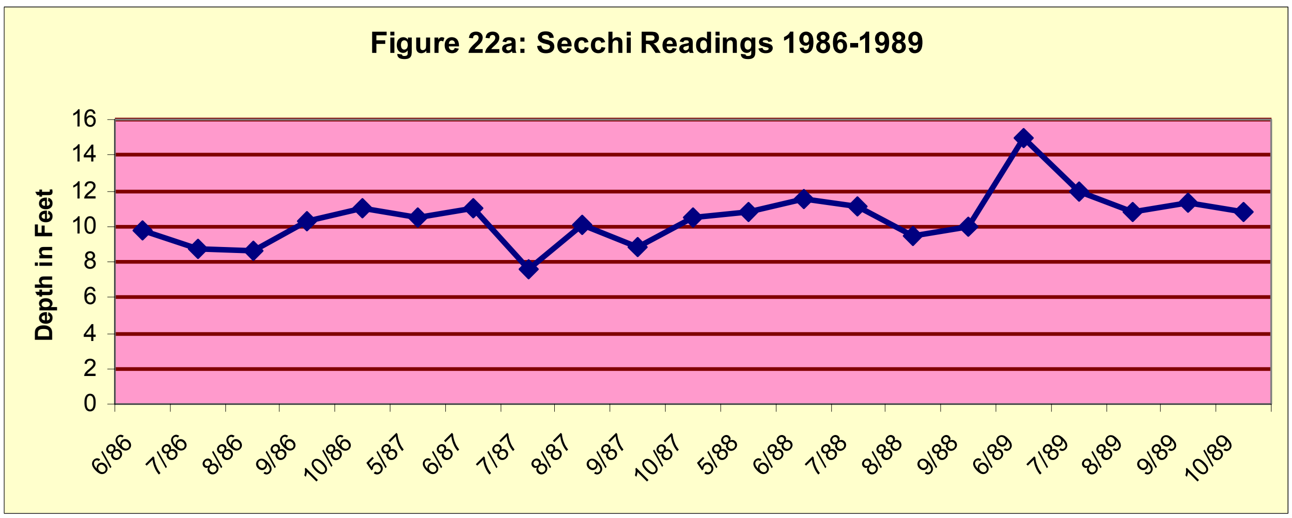
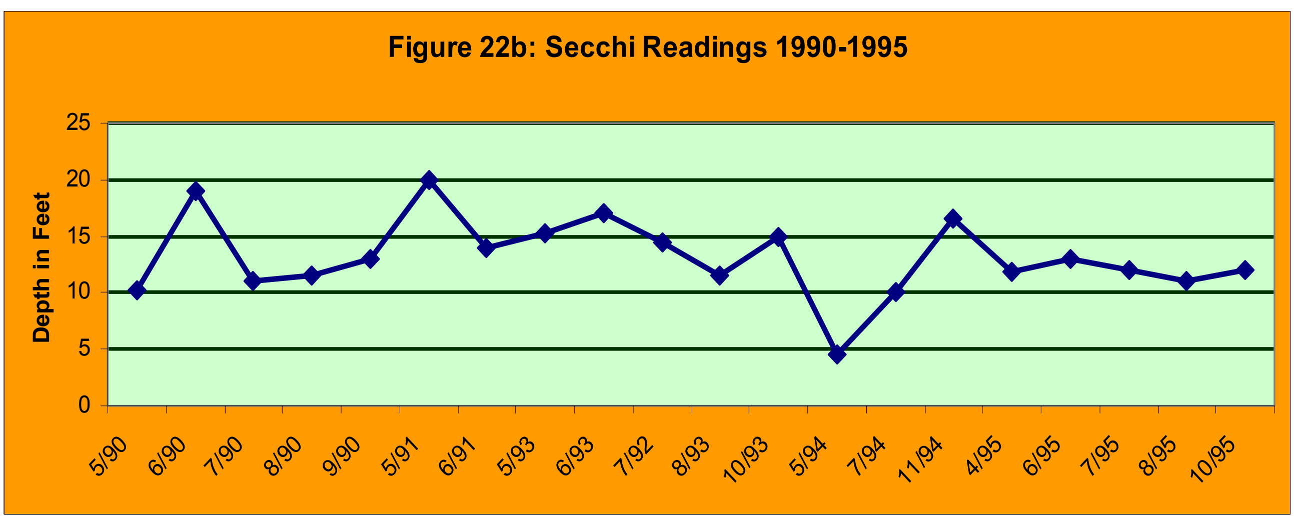
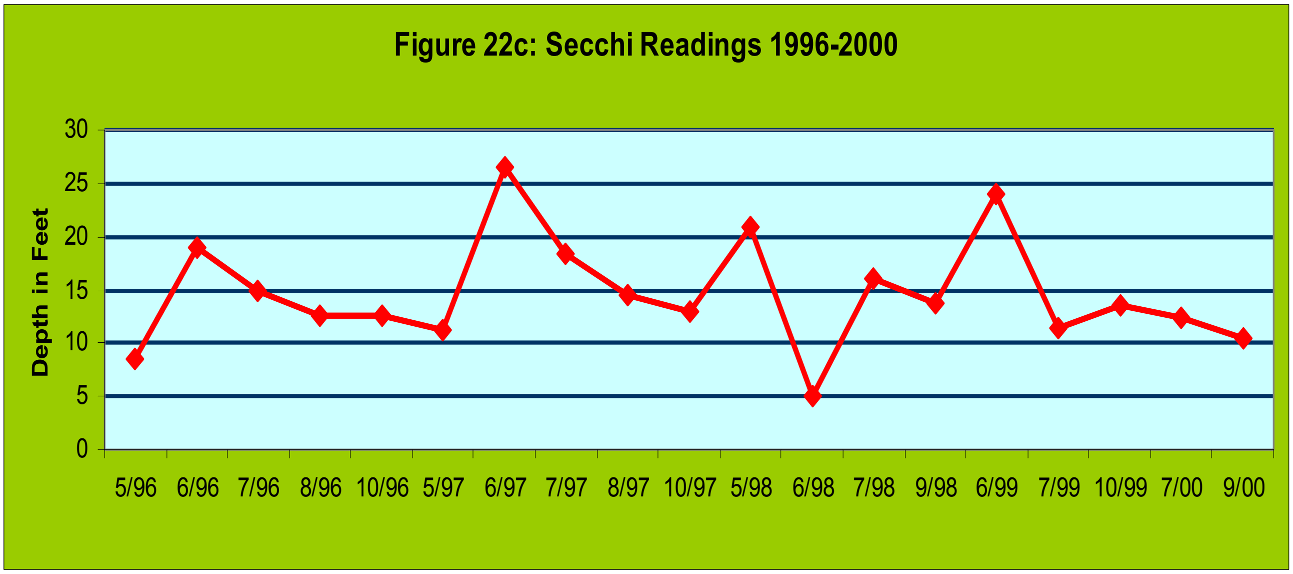
Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Jordan Lake in 2004-2006 was 11.19 feet. This is very good water clarity, putting Jordan Lake into the "oligotrophic" category for water clarity. Records since 1986 show that the water clarity in Jordan Lake has consistently remained high (see Figures 22 a,b,c,d).







