

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.

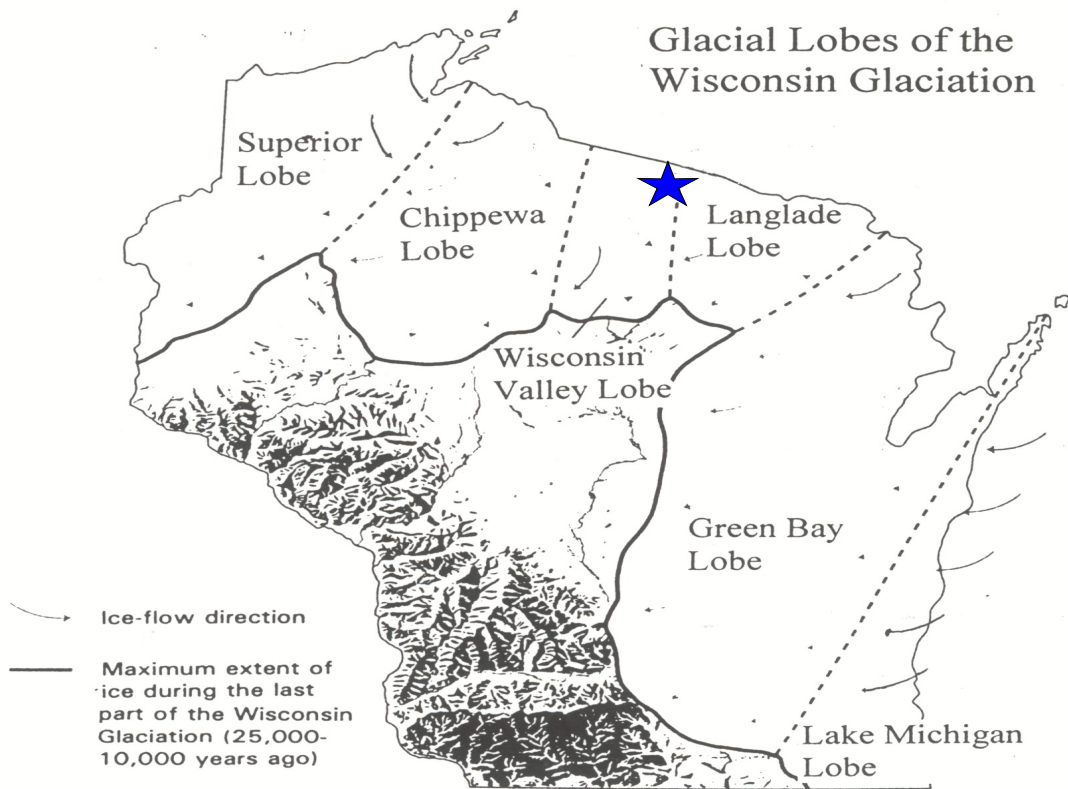


Figure 2. Glacial lobes of the Wisconsin glaciation. VanVliet Lake is located in the Wisconsin Valley lobe.

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).

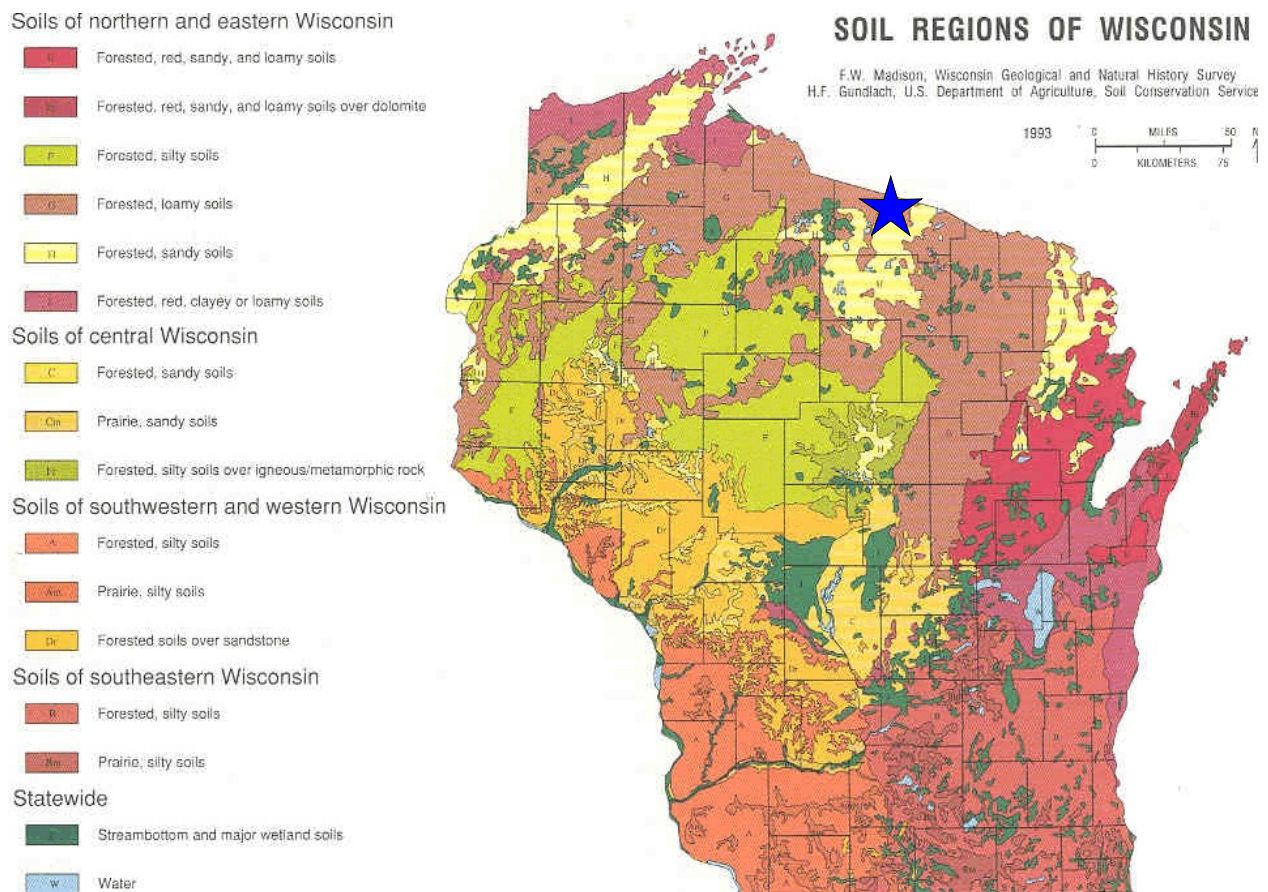


Figure 3. VanVliet Lake is located within a soils group characterized as forested silty soils.

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.

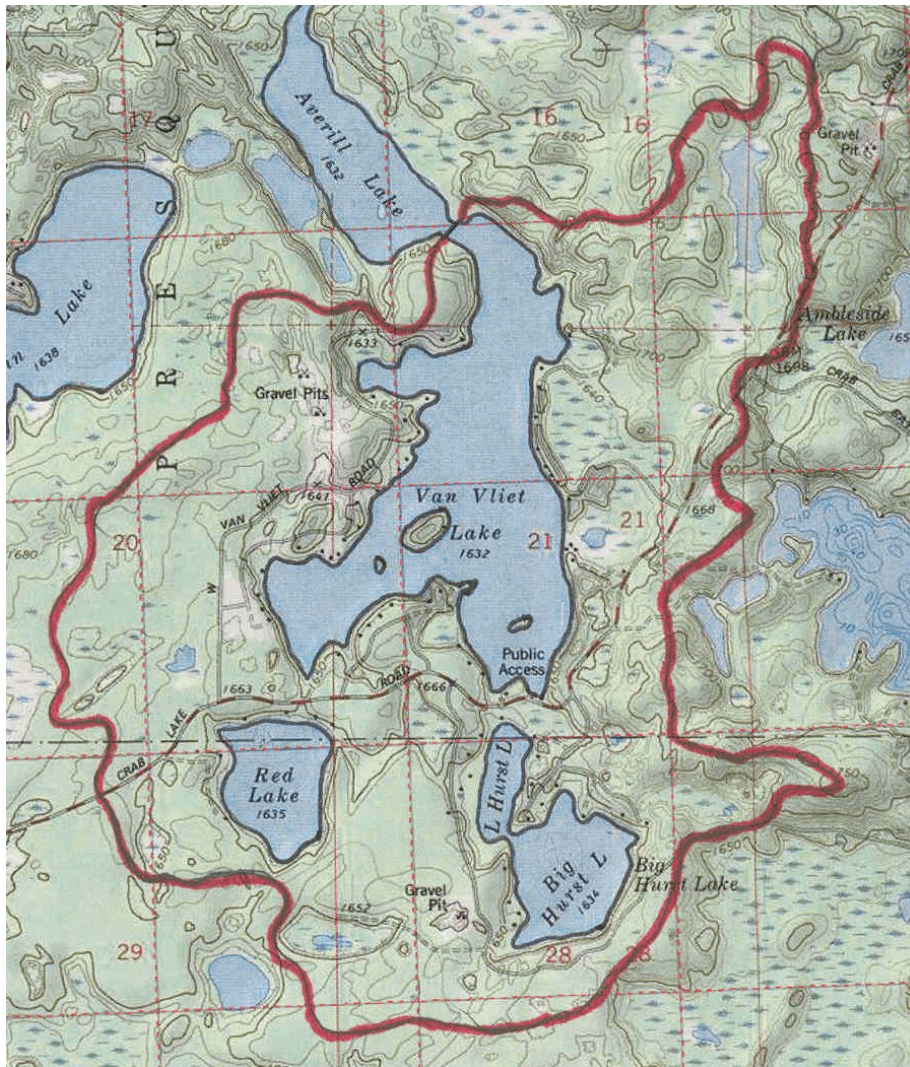


Figure 4. Watershed area for VanVliet Lake (delineation was made by Blue Water Science, 2004).

