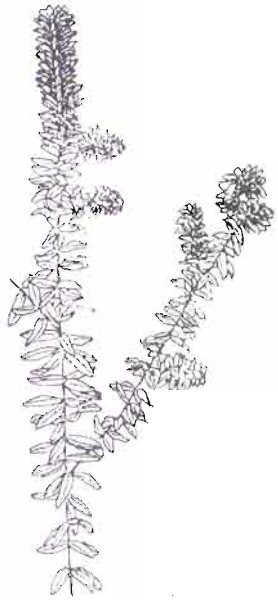
Table 11. Summer aquatic plant survey summary.

	All Stations
Number of submerged aquatic plant species found	17
Common plant species	Elodea, fern pondweed, and northern watermilfoil
Rarest plant	Needle spike rush, floatingleaf pondweed, buttercup, and rosette
Maximum depth of plant growth	13

Figure 19. Fern pondweed is sampled at this location on VanVliet Lake.

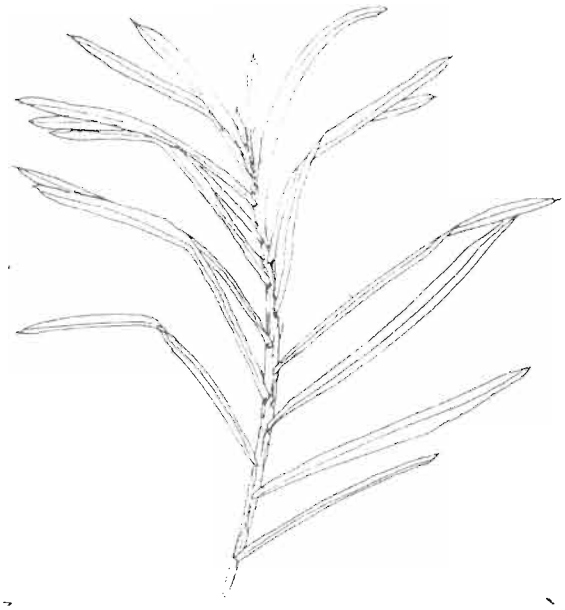
Common Plants in VanVliet Lake

Elodea



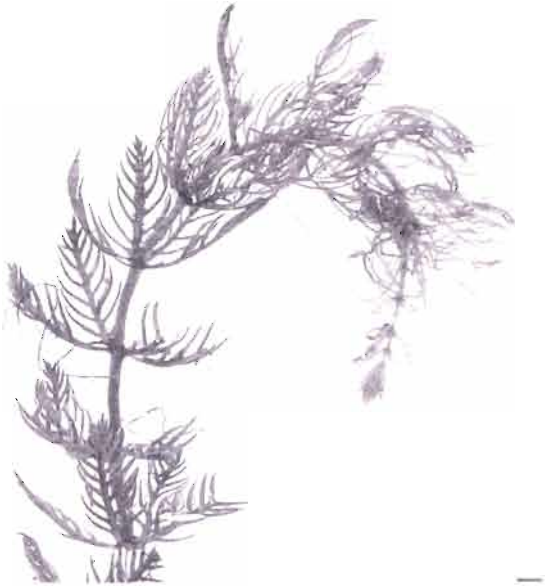
Elodea (*Elodea canadensis*) is found in water depths to 12 feet.

Fern pondweed



Fern pondweed (*Potamogeton Robbinsii*) is found in water depths to 12 feet.

Northern watermilfoil



Northern watermilfoil (*Myriophyllum sibiricum*) is found in water depths to 10 feet.

Coontail

Coontail (*Ceratophyllum demersum*) is dominant in all water depths.

Figure 20. [top] VanVliet Lake residents, assisted with the aquatic plant survey. [bottom] Flatstem pondweed was a common aquatic plant found in the VanVliet Lake aquatic plant survey.

Table 12. VanVliet Lake aquatic plant occurrences and densities for the July 9 and August 6, 2004 survey based on 26 transects and 3 depths, for a total of 62 stations. Density ratings are 1-5 with 1 being low and 5 being most dense.

	Depth 0-4 feet (n=26)			Depth 5-8 feet (n=22)			Depth 9-12 feet (n=14)			All Stations (n=62)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
Pickerel weed (*Pontederia sp*)	1	4	0.3	--	--	--	--	--	--	1	2	0.3
Spatterdock (*Nuphar variegatum*)	1	4	0.7	--	--	--	--	--	--	1	2	0.7
White waterlily (*Nymphaea sp*)	2	8	0.8	--	--	--	--	--	--	2	3	0.8
Coontail (*Ceratophyllum demersum*)	12	46	1.3	13	59	1.3	6	43	0.8	31	50	1.2
Chara (*Chara sp*)	2	8	0.5	--	--	--	--	--	--	2	3	0.5
Needle spike rush (*Eleocharis sp*)	1	4	0.5	--	--	--	--	--	--	1	2	0.5
Elodea (*Elodea canadensis*)	23	88	1.1	18	82	1.3	9	64	0.9	50	81	1.2
Northern watermilfoil (*Myriophyllum sibiricum*)	18	69	0.9	13	59	1.1	8	57	1.0	39	63	1.0
Cabbage (*Potamogeton amplifolius*)	8	31	1.1	9	41	1.3	--	--	--	17	27	1.2
Illinois pondweed (*P. illinoensis*)	5	19	0.7	3	14	0.6	1	7	1.0	9	15	0.7
Floatingleaf pondweed (*P. sp*)	1	4	1.0	--	--	--	--	--	--	1	2	1.0
Stringy pondweed (*P. sp*)	7	27	1.1	6	27	1.4	9	64	1.5	22	35	1.3
Claspingleaf pondweed (*P. Richardsonii*)	10	38	1.0	9	41	1.3	1	7	0.5	20	32	1.1
Fern pondweed (*P. robbinsii*)	20	77	2.4	18	82	1.8	9	64	1.1	47	76	1.9
Flatstem pondweed (*P. zosteriformis*)	10	38	0.8	7	32	1.4	6	43	0.9	23	37	1.0
Buttercup (*Ranunculus sp*)	1	4	1.0	--	--	--	--	--	--	1	2	1.0
Rosette (*Sagittaria sp*)	1	4	0.5	--	--	--	--	--	--	1	2	1.0
Water celery (*Vallisneria americana*)	7	27	0.9	5	23	0.8	--	--	--	12	19	0.9
Water stargrass (*Zosterella dubia*)	1	4	1.0	2	9	0.4	--	--	--	3	5	0.6
Unknown pondweed	1	4	1.0	--	--	--	--	--	--	1	2	1.0

Table 13. Individual transect data for VanVliet Lake on July 9 and August 6, 2004.

	T1		T2			T3			T4			T5			T6		
	0-4	5-8	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12
Pickerel weed	0.3																
Spatterdock	0.7																
White waterlily	1																
Coontail			1			2	1	1		0.5		1	1		1		
Chara																	
Needle spike rush																	
Elodea	3	2		1.5	1	1	1	0.5	1	0.5		0.5	1		1		1
Northern watermilfoil	1		1	0.8	1		1	0.3	0.5	1.5		1				0.5	
Cabbage		1				1										0.5	
Illinois pondweed																	
Floatingleaf pondweed																	
Stringy pondweed								1.5									
Claspingleaf pondweed	0.7	2								0.5							
Fern pondweed	1.7		1	1.5	1			1		0.5		1	1		1		1
Flatstem pondweed	0.3	2			1		3	0.5		0.5		1					
Buttercup																	
Rosette									1								
Water celery						1	1										
Water stargrass						1											
Unknown pondweed												1					
Filamentous algae																	

	T7			T8			T9			T10		T11		T12		
	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	0-4	5-8	0-4	5-8	9-12
Pickerel weed																
Spatterdock																
White waterlily																
Coontail	2	2	1	1	3	0.3		1	1		0.5				0.5	1
Chara				0.5										0.5		
Needle spike rush																
Elodea			0.5	0.5			0.5	1.3		1	2	1	1			1
Northern watermilfoil	2	1		0.5			1	1	1.5	2		0.5			1.3	
Cabbage											1	1	0.5			
Illinois pondweed								0.7			0.5					
Floatingleaf pondweed																
Stringy pondweed	2		0.5	0.5	2	0.3	0.5	1	1	2				1	1.3	1
Claspingleaf pondweed	2	1	0.5	0.5						1	0.5	1				
Fern pondweed	3	1	2	0.5		1.3		2		3	4.3	4	4	1	1	
Flatstem pondweed						0.7			1			1		1		
Buttercup														1		
Rosette																
Water celery	1			0.5							1			1		
Water stargrass																
Unknown pondweed																
Filamentous algae																

Table 13. Individual transect data for VanVliet Lake on July 9 and August 6, 2004 continued.

	T13			T14			T15			T16			T17		T18	
	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	9-12	0-4	5-8	0-4	5-8
Pickerel weed																
Spatterdock																
White waterlily																
Coontail	1			3.5			1				1			2		
Chara																
Needle spike rush							0.5									
Elodea	1	2	1	0.5	1	0.5	1	1.3	1	2	1.8		1.8	1	1.5	2
Northern watermilfoil	1	1	1	0.5	2	1		2	1	1	0.5	1.5	0.5		1	
Cabbage											0.5		0.8	2	2	2
Illinois pondweed												1	1		0.5	
Floatingleaf pondweed				1												
Stringy pondweed		2	3		1	2			3							
Claspingleaf pondweed	1	1		0.5										2		
Fern pondweed		1	1	1	1	0.5		0.5		3	2	1	2.5	3	2.5	2
Flatstem pondweed	1			0.5				0.5			1	1.5			0.5	
Buttercup				1												
Rosette																
Water celery	1						1	0.5								
Water stargrass																
Unknown pondweed																
Filamentous algae																

	T19		T20	T21	T22	T23		T24			T25		T26	T27
	0-4	5-8	0-4	0-4	0-4	0-4	5-8	0-4	5-8	9-12	0-4	5-8	0-4	5-8
Pickerel weed														
Spatterdock														
White waterlily	0.5													
Coontail				0.5			0.5	1	0.5	0.3		3	0.5	1.5
Chara														
Needle spike rush														
Elodea	1	2	0.5	1	0.5	1	2	0.5	0.3	1.5	1.5	0.5	3	2
Northern watermilfoil						0.5	0.8	2	1	0.5	0.5		0.5	
Cabbage	0.5					0.5	0.3				2	3.5		
Illinois pondweed				0.5		1	0.5						0.5	
Floatingleaf pondweed														
Stringy pondweed				1				1	1	1				
Claspingleaf pondweed	0.5	1			0.5	2	2					1.5		0.5
Fern pondweed	3.5	4	4.5	2.5	2	2	1.5		1	1	3.5	1.5	4	3
Flatstem pondweed	0.5	2	0.5						1	0.5	1.5			
Buttercup														
Rosette														
Water celery							1	1	0.5					
Water stargrass							0.3		0.5					
Unknown pondweed														
Filamentous algae													1.5	