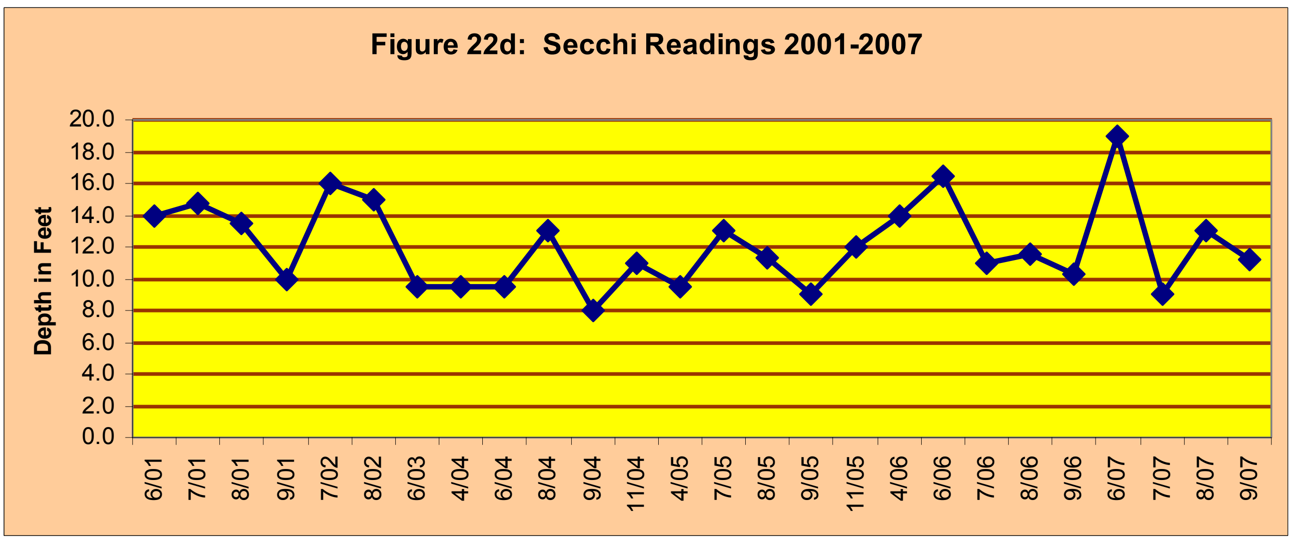


Figure 23 shows the yearly average summer Secchi readings in Jordan Lake between 1986 and 2007 and verifies that water clarity in Jordan Lake has consistently remained “very good” to “excellent”. This is one indication that Jordan Lake’s water quality remains high, at least in the upper levels of the lake. The overall Secchi disk average for 1986 through 2007 was 12.59 feet.