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 (#)	Undeveloped 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 (#)	Undeveloped 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

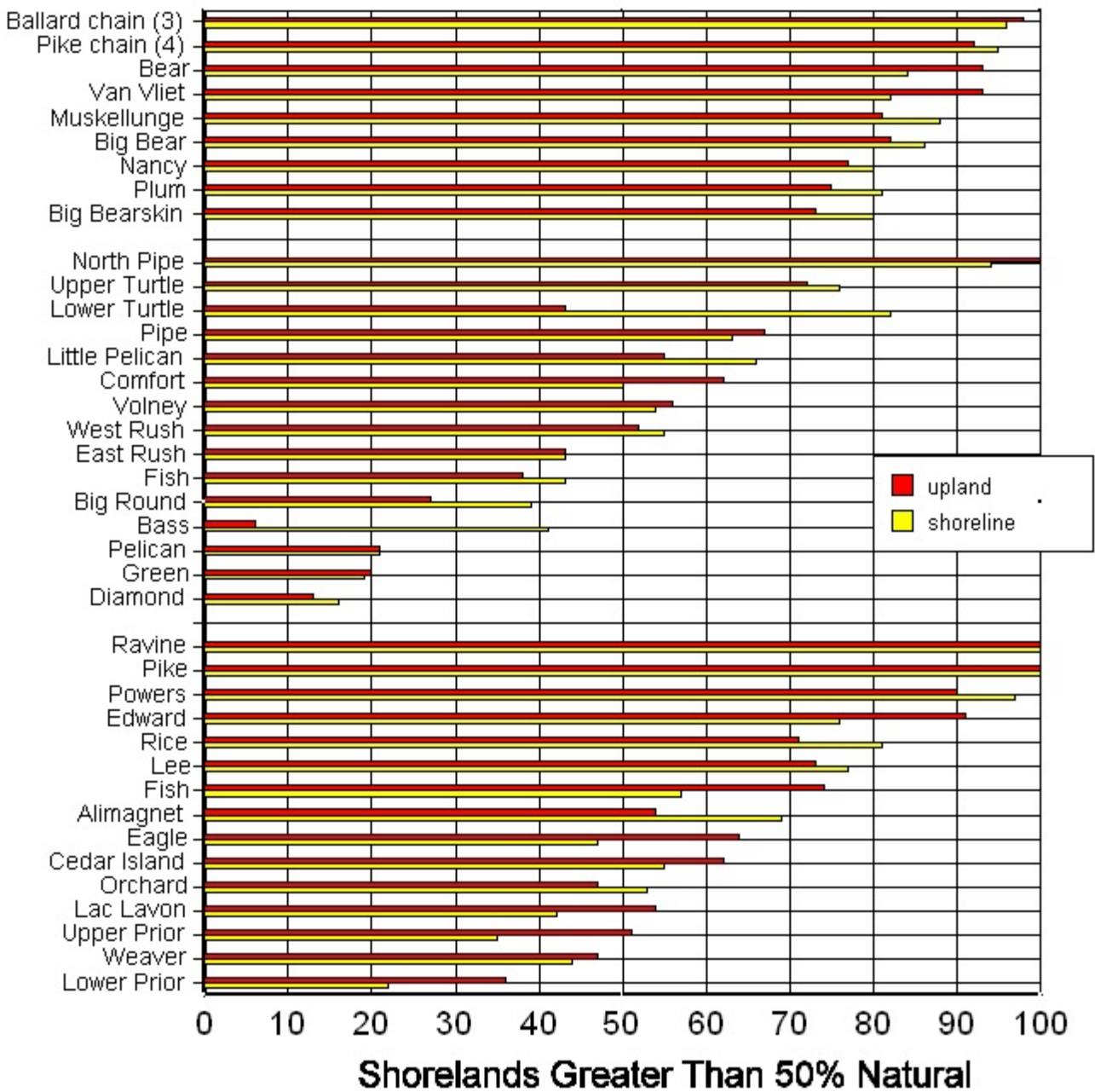


Figure 6. A summary of shoreland inventory results for lakes using an evaluation based on shoreland photographs. For each lake the percentage of shoreline and upland conditions with greater than 50% natural conditions is shown. The first tier of lakes are located in northern Wisconsin. The lower tier 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 microSiemens/cm² or micro umhos/cm². . . 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 in 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.

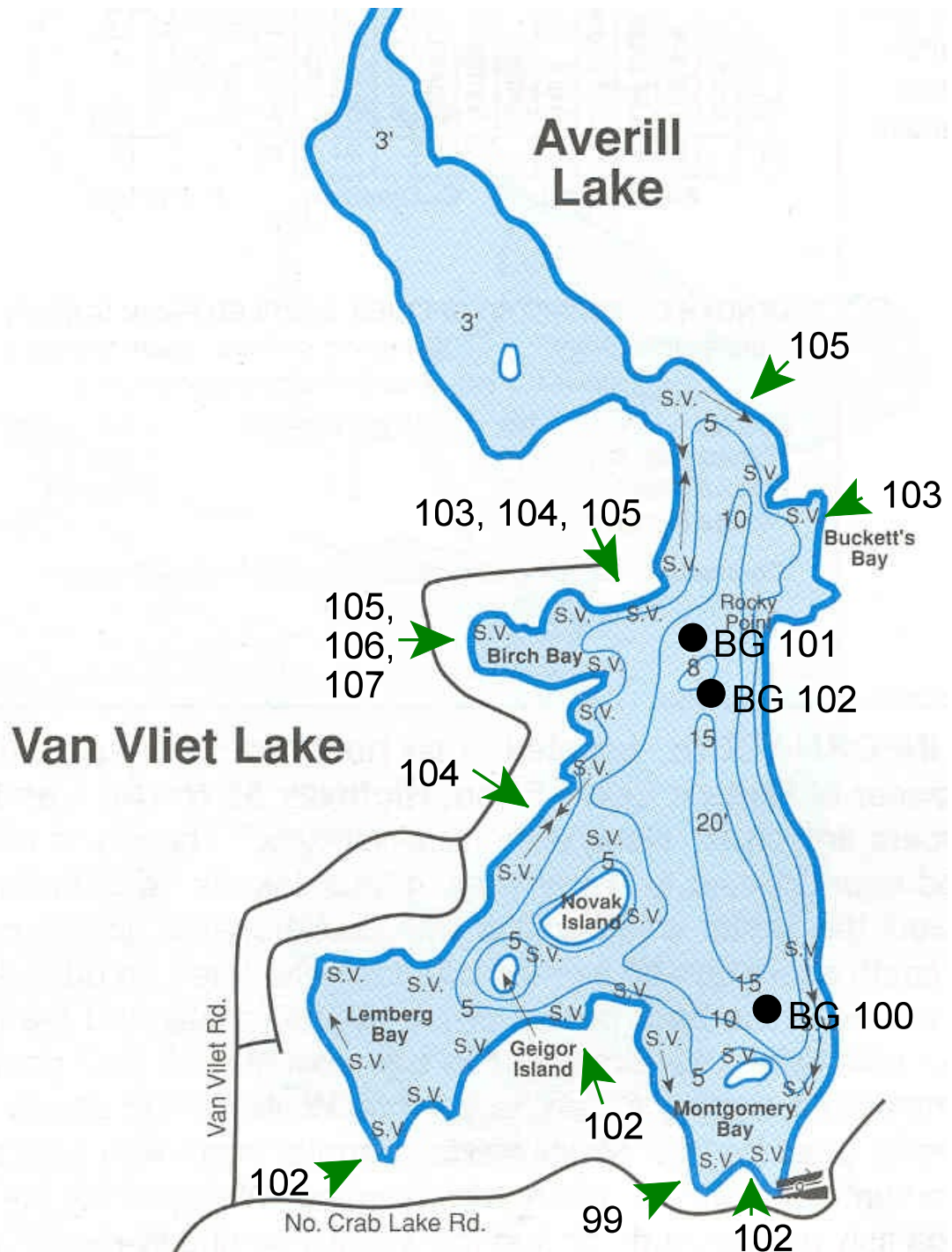


Figure 7. VanVliet Lake conductivity survey. Numbers on map represent conductivity readings in umhos/cm². BG represents background readings which were 100 - 102. Conductivity readings greater than background could indicate areas of groundwater inflow.



