LPL-672
LPL-673

Pipe Lakes Comprehensive Planning Report 2002

Prepared for the Wisconsin Department of Natural Resources and the Pipe Lakes Association

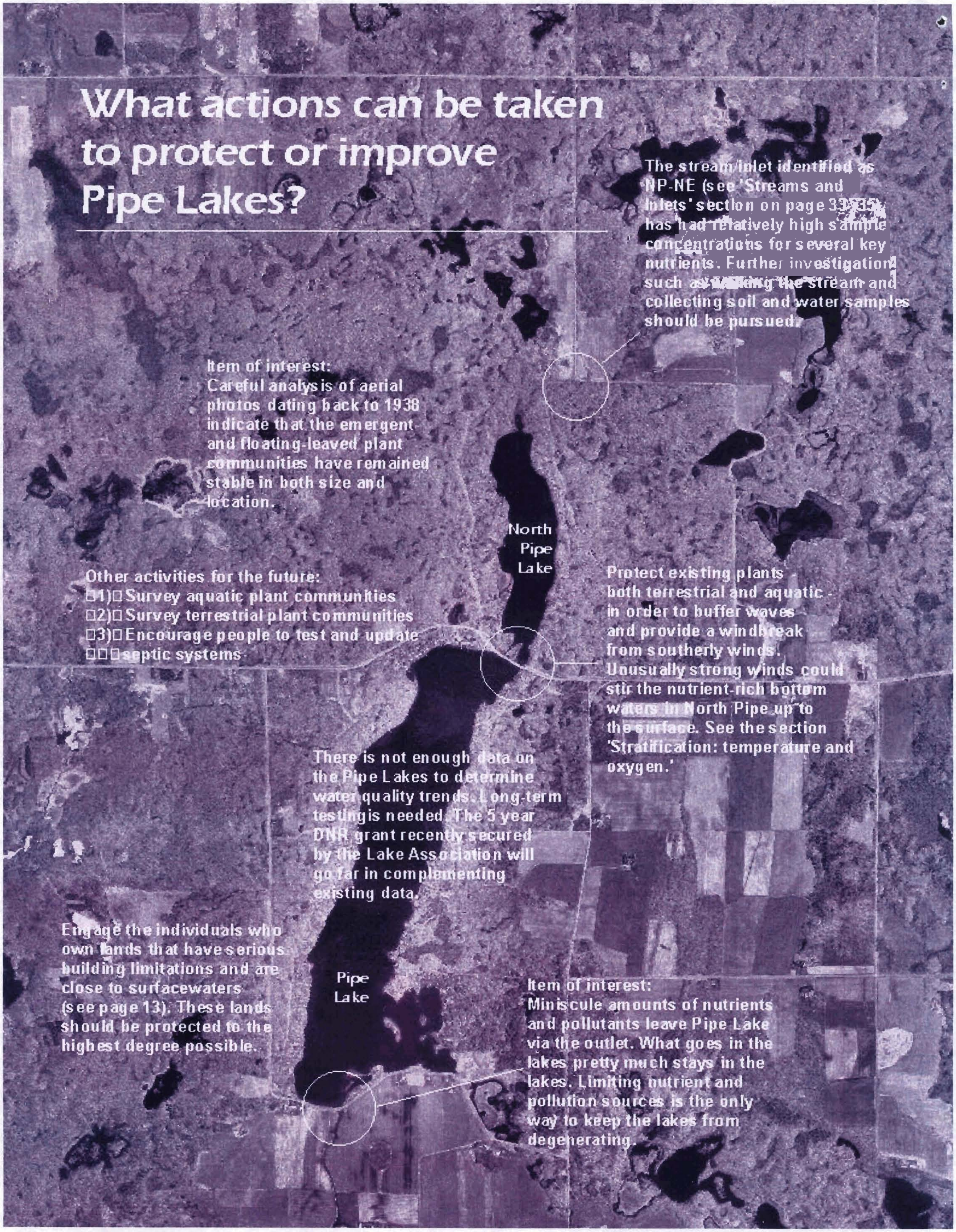
by:

Polk County Land and Water Resources Department

This report and many of the activities described within were made possible by a grant through the WiDNR Lake Management Planning Grant Program.

Table of Contents

What actions can be taken to protect or improve Pipe Lakes?



The stream/inlet identified as NP-NE (see 'Streams and Inlets' section on page 33-35) has had relatively high sample concentrations for several key nutrients. Further investigation such as walking the stream and collecting soil and water samples should be pursued.

Item of interest:
Careful analysis of aerial photos dating back to 1938 indicate that the emergent and floating-leaved plant communities have remained stable in both size and location.

Other activities for the future:

1) Survey aquatic plant communities
2) Survey terrestrial plant communities
3) Encourage people to test and update septic systems

Protect existing plants - both terrestrial and aquatic - in order to buffer waves and provide a windbreak from southerly winds. Unusually strong winds could stir the nutrient-rich bottom waters in North Pipe up to the surface. See the section 'Stratification: temperature and oxygen.'

There is not enough data on the Pipe Lakes to determine water quality trends. Long-term testing is needed. The 5 year DNR grant recently secured by the Lake Association will go far in complementing existing data.

Engage the individuals who own lands that have serious building limitations and are close to surfacewaters (see page 13). These lands should be protected to the highest degree possible.

Item of interest:
Miniscule amounts of nutrients and pollutants leave Pipe Lake via the outlet. What goes in the lakes pretty much stays in the lakes. Limiting nutrient and pollution sources is the only way to keep the lakes from degenerating.

Morphological Characteristics

Lake Area:
Pipe: 296 acres
North Pipe: 66 acres

Watershed Area:
Pipe: 2,473 acres (the North Pipe watershed is considered in this area. Only 1,266 acres drains to Pipe without first filtering through North Pipe.)
North Pipe: 1,265 acres

Watershed to Lake Area Ratio:
Pipe: 8 to 1 (4 to 1 only considering the land that drains to Pipe without first filtering through North Pipe.)
North Pipe: 19 to 1

Volume:
Pipe: 6,985 acre-feet (304,266,600 ft^3)
North Pipe: 1,050 acre-feet (45,738,000 ft^3)

Mean Depth:
Pipe: 27 feet
North Pipe: 17 feet

Maximum Depth:
Pipe: 68 feet
North Pipe: 37 feet

Fetch:
Pipe: 8,482 feet (1.6 miles)
North Pipe: 4,119 feet (0.8 miles)

Miles of Shoreline:
Pipe: 4.5 miles
North Pipe: 1.9 miles

Littoral Area:
Pipe: 0-15 feet deep - 135 acres (46% of surface area).
North Pipe: 0-10 feet deep - 31 acres (47% of surface area). This estimate is likely the maximum littoral area considering the limited light penetration.

Annual Precipitation:
The annual precipitation in 2001 at the Amery_2_N station is 36.42 inches. Summer 2000 precipitation, as recorded by four lake residents, averaged 13.5 inches from July to November.

Average Annual Evaporation:
44.15 inches per year. (This figure was from the closest station measuring mean "pan evaporation" in Minneapolis.)

Residence Time:
Pipe: 10.1 years
North Pipe: 1.5 years

Mixing:
Pipe: dimictic.
North Pipe: dimictic (see page 24)

Phosphorus Concentration:
Pipe: 10 ppm
North Pipe: 22 ppm

Introduction to the Land and Water

Glaciers

Pipe and North Pipe Lakes were formed about 12,300 years ago as the last glacier receded from the landscape. The glacier left behind monstrous chunks of ice, wholly or partially buried, that melted to form the earliest version of Pipe Lakes basin.

River systems connected the glacial meltwater with the lakes that dotted the landscape. The landscape and the lakes 100 centuries ago were neither rich nor diverse in plants or wildlife. The soil and vegetation was stripped from the land by the glaciers and the water filling the rivers and lakes was low in nutrients. The closest "living" example of what Pipe Lakes looked like at this time is probably Lake Superior: cold, clean, and clear, but not very fertile.

Over the millennia soils material was carried here by wind and eroded from the landscape. The ecosystem matured over time to eventually resemble what we see today: mixed forests, stands of pines, occasional prairie open space, and lots of lakes, rivers, and wetlands. The soils material that brought the nutrients necessary to sustain such a diverse landscape continue to build today.

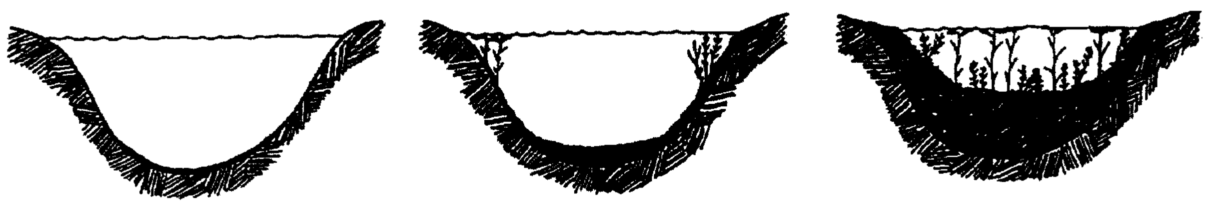
Lake aging process

When plants and trees die their decomposing structures nourish subsequent generations of plants and animals. Water, wind, and ice breakdown rocks and flatten hills. All of this material, both organic and inorganic, is pulled by gravity to the lowest point on the landscape, typically lakes. So lakes naturally fill in with this sediment to a point that they are more land than water. In the interim they transition from clear open water to something a little greener and a little more fertile. It takes thousands of years but lakes 'age' to become wetlands rich in nutrients and busy with wildlife.

Human influence

Unfortunately human activity on the landscape has increased the rate at which lakes age. Logging was the first blow to this region's lakes. The removal of vast stands of trees left

Typical natural aging process of a lake



OLIGOTROPHIC
- Clear water, low productivity
- Very desirable fishery of large game fish

MESOTROPHIC
- Increased production
- Accumulated organic matter
- Occasional algal bloom
- Good fishery

EUTROPHIC
- Very productive
- May experience oxygen depletion
- Rough fish common

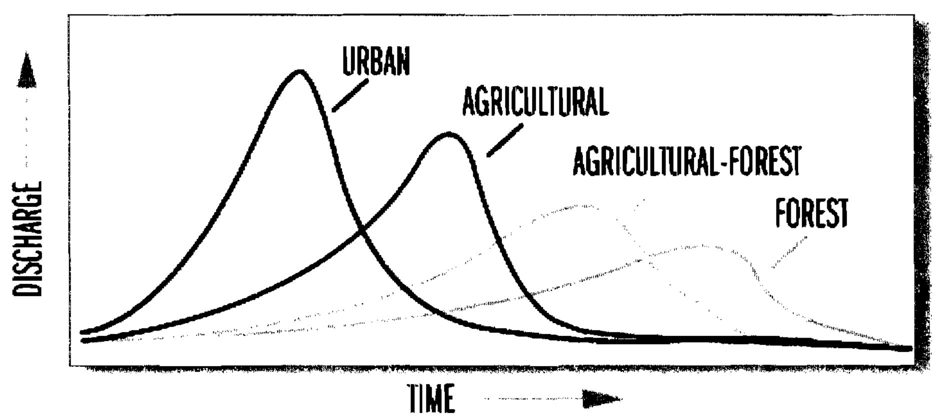
soil bare and vulnerable to erosion. Dams were erected to store the force of water and then let loose flushing logs and water down streams towards the mills. Both water and logs scoured the stream channels. Furthermore sudden, drastic changes in lake level wreaked havoc with shorelines.

Farming was the second wave of development in this region. Originally farms were small and diverse. Due to the fragile nature of their tools and techniques early settlers generally worked with the land instead of against it. But mechanization soon changed the way people farmed. Larger machines required larger fields and larger fields required more chemical inputs to control weeds and insects. Wetlands and flood-prone areas were drained and cultivated. In general, farming opened up the fertile but fragile soils to the erosive forces of wind and rain thereby compromising the health of both land and water.

A third wave of major human influence is upon us: residential development. The landscape is quickly being carved up from vast fields into relatively tiny lots complete with driveways and sod lawns. Construction erosion, runoff from lawn fertilizers, removing vegetation from both shorelines and lakes, septic system effluent, and simply runoff from roofs, driveways and roads all contribute nutrients and pollutants to lakes.

Humans have increased the rate at which lakes become green and fertile by 10, 100, and even 1,000 times. This is a threat that most people resonate with: the threat that their clean, clear lake will become green and stale in their lifetime. Humans cannot change the fact that lakes will change over time but they can affect the rate at which that change takes place. And ideally, like time itself, it will occur so slowly that it will be imperceptible in our lifetimes and the lifetimes of those to follow.

STORMWATER DISCHARGES FROM VARIOUS LAND COVERS



Natural Resources Research Institute, http://wow.nrri.umn.edu/wow/

Watersheds

A watershed, also called a drainage basin, is all of the land and water areas that drain toward a particular river or lake (see pages 9, and 11). Thus, a watershed is defined in terms of the selected lake (or river). There can be subwatersheds within watersheds. For example, a tributary to a lake has its own watershed, which is part of the larger total drainage area to the lake.