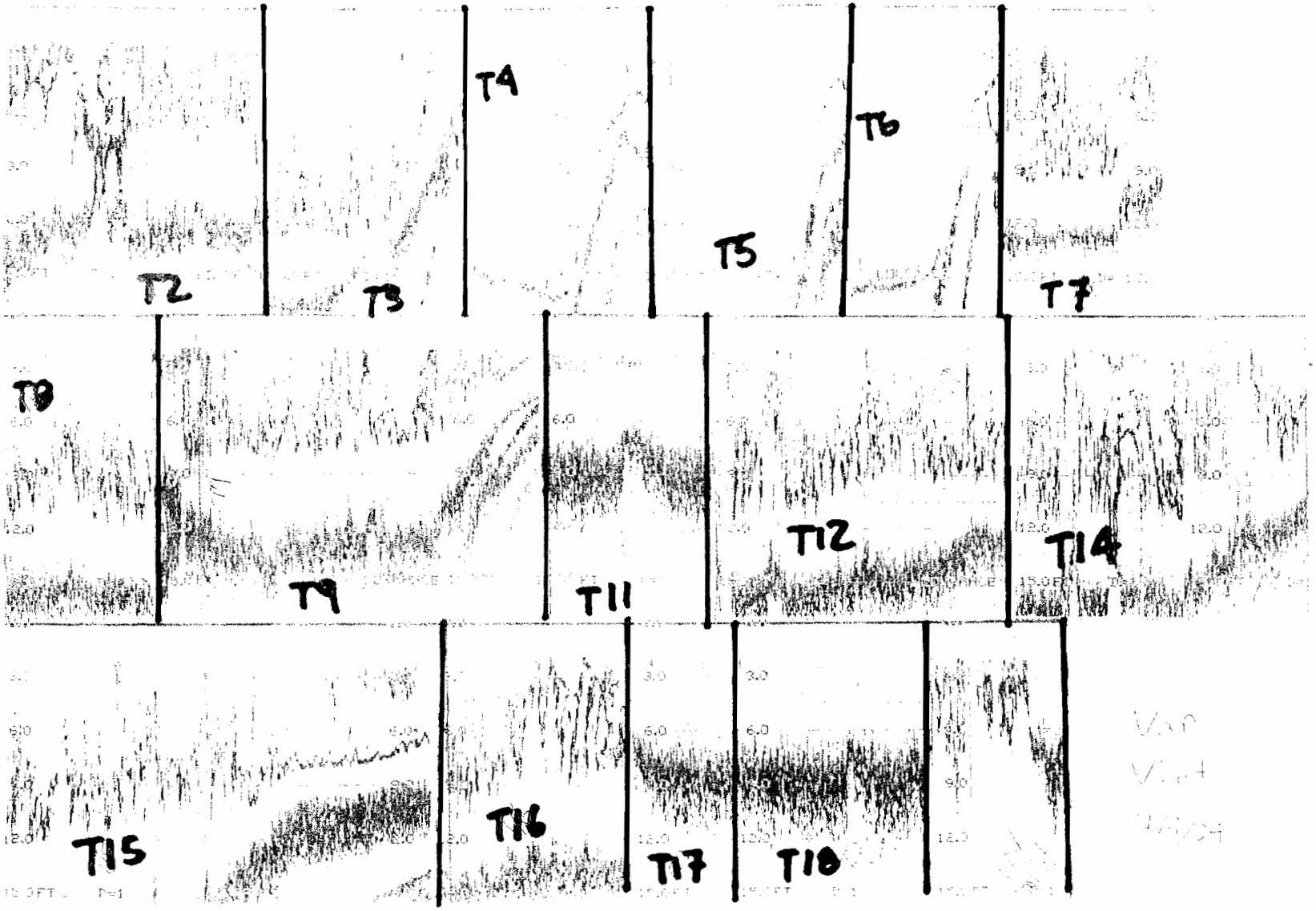


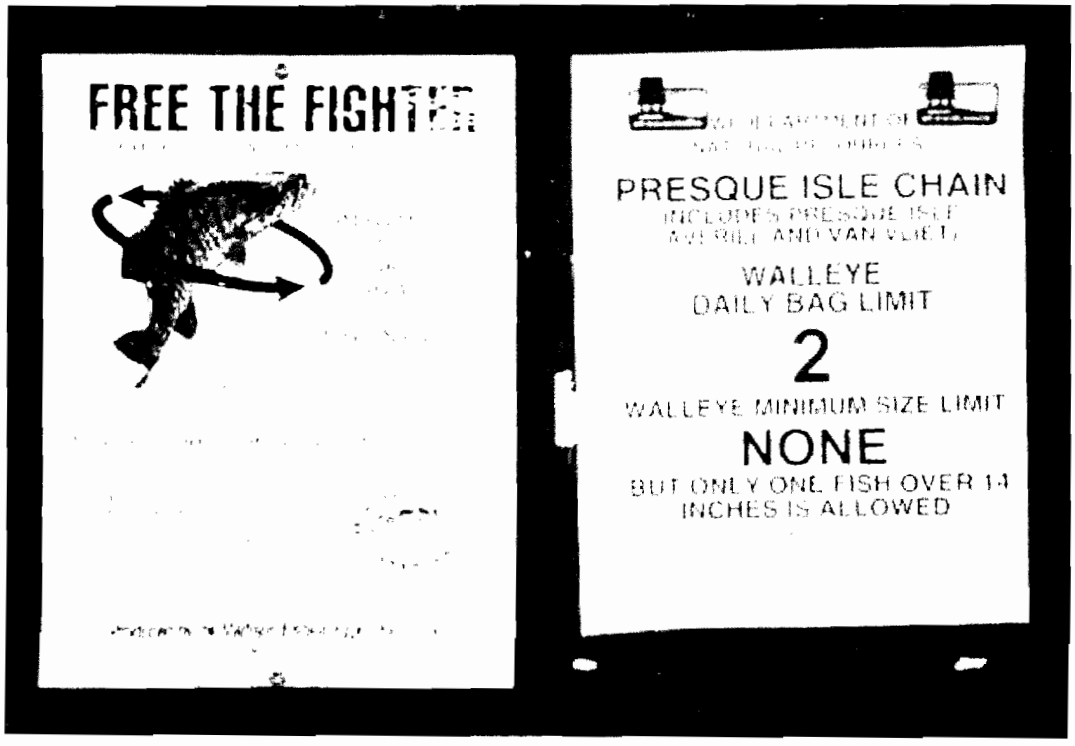
Figure 21. Sonar graphs show the aquatic plant canopy on selected transects in VanVliet Lake on July 9, 2004.

4.7. Fishery Status

VanVliet is a part of the Presque Isle chain which includes Presque Isle, Averill, and VanVliet Lakes. WDNR and GLIFWC surveys have examined walleye recruitment by using boom shocking equipment. Results of GLIFWC surveys are summarized below.

	Presque Isle					VanVliet				
Sample date	**September 7, 2004**					**August 30, 1999**				
Miles of shoreline surveyed	**8.8**					**5.0**				
Catch Data	**Number caught**	**Min length**	**Max length**	**Mean Length**	**Catch per effort**	**Number caught**	**Min length**	**Max length**	**Mean length**	**Catch per effort**
Walleye - total	118	4.5	16.8	9.0	13.4/ mile	47	8.1	20.3	10.9	9.4/ mile
Walleye - age 0	13	4.5	6.3	5.0	1.5/ mile	0	--	--	--	--
Walleye - age 1	72	6.5	9.5	8.3	8.2/ mile	19	8.1	9.7		3.8/ mile

The catch rate by boom shocking for Presque Isle and VanVliet was considered low by the WDNR. However, there is evidence for natural reproduction by walleyes and walleyes stocking is not necessary. The WDNR does stock muskies at one fish per two lake areas on odd numbered years.



5. Lake and Watershed Assessment

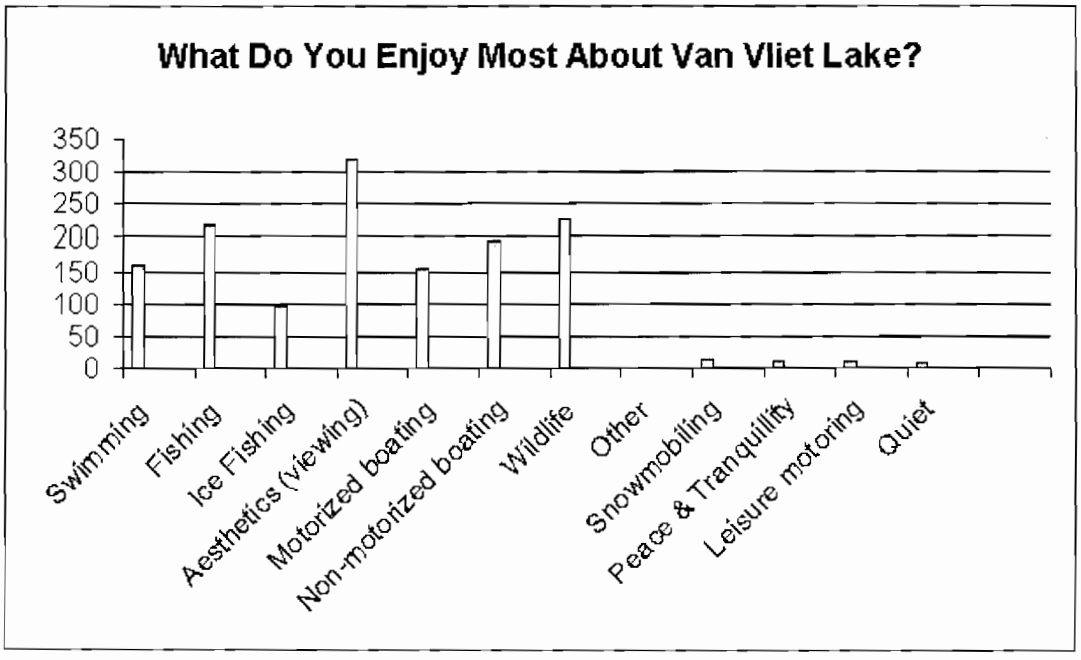
5.1. Lake Questionnaire Results

The VanVliet Lake questionnaire was developed to better understand the concerns, goals, and attitudes of homeowners living around the lake. Their thoughts and ideas about the use and the quality of the lake are shown below. The questionnaire was sent to 70 property owners, and 46 property owners responded to the VanVliet Lake questionnaire.