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.

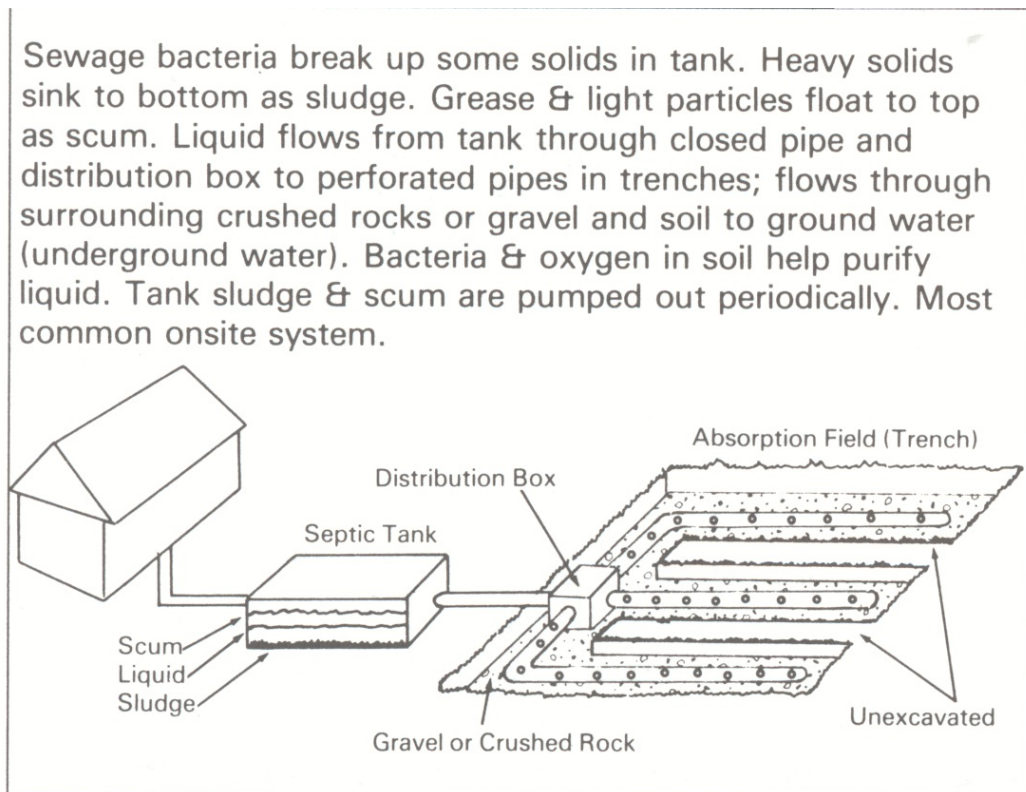


Figure 9. Typical onsite wastewater treatment system found in the VanVliet Lake watershed.

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.

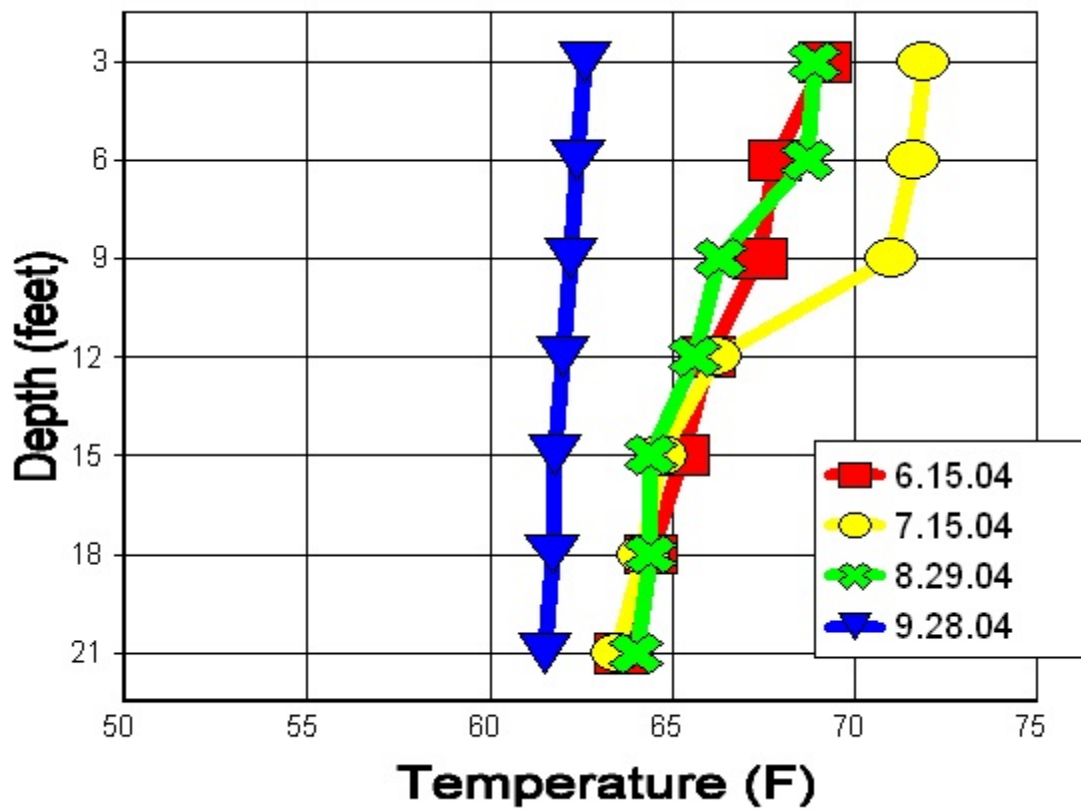


Figure 12. Temperature profiles for the summer of 2004.

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.

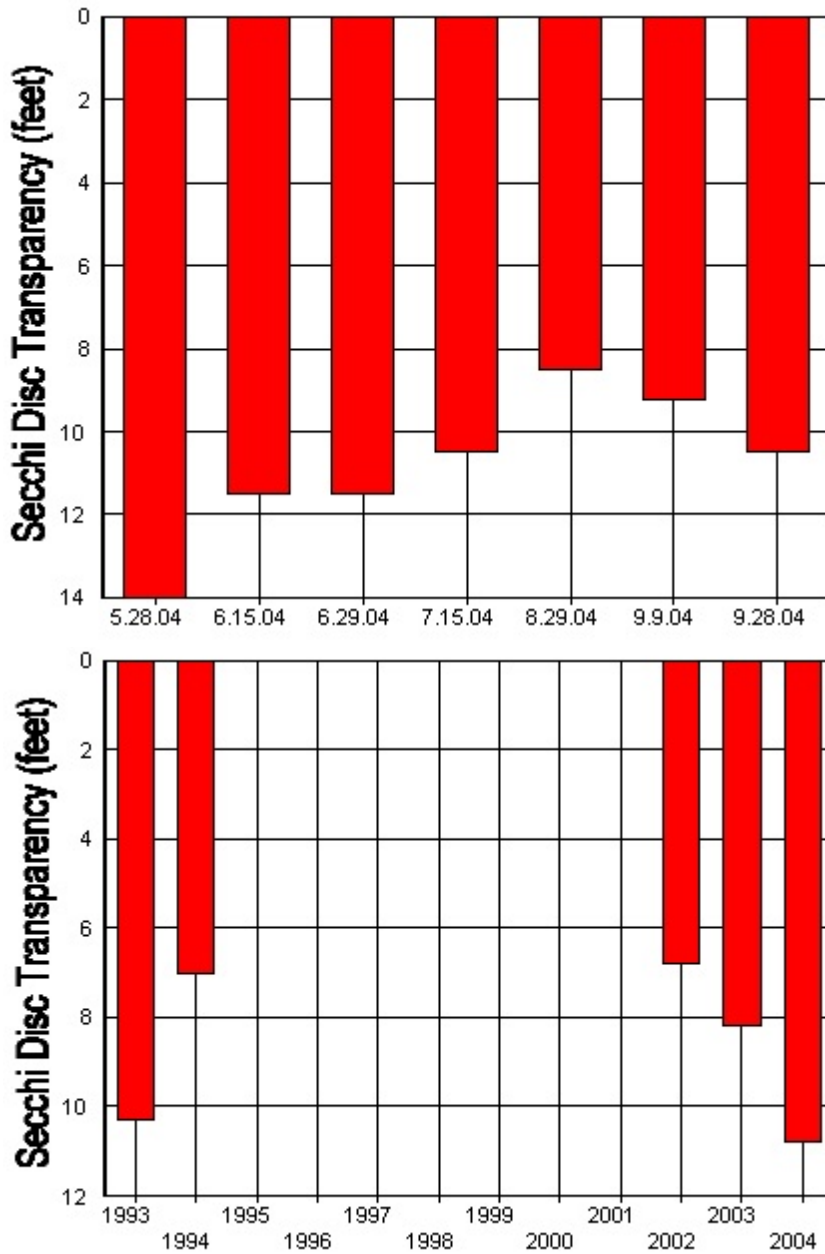


Figure 13. [top] Monthly Secchi disc readings in VanVliet Lake in 2004. [bottom] Yearly Secchi disc readings for VanVliet Lake.