A lake is a reflection of its watershed. More specifically, a lake reflects the watershed's size, topography, geology, landuse, soil fertility and erodibility, and vegetation (see pages 9 and 13). The impact of the watershed is evident in the relation of nutrient loading to the watershed; and lake surface area ratio.

The Pipe Lakes' watershed is primarily forested which bodes well for both lakes (see page 9). Forests tend to hold tightly onto nutrients as well as store water for the short term in the canopy thereby reducing runoff volume and erosion potential. Maintaining a high percentage of forest land in the watershed will help to guarantee good water quality into the future.

The ratio of watershed area to lake area also favors good water quality (see page 3). Typically, water quality decreases with an increasing ratio of watershed area to lake area. This is obvious when one considers that as the ratio of watershed to lake area increases there are additional sources (and volumes) of runoff to the lake. In larger watersheds, there is also a greater opportunity for water from precipitation to contact the soil and leach minerals before discharging into the lake.

Pipe Lake has a very small watershed that is maintained primarily by groundwater flow and is referred to as a seepage lake. In contrast, lakes fed primarily by inflowing streams or rivers are known as drainage lakes. Seepage lakes tend to have good water quality compared with drainage lakes. However, seepage lakes are often more susceptible to the ravages of acid rain because of their low buffering capacity as discussed in the section 'pH, alkalinity and acid rain.'

North Pipe is also a seepage lake but it has a considerably larger watershed to lake ratio. This makes it more likely to be affected by the landscape that surrounds it and more sensitive to land use changes.

Zaporozec (1987) described this area as hydrogeologicly complex. Well data is scarce further complicating hydrogeologic evaluation. However, the land surrounding Pipe lake, except for its southerly tip appears to have a perched water table. The upper groundwater system is likely recharging from precipitation and discharging into the lakes and surrounding wetlands. Although this perched water table protects drinking water from pollution (water level in drinking water wells is 50 to 100 feet lower than the surface water) it also means that contamination in this layer will quickly reach the lakes.

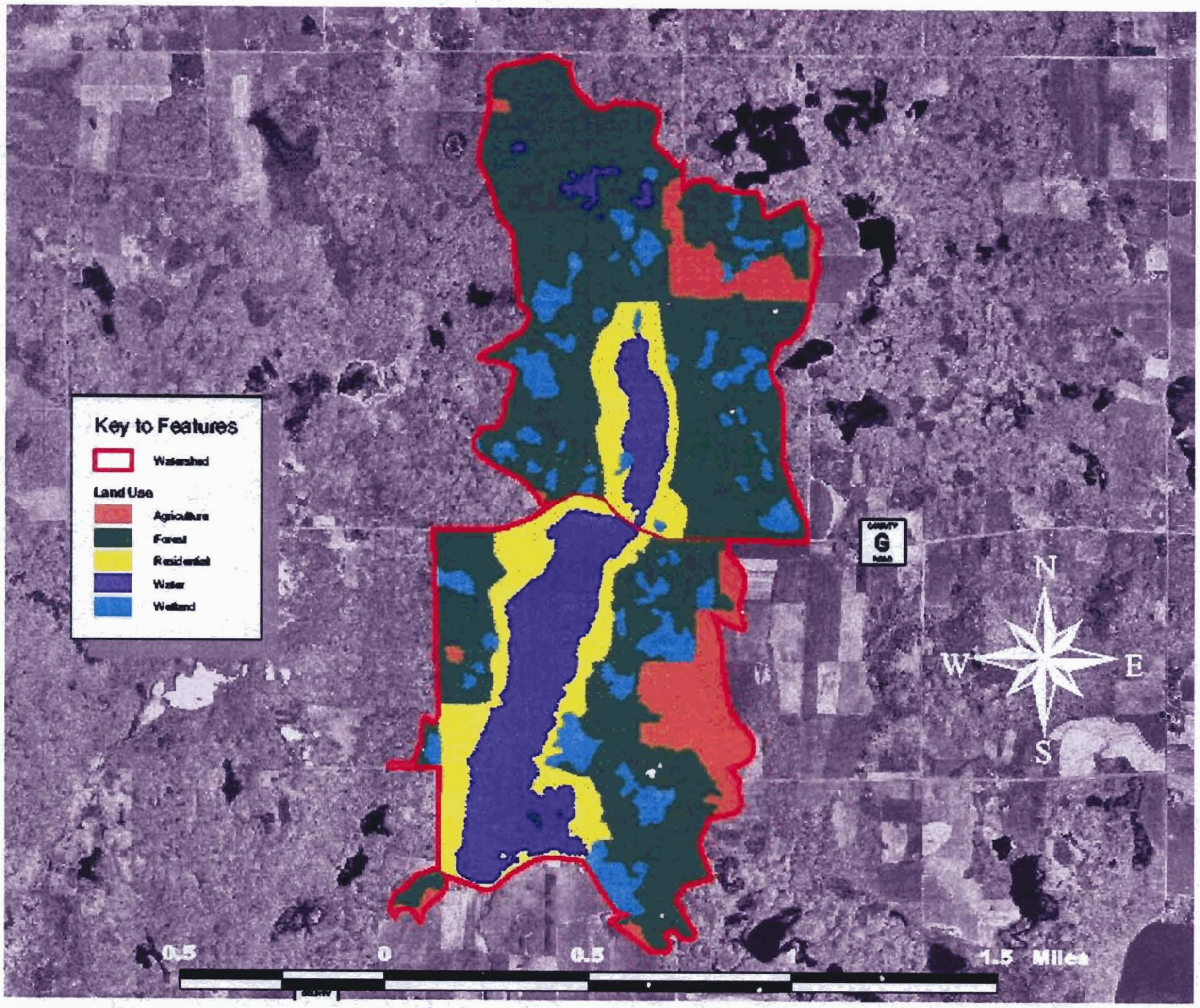
Watersheds in greater depth

As a form of ecosystem management, watershed management encompasses the entire watershed system, from uplands and headwaters, to floodplain wetlands and river channels. It focuses on the processing of energy and materials (water, sediments, nutrients, and toxics) downslope through this system.

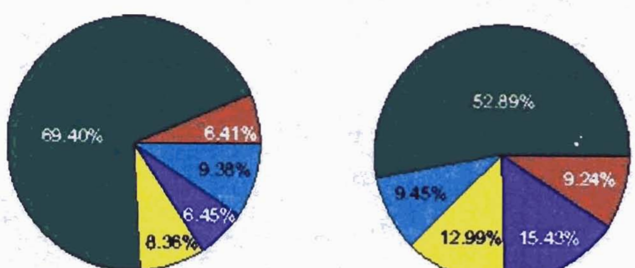
Of principle concern is management of the basin's water budget, that is the routing of precipitation through the pathways of evaporation, infiltration, and overland flow. This routing of groundwater and overland flow defines the delivery patterns to particular streams, lakes, and wetlands; and largely shapes the nature of these aquatic systems.

Watershed management requires the use of the social, ecological, and economic sciences. Common goals for land and water resources must be developed among people of diverse social backgrounds and values. An understanding of the structure and function--historical and current--of the watershed system is required, so that the ecological effects of various alternative actions can be considered. The decision process also must weigh the economic benefits and costs of alternative actions, and blend current market dynamics with considerations of long-term sustainability

Land Use



Relative comparison of land use area

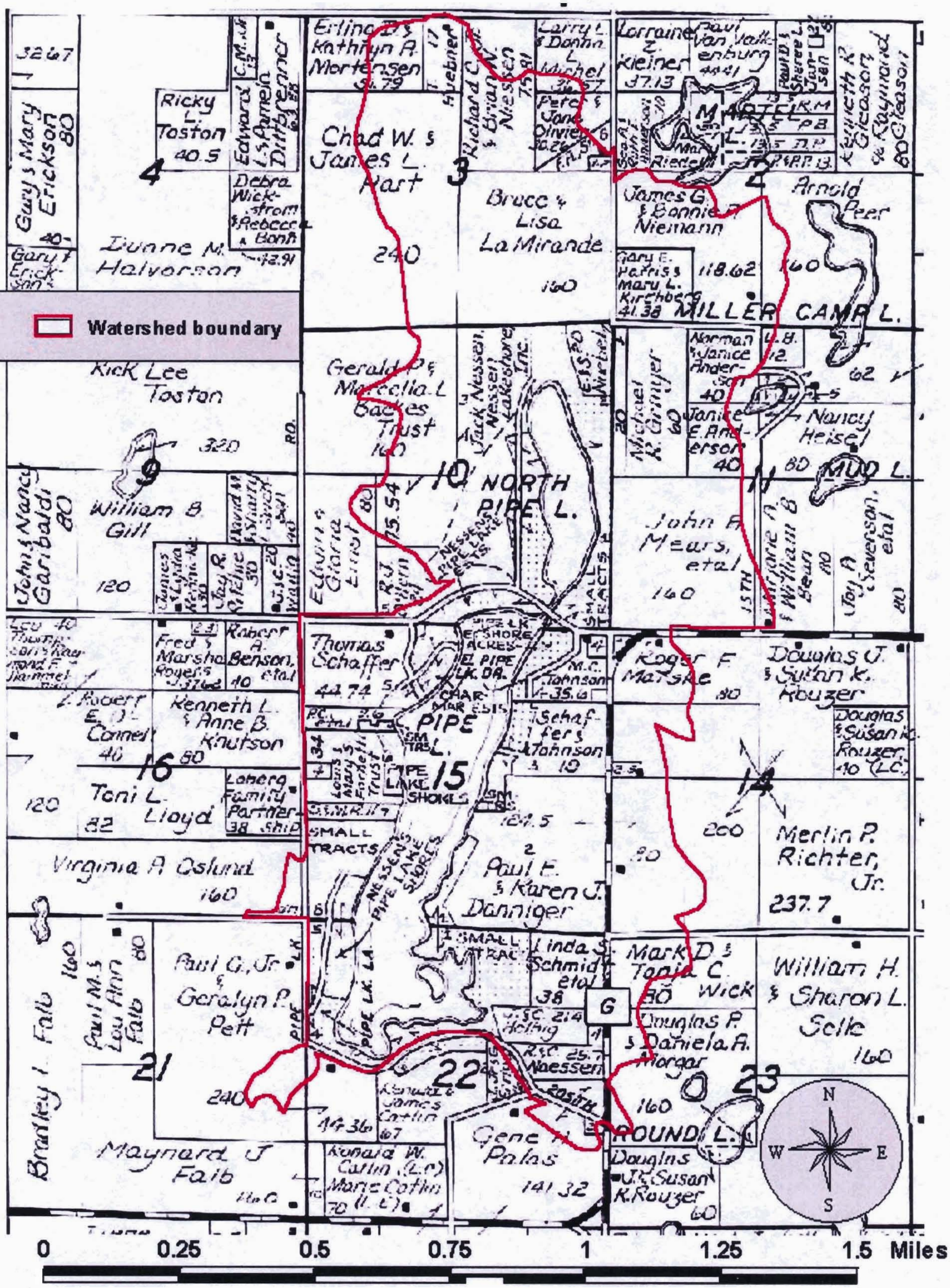


North Pipe Lake watershed land use

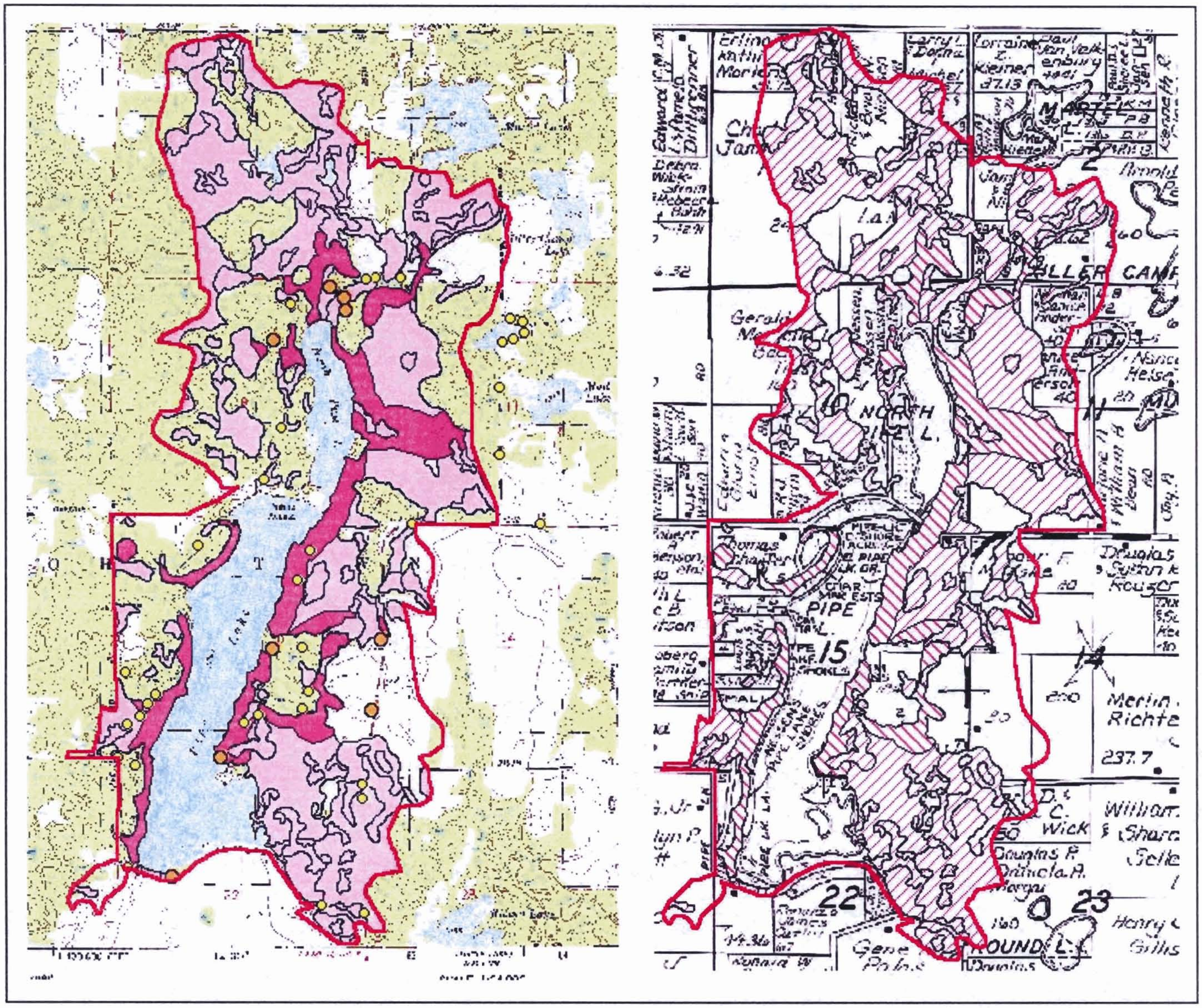
Entire Pipe Lakes watershed land use

Note: Although only the northern portion of the watershed drains to North Pipe Lake, the entire watershed drains to Pipe Lake

Land ownership



Sensitive areas by soil type



Soils with SEVERE limitations* AND 12-20% slopes AND within 450 feet of the lake or drainageway.