1. What do you enjoy most about VanVliet Lake.

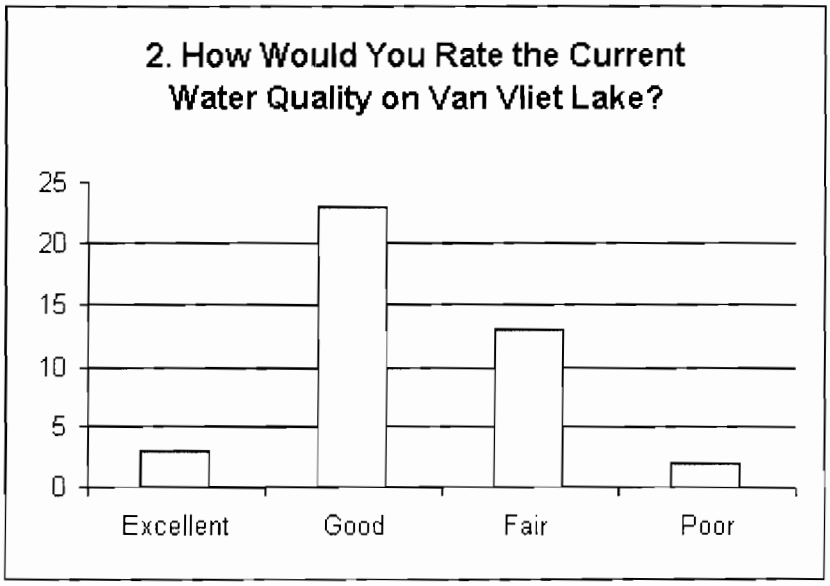
Score*		1	2	3	4	5	6	7
159	Swimming	3	6	3	5	5	6	5
219	Fishing	12	4	5	5	6	4	1
97	Ice Fishing	2	2	1	0	3	3	19
319	Aesthetics (viewing)	26	11	4	2	0	0	0
153	Motorized boating	3	2	2	8	9	8	0
193	Non-motorized boating	3	4	12	6	6	4	1
226	Wildlife	3	14	10	4	4	2	1
	Other							
13	Snowmobiling	1			1			
12	Peace & Tranquillity			2				
10	Leisure motoring				2			
8	Quiet	1						

* Score is number of answers times a value = 8 is highest; 1 is lowest



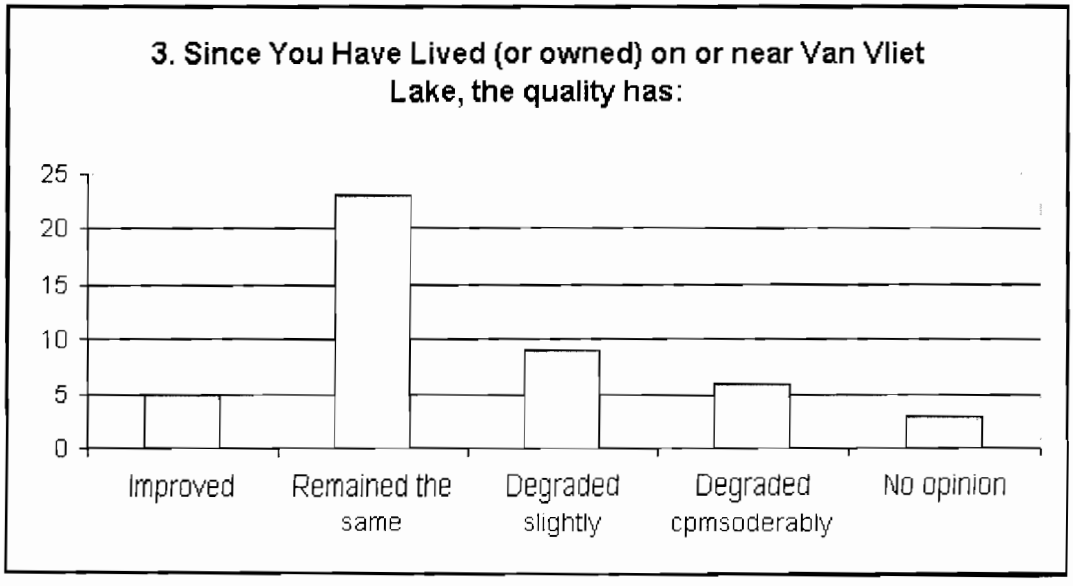
2. How Would You Rate the Current Water Quality of VanVliet Lake?

Excellent	3
Good	23
Fair	13
Poor	2



3. Since you have lived (or owned) on or near VanVliet Lake, the quality has:

Improved	5
Remained the same	23
Degraded slightly	9
Degraded considerably	6
No opinion	3



Questionnaire Summary: From the responses received by the lake association, the most enjoyable activity on the lake is viewing and watching wildlife. Fishing and non-motorized boating were the next favored activities. These results are similar to other responses from northern Wisconsin lake surveys. Lake residents rated the water quality as good and the majority thought the quality had remained the same or improved.

5.2. VanVliet Lake Status

The status of VanVliet Lake is mesotrophic meaning it has moderate fertility. VanVliet has typical phosphorus concentrations compared to many of the surrounding lakes (although Presque Isle is probably lower). One way to compare the status of VanVliet Lake is to compare it to other lakes in a similar setting or ecoregion.

Ecoregions are geographic regions that have similar geology, soils, and land use. The continental United States has been divided into 84 ecoregions, and there are six ecoregions in Wisconsin. A map of Wisconsin ecoregions is shown in Figure 22. VanVliet Lake is in the Northern Lakes and Forests ecoregion (Figure 22). Lakes in this area of the state have some of the best water quality values in the State. A range of ecoregion values for lakes in the ecoregion along with actual VanVliet Lake data is shown in Table 14.

Table 14. Summer average quality characteristics for lakes in the Northern Lakes and Forest ecoregion (Minnesota Pollution Control Agency, 1988).

Parameter	Northern Lakes and Forests	VanVliet (2004)
Total phosphorus (ug/l) - top	14-27	18
Algae [as Chlorophyll (ug/l)]	<10	4
Chlorophyll - max (ug/l)	<15	6
Secchi disc (ft)	8-15	10.8

These comparisons indicate that the water quality of VanVliet Lake is within range compared to relatively unimpacted lakes within the Northern Lakes and Forests Ecoregion. The challenge will be to maintain water quality values within ecoregion ranges.

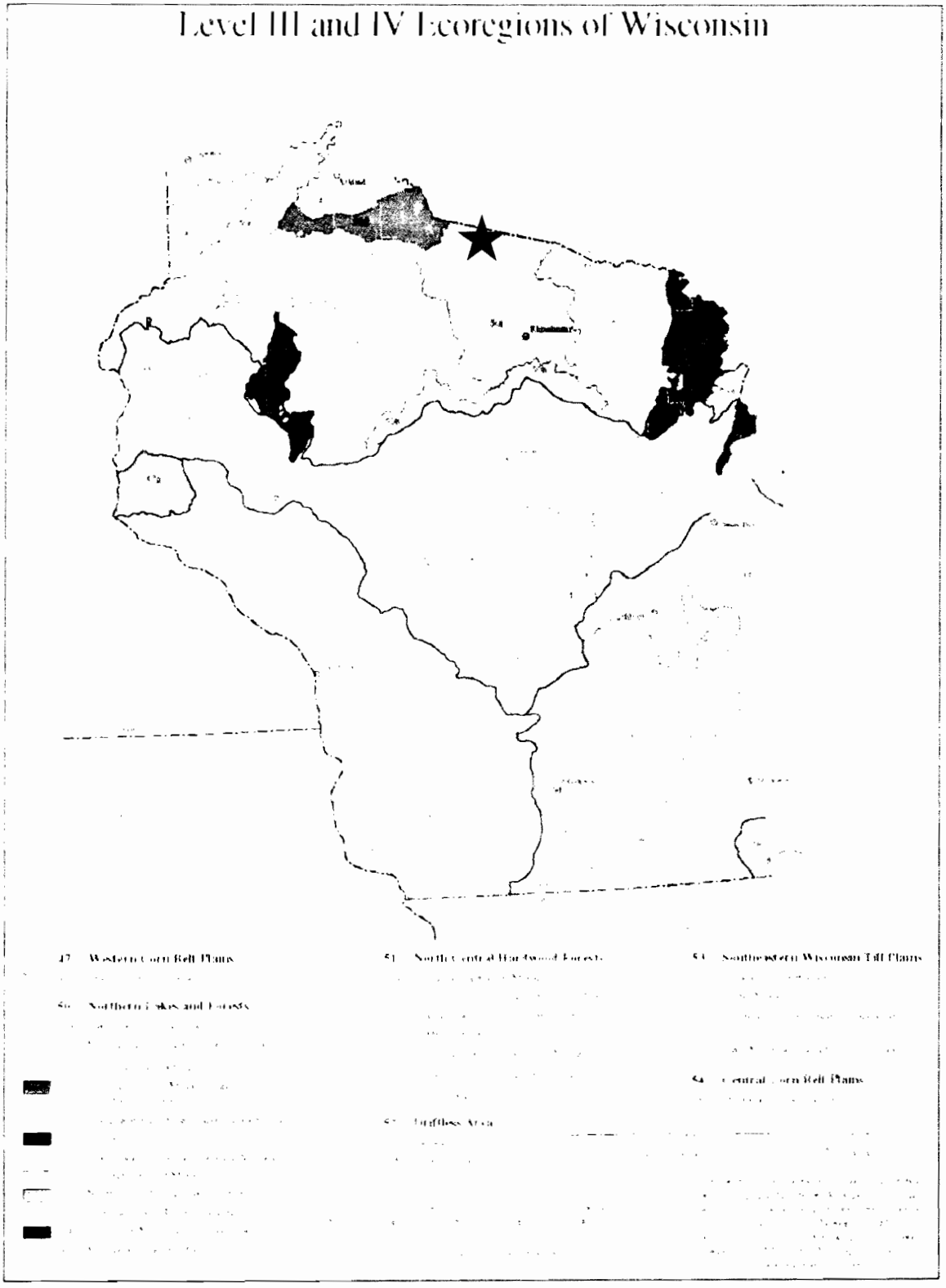


Figure 22. Ecoregion map for Wisconsin. Areas that are labeled with a "50" are within the Northern Lakes and Forest Ecoregion (blue and dark blue shading). Areas labeled with a "51" are in the Central Hardwood Forest Ecoregion. VanVliet Lake, located in Vilas County is located in the Northern Lakes and Forest Ecoregion.