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.

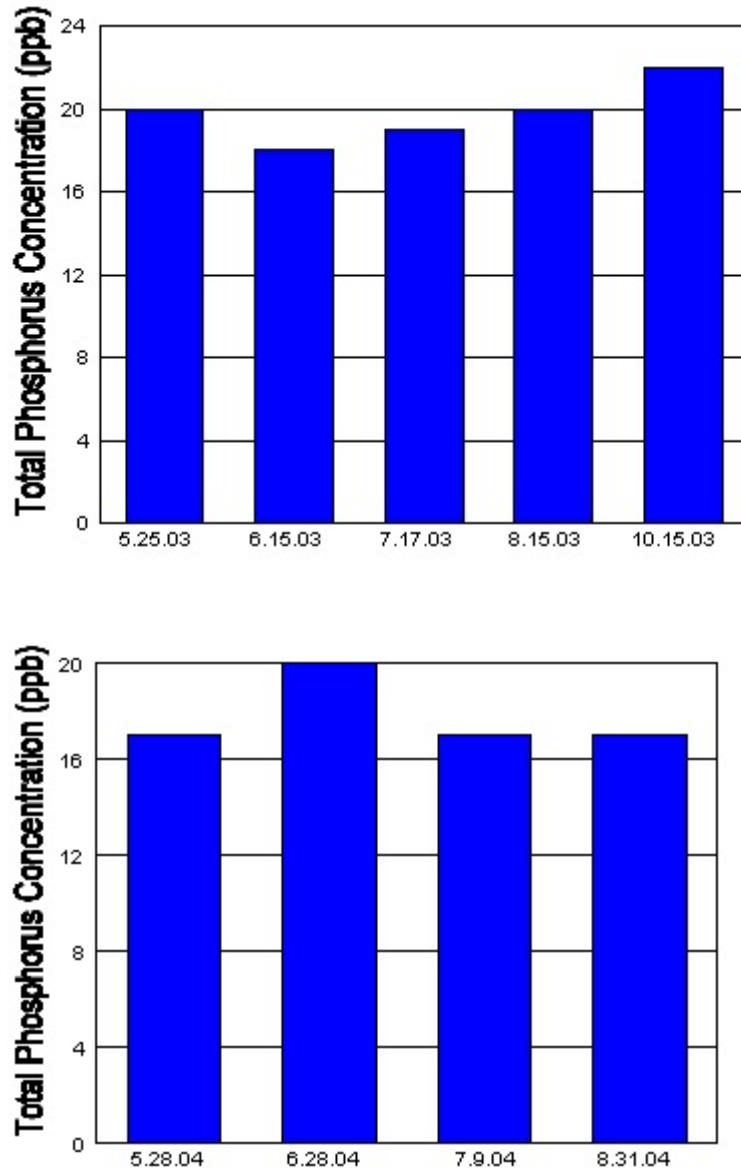


Figure 14. Monthly surface total phosphorus concentrations for 2003 and 2004.

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.

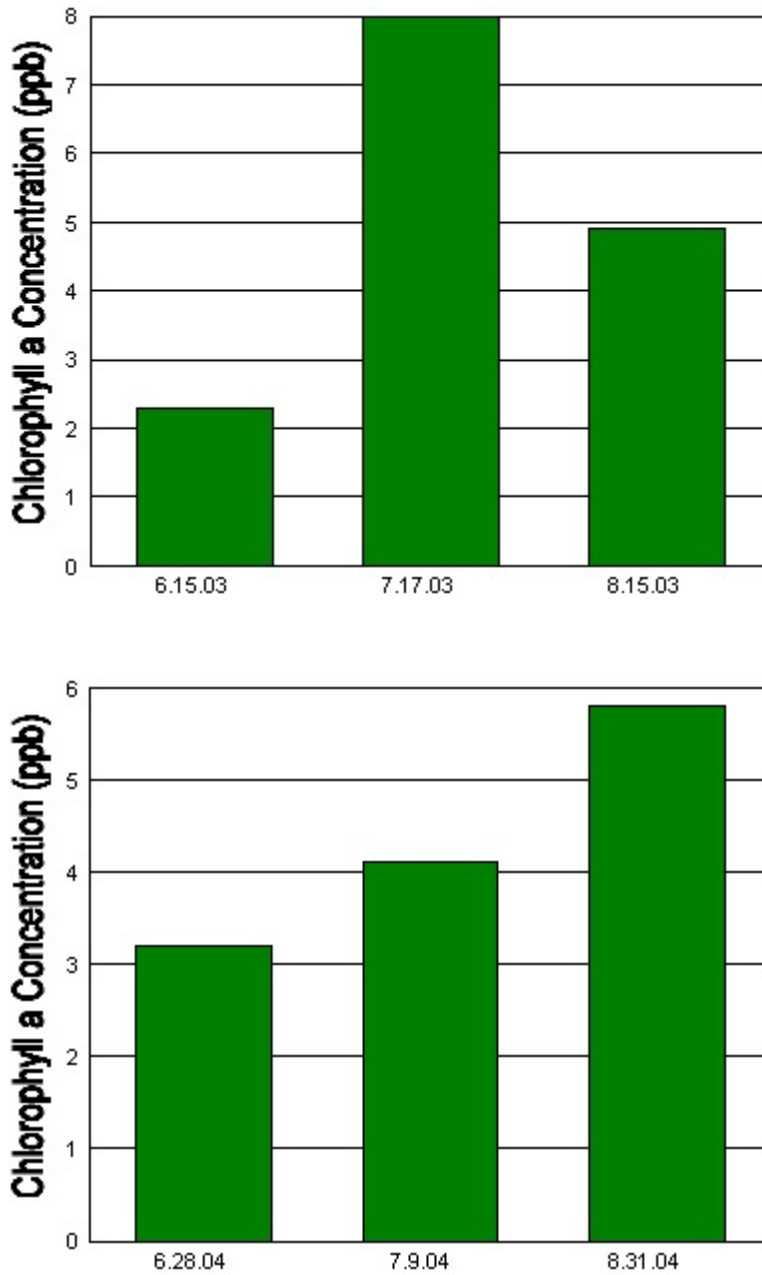


Figure 15. Monthly chlorophyll concentrations in VanVliet Lake for 2003 and 2004.

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.