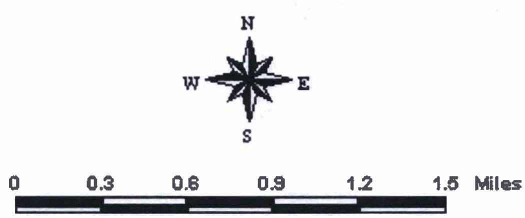
Soils with SEVERE limitations*

Pipe Lakes watershed boundary

Surface water sample locations

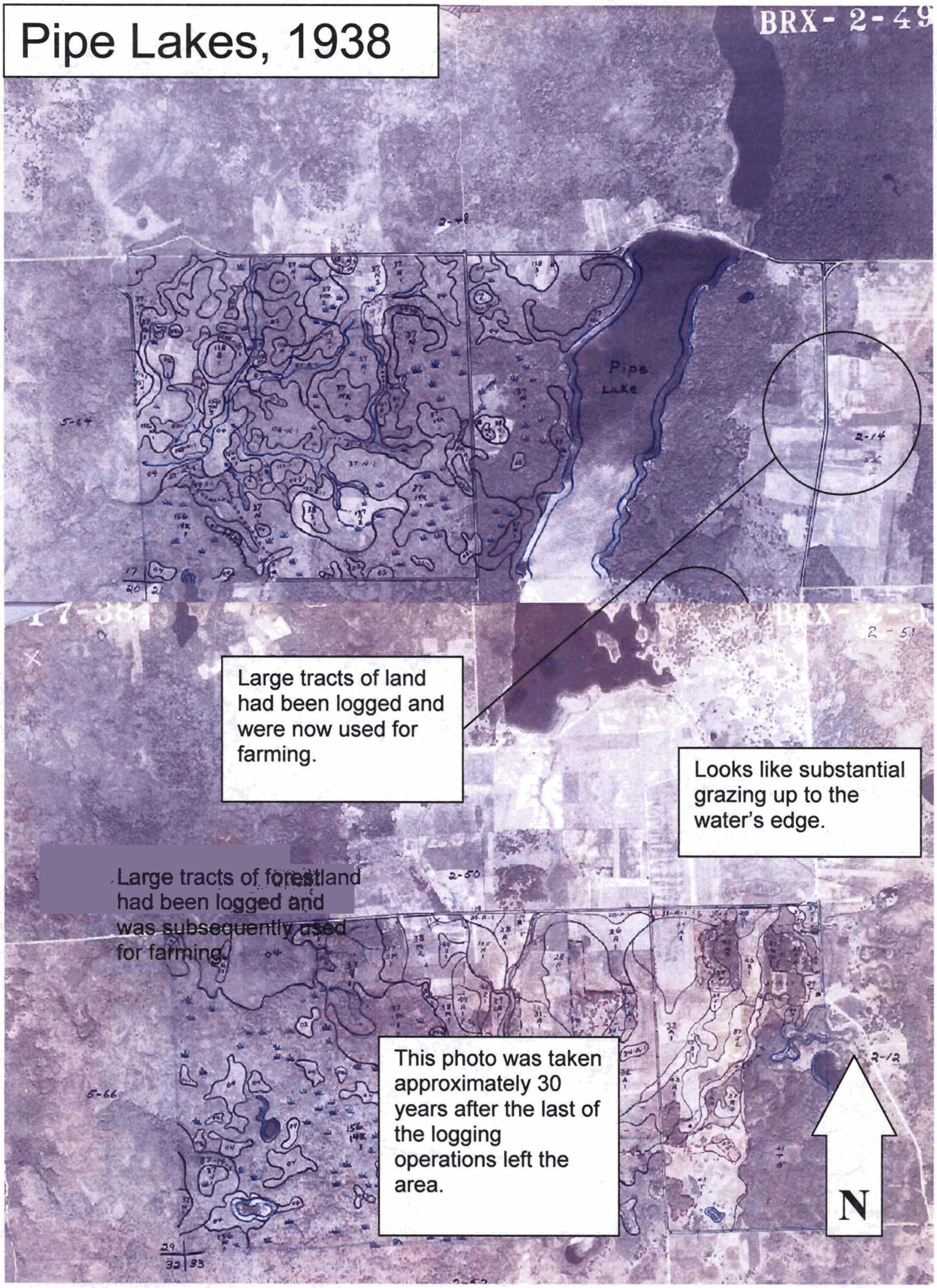
Culverts

Surface water drainageways

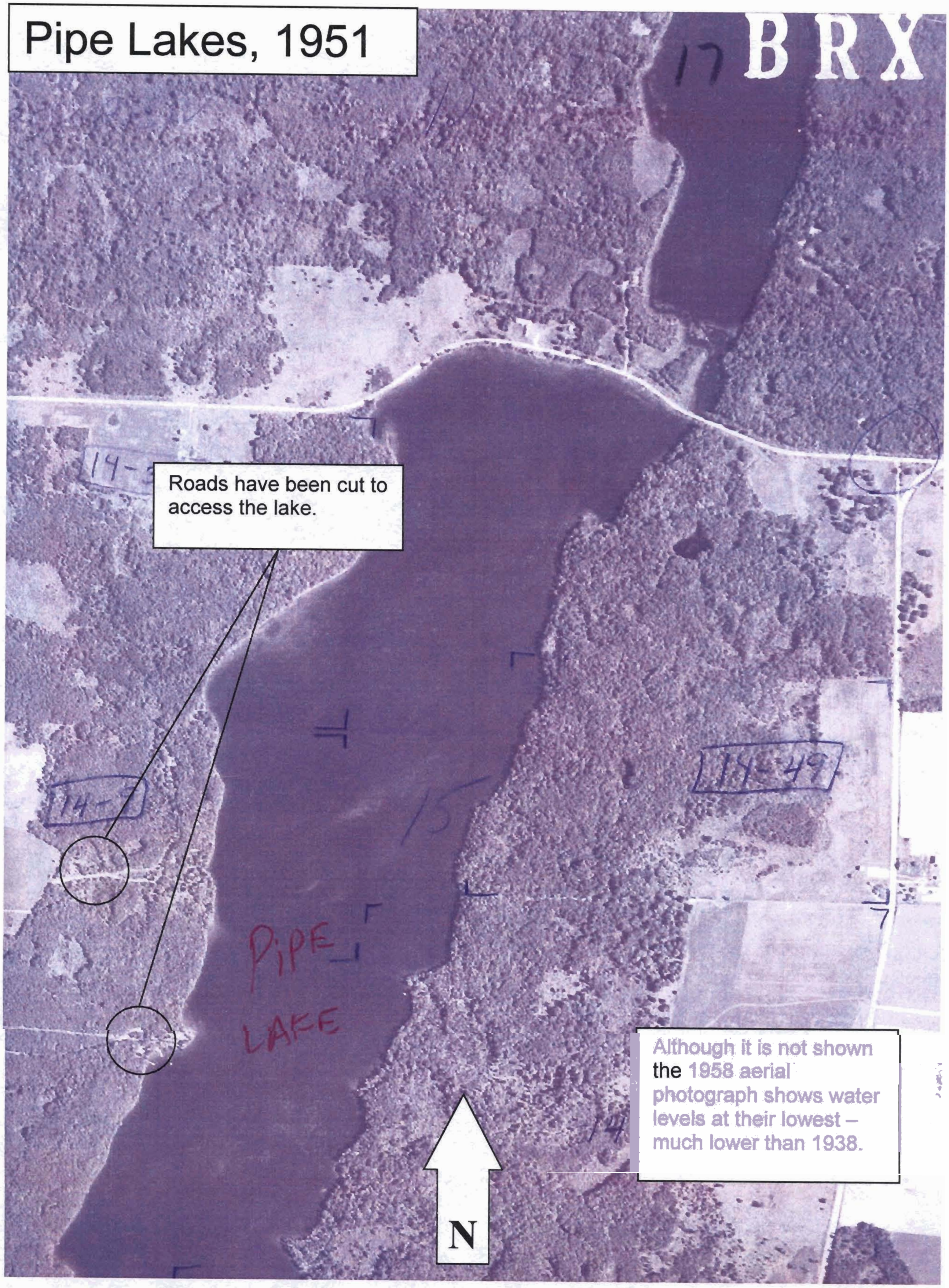


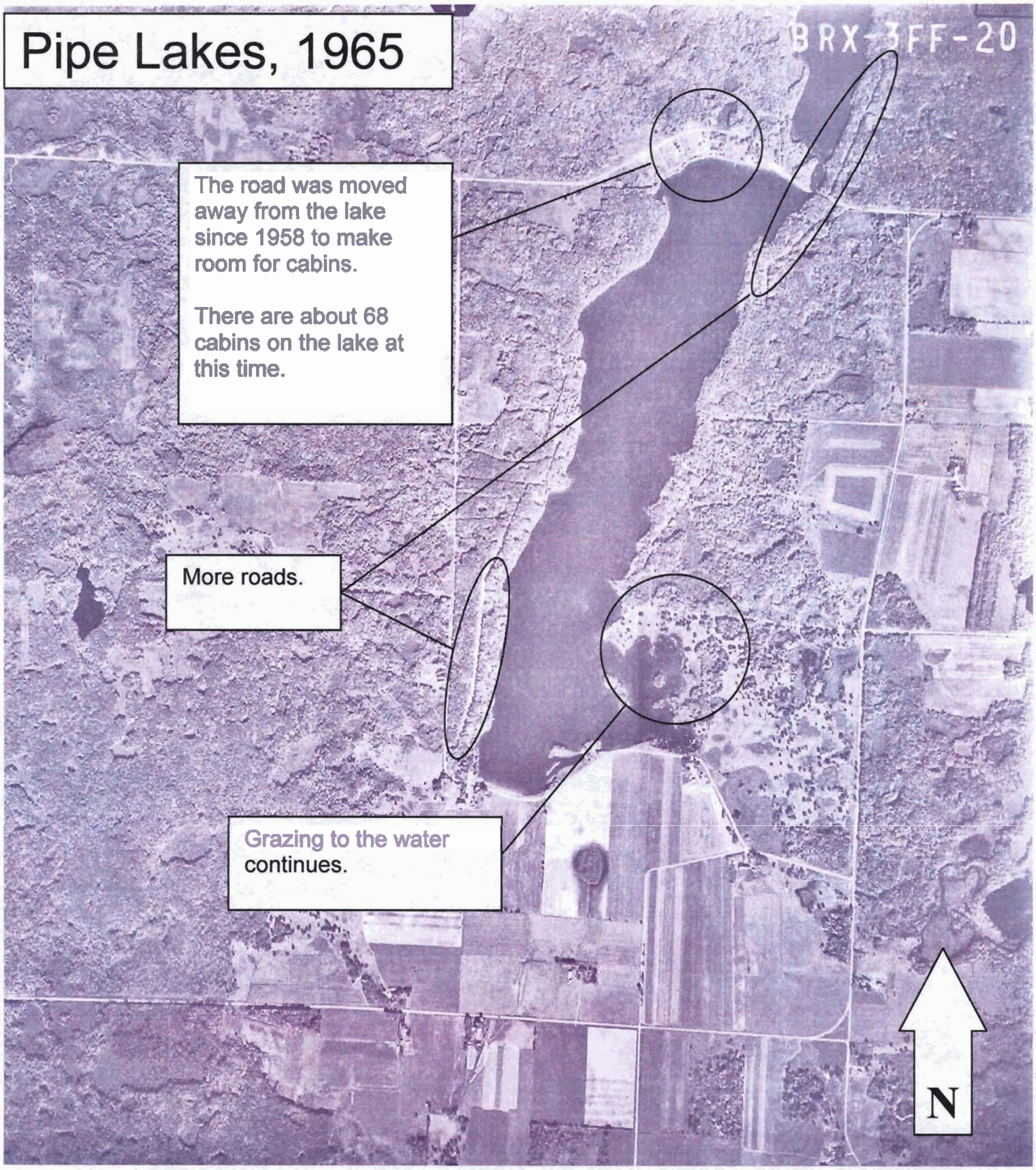
*Severe limitations refer to septic systems AND building site development with or without basements. Severe limitations indicate that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required - and even this may not make construction feasible.