5.3. Nutrient Inputs to VanVliet Lake

Based on Northern Lakes and Forests Ecoregion ranges, VanVliet Lake has phosphorus levels within range of lakes in this ecoregion. This is a desirable situation and nuisance algae blooms should be rare in VanVliet. The reason for the good lake phosphorus concentration is due to the low amount of phosphorus coming into VanVliet Lake. A summary of estimated phosphorus loads is shown in Figure 23. A total annual phosphorus load of 126 pounds of phosphorus is estimated based on a lake phosphorus concentration of 18 ppb. Rainfall appears to be the biggest nutrient contributor. The watershed area that drains to VanVliet Lake is dominated by forested acreage and nutrient inputs from the watershed are considered modest.

For onsite system nutrient inputs, the WILMS model was used. Based on 15 permanent residences and 65 seasonal residences a phosphorus loading from septic systems is about 6 pounds per year.

Phosphorus loading from groundwater is another phosphorus source to VanVliet Lake. The WDNR lake study in 1980 measured phosphorus concentrations in groundwater at 27 ppb. Using this concentration, it is estimated 12 pounds of phosphorus enters VanVliet Lake from groundwater.

The total estimated annual watershed phosphorus load to VanVliet Lake is estimated at 123 pounds.

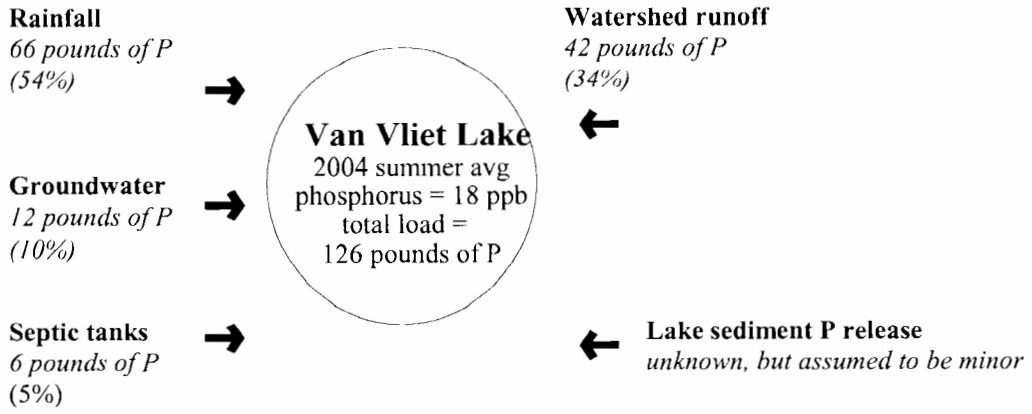


Figure 23. Sources of watershed phosphorus (P) that feed into VanVliet Lake are shown above. It is estimated that approximately 126 pounds of phosphorus enter VanVliet Lake on an annual basis.

5.4. Setting Water Quality Goals for VanVliet Lake

Water quality in VanVliet Lake appears to be about as good as would be predicted based on the ecoregion setting. Lake models were run to help determine feasible water quality goals for VanVliet Lake. A lake model is a mathematical equation that uses phosphorus inputs along with lake and watershed characteristics to predict what a lake phosphorus concentration should be. Once a lake phosphorus concentration is determined, then seasonal water clarity and algae concentrations can be calculated as well.

Two lake models were run for the following conditions and then compared to existing observed conditions.

1. Phosphorus loading under ecoregion pre-development conditions (run-off phosphorus concentration at 20 ppb).
2. Phosphorus loading from relatively unimpacted lakes under current ecoregion conditions (runoff phosphorus concentration at 50 ppb).

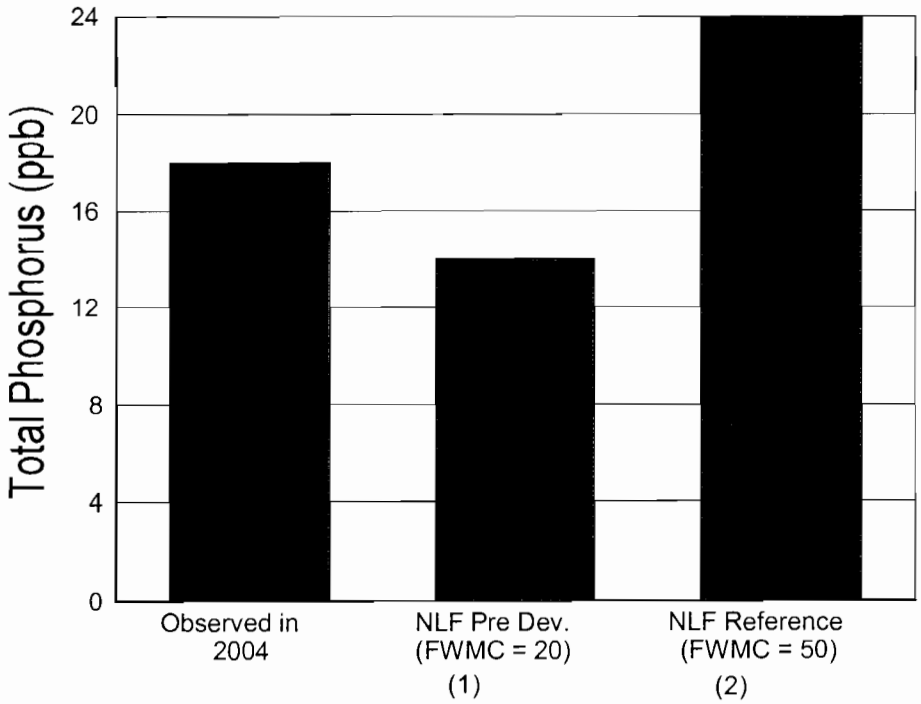


Figure 24. Comparison of total phosphorus conditions for VanVliet Lake in 2004 (red bars) to predicted conditions for a lake the size of VanVliet Lake situated in the Northern Lakes and Forest (NLF) ecoregion under two runoff conditions (blue bars)(FWMC = Flow weighted mean concentration in ppb)..

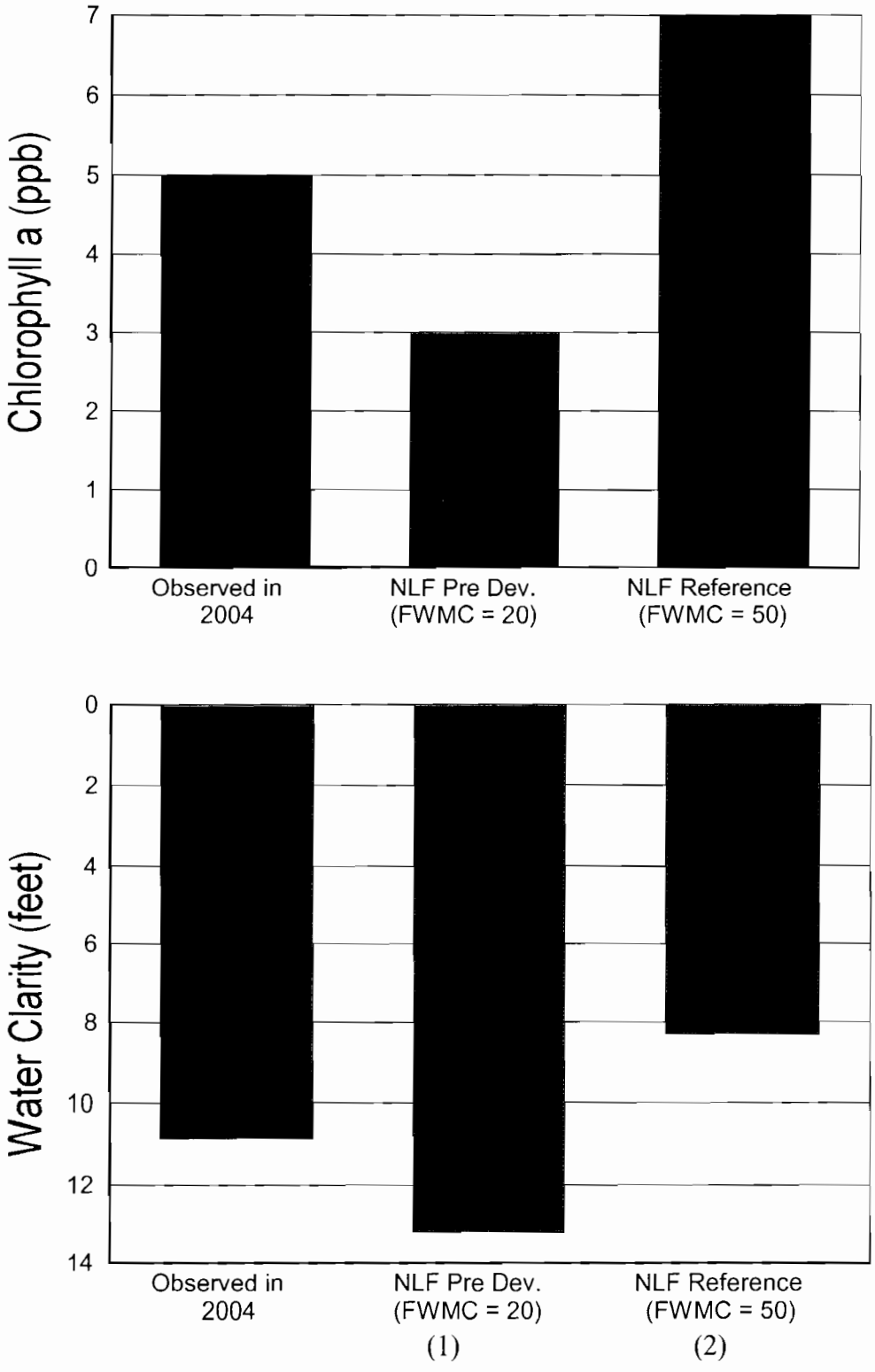


Figure 24. Comparison of chlorophyll a and water clarity conditions for VanVliet Lake in 2004 (red bars) to predicted conditions for a lake the size of VanVliet Lake situated in the Northern Lakes and Forest (NLF) ecoregion under two runoff conditions (blue bars).

Lake Goals: Based on lake modeling considerations it appears VanVliet Lake has water quality conditions that would be expected for a lake in this watershed setting.