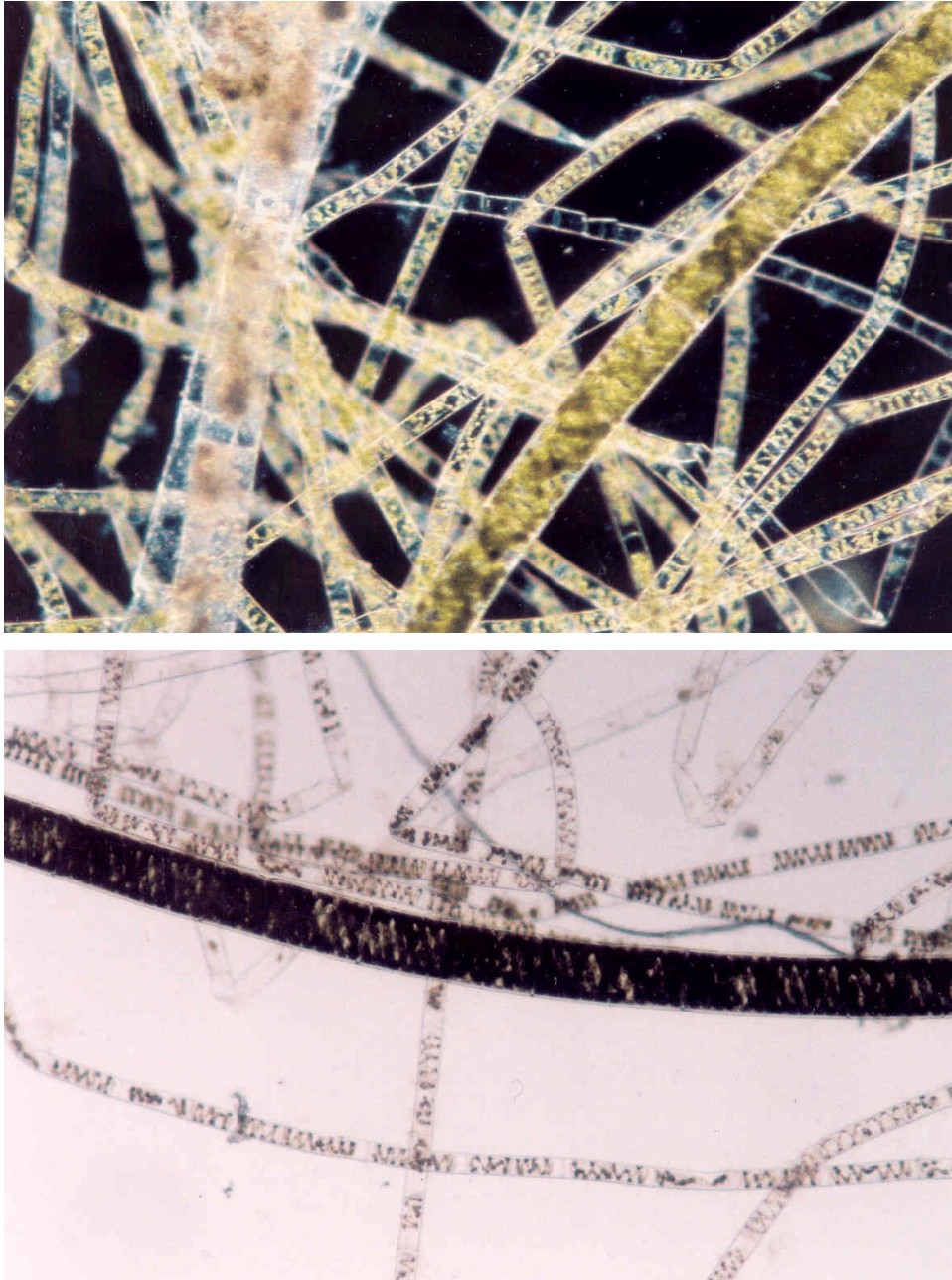


Figure 16. *Spirogyra* algae from VanVliet Lake in August 2004.
[top] *Spirogyra*, is the dominant algal species.
[bottom] Two species of *Spirogyra*, are present in VanVliet Lake.

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.

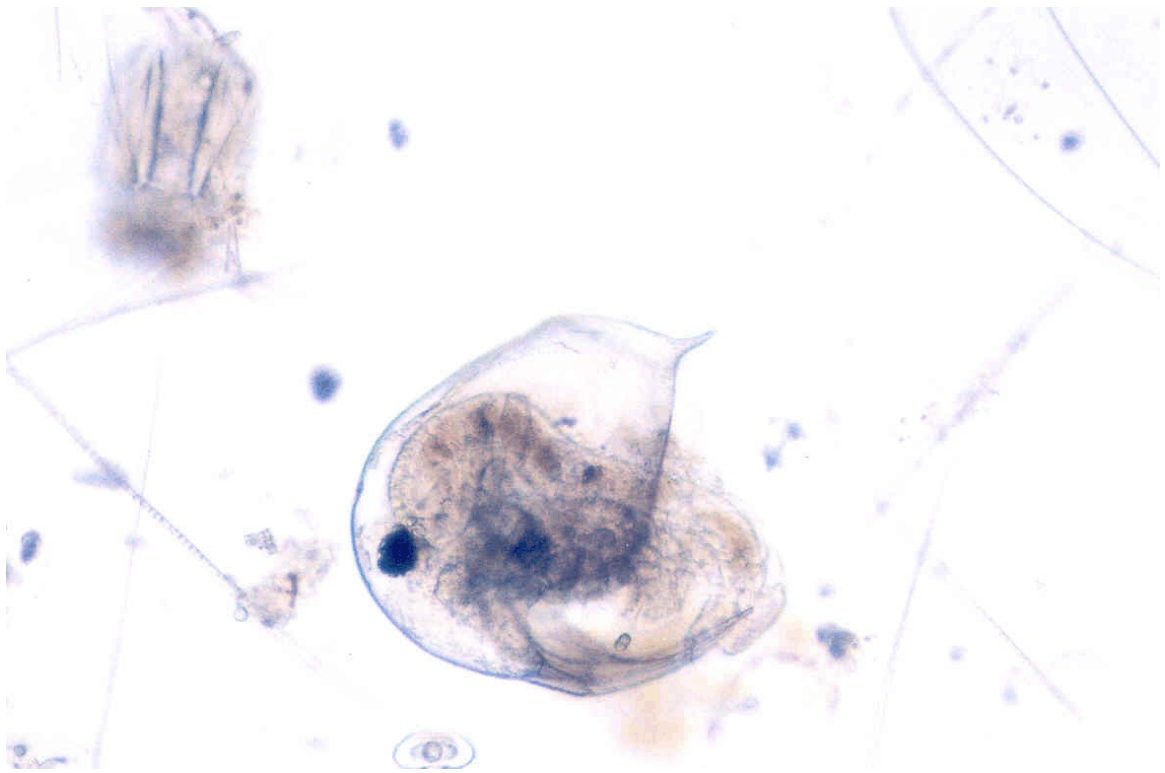


Figure 17. The animal in the middle of the picture is a *Bosmina*, a cladoceran zooplankton that feeds on algae (June 5, 2004).

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
<i>Bosmina</i>	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.

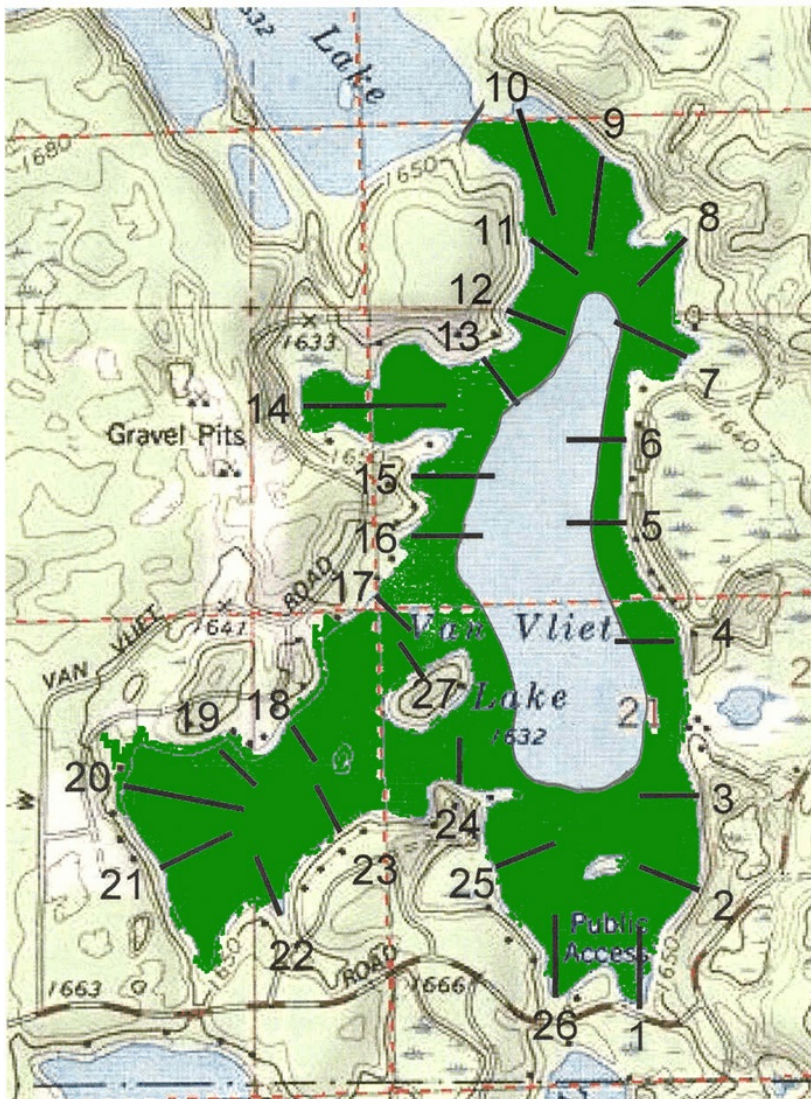


Figure 18. Aquatic plant coverage on VanVliet Lake on July and August, 2004.

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.