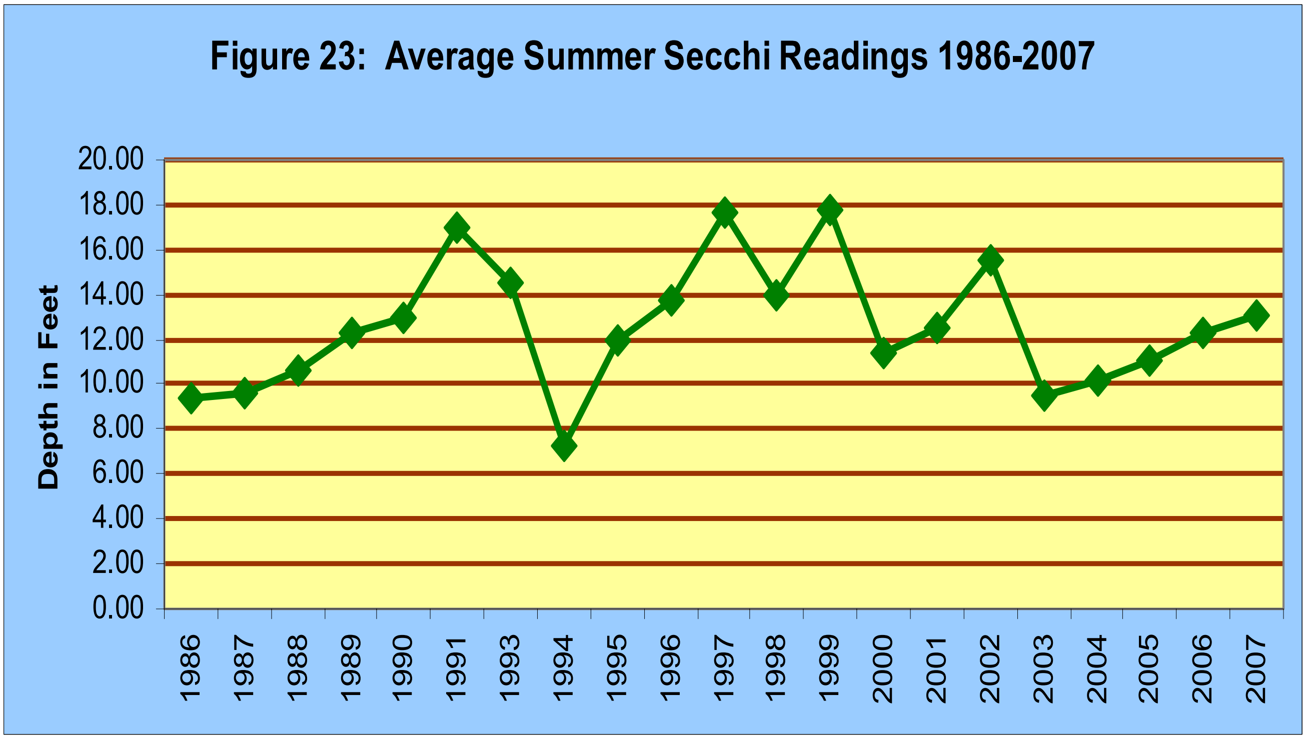


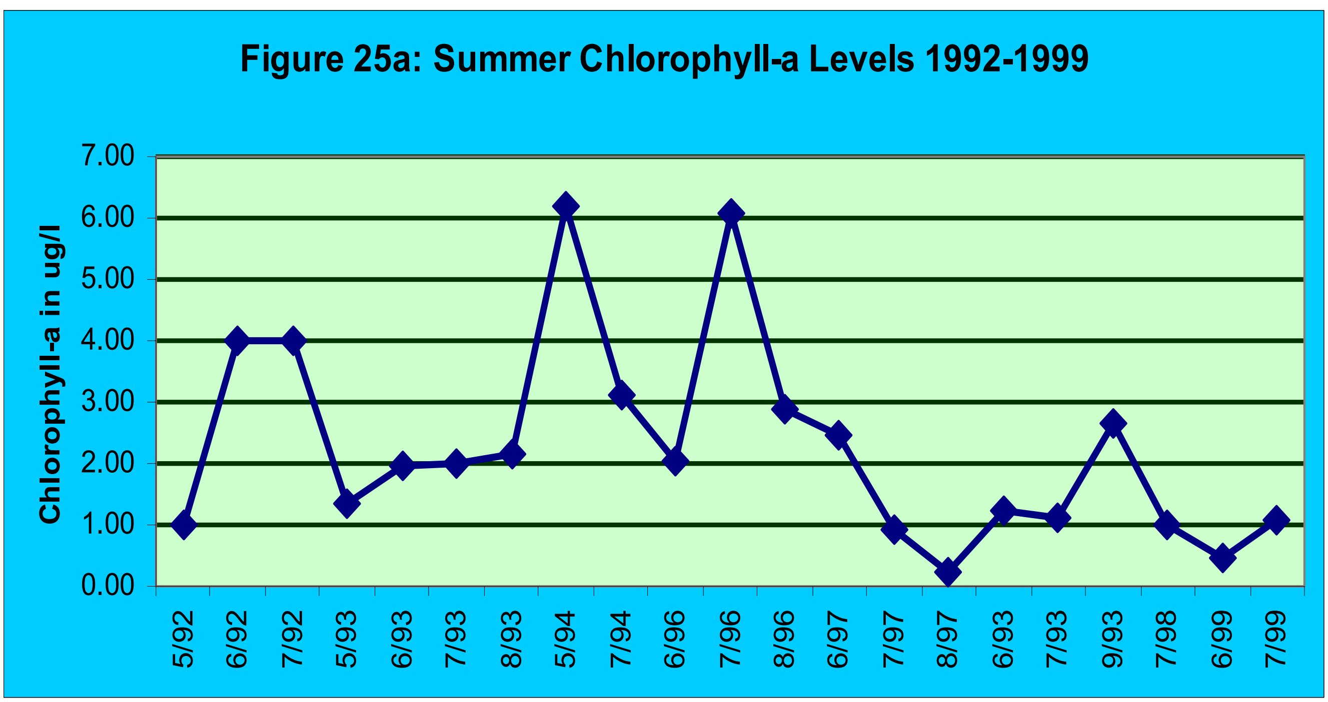
Figure 23: Average Summer Secchi Readings 1986-2007

Figure 24: Photo of Testing Water Clarity with Secchi Disk

Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. The 2004-2006 summer (June-September) average chlorophyll concentration in Jordan Lake was 2.23 micrograms/liter. This low algae concentration places Jordan Lake at the "oligotrophic" level for chlorophyll a results.

Chlorophyll-a averages have stayed low since 1992, the first year for which records were found, and have remained very low through 2007, when the Adams County LWCD was monitoring the lake.



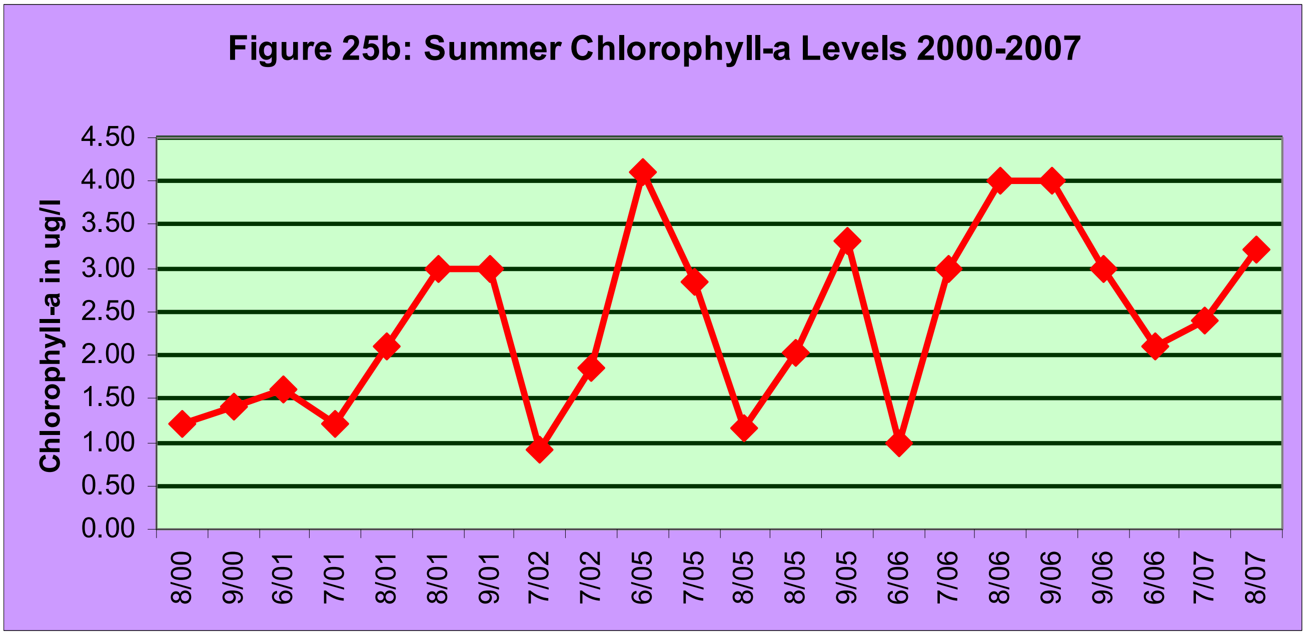
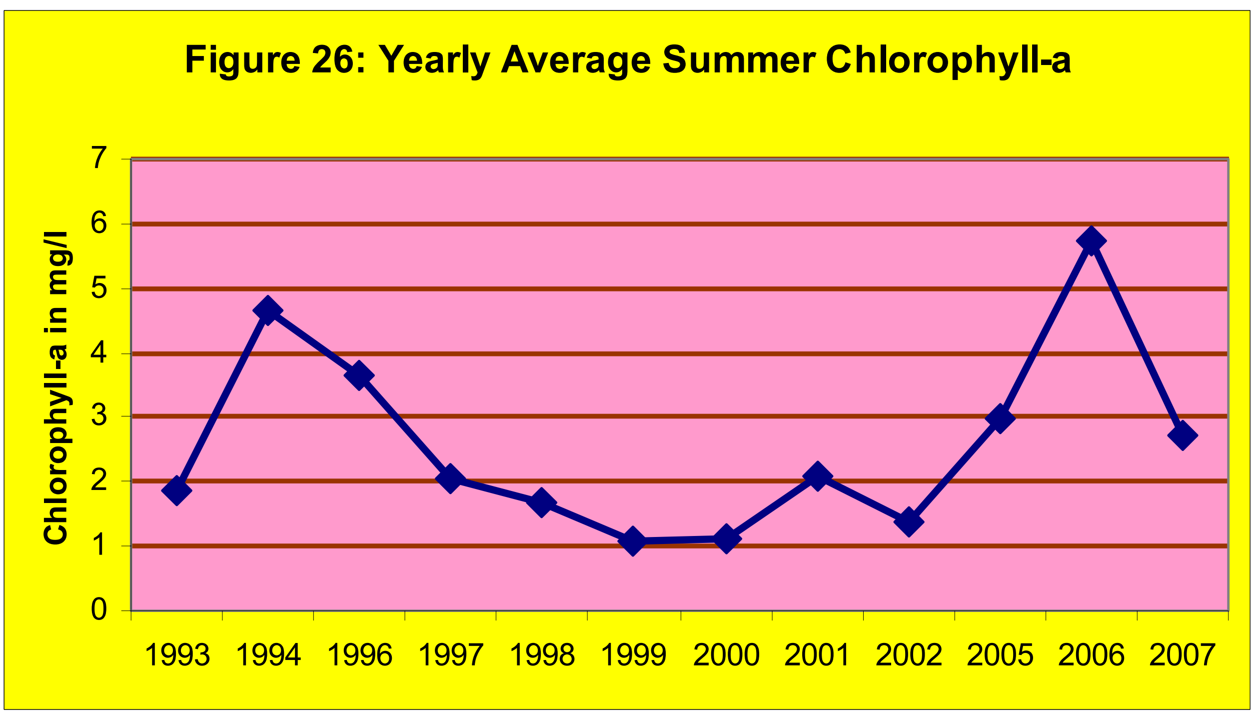