The proposed water quality goal for lake phosphorus is 18 ppb is slightly better than the estimated ecoregion model of 24 ppb but is higher than pre-development estimates of 14 ppb.

The key to maintaining this lake phosphorus goal will be to maintain low nutrient inputs into VanVliet Lake.

5.5. Significant Findings and Water Quality Strategy

- Water quality of VanVliet is within range of lakes within the Lakes and Forests Ecoregion. Water quality parameters consisted of transparency readings, phosphorus, and chlorophyll.

- Lake water quality in VanVliet is about what would be expected based on watershed size and the ecoregion setting.

- Lake management efforts should be directed to protect the existing good water quality.

- Native aquatic plants are diverse but two species present some navigational problems. In the shallow southwest bay, fern pondweed is found close to the surface or floating. In a channel along the west side, broadleaf pondweed grows to the surface and can restrict some types of navigation.

- Managing the excessive growth of the aquatic plants could be considered. Harvesting or cutting methods are recommended for broadleaf pondweed. If a plant cutter is used then a plant collection effort is necessary.

6. Lake Management Plan for Protecting the Lake Environment

Project ideas for VanVliet Lake are geared toward long-term protection of water quality.

A list of projects has seven main components:

1. Watershed projects.
2. On-site system maintenance.
3. Aquascaping projects.
4. Aquatic plant projects.
5. Fish management options.
6. Ongoing education program.
7. Watershed and lake monitoring program.

Details for these projects areas are given in the next few pages.

Project 1. Watershed Projects

The main goal of the watershed projects program is to protect the natural character of the watershed which helps maintain good runoff water quality.

Currently, a majority of the watershed area is composed of wetlands and forests. An especially striking feature is a stand of over 400 acres of hemlocks, much of it is old growth, located in the northern end of VanVliet Lake's watershed and continuing into the Averill Lake watershed.

A hemlock stand of this type would be valuable to protect for ecological, wildlife, and lake water quality considerations.

Ongoing efforts will be needed and are recommended in order to protect and preserve this natural resource asset.

Project 2. On-site System Maintenance

The septic tank/soil absorption field has been one of the most popular forms of on-site wastewater treatment for years. When soil conditions are proper and the system is well maintained, this is a very good system for wastewater treatment. The on-site system is the dominant type of wastewater treatment found around VanVliet Lake today.

However, problems can develop if the on-site system has not been designed properly or well-maintained. Around VanVliet Lake there are probably some on-site systems that need maintenance or upgrades. At the same time, it is good practice to ensure that systems that are functioning adequately now will continue to do so in the future.

This project calls for an organized program to be developed that makes homeowners aware of all they can do to maintain their on-site systems.

A description of possible activities associated with the on-site maintenance program are described below:

- **Workshop**
  A workshop should be scheduled for VanVliet Lake Watershed residents to demonstrate the installation of a conforming septic system and the proper care and maintenance of a septic tank and septic system.

- **Septic Tank Pumping Campaign**
  Vilas County requires every septic tank associated with a permanent residence pumped 2-3 years in the shoreland area to help reduce phosphorous loading to the septic system drainfield.

- **Ordinance Implementation**
  Work to maintain enforcement of the county ordinance, where septic systems must be "evaluated" at the time a property is transferred. The seller would obtain a septic system evaluation from Vilas County at the time of property transfer. The evaluation would determine if the septic system was "failing", "non-conforming", or "conforming". A "failing" septic system includes septic systems that discharge onto the ground surface, discharges into tiles and surface waters, and systems found to be contaminating a well. The county would require a "failing" system to be brought into compliance with the Vilas County ordinance within 90 days of property transfer.

Additional information on Vilas County septic system rules in found in the Appendix.

Project 3. Aquascaping Projects

Controls are in place at the county level to guide new shoreland development. A number of excellent reference publications are available to assist in promoting shoreland stewardship. For existing shoreland properties, it is important to either maintain or to improve the natural vegetative buffer.

The shoreland area is valuable for promoting a natural lake environment and a natural lake experience for lake users. The shoreland is defined as the upland area about 300 to 1,000 feet back from the shoreline, and out into the lake to about the end of your dock (Figure 25). A shoreland with native vegetation offers more wildlife and water quality benefits than a lawn that extends to the lake's edge. A summary of attributes and functions of native plants in the shoreland area is shown in Table 15.

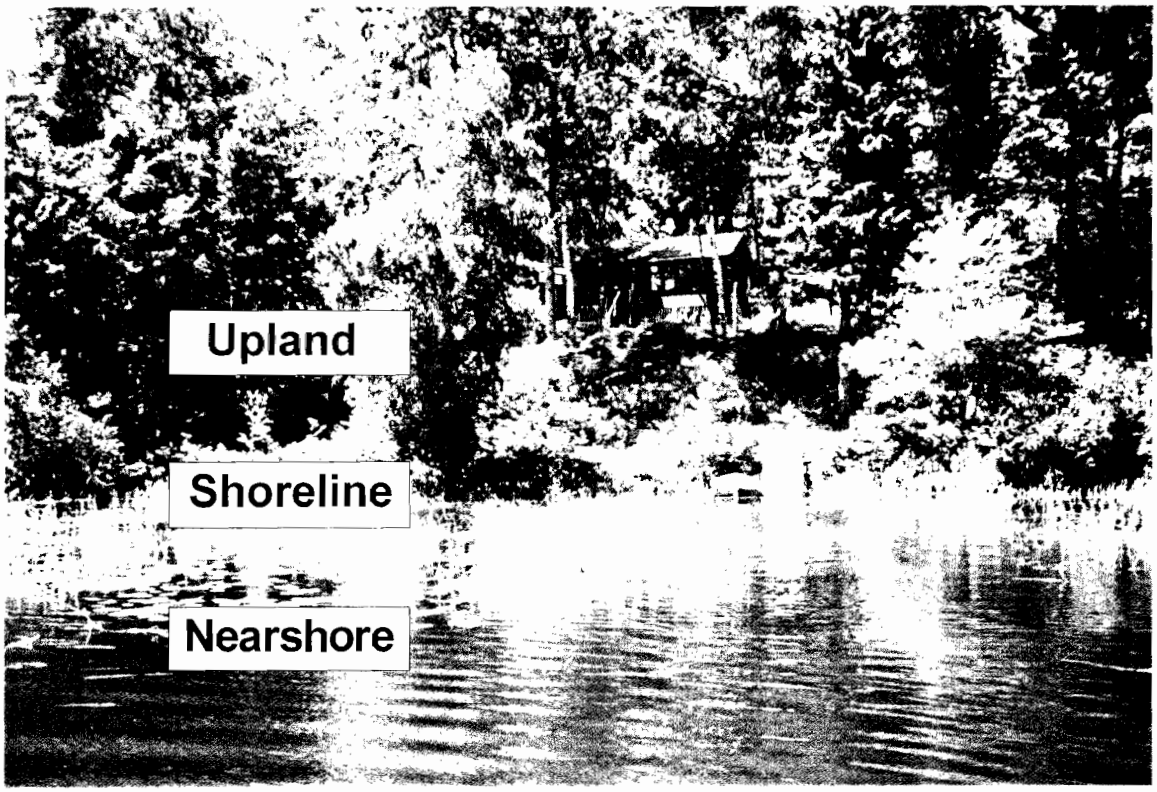


Figure 25. Cross section of the lake shoreland habitat.

Table 15. Attributes and functions of native plants in the shoreland area (Source: Henderson and others, 1999. Lakescaping for Wildlife and Water Quality. MnDNR)).

Important functions of plants in and around lakes

Submergent and emergent plants

- Plants produce leaves and stems (carbohydrates) that fuel an immense food web.
- Aquatic plants produce oxygen through photosynthesis. The oxygen is released into lake water.
- Submerged and emergent plants provide underwater cover for fish, amphibians, birds, insects, and many other organisms.
- Underwater plants provide a surface for algae and bacteria to adhere to. These important microorganisms break down polluting nutrients and chemicals in lake water and are an important source of food for organisms higher in the food chain.
- Emergent plants break the energy of waves with their multitude of flexible stems, lessening the water's impact on bank and thus preventing erosion.
- Plants stabilize bottom sediments, which otherwise can be resuspended by currents and wave action. This reduces turbidity and nutrient cycling in the lake.

Shoreline and upland plants

- Shoreline and upland plants provide food and cover for a variety of birds, amphibians, insects, and mammals above the water.
- The extensive root systems of shoreline plants stabilize lake-bank soils against pounding waves.
- Plants growing on upland slopes that reach down to lake hold soil in place against the eroding forces of water running over the ground, and help to keep lake water clean.
- Upland plants absorb nutrients, like phosphorus and nitrogen, found in fertilizers and animal waste, which in excessive concentrations are lake pollutants.

Improving Upland Native Landscape Conditions: In the glacial lake states, three broad vegetative groups occur: pine forests with a variety of ground cover species including shrubs and sedges: hardwood forests with a variety of understory species, including ferns: and tallgrass prairie with a variety of grasses as well as bur oaks and willow trees. Residences around VanVliet Lake are in the hardwood forest group.

Reestablishing native conditions in the shoreland area not only improves stormwater runoff quality, it also attracts a variety of wildlife and waterfowl to the shoreland area. Benefits multiply when other neighbors naturalize because the effects are cumulative and significant for water quality and wildlife habitat.

When installing native vegetation close to the shoreline residents are actually installing a buffer. A buffer is a strip of native vegetation wide-enough to produce water quality and wildlife improvements. Much of the natural vegetative buffer has been lost in shoreland areas with development where lawns have been extended right down to the shore.

Lawns are not necessarily bad for a lake. However they can be over fertilized and then runoff carries phosphorus to the lake. Also, lawns function as a low grade open prairie, with poor cover for wildlife and a food supply that is generally poor, except for geese

who may find it attractive. Replacing lawn areas with native landscaping projects reduces the need for fertilizer, reduces the time it takes to mow, increases the natural beauty of a shoreland area, and attracts wildlife.

Lawns do not make very good upland buffers. With runoff, short grass blades bend and do not serve as a very effective filter. Tall grass that remains upright with runoff is a better filter. Kentucky bluegrass (which actually is an exotic grass) is shallow-rooted and does not protect soil near shorelines as well as deep-rooted native prairie grasses, shrubs, or other perennials. Grass up to the shoreline offers poor cover, so predators visit other hiding areas more frequently reducing the prey food base and limiting predator populations in the long run. Also with short ground cover, ground temperatures increase in summer, evapotranspiration increases and results in drying conditions, reducing habitat for frogs and shoreline dependent animals.