Pipe Lakes, 1938



Pipe Lakes, 1951




Pipe Lakes, 1965
The road was moved away from the lake since 1958 to make room for cabins.
There are about 68 cabins on the lake at this time.
More roads.
Grazing to the water continues.
N


Pipe Lakes, 1973
There were approximately 90 cabins on the lakes in 1973.
N


Pipe Lakes, 1996
N


Pipe Lakes, 2001
N

The Lakes

Water clarity

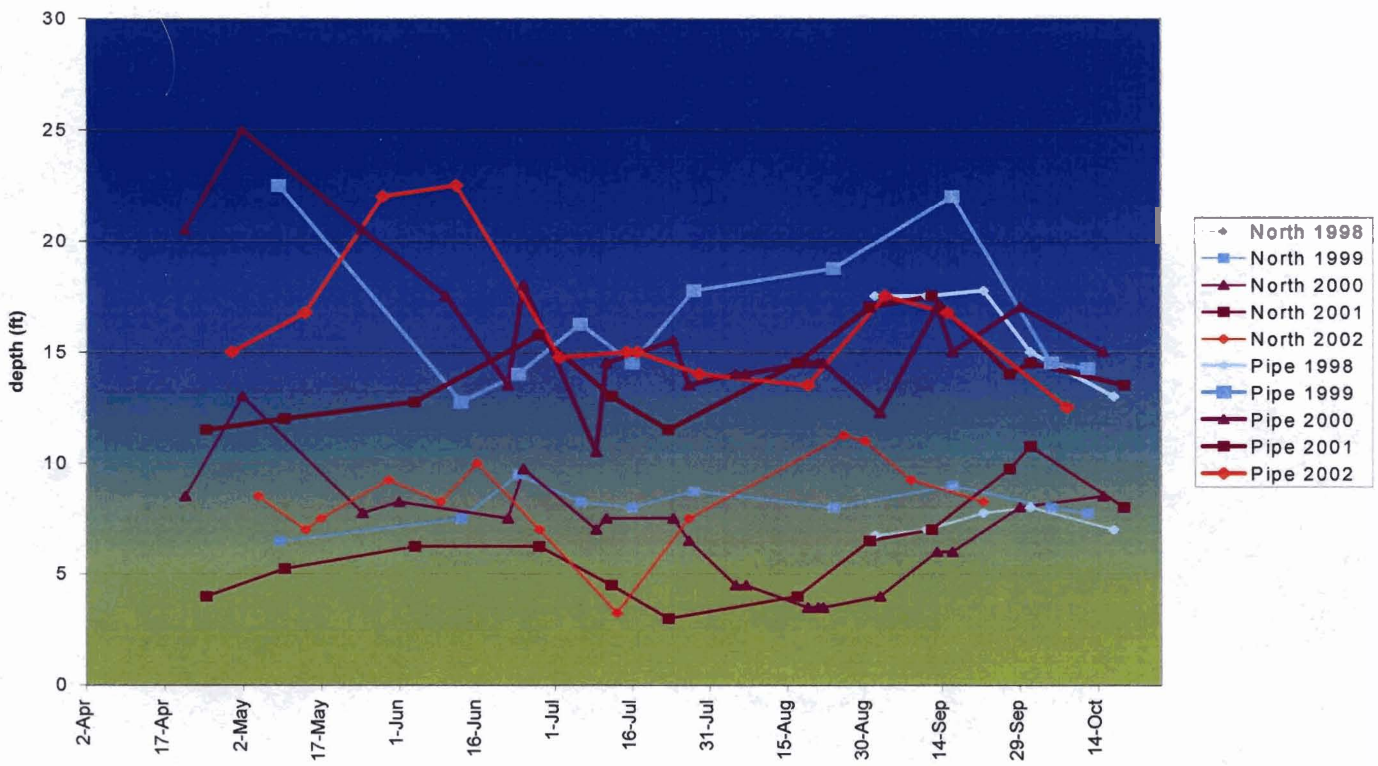
Water clarity varies throughout the year and even throughout the summer. Lake water is clearest during late fall, winter, and early spring. During these seasons there is typically little runoff from the neighboring landscape and the water is too cold to support prolific microorganism growth in the water column. As summer progresses runoff from rain and snowmelt carry suspended particles to the lake that reduce light penetration. Also, as the water warms microorganisms in the water column, such as algae, become dense enough to further limit light penetration. Then in the fall, as the water cools and biological processes slow, lakes again become clearer.

Water clarity is measured with a Secchi disk. This 8-inch disk is lowered from a boat usually at the deepest part of a lake until it just disappears from sight, then raised until it is just visible. The average of the two depths is recorded as the 'Secchi depth.'

Pipe Lake's average Secchi depth reading for July (typically the month with the lowest water clarity) from 1999-2002 is over 14 feet. This easily ranks Pipe Lake as one of the clearest lakes around. Secchi depth readings may vary as much as ten feet from month to month but this appears to be natural fluctuation in a healthy lake. Although some Secchi readings have been documented since 1994 the records are spotty and are not sufficient to show long-term trends in water clarity. It is strongly suggested that Secchi depth readings be taken at least weekly by lake volunteer(s) from ice-off to ice-on every year.

North Pipe Lake's average Secchi depth reading for July from 1999-2002 is less than half of Pipe Lake's at about 6.5 feet. Data from these four years doesn't show any pattern to North Pipe's variations in water clarity. Like Pipe Lake, the data is too sparse to demonstrate any trends. However, data collected on true-color, turbidity, and chlorophyll-a concentrations help explain why

Pipe Lakes Secchi depth, 1998-2002



North Pipe has dramatically lower water clarity than Pipe Lake.

True-color

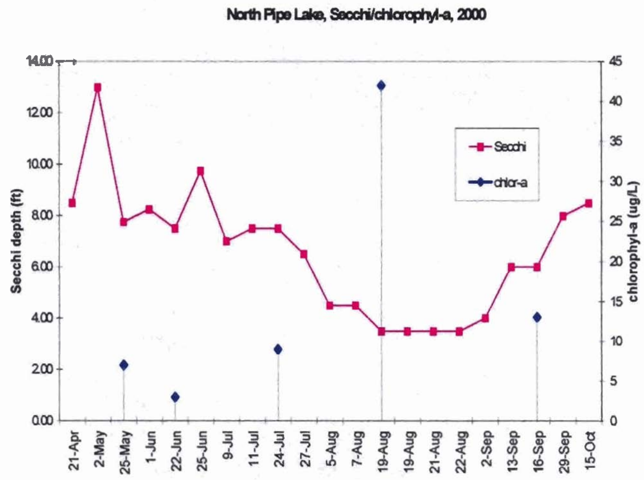
The true-color of North Pipe (a measure of dissolved minerals and organic compounds that stain water like tea) was 30 units at the surface and 55 units at the bottom compared to Pipe Lake's 5 units. These North Pipe readings affect water clarity; however, North Pipe is at a point where even small increases in color will produce substantial decreases in water clarity. Couple that with comparatively higher turbidity readings (a measure of suspended particles in the water column) and one can actually quantify the water clarity differences between the two lakes.

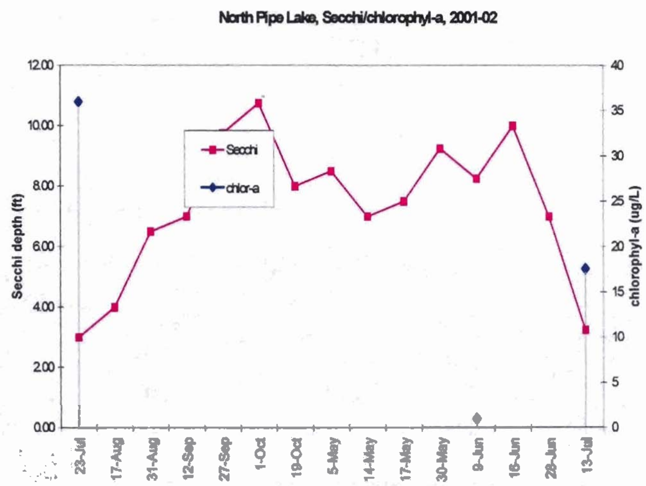
Chlorophyll-a

Chlorophyll-a is a measure of algae. Algae and other microorganisms are a natural part of lake ecosystems. These microscopic critters constitute the base of a lake's food chain just like plankton in the oceans.

A relationship appears evident between chlorophyll-a and water clarity. When chlorophyll-a levels are high in North Pipe Secchi depth readings are low. Furthermore, these concentrations are ten times higher than those on Pipe. This information along with the true-color readings indicates that the primary reason for the lower water clarity in North Pipe is the presence of algae in the water column.

In this region algae growth is typically associated with the nutrient phosphorus but the data collected on North Pipe does not show any strong correlation between these two parameters. This may be because of the lack of historical data or because sampling efforts have not concentrated on this aspect of lake chemistry.





Phosphorus

The **total phosphorus** results in North Pipe have been high enough on occasion to classify the lake as *eutrophic*. Eutrophic lakes are characterized by extremely low water clarity, nuisance aquatic plant growth that affects boating and recreation, and algal scums. Fortunately the lake does not appear to have fully crossed this threshold.

The **dissolved reactive phosphorus** (DRP) results are low for both Pipe and North Pipe Lakes. DRP is the phosphorus that is immediately available in the water column for take up by plants or algae. North Pipe's low DRP is a contributing factor to its relatively high productivity but without the presence of nuisance algae blooms.

N:P ratio

North Pipe's N:P (nitrogen:phosphorus) ratio is 7:1 where as South Pipe's N:P ratio is 14:1. Therefore Pipe Lake is considerably more sensitive to phosphorus inputs. This means that adding even a modest amount of phosphorus to Pipe Lake will dramatically affect the lake's productivity - likely resulting in increased plant and algae growth. Conversely, phosphorus inputs to North Pipe may not result in observable consequences…at least immediately.

Stratification: temperature and oxygen

Water profile monitoring indicates that the lakes differ greatly in their temperature and dissolved oxygen profiles. It appears that Pipe Lake mixes completely shortly after ice-out. This means that even the bottom waters become oxygenated. However, around July the lake becomes thermally stratified and the bottom waters become devoid of oxygen. This makes Pipe Lake *dimictic* which means that although the lake stratifies during the summer it will thoroughly mix during the spring and fall overturn events.

Although only one sampling event on 5/5/02 indicates that North Pipe had a consistent dissolved oxygen reading throughout the water

TSI	General description
<30	Oligotrophic; clear water, high dissolved oxygen throughout the year in the entire water body.
30-40	Oligotrophic; clear water, possible periods of anoxia in the lake bottom (dissolved oxygen = 0).
40-50	Mesotrophic; moderately clear water, increasing chance of anoxia near bottom in summer, fully acceptable for all recreation/aesthetic uses.
50-60	Mildly eutrophic; decreased water clarity, anoxic near bottom, nuisance aquatic plant growth, warm water fisheries only.
60-70	Eutrophic; blue-green algae dominance, scums possible, prolific aquatic plant growth.
70-80	Hypereutrophic, heavy algal blooms possible throughout summer; dense beds of aquatic plants.
>80	Algal scum, summer fish kills, few aquatic plants due to algal shading, rough fish dominant.

Pipe Lake
TSI 37

North Pipe Lake
TSI 53

The Carlson trophic state index was developed by Dr. Robert Carlson in 1977

The TSI values (trophic state index) were determined using a computer model (WiLMS) These numbers were very close to the results of the chemical sampling from 1999-2002. If the actual samples were used to determine a TSI for North Pipe it would be placed right on cusp of mesotrophic and mildly eutrophic.

column, modeling (use of the Osgood Index) suggests that the lake is dimictic. Since dissolved oxygen has not been sampled in April or November it is quite possible that mixing events have been missed. Further sampling, especially between October and May, would clarify the tendency of North Pipe to mix or stratify.

Oxygenating the bottom waters helps keep phosphorus from releasing from the sediments. So mixing on Pipe Lake is a good thing. The potential lack of mixing on North Pipe is a double-edged sword. Data shows that a considerable amount of phosphorus exists at the bottom of North Pipe which is at least partly due to the low oxygen levels. However, if complete turnover occurred the bottom phosphorus would become available throughout the water column. This nutrient boost in near the surface during the growing season may stimulate aquatic plant and algae growth.