Figure 26 outlines the yearly average levels in summer chlorophyll-a in Jordan Lake from 1993 though 2007. For the entire fourteen years, the average summer chlorophyll-a level in the lake was 2.38 milligrams/liter, a very low level, unlikely to cause algal blooms.

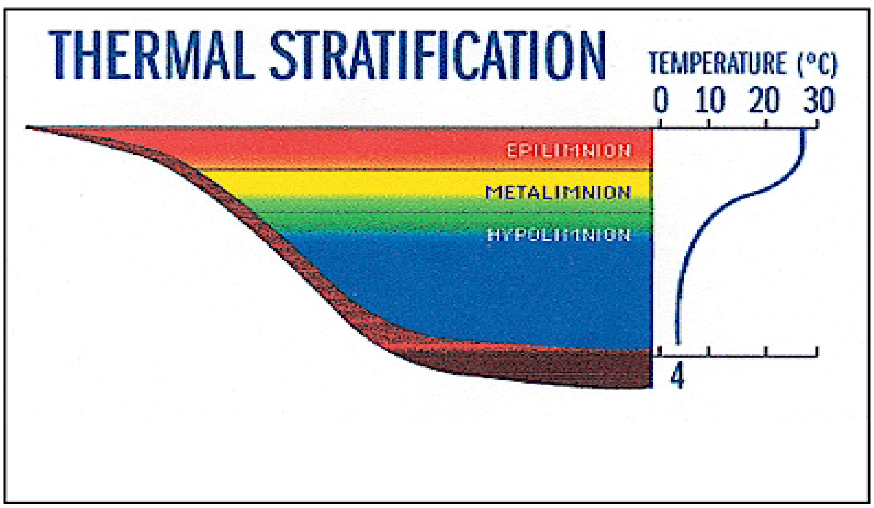


Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants. In a deep lake like Jordan Lake, during the spring and fall, the lake turns over, redistributing the nutrients in the water column.

Oxygen consumption in the sediment and the water just above it (hypolimnion) is more sensitive that those in the two upper layers of water (metalimnion and epilimnion) because the bottom consumption is less likely to be balanced by the circulation and photosynthesis output available to the upper layers.

Figure 27: Lake Stratification Layers



Low oxygen during the summer in the bottom waters of a lake occurs naturally as oxygen in the bottom layer is consumed, but not replenished. It is common that as the summer progresses, the oxygen concentration of the bottom waters decreases. In Jordan Lake, there were hypoxic periods in the depths from 30 feet to 50 feet during the summers of 1998, 2000, 2001, 2002, 2004 and 2005. By the end of summer 1998, oxygen concentration at 40 feet depth was only 3.6 mg/l and continued to decrease as depth increased down to .1 mg/l at 70 feet deep. In the summer of 2000, dissolved oxygen levels were 2.8 mg/l at 40 feet; in the summer of 2001, dissolved oxygen levels were down to 3.4 mg/l in 30 feet deep by July and again continued to decrease as the depth increased. Similar patterns were found in 2002, 2004 and 2005. This pattern was not present in other years tested when oxygen levels at all depths were over 5 mg/l (the minimum level for most fish survival).

The charts (Figures 28 a,b,c) below show the annual (2004-2006) variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the year:

Figure 28a: Dissolved Oxygen Levels During 2004 Water Testing In milligrams/liter