Buffer Strip Considerations: A functional upland buffer should be at least 15 feet deep. With this you start getting water quality and wildlife habitat benefits. But a 35 foot deep buffer is recommended. In the past, before lakeshore development, buffers ringed the entire lake. For lakeshore residents it is recommended the length of the buffer extend for 75% of the shoreline, although 50% would produce buffer benefits.

A buffer strip can address two problem areas right away. Geese are shy about walking through tall grass because of the threat of predators. There will always be a few who charge right through but it is a deterrent for most of them. Also, muskrats shouldn't be a problem. They may burrow into the bank, but generally not more then 10 feet. With a buffer going back 15 to 25 feet, you won't be mowing over their dens. An occasional den shouldn't produce muskrat densities that limit desirable aquatic vegetation.

Several types of buffers can be installed or propagated that offer nutrient removal as well as wildlife benefits. Examples include:

Tall grass, sedge, flower buffer: Provides nesting cover for mallards, blue-winged teal and Canada geese. Provides above ground nesting habitat for sedge wrens, common yellow throat and others.

Shrub and brush buffer: Provides nesting habitat for lakeside songbirds such as yellow warblers, common yellowthroat, swamp sparrows, and flycatchers. It also provides significant cover during migration.

Forested buffers: Provides habitat for nesting warblers and yellow-throated vireo, Diamond herons, woodducks, hocked mergansers, and others. Upland birds such as red-winged blackbirds, orioles, and woodpeckers use the forest edge for nesting and feeding habitat.

Even standing dead trees, which are referred to as snags, have a critical role. When they are left standing they serve as perching sites for kingfishers and provide nesting sites for herons, egrets, eagles, and ospreys. In the midwest over 40 bird species and 25 mammal species use snags. To be useful, they should be at least 15 feet tall and 6-inches in diameter.

The initial step for lake residents to get started is to simply make a commitment to try something. Just what the final commitment is evolves as they go through a selection process. The next step in the process is to conduct a site inventory. On a map with lot boundaries, house and buildings, driveway, turf areas, trees, shrubs, and other features are drawn. If there is a chance, the property is checked during a rainstorm. Look for sources of runoff and even flag the routes. Find out where the water from the roof goes, and see if there are temporary ponding and infiltration areas. Are the paths down to the lake eroding? Then the next step is to consider a planting approach.

Native Landscaping for Buffers: Three Approaches: Native landscaping efforts can be put into three categories:

1. Naturalization
2. Accelerated Naturalization
3. Reconstruction

1. Naturalization: With this approach, the resident is going to allow an area to go natural. Whatever is present in the seedbank is what will grow. If they want to install a buffer along the shoreline, let a band of vegetation grow at least 15 feet deep from the shoreline back and preferably 25 feet or deeper. Just by not mowing will do the trick. Residents can check how it looks at the end of the summer. It will take up to three years for flowers and native grasses to grow up and be noticed. Residents can also select other spots on their property to "naturalize".

2. Accelerated Naturalization: After developing a plant list of species from the area, residents may want to mimic some features right away. They can lay out a planting scheme and plant right into existing vegetation. Several Minnesota nurseries can supply native plant stock and seeds. The nurseries can also help select plants and offer planting tips. Wildflowers can be interspersed with wild grasses and sedges. Mulch around the new seedlings. With this approach lake residents can accelerate the naturalization process.

3. Reconstruction: To reestablish a native landscape with the resident's input and vision, another option is to reconstruct the site with all new plants. Again plant selection should be based on plants growing in the area. Site preparation is a key factor. Residents will want to eliminate invasive weeds and eliminate turf. This can be done with either herbicides or by laying down newsprint or other types of paper followed by 4 to 6 inches of hardwood mulch. Plantings are made through the mulch. This is the most expensive of the three native landscaping categories. Residents can do the reconstruction all at once, or phase it in over 3 to 5 years. This allows them to budget annually and continue evolving the plan as time goes by.

Also mixing and matching the level-of-effort categories allows planting flexibility. Maybe a homeowner employs naturalization along the sides of the lot and reconstruction for half of the shoreline and accelerated naturalization for the other half. Examples of the three approaches are shown in Figure 26.

Project 4. Aquatic Plant Projects

Currently, VanVliet Lake has a variety of emergent and submergent aquatic plant growth. Aquatic plants are vital for helping sustain clear water conditions and contribute to fish habitat. Currently, there are no exotic plant species found in VanVliet Lake. However, in a couple of areas, native aquatic plants can produce navigational hindrances in some summers.

The primary aquatic plant goal is to maintain and/or protect submerged aquatic plants in VanVliet Lake. Two plant protection ideas are given below:

1. Maintaining good shoreland conditions can promote improved plant distribution. Ongoing aquatic plant monitoring and delineation will be important.

2. Conduct pondweed control demonstrations to evaluate the best way to control nuisance growth in VanVliet Lake.

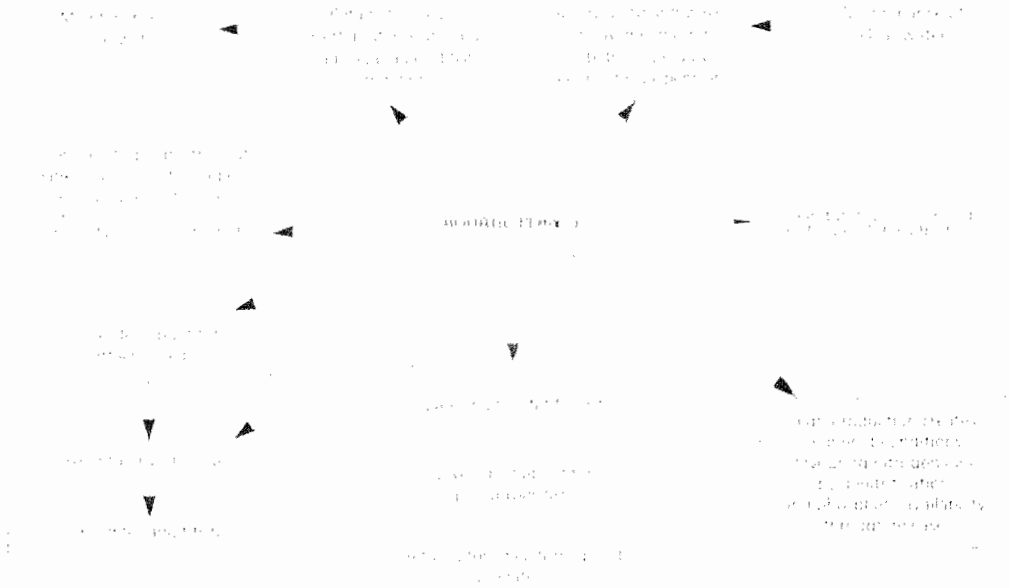


Figure 27. Links between aquatic plants and other organisms, including ourselves (source: Moss and others. 1996. A guide to the restoration of nutrient-enriched shallow lakes. Broads Authority Norwich, England).

Aquatic Plant Management Options: Based on the aquatic plant survey results from 2004, two species of native aquatic plants may produce some navigational restrictions in the southwest bay and along the western shoreline of VanVliet Lake.

In the southwest bay, fern pondweed is found either floating at the surface or anchored in the soft sediment and extending into the water column. Because the bay is only 2 to 3 feet deep, it does not take much plant material to produce nuisance conditions.

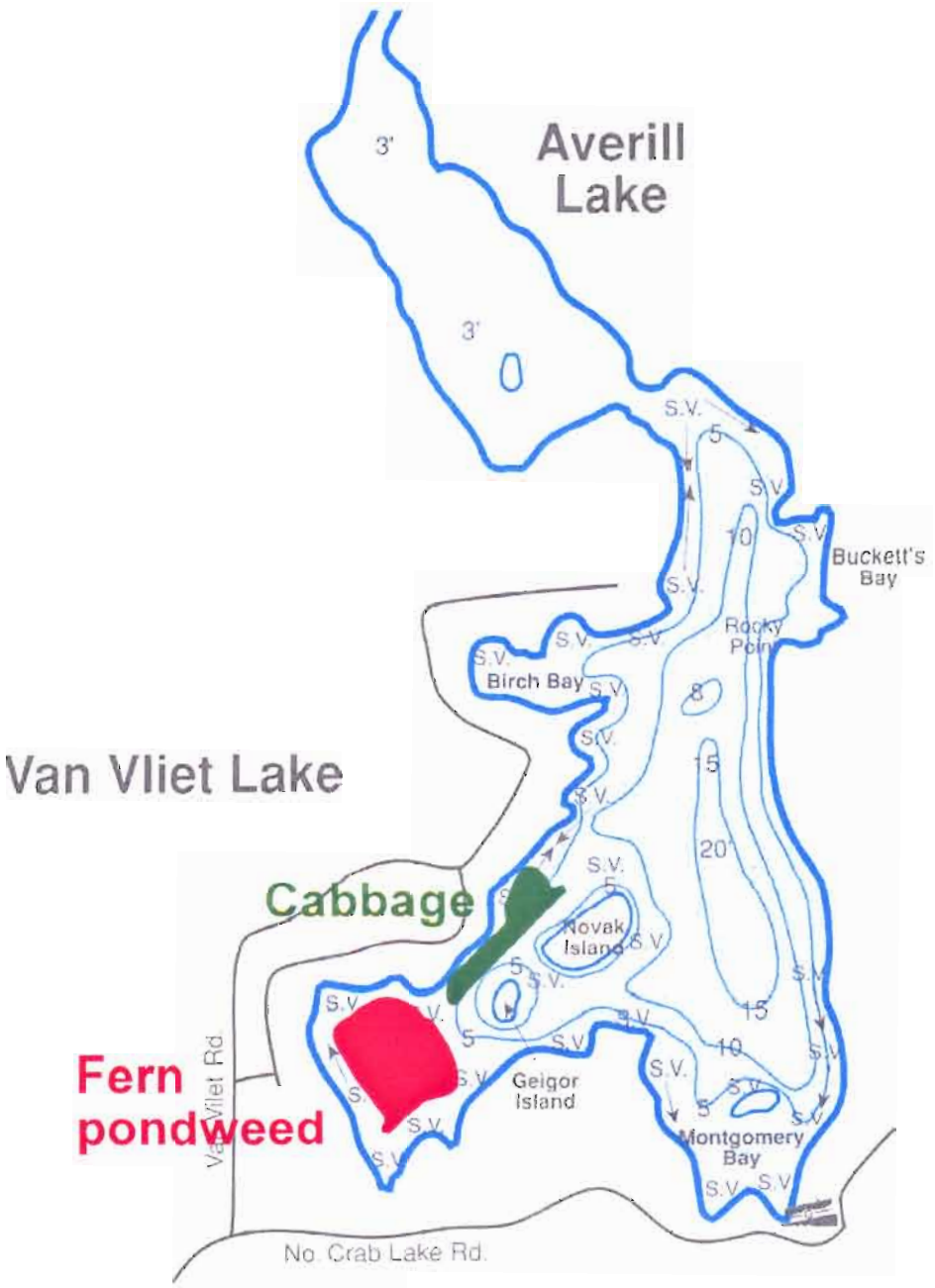


Figure 28. Areas where aquatic plants have occasionally grown to nuisance conditions. In the southeast bay (Montgomery Bay on the map), fern pondweed, and elodea grow up to the surface in shallow water (4 feet or less). Navigation channels could be cut through these areas to facilitate boat traffic in and out of VanVliet Lake.