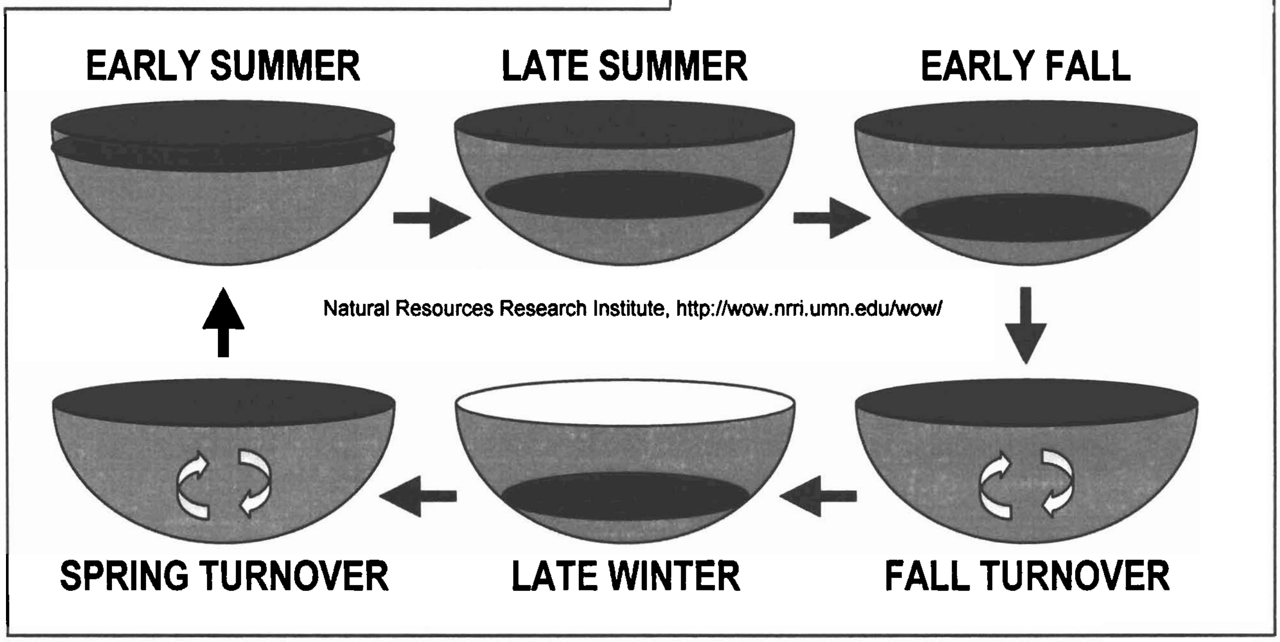
In both basins the conductivity data supports the dissolved oxygen and temperature data. The conductivity increases in the deeper holes is likely due to the reduction of the sediments by anaerobic bacteria.

What exactly is 'turnover?'

In Wisconsin, most lakes the size and depth of Pipe and North Pipe stratify. As the surface waters warm during the summer months the lake separates into distinct layers kind of like the vinegar, oil, and water in salad dressing. But unlike salad dressing this phenomena has to do with water temperature and density.

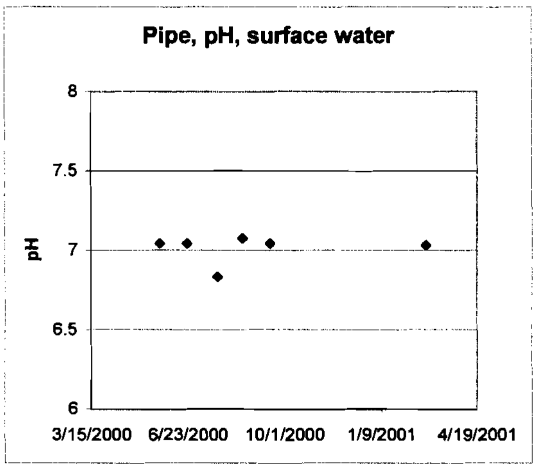
This disconnect traps nutrients and chemicals in one layer or another. For instance, at the bottom layers the decomposition of organic material uses up oxygen. As oxygen is depleted at these depths there is no way for oxygen to be replenished from the oxygen-rich waters at the surface. That is until the surface waters cool during fall and the autumn winds stir the lake and mix the oxygen-rich surface with the oxygen-depleted bottom.

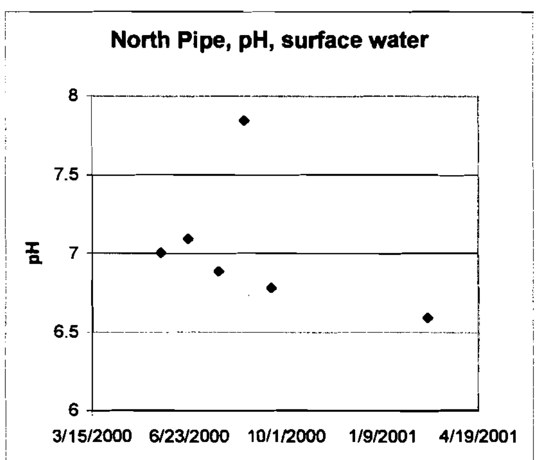
This process ensures that fish and other aquatic critters will have enough oxygen to survive the winter under the ice. Under the ice lakes again stratify and oxygen is typically depleted at depth. After ice-out in the spring winds again help stir the lake and oxygenate the lake from top to bottom.



pH, alkalinity, and acid rain

Both lakes generally appear to have a neutral pH (pH = 7). This is perfect for fish, aquatic plants, and wildlife. Unfortunately both lakes also have fairly low alkalinity (~15 mg/l of $CaCO_3$) and are therefore sensitive to the ravages of acid rain. A lake's alkalinity is a result of its geology so there's not much human influence to be considered with this parameter other than erosion.





Lakes in this region already receive mercury deposits from the rain that primarily originate in the Twin Cities Metropolitan Area as a result of automobile emissions and industrial pollution (power plants for example). (Incidentally mercury levels are high enough that fish consumption advisories exist on all area lakes including Pipe Lakes.) These same sources cause acid rain. And the same atmospheric forces that carry mercury on the wind to our lakes carry acid rain. Acid rain has the potential to lower the pH of Pipe Lake to the point that fish cannot survive - as has already occurred in Canadian provinces and northern New England states.

Conclusions

Both Pipe and North Pipe Lakes currently provide a productive fishery and opportunity for the widest possible variety of recreation. The diversity of plant life both in and adjacent to the lakes provide food and habitat for an array of wildlife. Pipe Lakes property owners enjoy a serene setting compatible for wildlife viewing, boating, swimming, fishing, and winter activities.

The future of Pipe Lakes obviously cannot be predicted. However, it is not unreasonable to assume that the recreational opportunities that this area offers will attract people and development. Residential development within the watershed would increase the nutrient load to the lakes and negatively affect the surrounding ecosystem. Roads, driveways, rooftops, and yards are sources of pollution and they make crummy wildlife habitat.

North Pipe is considered *mildly eutrophic* which is a condition typically characterized by decreased water clarity, low oxygen levels near-bottom, and nuisance aquatic plant growth. Continued nutrient inputs will eventually push the lake to *eutrophic,* which is a state characterized by blue-green algae dominance, scums, and prolific aquatic plant growth. Eutrophic lakes don't offer nearly as many recreational opportunities as mildly eutrophic lakes. The primary goal of managing North Pipe Lake, for now, should be to prevent further *eutrophication* of the lake in order to preserve the current recreational opportunities in balance with a healthy ecosystem.

Pipe Lake is considered *oligotrophic,* which is a condition characterized by clear water, moderate aquatic plant growth, and possible periods of anoxia (no oxygen) near the bottom. Slight increases in nutrient inputs will cause sharp declines in water clarity and increases in aquatic plant growth. The primary goal of managing Pipe Lake should be to prevent further *eutrophication* of the lake in order to preserve the current recreational opportunities in balance with a healthy ecosystem. Since North Pipe drains directly to Pipe Lake this goal can be partially achieved by focusing efforts on protecting North Pipe Lake.

Long-term data is absolutely essential to ensuring that these lakes are managed properly and that limited resources are directed in a manner that will maximize their effectiveness. The Lake Association has recently secured a DNR grant that will continue where this grant left off. But the Association should continue to work with their members, the DNR, and other agencies and groups to ensure that these lakes are monitored for decades to come.

At a <u>minimum</u> these lakes should be monitored throughout the ice-free period for the following:

1) Secchi disk, weekly
2) Total phosphorus, monthly
3) Chlorophyll-a, monthly

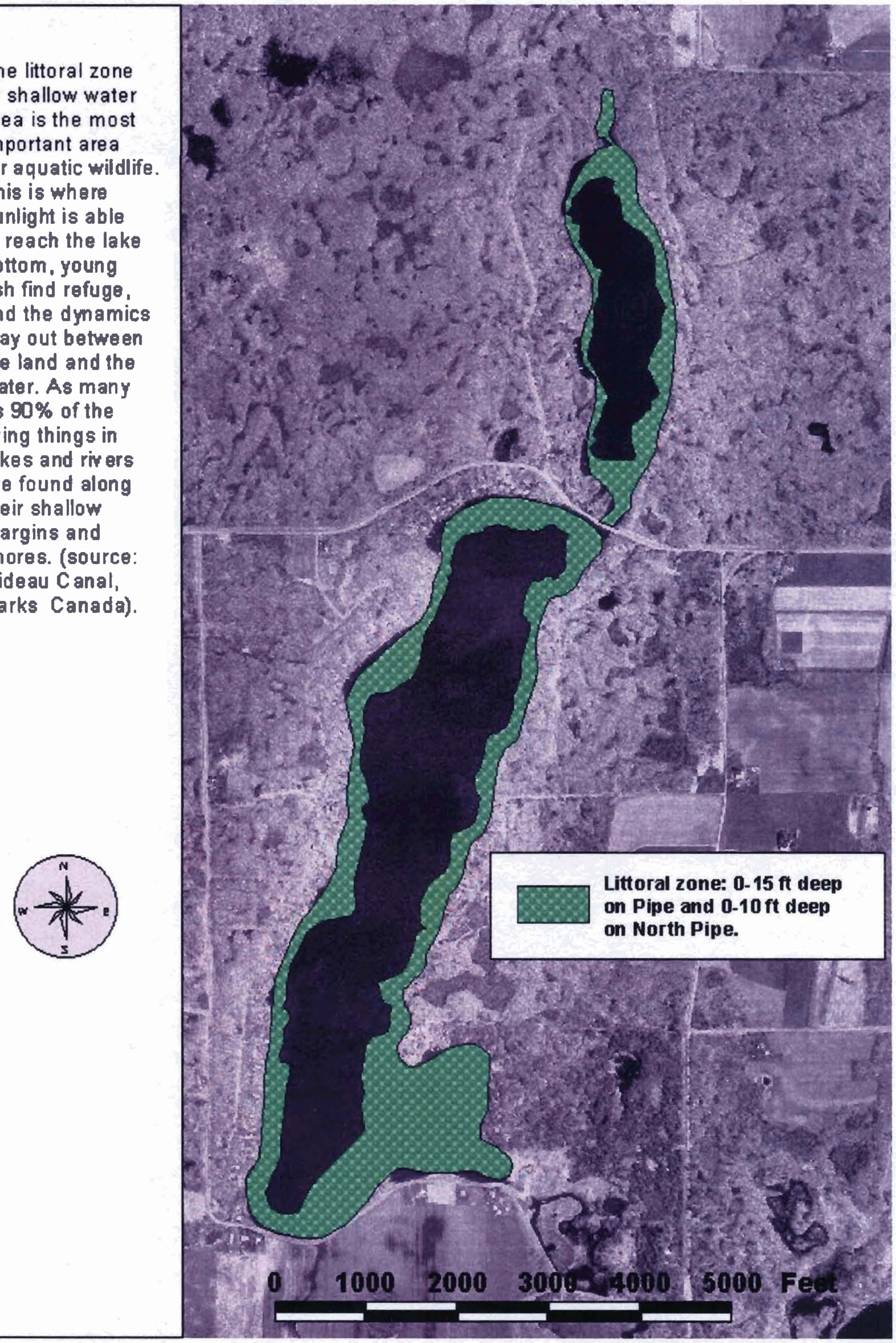
If resources are available the Association should consider adding the following parameters to a long-term monitoring program:

1) Temperature and dissolved oxygen profile, weekly
2) Major nutrients, pH and alkalinity, basic cations, sulfate, chloride, turbidity, color, and conductivity during spring & fall turnover events
3) Precipitation, as it occurs
4) Lake level, 2 times/week or more

There is no substitute for actual facts and figures – even if it is the most rudimentary information.

Shallow water sensitive areas

The littoral zone or shallow water area is the most important area for aquatic wildlife. This is where sunlight is able to reach the lake bottom, young fish find refuge, and the dynamics play out between the land and the water. As many as 90% of the living things in lakes and rivers are found along their shallow margins and shores. (source: Rideau Canal, Parks Canada).