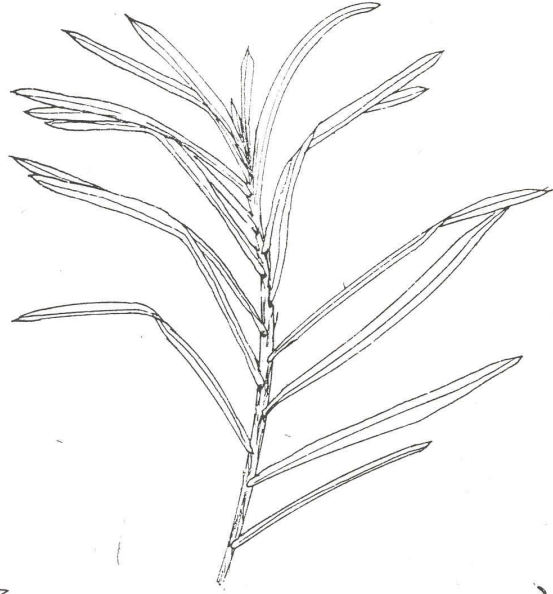
Common Plants in VanVliet Lake

Elodea



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

Fern pondweed



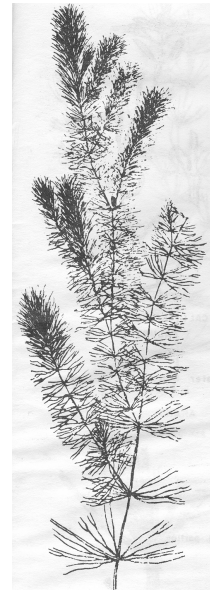
Fern pondweed (*Potamogeton Robbinsii*) is found in water depths to 12 feet.

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

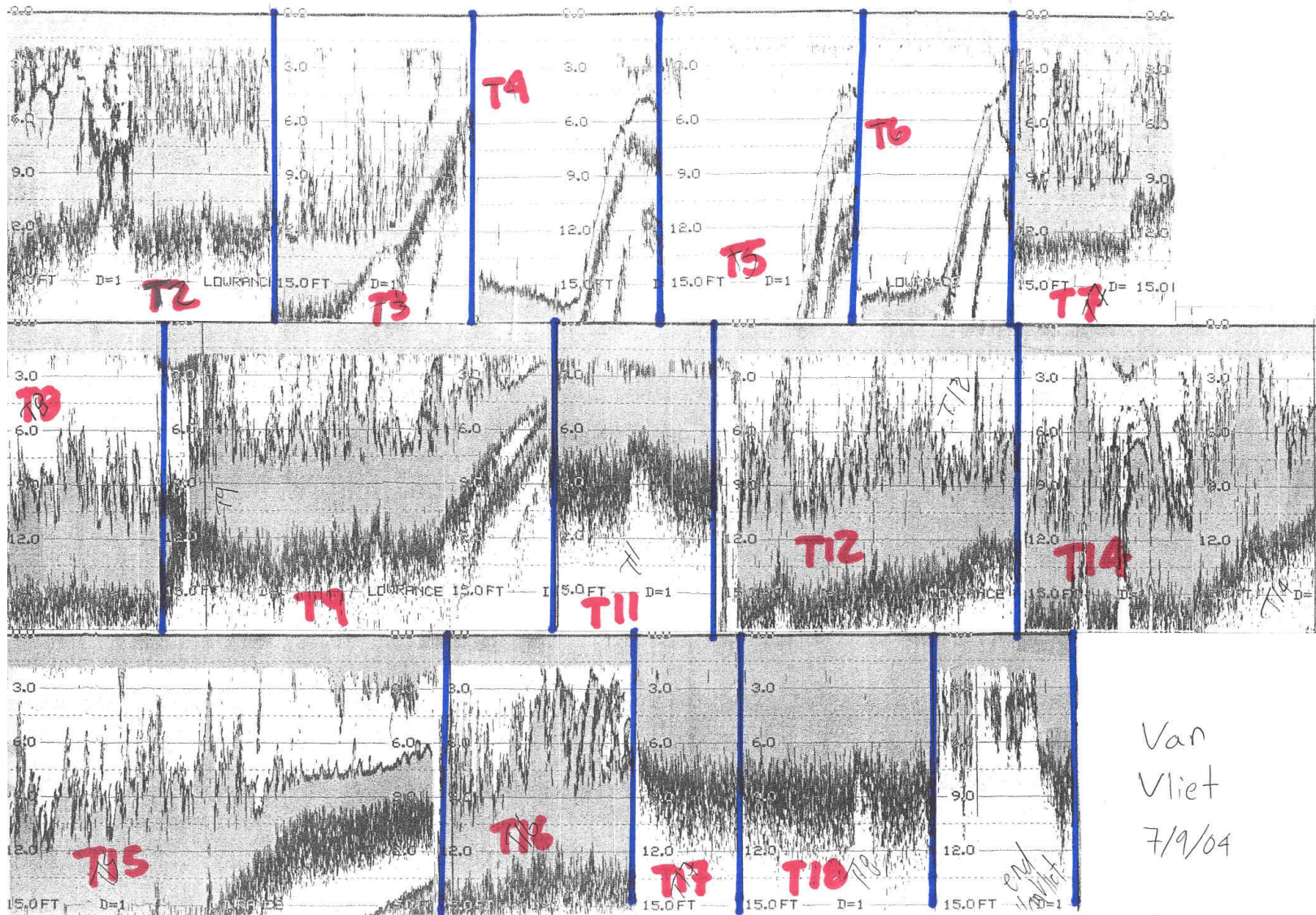


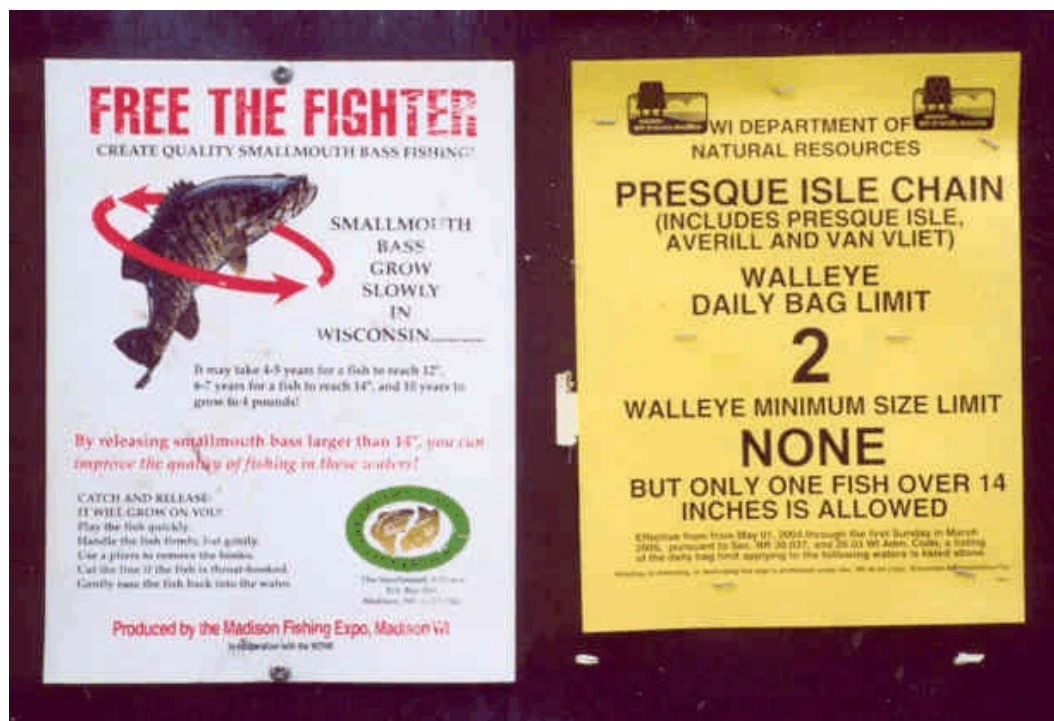
Figure 21. Sonar graphs show the aquatic plant canopy on selected transects in VanVliet Lake on July 9, 2004.

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

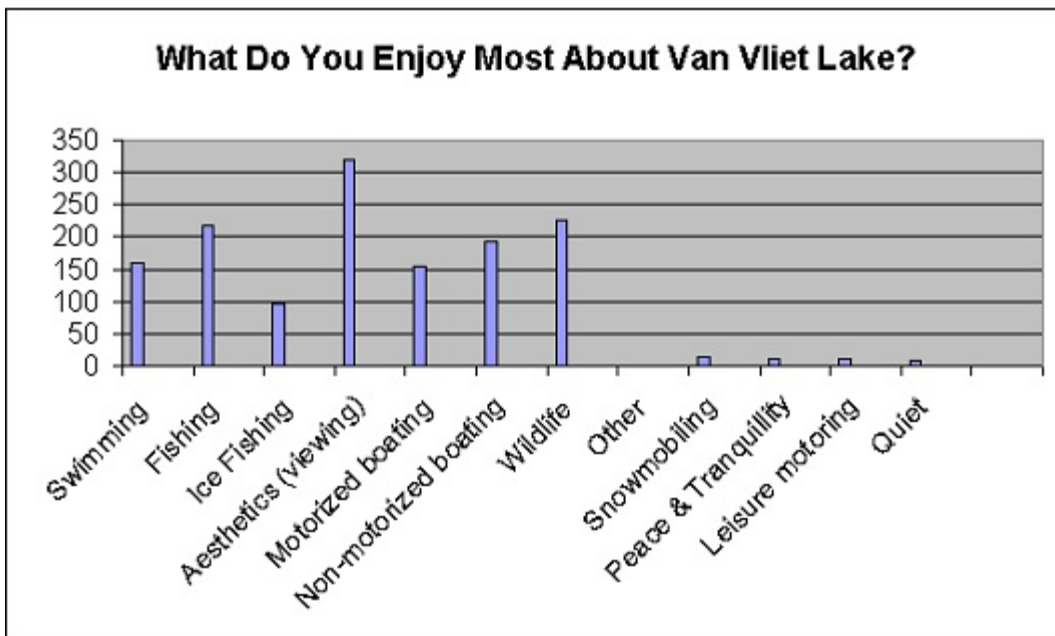
5.1. Lake Questionnaire Results

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.