It appears that fern pondweed conditions in early summer are probably influenced by ice effects. In the shallow bay, ice typically reaches to the lake bottom and may entrain pondweed into the ice. When the ice goes out, some fern pondweed is brought to the surface and floats for a while although it eventually sinks. However, later in the summer, normal growth of fern pondweed occurs and because the bay is only 2 to 3 feet deep, even average plant growth can result in plants reaching the water surface. If plant management is considered, a mechanical harvester is recommended because it will pick up the plant material. However, because of the soft sediment, there will be come sediment resuspension and a turbid condition will persist for a few days after harvesting is completed. Estimated cost of hiring the harvester for one day is about $1,000. It is estimated a mechanical harvester could cover about five to six acres of the sparsely growing fern pondweed per day.

Figure 29. Fern pondweed is a weakly rooted plant and is the dominant plant in the soft mucky sediment in the southwest bay.

Another area where plants grow to the surface is along the western side of VanVliet. Here the plant species is a broadleaf pondweed also referred to as cabbage. When cabbage reaches the water surface, navigation is hindered. Cutting or harvesting a channel about 20 to 30 feet wide through the surface matted growth would allow unrestricted navigation and should not harm the lake. If a cutter is used, cut weeds should be picked up. Mechanical harvesters pick-up most of the plants that are cut. Hiring a mechanical harvester to cut a channel would cost about $800 - $1,000. A single day of harvesting would probably be enough to create channels through the plant patch.

Figure 30. A mechanical harvester is recommended for picking up fern pondweed in the shallow southwest bay if plant management is considered.

Figure 31. Hockney-type weed cutter or a mechanical harvester could be used to cut one or two channels through the cabbage on the west side of VanVliet Lake.

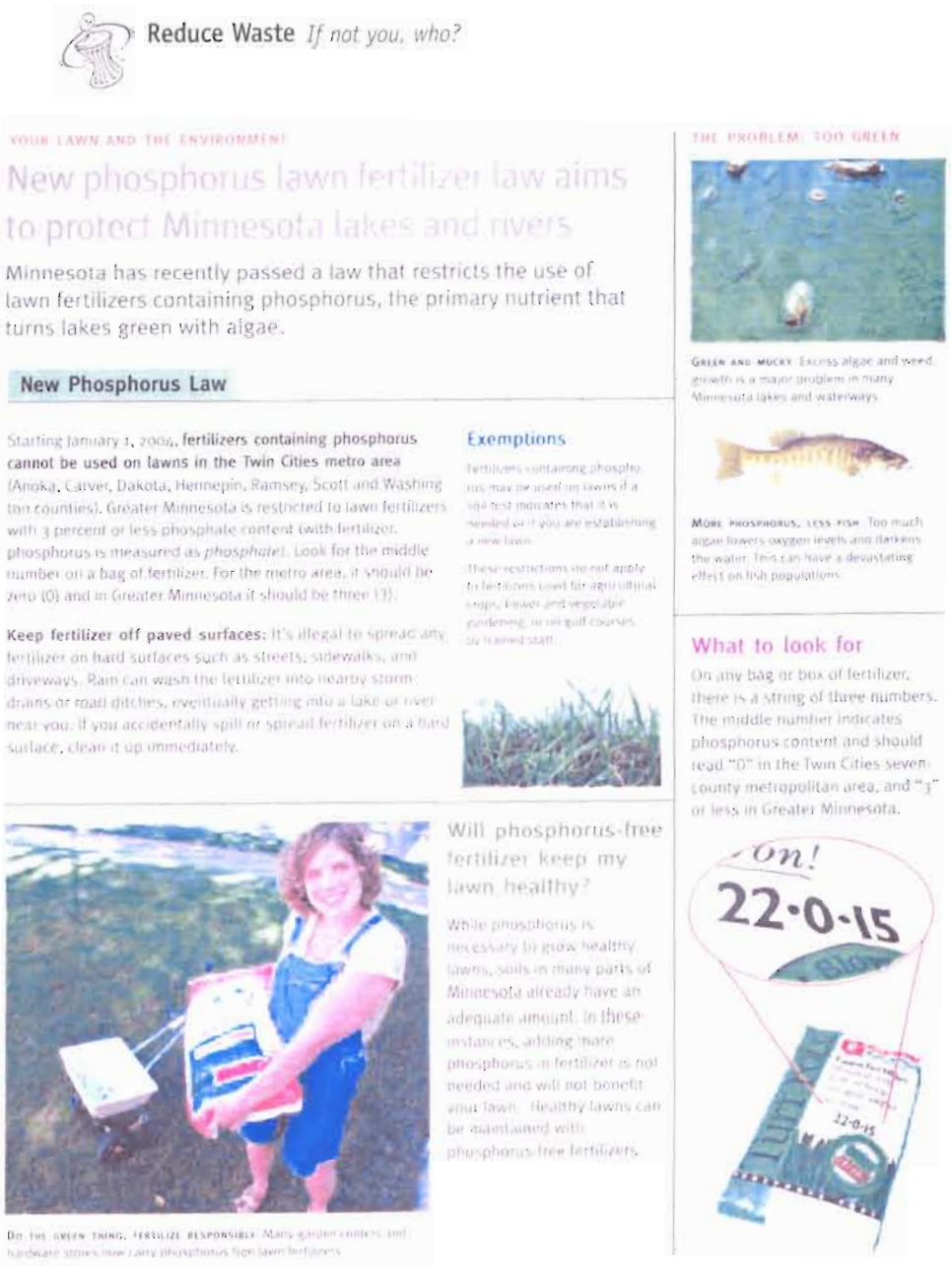
Project 5. Fish Management Options

VanVliet Lake is a part of the Presque Isle Chain, which includes Presque Isle, Averill, and VanVliet Lakes. All three lakes are managed as a group. Boom shocking surveys indicate natural walleye reproduction is occurring in the chain and walleye stocking is probably unnecessary. Currently the plan by the WDNR is to stock muskies at one fish per two lake acres on odd numbered years.

One fishing tournament per year, usually over a weekend, is held on the chain. Fishing pressure and impacts are not considered to be excessive by the WDNR.

Project 6. Ongoing Education Program

Lake residents get an important amount of lake protection information from the lake newsletter. Each issue should offer tips on lake protection techniques. There is abundant material available. An example of an informational piece is shown below.



Reduce Waste *If not you, who?*

YOUR LAWN AND THE ENVIRONMENT

New phosphorus lawn fertilizer law aims to protect Minnesota lakes and rivers

Minnesota has recently passed a law that restricts the use of lawn fertilizers containing phosphorus, the primary nutrient that turns lakes green with algae.

New Phosphorus Law

Starting January 1, 2004, **fertilizers containing phosphorus cannot be used on lawns in the Twin Cities metro area** (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties). Greater Minnesota is restricted to lawn fertilizers with 3 percent or less phosphate content (with fertilizer, phosphorus is measured as *phosphate*). Look for the middle number on a bag of fertilizer. For the metro area, it should be zero (0) and in Greater Minnesota it should be three (3).

Keep fertilizer off paved surfaces: It's illegal to spread any fertilizer on hard surfaces such as streets, sidewalks, and driveways. Rain can wash the fertilizer into nearby storm drains or road ditches, eventually getting into a lake or river near you. If you accidentally spill or spread fertilizer on a hard surface, clean it up immediately.

Exemptions

Fertilizers containing phosphorus may be used on lawns if a soil test indicates that it is needed or if you are establishing a new lawn.

These restrictions do not apply to fertilizers used for agricultural crops, flower and vegetable gardening, or on golf courses by trained staff.

DO THE GREEN THING. FERTILIZE RESPONSIBLY. Many garden centers and hardware stores now carry phosphorus free lawn fertilizers.

Will phosphorus-free fertilizer keep my lawn healthy?

While phosphorus is necessary to grow healthy lawns, soils in many parts of Minnesota already have an adequate amount. In these instances, adding more phosphorus in fertilizer is not needed and will not benefit your lawn. Healthy lawns can be maintained with phosphorus free fertilizers.

THE PROBLEM: TOO GREEN

GREEN AND MUCKY. Excess algae and weed growth is a major problem in many Minnesota lakes and waterways.

MORE PHOSPHORUS, LESS FISH. Too much algae lowers oxygen levels and darkens the water. This can have a devastating effect on fish populations.

What to look for

On any bag or box of fertilizer, there is a string of three numbers. The middle number indicates phosphorus content and should read "0" in the Twin Cities seven county metropolitan area, and "3" or less in Greater Minnesota.

What can you do to protect water quality?

Fertilizers, leaves, grass clippings, eroded soil, and animal waste are all sources of phosphorus. When they are swept or washed into the nearest street or storm drain, they end up in your local lake or river. You can do your part to protect water quality by doing the following:

- Follow Minnesota's new phosphorus lawn fertilizer law.
- Keep leaves and lawn clippings out of your gutters, streets, and ditches.
- Clean lawn and garden equipment on the grass, not on hard surfaces. Never wash or blow soil or grass clippings into the street.
- Pick up pet waste promptly. Pet waste can contain harmful bacteria as well as nutrients. Never drop pet waste in the street or ditches.

- Control soil erosion around your house. When left bare, soil is easily washed away with rain, carrying phosphorus with it. Soil erosion can be prevented by keeping soil covered with vegetation or mulch.

To obtain additional copies of this fact sheet

contact Office of Environmental Assistance's **Education Clearinghouse** at 1-800-877-6300, 651-215-0232 or e-mail: clearinghouse@moea.state.mn.us

Sweep it up. Grass clippings and leaves left on streets and sidewalks are a major source of phosphorus.