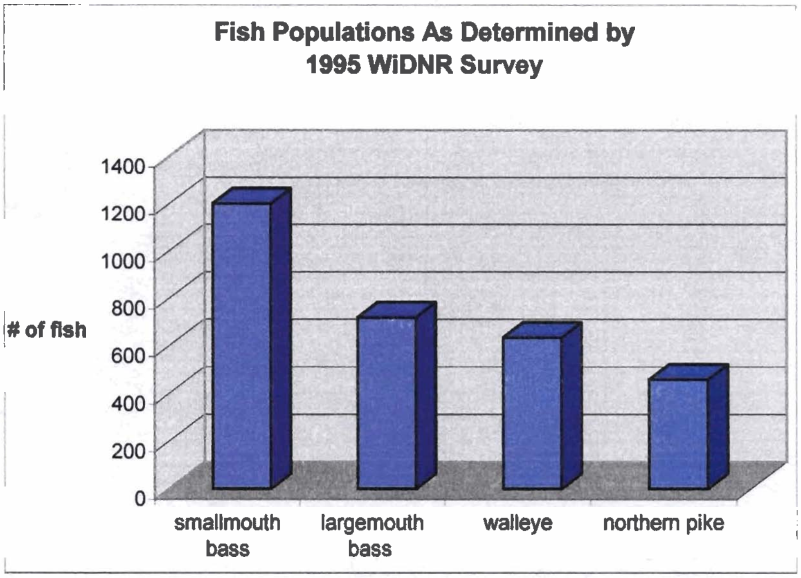
Fisheries and Habitat

Fisheries Data

In 1995 a survey was conducted on Pipe Lakes by the DNR to evaluate the game fish population. Smallmouth bass were found to be the most abundant large gamefish.

Panfish were also sampled. Bluegills were captured in the greatest numbers, followed by fewer numbers of rock bass, black crappies, yellow bullheads, green sunfish, hybrid sunfish (bluegill x green sunfish), yellow perch, black bullheads and golden shiners. A smaller net was used to capture spottail shiners, bluntnose minnows, mud minnows, and Johnny darters. Of these, the bluntnose minnows and spottail shiners were most abundant.

The presence of smallmouth bass, largemouth bass, bluegills, rock bass, and yellow bullheads indicate good water quality, however, since both Pipe and North Pipe Lakes were included in this survey it is impossible to make any meaningful conclusions about water quality.



Dennis Schupp, a retired Minnesota DNR fisheries biologist, has studied the correlation between composition and abundance of sensitive fisheries populations and water quality. Schupp published an article in the North America Lake Management Association's journal *Lakeline*, in December 1993 entitled 'Developing Lake Goals for Water Quality and Fisheries.'

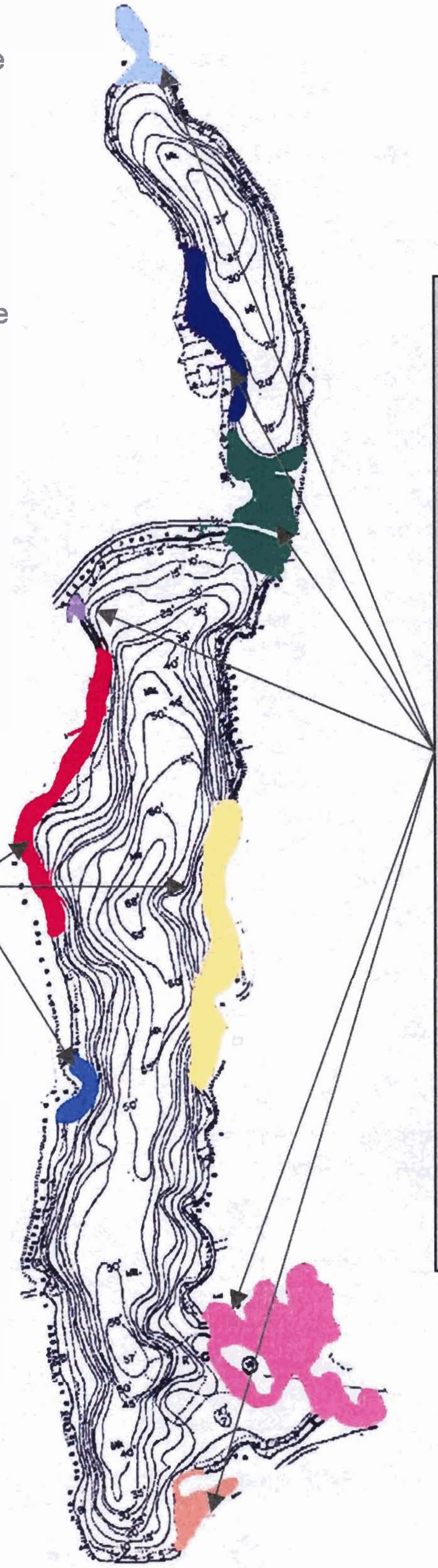
Schupp notes that smallmouth bass, largemouth bass, rock bass, bluegills and pumpkinseeds are common in lakes considered to be in 'good' condition. Of these fish sunfish, smallmouth bass and rock bass are usually associated with the highest water quality. Secchi disk readings in lakes containing these species often exceed six feet.

Fisheries and Habitat

Sensitive areas survey

Environmentally sensitive areas were identified on Pipe and North Pipe Lakes by DNR biologists in 1999. These areas merit special protection because they provide critical or unique fish and wildlife habitat as described. The full report, *Pipe Lake Sensitive Area Survey Report and Management Guidelines,* is available from the DNR.

During this survey there were no documented occurrences of purple loosestrife: a persistent exotic plant that is dominating shallow water habitat in the Midwest and Canada. However, the threat of purple loosestrife is always a concern and should be dealt with immediately.



Generally bass, panfish and northern pike spawning and nursery areas and habitat for forage species. Turtles, amphibians, eagles, loons, herons, waterfowl, and even some songbirds also benefit from these habitats. Chemical treatments and mechanical removal efforts should be limited to navigation channels only. The plant communities includes the following:

- **Emergent:** bur-reed, arrowroot, cattail, pickerel weed, bulrush.
- **Floating leafed:** yellow pond lily, white water lily, watershield.
- **Submergent:** wild celery, pipewort, long-leaf pondweed, Robbinson pondweed, flat stem pondweed, large leaf pondweed, bushy pondweed.

High quality walleye spawning habitat. No dredging, structures or deposits should occur in these areas.

Furthermore, there were no documented occurrences of Eurasian water milfoil (EWM): a persistent aquatic plant that grows in densities capable of choking out native vegetation and causing navigation problems. EWM is moved from lake to lake on boats and boat trailers that come from an infested lake.

Fisheries and Habitat

Management recommendations

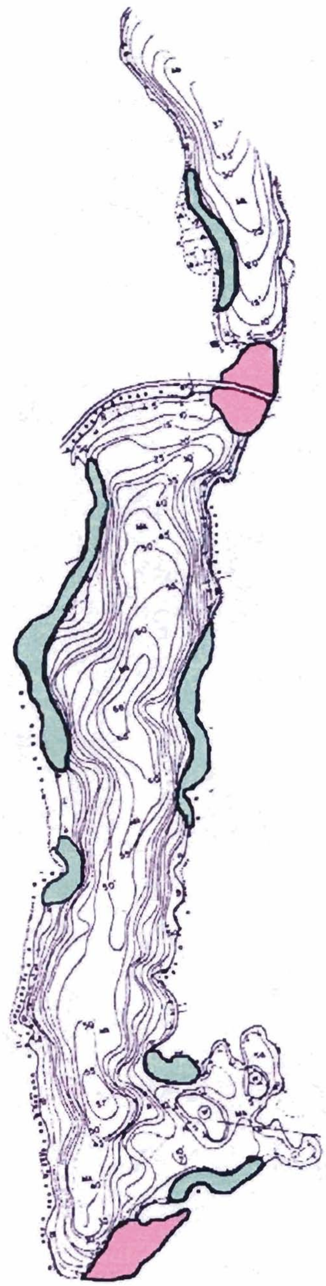
Based on fisheries data and the DNR sensitive areas survey the following guidelines are suggested to protect fish and wildlife habitat in Pipe and North Pipe Lakes:

No Wake Zone = no wake 15-20 feet from shore

- Minimal Boat Usage = closed throttle year-round and restricted boating during spawning

To implement such boating restrictions the Lake Association would need to work with the DNR and perhaps the township to enact and ordinance. Signage and other outreach measures would help get the word out. Lake property owners have a good record statewide of monitoring activities in sensitive areas and protecting the resource.

Furthermore, vigilance by Lake Association members will help to ensure that the lakes are not overrun by an exotic plant or animal. The presence of such would dramatically affect the lakes' ecosystems as well as the management goals regarding the lakes. The DNR and the Polk County Land and Water Resources Department can train Association members to identify exotic plants and animals.

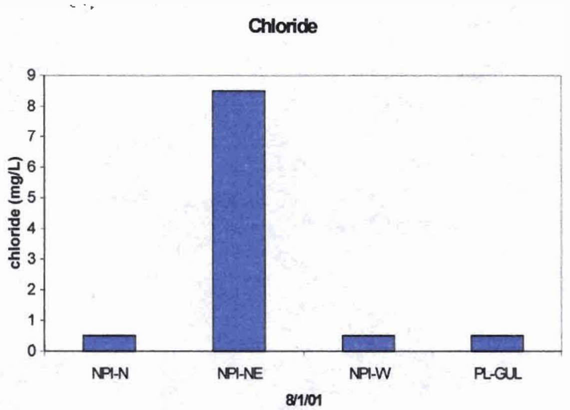


	No wake zone
	Minimal boat usage

Special note about this section and NPI-NE: *Samples taken from* **NPI-NE on 8/1/01** *may not be indicative of actual runoff. Samples were taken from stagnant water near a culvert following a rain event.*

Chloride

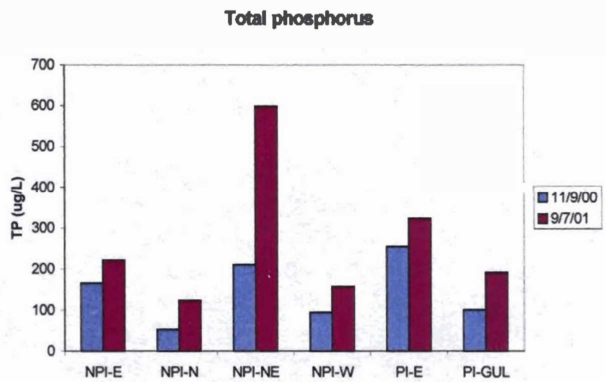
Chloride occurs naturally in the environment and does not affect plant and algae growth. However, chloride is not common in this region due to limited quantities in the rocks and soils. Besides local geology sources of chloride include septic systems, animal waste, fertilizers, and road salt. Three inlets (see page 35) on North Pipe were tested for chloride. NPI-N and NPI-W had levels that were below the detectable threshold. NPI-NE had a comparatively high concentration. This indicates that NPI-NE may be a source of nutrient pollution that is linked to human activities. This is good news since human activities are easier to control than ecological processes.



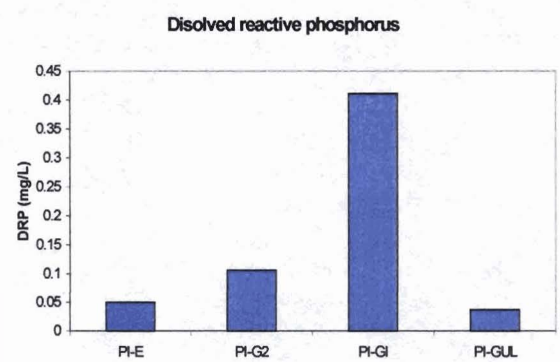
Phosphorus

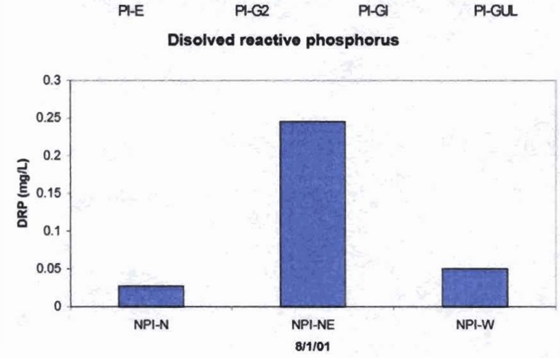
Phosphorus is typically the limiting nutrient affecting plant growth in this region. This means that a slight increase of phosphorus within a lake is likely to dramatically increase plant and algae growth while at the same time decreasing water clarity. Phosphorus occurs naturally in some soils and is a product of decomposing plants. Phosphorus sources also include rainfall, septic systems, lawn and agricultural fertilizers, animal waste, yard and shoreline erosion, and detergents.

Total phosphorus was measured at least once at all inlets. The most notable observation of this data is that NPI-NE had 3 of the 6 highest sample concentrations. PI-E had 2 of the 6 highest sample concentrations. NPI-E also had comparatively high readings.



Dissolved reactive phosphorus was measured at all of the inlets except PI-G1. NPI-NE again had 3 of the 6 highest sample concentrations. PI-G2 also had particularly high concentrations in 2 sampling occasions. NPI-E, PI-E, and PL-GUL are also a concern.