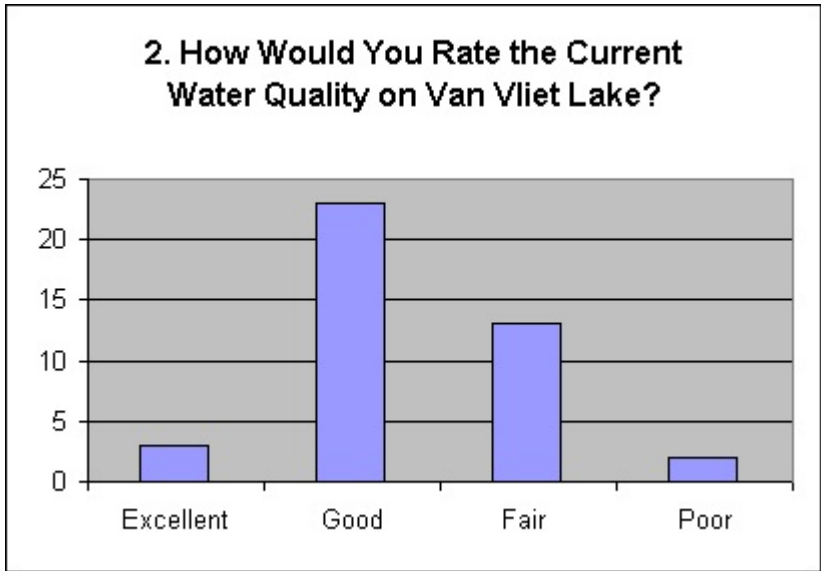
Score*		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
159	Swimming	3	6	3	5	5	6	5
219	Fishing	12	4	5	5	6	4	1
97	Ice Fishing	2	2	1	0	3	3	19
319	Aesthetics (viewing)	26	11	4	2	0	0	0
153	Motorized boating	3	2	2	8	9	8	0
193	Non-motorized boating	3	4	12	6	6	4	1
226	Wildlife	3	14	10	4	4	2	1
	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



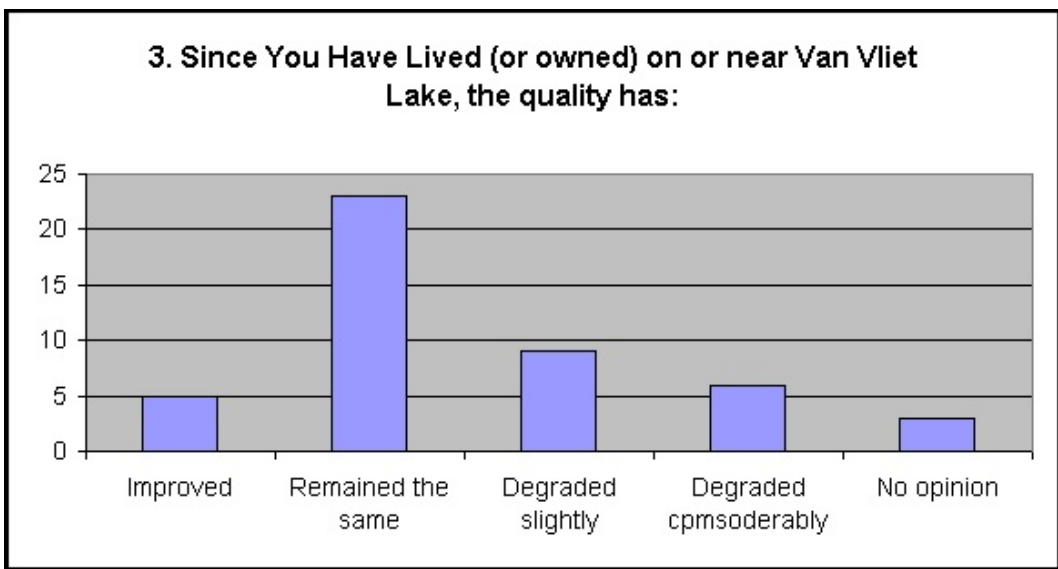
2. How Would You Rate the Current Water Quality of VanVliet Lake?

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.

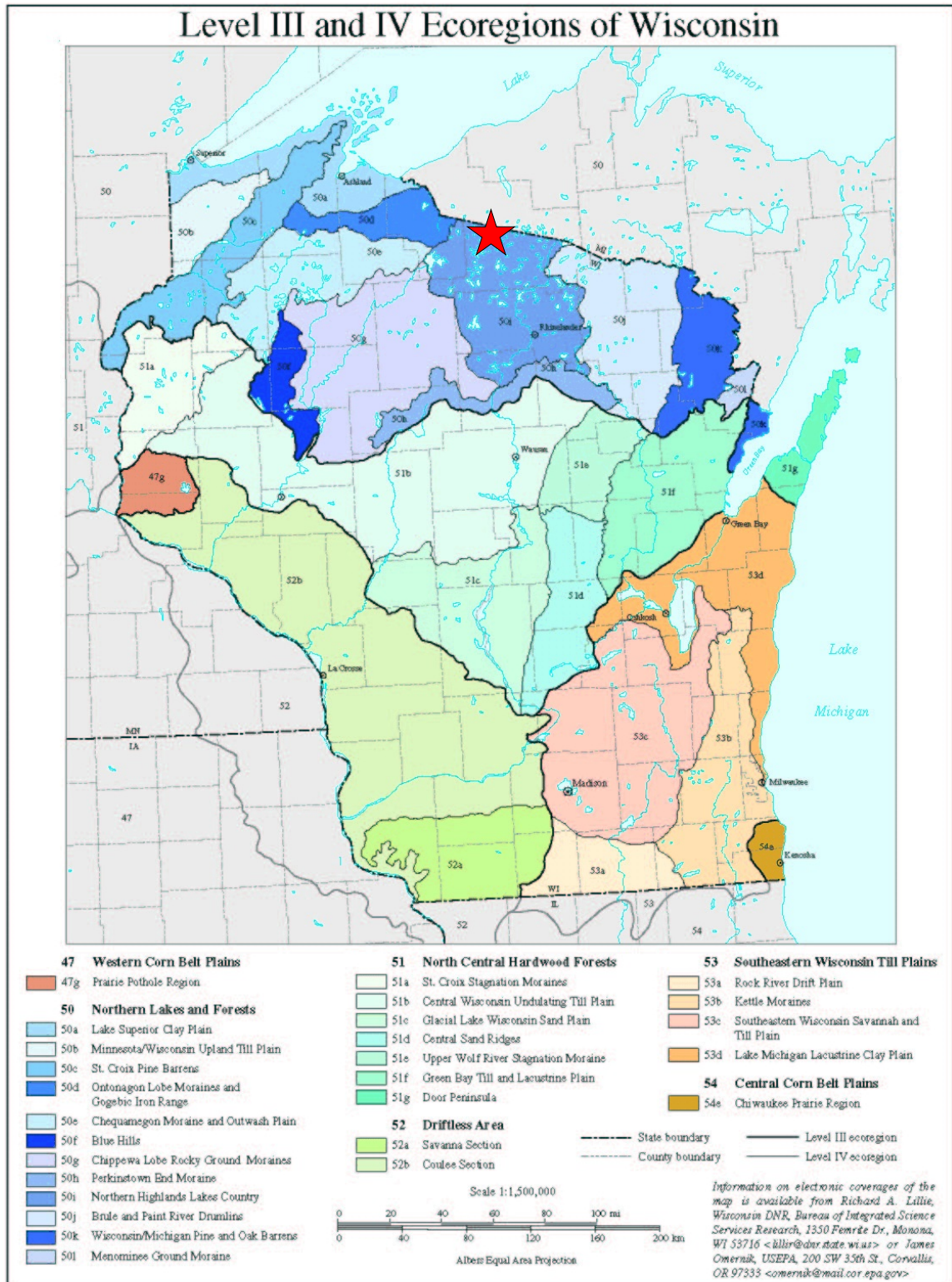


Figure 22. Ecoregion map for Wisconsin. Areas that are labeled with a “50” are within the Northern Lakes and Forest Ecoregion (blue and dark blue shading). Areas labeled with a “51” are in the Central Hardwood Forest Ecoregion. VanVliet Lake, located in Vilas County is located in the Northern Lakes and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