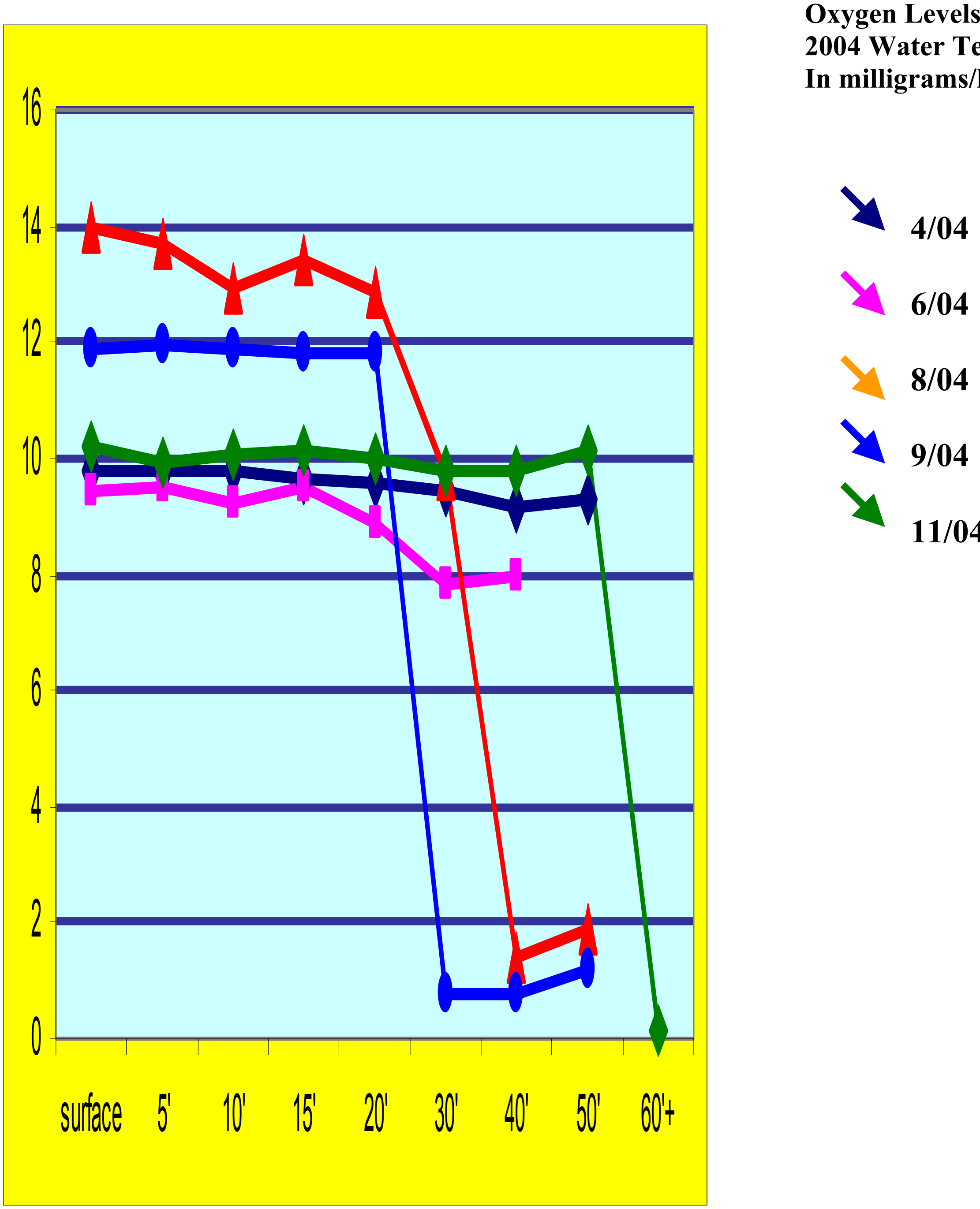
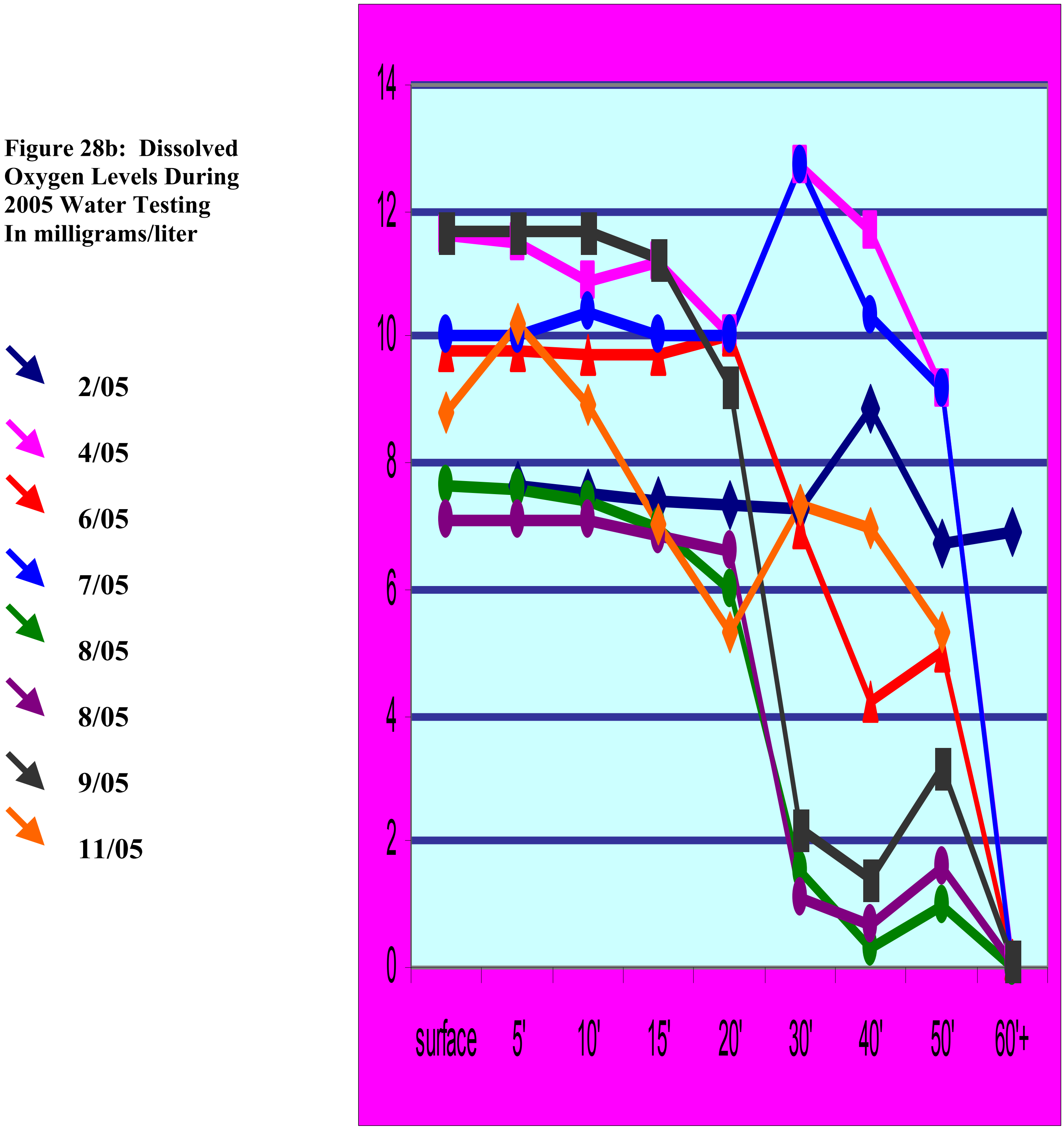


Figure 28b: Dissolved Oxygen Levels During 2005 Water Testing In milligrams/liter