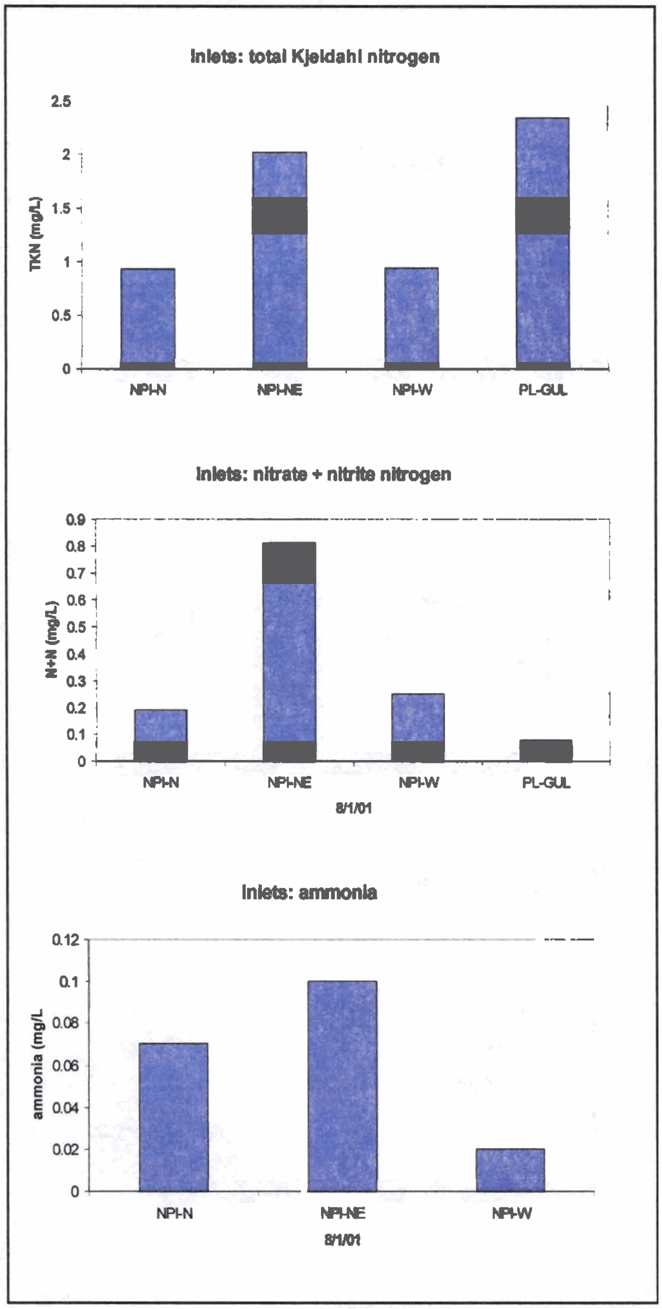




Streams and Inlets

Nitrogen

Nitrogen is a naturally occurring element. Nitrogen is second only to phosphorus in its importance as a plant nutrient. Sources include rainfall, septic systems, lawn and agricultural fertilizers, and animal wastes. NPI-NE had consistently high sample concentrations of nitrogen in its various forms: nitrate+nitrite, total Kjeldahl nitrogen, and ammonia.



Conclusions

The stream sampling to date has been primarily to identify pollution hot spots. This work suggests that future monitoring efforts should be concentrated on those inlets that have repeatedly shown relatively high sample concentrations such as NPI-NE. PI-E and PI-GUL are also a primary concerns because of relatively high total phosphorus readings and because they likely drain comparatively more land – including agricultural land - thereby diluting sample concentrations collected so far.

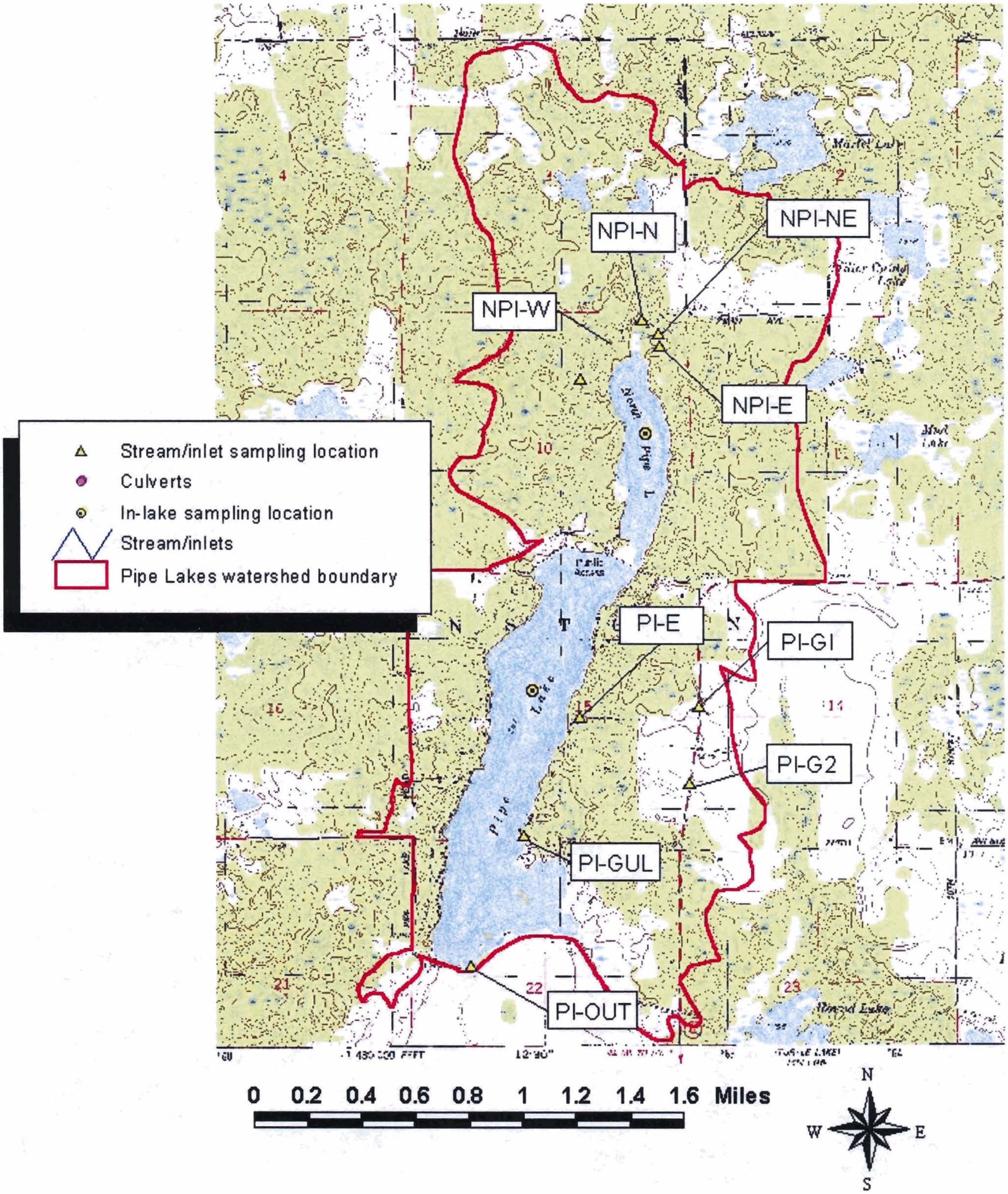
Two samples in the spring would gather data on snowmelt and a spring rain. Any subsequent summer and fall samples would focus on large rain events that would likely flush nutrients from the stream's sub-watershed into the lake. If chemical samples are taken in conjunction with flow data it would be possible to quantify the annual nutrient load from a specific stream or inlet.

Stream sample analysis is available from both the State Laboratory of Hygiene in Madison and the Environmental Task Force Lab on the UW campus in Steven's Point. At $55/sample the ETF lab charges considerably less than the SLOH for testing the following parameters:

- Ammonia
- Nitrate + nitrite
- Kjeldahl nitrogen
- Disolved reactive phosphorus
- Total phosphorus
- Total suspended solids

It is strongly suggested that the Lake Association work closely with an expert from the DNR, a laboratory, a private consulting firm, or the County's Land and Water Resources Department to develop a testing protocol to monitor streams. This testing is expensive and some professional guidance up front is a wise investment of time and/or money.

Sample locations



Modeling

Pipe and North Pipe Lakes were modeled for current conditions, pre-development, and projected development. Phosphorus was the primary parameter in these modeling scenarios because it is the limiting nutrient for algal growth in most fresh water lakes. The following tables and graphs were based on annual phosphorus loading by land use and the Nurenberg model for estimating the amount of phosphorous in the water column.

The models best suited to represent both Pipe and North Pipe were the Reckhow Natural Lake Model (1979) and the Vollenweider Lake Model (1982). The Reckhow model predicts growing season observations while the Vollenweider predicts a spring turnover and growing season average. The Reckhow model seems to best represent current conditions based on sampling data.

Table 1. Pipe and North Pipe Lake current conditions

	Total Loading (Land Use)	Reckhow, 1979 Natural Lake Model	Vollenweider, 1982 Lake Model
North Pipe	93.8 kg	22 mg/m^3	29 mg/m^3
Pipe	156.3 kg	10 mg/m^3	25 mg/m^{3*}

* North Pipe Lake may not fully turn over

Under current zoning laws it is possible to develop all of the forestland in the Pipe Lakes watershed with low-density residential development. Such a change in land use would more than double the phosphorus concentration in North Pipe Lake. However, both models predict that the concentration in Pipe Lake would remain stable. This suggests that North Pipe provides runoff filtering for Pipe Lake because the runoff that originates north of 220th Avenue must first go through North Pipe before it enters Pipe. This scenario indicates that North Pipe would become considerably greener than it is now. Unpleasant algal blooms would likely persist throughout the warmest summer months.

Table 2. Pipe Lake and North Pipe Lake projected development conditions prediction

	Total Loading (Land Use)	Reckhow, 1979 Natural Lake Model	Vollenweider, 1982 Lake Model
North Pipe	228.3 kg	54 mg/m^3	62 mg/m^3
Pipe	170 kg	11 mg/m^3	27 mg/m^3

The model was used to estimate the conditions of each lake prior to white settlement. In this scenario both lakes are crystal clear.

Table 3. Pipe Lake and North Pipe Lake predevelopment conditions

	Total Loading (Land Use)	Reckhow, 1979 Natural Lake Model	Vollenweider, 1982 Lake Model
North Pipe	28.2 kg	12 mg/m^3	17 mg/m^3
Pipe	59.6 kg	4 mg/m^3	11 mg/m^3

The lakes were also modeled for 12%, 20% and 45% reductions in phosphorous loading. This assumes that it is possible to reduce nutrient loading from the landscape by focusing attention on erosion, shoreline development, agriculture and other potential sources. On-the-ground practices that can alleviate nutrient loading from the landscape include shoreline restoration, erosion control during construction, conservation tillage, and conservation buffers. Furthermore, limiting horsepower and/or motorboat speed could reduce the internal phosphorus cycling (caused by stirring up sediments).

Table 4. Pipe and North Pipe Lake predicting a 12% phosphorous reduction

	Total Loading (Land Use)	Reckhow, 1979 Natural Lake Model	Vollenweider, 1982 Lake Model
North Pipe	83.6 kg	20 mg/m^3	26 mg/m^3
Pipe	144.1 kg	9 mg/m^3	23 mg/m^3

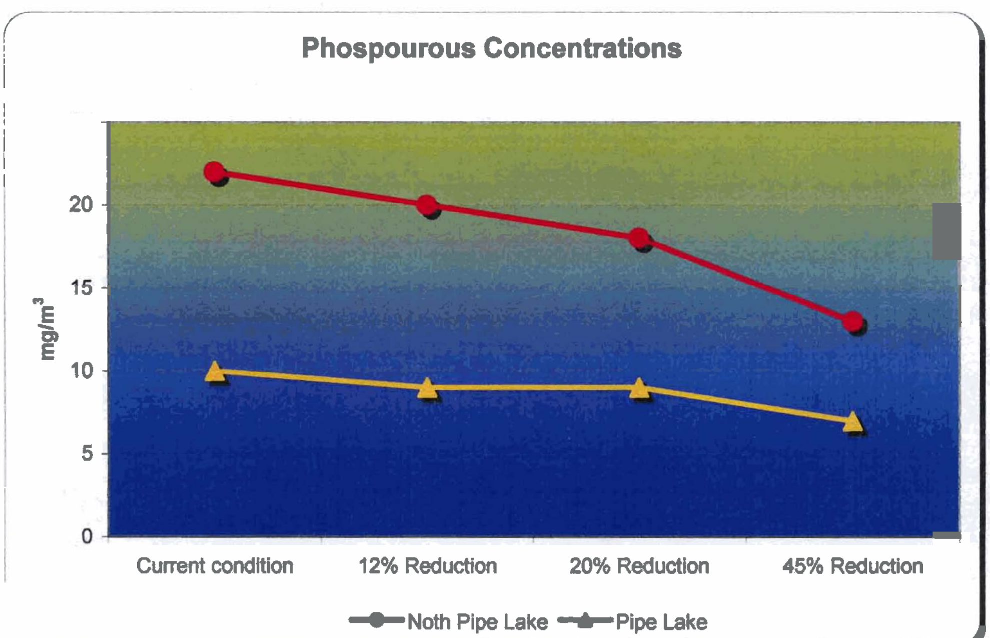
Table 5. Pipe and North Pipe Lake predicting a 20% phosphorous reduction

	Total Loading (Land Use)	Reckhow, 1979 Natural Lake Model	Vollenweider, 1982 Lake Model
North Pipe	76.8 kg	18 mg/m^3	24 mg/m^3
Pipe	136 kg	9 mg/m^3	22 mg/m^3

Table 6. Pipe North Pipe Lake predicting a 45% phosphorous reduction

	Total Loading (Land Use)	Reckhow, 1979 Natural Lake Model	Vollenweider, 1982 Lake Model
North Pipe	55.7 kg	13 mg/m^3	18 mg/m^3
Pipe	110.5 kg	7 mg/m^3	18 mg/m^3

According to the models, a 45% reduction in phosphorous loading would be necessary to significantly affect the total phosphorous concentrations in the water column of North Pipe Lake. It appears that Pipe Lake would benefit little from reducing phosphorus loading by the same amount. It is necessary to quantify the amount of nutrients entering the lake from the various streams and inlets in order to determine whether or not significant reductions in nutrient runoff is possible. This topic is covered more thoroughly in the conclusion of the 'Streams and Inlets' chapter.