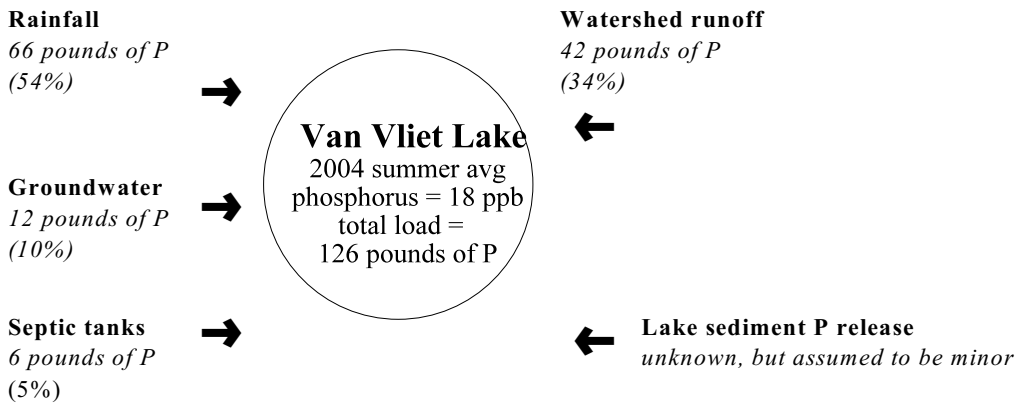


Figure 23. Sources of watershed phosphorus (P) that feed into VanVliet Lake are shown above. It is estimated that approximately 126 pounds of phosphorus enter VanVliet Lake on an annual basis.

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).

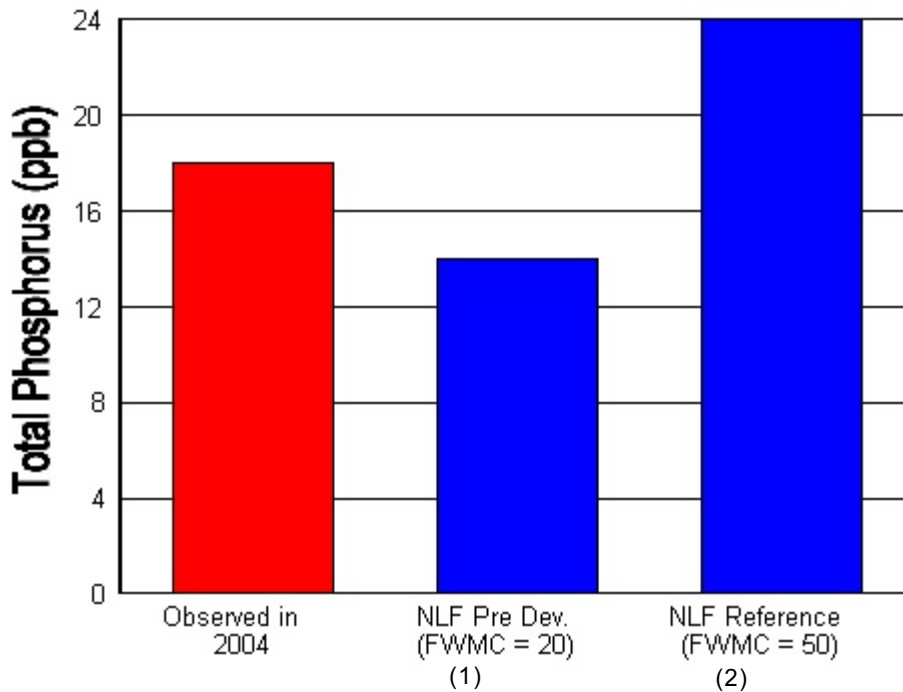


Figure 24. Comparison of total phosphorus conditions for VanVliet Lake in 2004 (red bars) to predicted conditions for a lake the size of VanVliet Lake situated in the Northern Lakes and Forest (NLF) ecoregion under two runoff conditions (blue bars)(FWMC = Flow weighted mean concentration in ppb)..

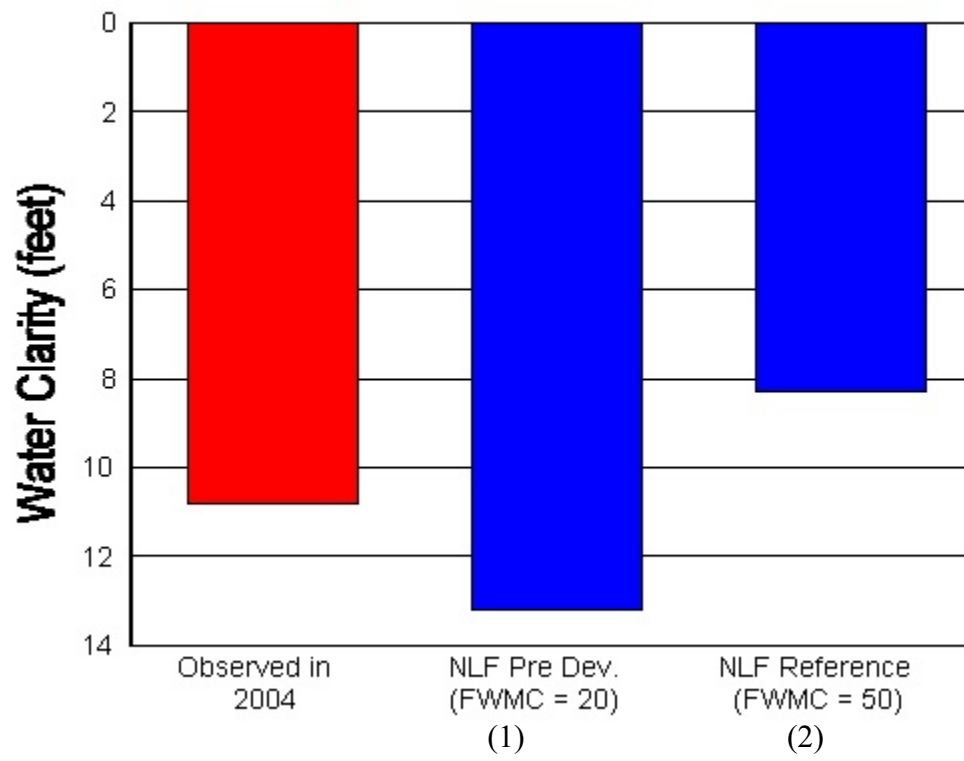
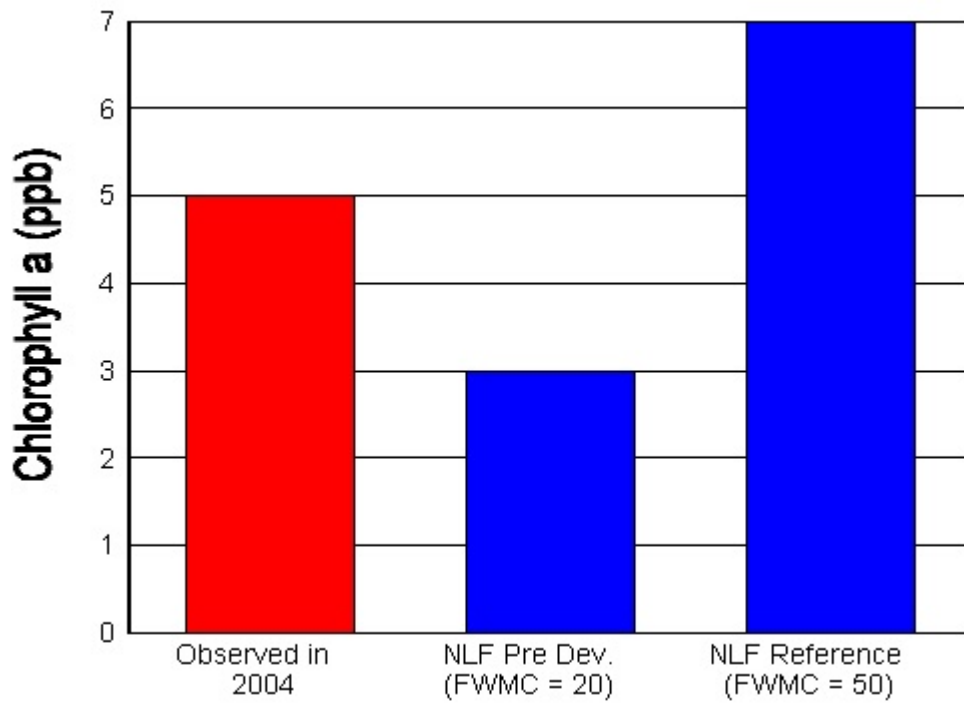


Figure 24. Comparison of chlorophyll a and water clarity conditions for VanVliet Lake in 2004 (red bars) to predicted conditions for a lake the size of VanVliet Lake situated in the Northern Lakes and Forest (NLF) ecoregion under two runoff conditions (blue bars).

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.