Find out what you need: Test your soil

A soil test is a good idea, especially if you are concerned that your lawn may need phosphorus.

Instructions on soil testing are available through the University of Minnesota Extension Service's INFO-U by calling 612-624-2200 (metro) or 1-800-525-8636 and requesting message 468.

Soil testing information can also be obtained through the Internet by visiting **www.extension.umn.edu** and searching for "Lawn Soil Testing."

A list of laboratories certified for soil testing by the Minnesota Department of Agriculture can be found at **www.mda.state.mn.us/appd/soilabs.htm**.

Visit **www.reduce.org** for lots of ideas about reducing waste and toxic chemicals in your day-to-day life.

reduce.org

For more information on lawn care

- The **Yard & Garden Line** is the University of Minnesota Extension Service's one-stop telephone link to information about plants and insects in the home landscape. Call 612-624-4771, or (toll free) 1-888-624-4771 in Greater Minnesota.
- University of Minnesota **Extension Service's web site**: www.extension.umn.edu. From the home page click on "Garden" then on "Lawns."
- University of Minnesota Extension Service - **Sustainable Urban Landscape Information Series** (SULIS): www.sustland.umn.edu. From the home page, click on "Maintenance" then on "Lawn care."
- **Minnesota Department of Agriculture**: www.mda.state.mn.us. From the home page, click on "Water & Land," then on "Lawn Care & Water Quality."

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Project 7. Watershed and Lake Monitoring Program

At this time, because of good lake water quality and no permanent stream inflows, watershed water quality monitoring is not proposed. A lake monitoring program is outlined in Table 16. It is designed to be flexible to accommodate the volunteer work force and a fluctuating budget.

Table 16. VanVliet Lake Water Quality Monitoring Program

Category	Level	Alternative	Labor Needed	Cost/Year
A. Dissolved oxygen and temperature profiles	1	Check dissolved oxygen in VanVliet Lake once per month in January, February, and March depending on winter conditions.	Moderate	$0
	2	Check dissolved oxygen in VanVliet Lake every one to two weeks in December, January, February, and March, depending on winter conditions.	Moderate	$0
	3	Check dissolved oxygen and temperatures once per month from May - September.		
B. Water clarity	1	Secchi disc taken at spring and fall turnover.	Low	$0
	2	Secchi disc monitoring once per month May - October.	Low-moderate	$0
	3	Secchi disc monitoring twice per month, May - October.	Moderate	$0
C. Water chemistry	1	Spring and fall turnover samples are collected and sent to UW-Stevens Point. Selected parameters for analysis include: TP and chlorophyll.	Low	$200
	2	Sample for phosphorus and chlorophyll once per month from May - September (surface water only) with the Self-Help Monitoring Program.	Low-moderate	$300
	3	Sample for phosphorus and chlorophyll twice per month from May - October.	Moderate	$600
	4	Sample for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N once per month (May-October)	Moderate	$960
	5	Sample for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N twice per month (May-October).	Moderate	$1,920
D. Special samples or surveys	1	Special monitoring: suspended solids, BOD, chloride, turbidity, sampling bottom water, and other parameters as appropriate. Aquatic plant surveys, etc.	--	$100-$3,000

A recommended monitoring program consists of Level A1, A3, B2, and C3 annually. An aquatic plant survey (Level D1) should be conducted every three years.

Appendix A

Special Project: Lake Sediment Testing Used to Evaluate Potential for the Nuisance Growth of Two Species of Exotic Aquatic Plants

Lake Sediment Sample Objectives: Sampling results from over 50 lakes indicate lake sediment characteristics help delineate areas of potential nuisance verses non-nuisance growth for two invasive aquatic plant species, curlyleaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) (where nuisance growth is defined as plants matting at the surface)(McComas, unpublished). Lake sediments were collected using a zone sampling program and standard agricultural soil test methods were used for lake sediment analysis. For curlyleaf pondweed, the primary parameter correlated with nuisance growth conditions was a sediment pH above 7.7. Other important parameters included a bulk density less than 0.50 g/cm^3-dry, organic matter greater then 30% and a Fe:Mn ratio of less than 1.6. Nuisance growth of Eurasian watermilfoil was influenced by different conditions. The two most significant sediment parameters were nitrogen, as exchangeable ammonia greater than 10 µg/cm^3-dry, and organic matter, less than 20%.

Knowing the delineation of potential nuisance and non-nuisance plant growth using lake sediment sampling assists managers in formulating aquatic plant management actions. For example, where sediment results indicate non-nuisance growth conditions would be expected, those areas can be left alone because the non-native plants present no ecological or recreational problem.

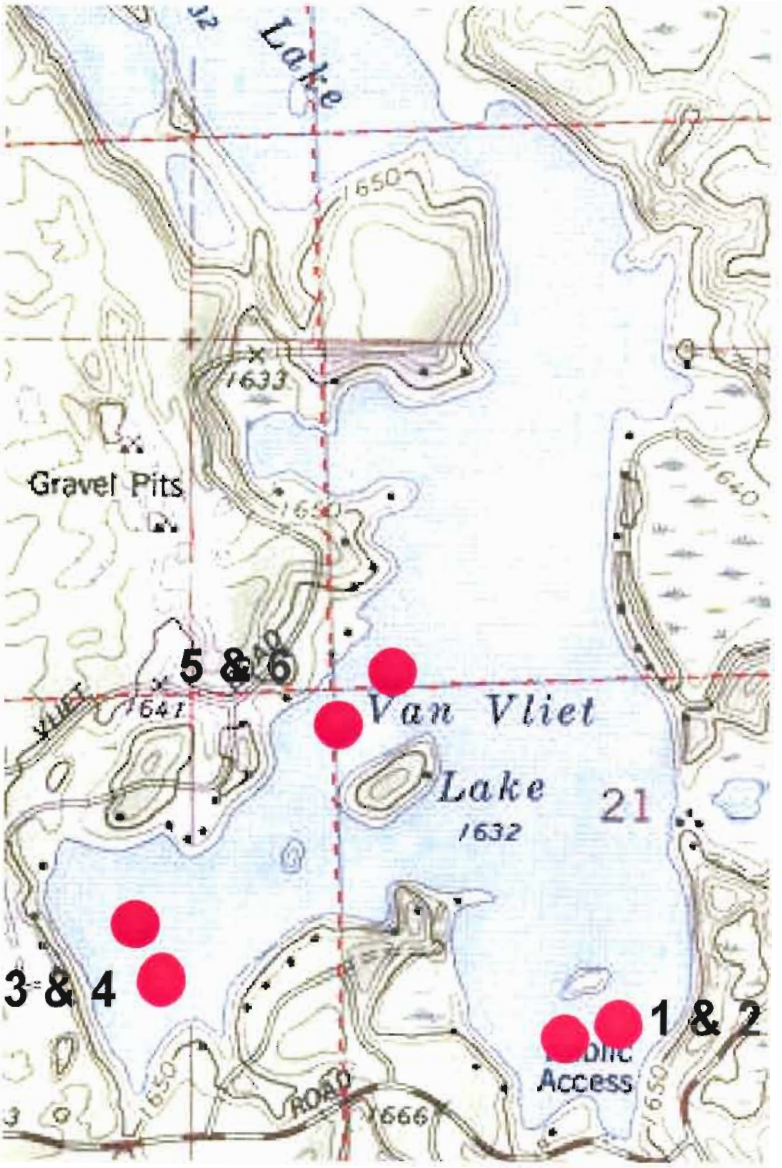

Figure A-1. Lake sediment sample locations.

Results of the lake sediment testing are shown in Table A1.

Table A-1. VanVliet sediment results for six samples from three primary sites.

	Site 1		Site 2		Site 3	
	1	2	3	4	5	6
Bulk density	0.35	0.37	0.43	0.35	0.35	0.33
Organic matter	54.6	52.9	71.1	70.3	52.5	51.4
pH	5.4	5.5	5.4	5.7	5.4	5.4
NH_4-N	2.5	1.9	10.0	3.4	2.7	2.5
Bray P	0.9	0.6	6.6	2.6	0.6	0.6
Olsen P	1.5	1.0	7.4	2.1	0.9	0.6
K	18.1	16.5	54.8	21.2	13.6	10.4
Ca	645	665	1,133	690	477	401
Mg	37.6	45.3	124	54.7	40.1	32.8
Fe	340	293	304	261	354	325
Mn	25.1	19.6	38.8	25.8	21.2	19.6
SO_4	674.5	54.5	353	66.4	26.6	28.6
B	0.9	0.8	1.4	0.6	0.6	0.6
Zn	5.0	3.7	7.3	3.7	2.8	2.5
CU	1.5	1.7	2.3	1.4	1.9	1.8
Fe:Mn	13.6	15.0	7.8	10.1	16.7	16.6
Site characteristics			loose sediment	fern pondweed	cabbage	cabbage

Sediment results indicate there is only a moderate potential for the exotic plant, curlyleaf pondweed, to grow to nuisance conditions at three locations sampled in VanVliet Lake. Currently, curlyleaf pondweed is not found in VanVliet Lake.

Table A-2. VanVliet Lake sediment data and ratings for potential nuisance curlyleaf pondweed growth.

Sample ID	Bulk density (g/cm^3)	Organic Matter (%)	pH (su)	Fe:Mn Ratio	Potential for Nuisance Curlyleaf Pondweed Growth
non-nuisance	1.04	5	6.8	4.6	Low
light nuisance	0.94	11	6.2	5.9	Med
heavy nuisance	<0.51	>20	>7.7	<1.6	High
1	0.35	54.6	5.4	13.6	Medium
2	0.37	52.9	5.5	15.0	Medium
3	0.43	71.1	5.4	7.8	Medium
4	0.35	70.3	5.7	10.1	Medium
5	0.35	52.5	5.4	16.7	Medium
6	0.33	51.4	5.4	16.6	Medium

Sediment results indicate there is a low potential for the exotic plant, Eurasian watermilfoil, to grow to nuisance conditions in VanVliet Lake. Currently, Eurasian watermilfoil is not found in VanVliet Lake.

Table A-3. VanVliet Lake sediment data and ratings for potential nuisance Eurasian watermilfoil growth.

Sample Number	NH_4 ($\mu g/cm^3$)	Organic Matter (%)	Potential for Nuisance EWM Growth
non-nuisance or light nuisance	<10	>20	Low (green) to Medium (yellow)
heavy nuisance	>10	<20	High (red)
1	2.5	54.6	Low
2	1.9	52.9	Low
3	10.0	71.1	Medium
4	3.4	70.3	Low
5	2.7	52.5	Low
6	2.5	51.4	Low