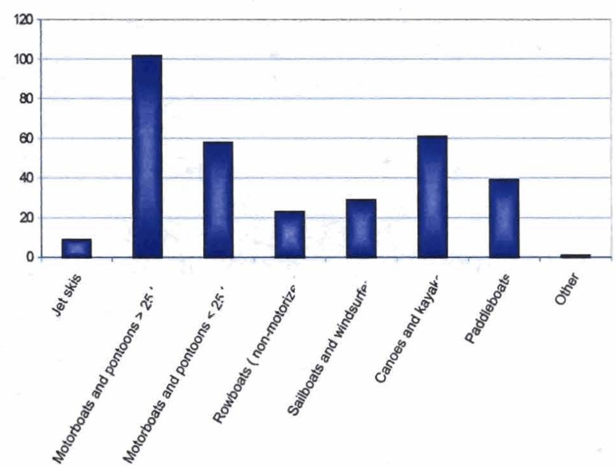
Sociologic Landowner Survey

In summer 2000 a sociological landowner survey was sent to property owners within the Pipe Lakes watershed. The survey was designed to assess landowner objectives, concerns and ideas as well as to forecast future change-of-ownership trends.

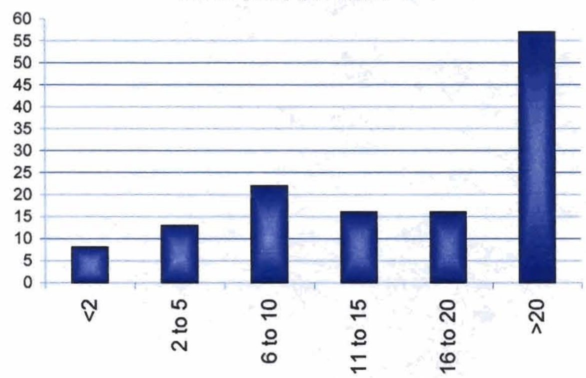
Biographic data

Although 57 respondents (43%) have owned their property for more than twenty years, 43 respondents (33%) have owned their property for ten years or less. This is a typical pattern of ownership as compared to other watersheds surveyed in Polk County. This survey does not specify whether the newer property owners bought existing homes or built new homes on previously undeveloped lots.

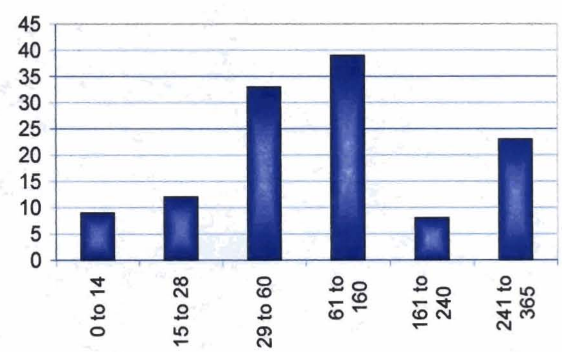
How many of the following watercraft are kept on your property for use on/in Pipe lakes?



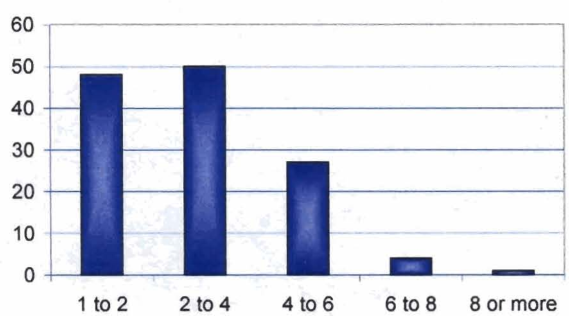
How many years have you owned property on or near the lake?



How many days in an average year is your property occupied?



On an average day that your property is occupied, how many people occupy the property?

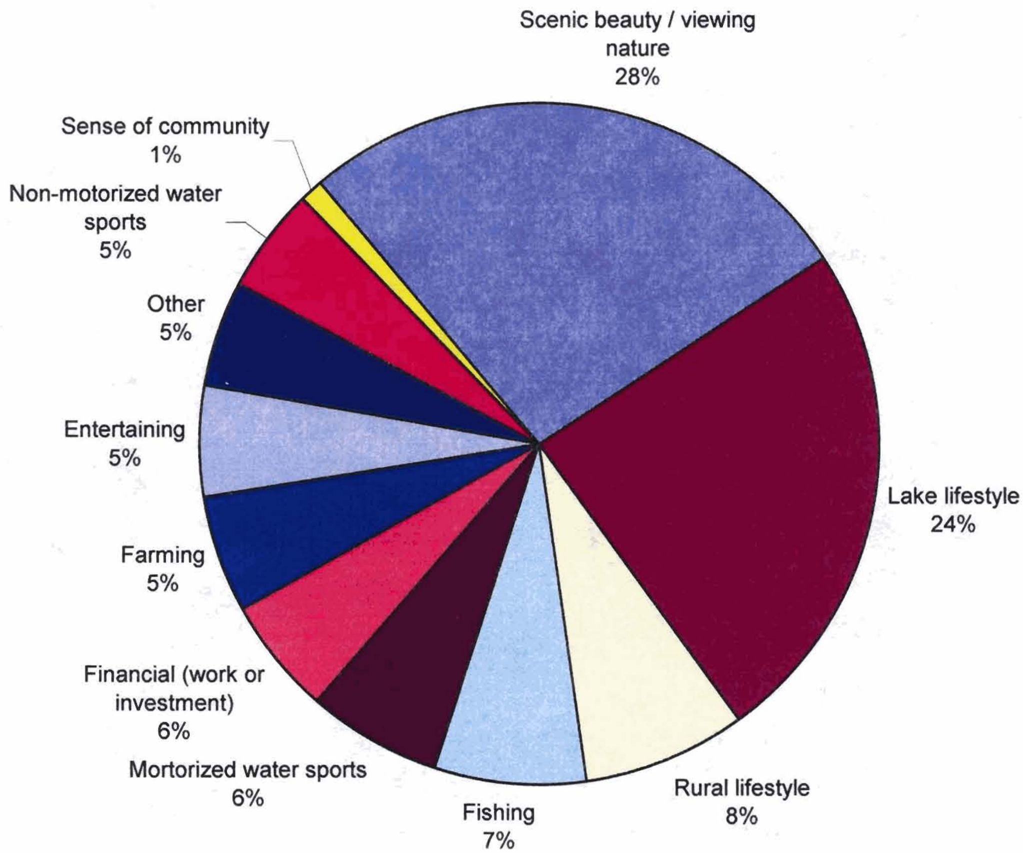


Sociologic Landowner Survey

Reasons for owning property

Property owners indicated being attracted to the area for the aesthetics offered by rustic and natural surroundings as well as the amenities associated with living on a lake.

*What is the most important reason that you own property on or near Pipe Lakes?**



**Respondents ranked their top three reasons for owning property on or near the lakes. The pie chart is a tally of all the issues ranked as the <u>foremost</u> reason.*

Sociologic Landowner Survey

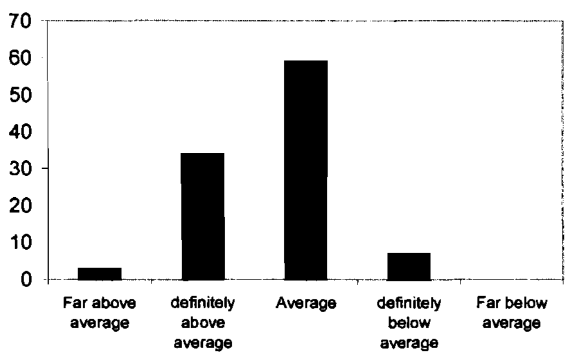
Perceptions regarding water quality

Generally, respondents indicated that the water quality of Pipe Lakes as average or above average. However, a majority of respondents (56%) feel the water quality has degraded since their tenure on/near the lakes. Thirty-four percent (34%) have not noticed a change and only 3% think the water quality has improved.

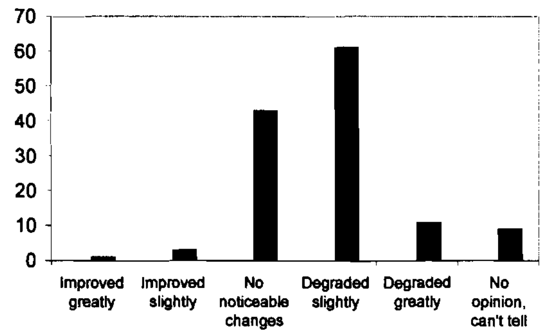
There are many respondents who offered no feedback on this portion of the survey. Education and outreach in this area may help people to better recognize indicators of natural resource health or at least prompt people to consider the lake in an ecosystem context.

The most notable item regarding people's perceptions of the lakes' quality as a natural resource was the way people described the shorelines of both lakes. Respondents described the shorelines of both North and Pipe Lakes almost identically. However, the shorelines are quite different. Although both lakes are essentially completely developed North Pipe has retained a more natural look by way of larger lot sizes, natural shorelines, and considerable setbacks. All but one lakefront property on North Pipe are screened by trees and other vegetation. Conversely Pipe Lake has more suburban-looking lawns and landscaping and considerably smaller lot sizes.

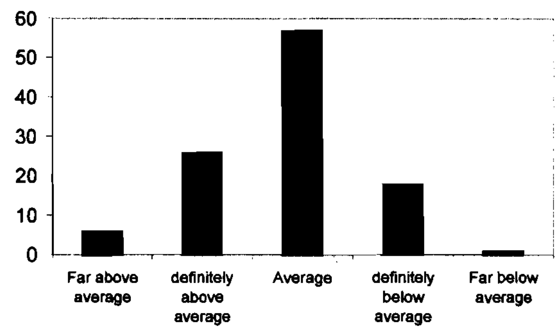
How would you describe the quality of the shoreline of North Pipe Lake?



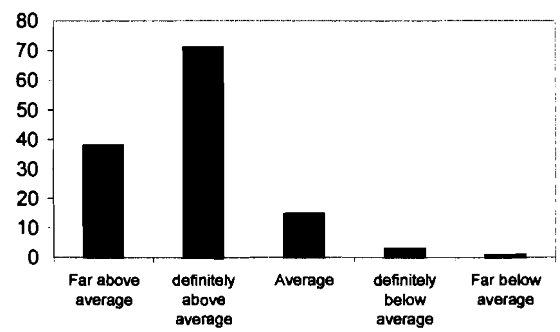
Since you have lived on or near the lake, how would you describe the change in water quality?



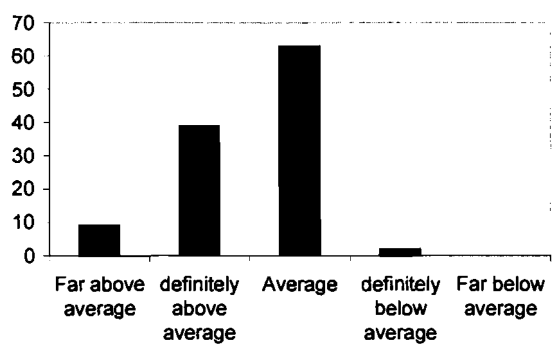
How would you describe the water quality in North Pipe Lake?



How would you describe the water quality in "south" Pipe Lake?



How would you describe the quality of the shoreline of "south" Pipe Lake?



Sociologic Landowner Survey

Willingness to provide financial support

The willingness of property owners to financially support the maintenance or improvement of Pipe Lakes and their associated land resources is strong but not as strong as on some other local lakes. Sixty-nine percent (69%) of respondents are willing to provide annual financial support. Of those 34% are willing to contribute $11-50 and 37% are willing to contribute $51-100. A whopping 18% would offer annual contributions in the $101-500 range.