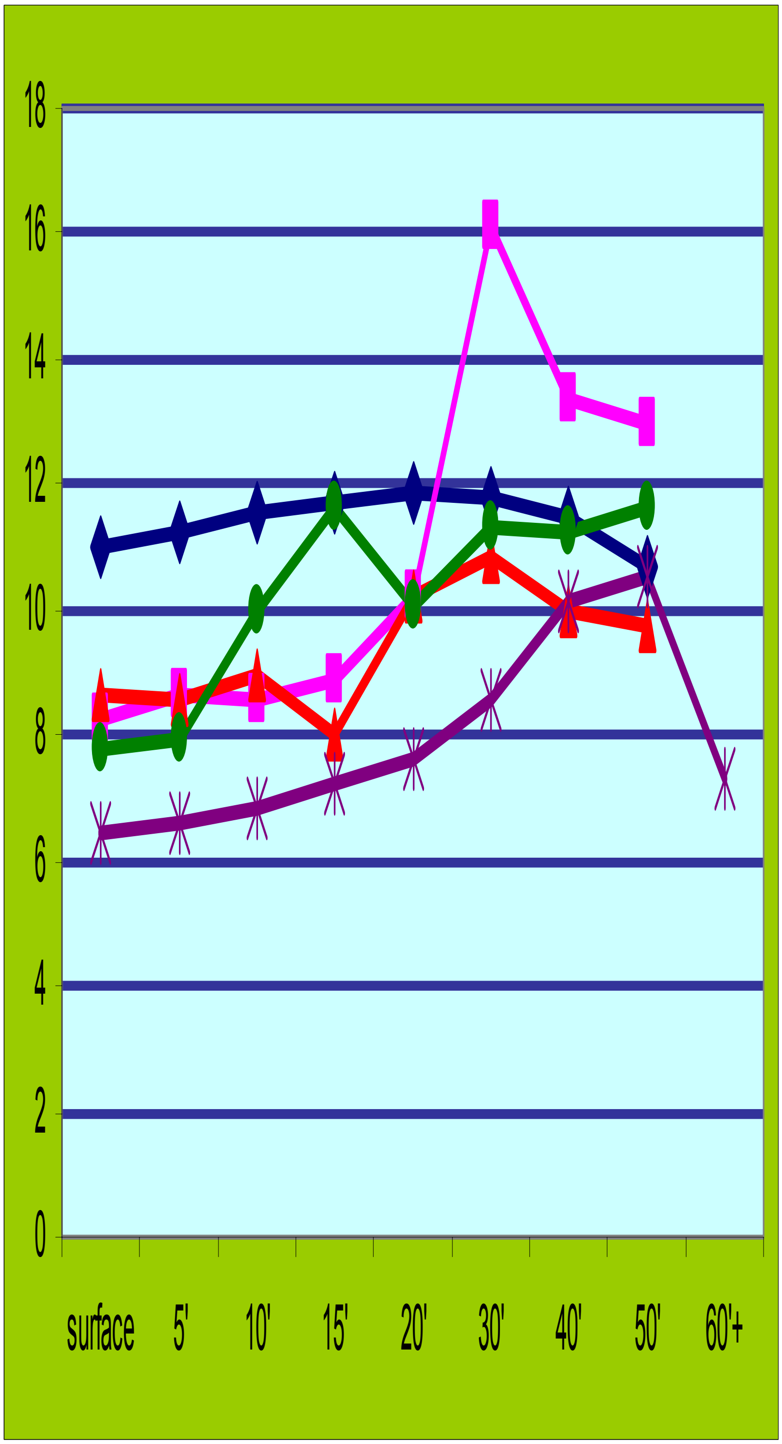


Figure28c: Dissolved Oxygen Levels During 2006 Water Testing In milligrams/liter

By autumn, when the surface waters have cooled and water density throughout the water column is the same, the water column mixes vertically, a process known as "fall turnover."

Human activity can aggravate the development of low oxygen (hypoxic) or no oxygen (anoxic) in the bottom waters. For example, the addition of phosphorus usually leads to an increase in the growth of algae and aquatic plants—both of which consume oxygen during their photosynthesis. It has also been hypothesized that hypoxia or anoxia can be affected by climate changes, such as a longer and/or warmer summer, low lake levels, and changes in water temperature due to cover (i.e., shore vegetation) being removed.

The development of hypoxia or anoxia can have negative effects. The first effect usually noticed by human is fish kills. Fish kills result when fish species that need cold oxygen-rich water to survive can't find it in the lake anymore or when some of their invertebrate food (such as mayfly nymphs) is gone due to low oxygen levels. Another noticeable effect can be an increase in the frequency and distribution of algal blooms. In some instances, anoxia can lead to blooms of toxic algae and the production of water-borne toxins that can harm humans and wildlife. Anoxia sometimes also leads to increased phosphorus cycling, undesirable water taste or odor levels, and interference with recreational uses such as swimming, boating and fishing.

As noted above, summer hypoxia or anoxia can result in phosphorus being released into the upper water column and being available for algal blooms and increased aquatic plant growth. The results from 1992 through 2007 show that summer hypoxia/anoxia in the lower depths was an issue in six of the seventeen years of records for Jordan Lake..

The data from 2004-2006 (see Figures 28a, b, c) shows there is potential for phosphorus loading from the lower depths (hypolimnion) during the summer months in Jordan Lake if the hypoxia/anoxia continues. Dissolved oxygen needs to be monitored during the late summer months in the lower depths on Jordan Lake to determine whether hypoxia/anoxia is a frequently-occurring condition that may need to be addressed by management practices.

Water Hardness, Alkalinity and pH

Testing done by Adams County LWCD on Jordan Lake included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Mg/l CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 29: Levels of Hardness in Mg/l of Calcium Carbonate

One method of evaluating hardness is to test the water for the amount of calcium carbonate ($CaCO_3$) it contains. The surface water of all of the public access lakes in Adams County have water that is moderately hard to very hard, whether they are impoundments (man-made lakes) or natural lakes. In 2005 and 2006, random samples were also taken of wells around Jordan Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater ranged from 242 (very hard) to 424 (very hard). Surface water in Jordan Lake has a much lower hardness average of 119.71 mg/l $CaCO_3$, varying from 112 to 129. The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.

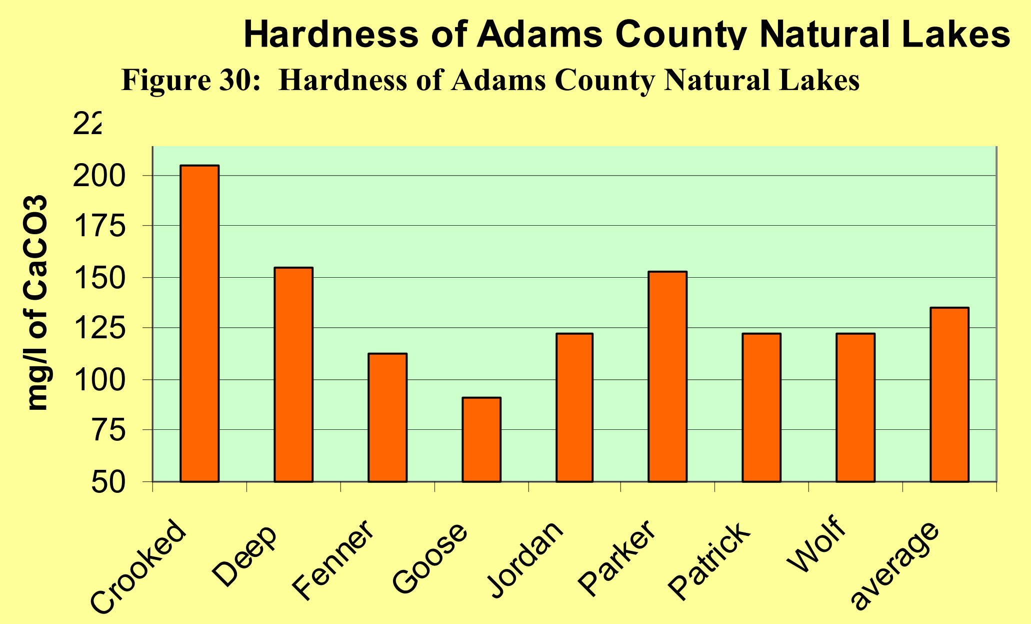


Figure 30: Hardness of Adams County Natural Lakes

As the graph (Figure 30) shows, Jordan Lake surface water testing results showed "moderately" water (119.21 mg/l CaCO3), although Jordan Lake's hardness is less than the hardness average for the natural lakes in Adams County of 135.25 mg/l of Calcium Carbonate. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

However, hard water lakes also often have marl sediments that precipitate the phosphorus out, serving to help balance the phosphorus loaded from the watershed. Hardness levels over 180 mg/l can cause marl to start precipitating out of the water or sediment, thus releasing phosphorus for aquatic plant and algae use. But since Jordan Lake's hardness less is far below that, the marl in the lake is likely to keep binding a significant amount of phosphorus that would otherwise be in the water column.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition. Surface water alkalinity testing of Jordan Lake ranged from 116 milliequivalents/liter to 120 milliequivalents/liter with an average of 117.29 milliequivalents/liter.

Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

Figure 31: Acid Rain Sensitivity

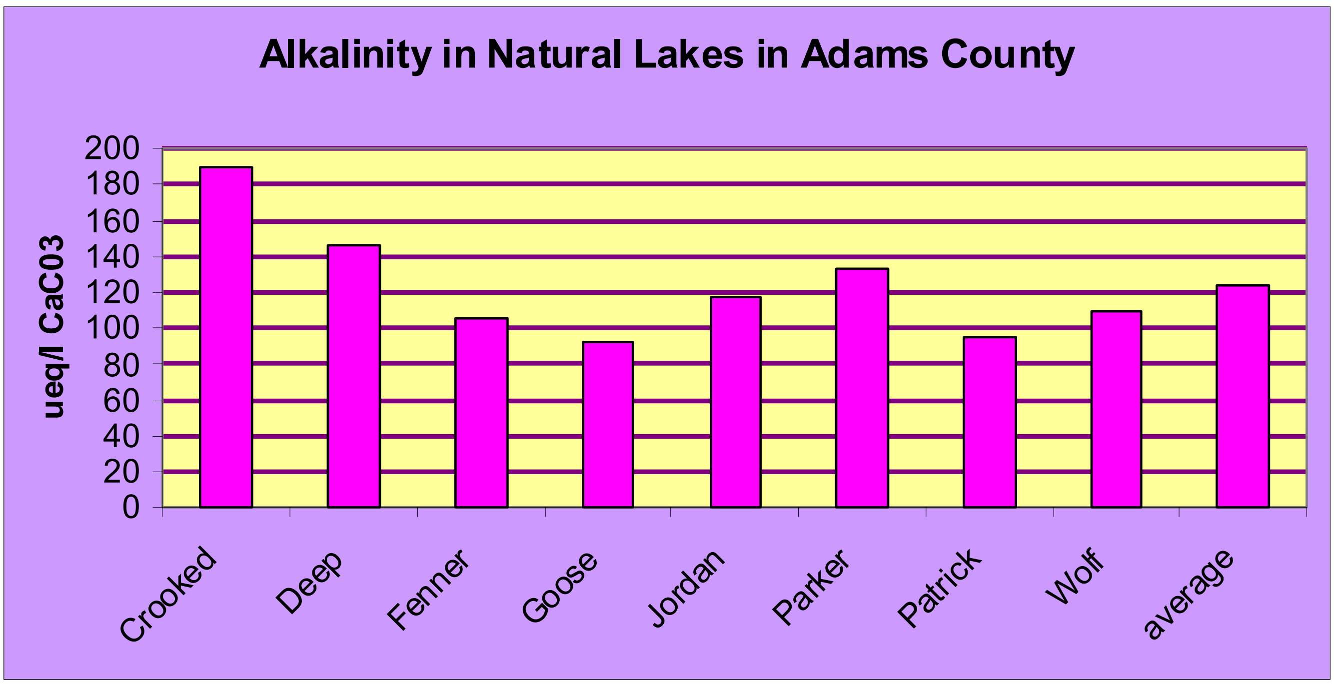
Well water testing results ranged from 120 milliequivalents/liter to 396 milliequivalents/liter in alkalinity, averaging 123.38 ueq/l, somewhat higher than the surface water results. Jordan Lake's potential sensitivity to acid rain is moderate, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.

Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

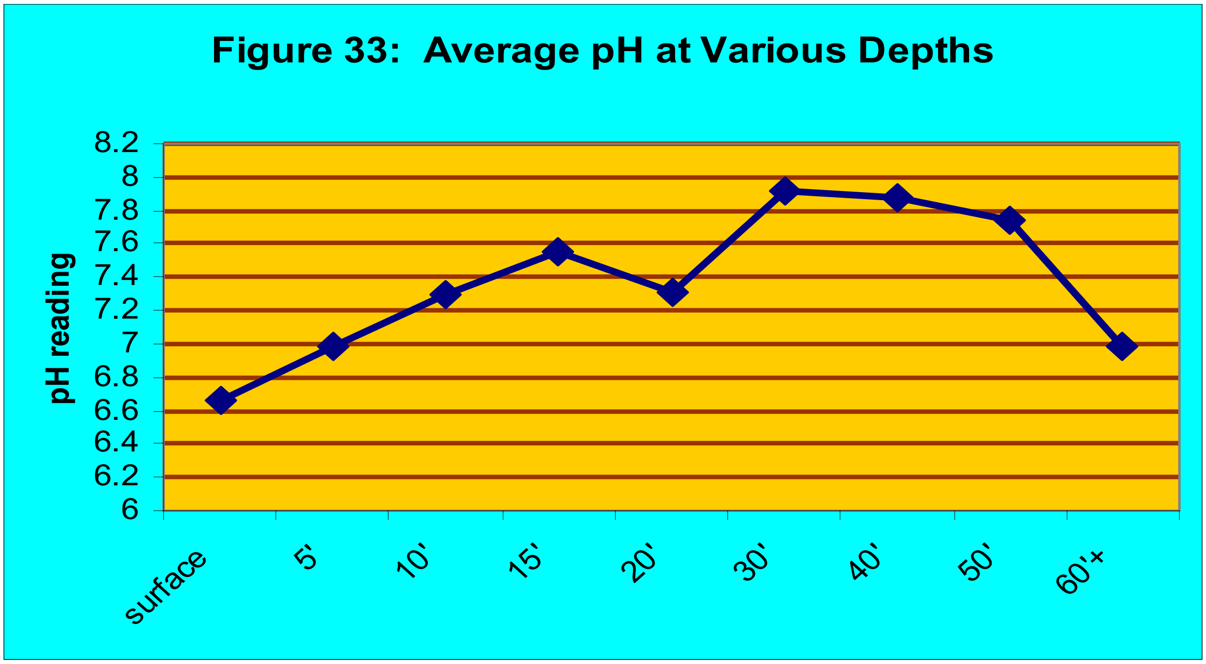
Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up

so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.

Figure 32: Alkalinity in Natural Lakes in Adams County



The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in Jordan Lake. Unlike many lakes in Adams County that start at about neutral at the bottom and raise in pH to over neutral, Jordan Lake has pH levels starting at just under neutral (6.98) at 60'+ depth, then increasing in alkalinity as the depth gets less, then starting down again in pH until the surface water pH averages 6.66. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.



More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 34):

Figure 34: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

A lake with a neutral or slightly alkaline pH like Jordan Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Jordan Lake.

Other Water Quality Testing Results

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated about 125 mg/l may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from calcium and magnesium. The average Calcium level in Jordan Lake's water during the testing period was 38.65 mg/l. The average Magnesium level was 40.58 mg/l. Both of these are low-level readings.

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The chloride levels found in Jordan Lake during the testing period were all below 3 mg/l (average 2.11 mg/l), or just under the natural level of chloride in this area of Wisconsin.

NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts, coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Jordan Lake combination spring levels from 1998 to 2006 never rose to more than .37 mg/l, just above the .3 mg/l predictive level for nitrogen-related algal blooms. If nitrogen-related algal blooms occur, they may be localized in areas of higher nitrogen levels.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. The level of these two is generally not useful as a specific pollution indicator, but increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Some health professionals have suggested that sodium levels over 20 mg/l may be harmful to heart and kidney patients if ingested.

Both sodium and potassium levels in Jordan Lake are very low: the average sodium level was 2.56 mg/l; the average potassium reading was .1.56 mg/l.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l. Jordan Lake sulfate levels averaged 2.65 mg/l during the testing period, far below either level.

TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Jordan Lake's waters were 2.08 NTU in 1992; 2.03 NTU in 2004, 2.49 NTU in 2005, and 2.59 NTU in 2006—all low levels.

Figure 35: Examples of Very Turbid Water

HYDROLOGIC BUDGET

Jordan Lake has a surface area of 215 acres. The most recent bathymetric (depth) map is from 1941 and indicates a maximum depth of 85 feet. Recent testing on the lake and known increased water levels suggest that the maximum depth is closer to 100 feet, with an average depth of 25.7 feet, and a lake volume of 5525.5 acre-feet.

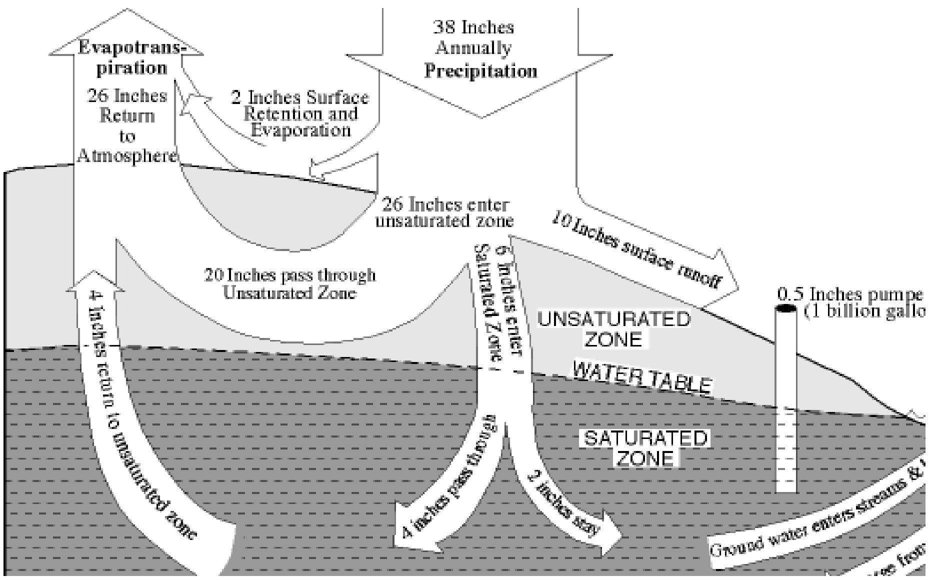
A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. "Flushing rate" is the time it takes a lake's volume to be replaced. "Annual runoff volume", as used in WiLMS, is the total water yield from the drainage area reaching the lake. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for Jordan Lake as 6869.5 acres. The average unit runoff for Adams County in the Jordan Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 5381.1 acre-feet/year. Anticipated annual hydraulic loading is 5427.7 acre-feet/year. Areal water load is 25.2 feet/year.

In a seepage lake like Jordan Lake, water and its nutrient load tend to stay longer within the lake before leaving it than in a lake with an inlet and/or outlet—in Jordan Lake's case, modeling estimates a water residence of 1.02 years. The calculated lake flushing rate is .0.98 1/year.

Figure 36: Jordan Lake Bathymetric Map

Figure 37: Example of Hydrologic Budget



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status. (See Figure 38). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. In comparing water quality testing results with the prediction from the computer modeling of this modeling with the actual figures outlined above, the actual Trophic State of Jordan Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for Jordan Lake would be **41**. This score places Jordan Lake's overall TSI at below the overall average of 43.88 for natural lakes in Adams County (in the case of TSI, the lower the score, the better).

Figure 38: Trophic Status Table

Jordan Lake = 41 → (40-50)

Score	TSI Level Description
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

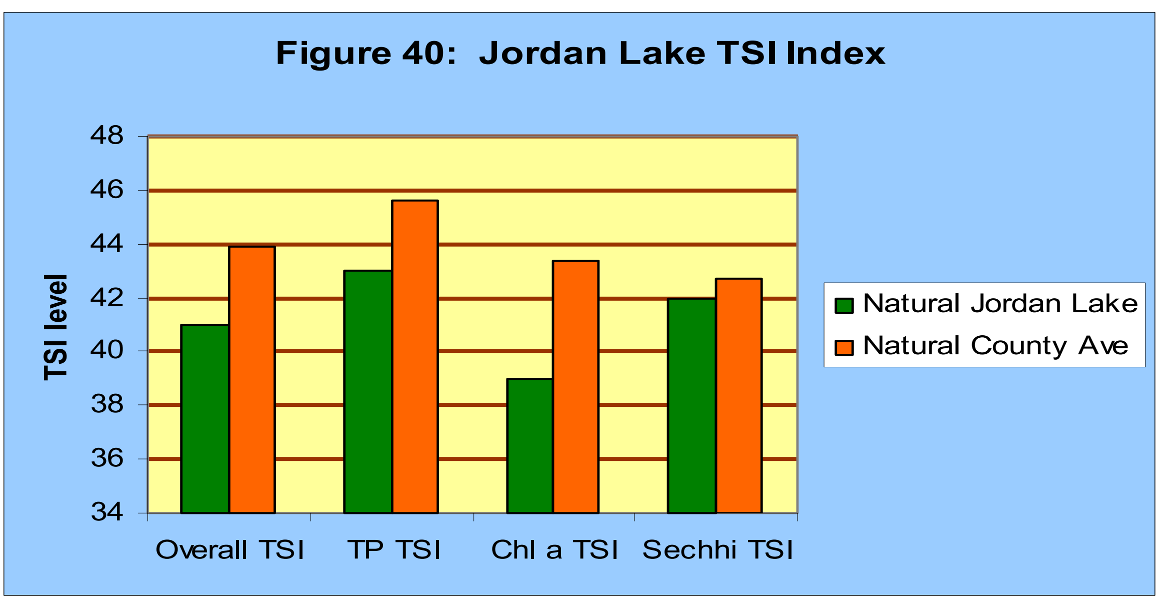
Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average summer epilimnetic total phosphorus for Jordan Lake was 15 micrograms/liter. The average summer chlorophyll-a concentration was 2.23 milligrams/liter. Growing season water clarity averaged a depth of 11.19 feet. Figure 40 shows where each of these measurements from Jordan Lake fall in trophic level.

Figure 39: Jordan Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(mg/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	**1 to 5**	**8 to 19**
Mesotrophic	Good	**10 to 30**	5 to 10	6 to 8
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Jordan Lake		**15**	**2.23**	**11.19**

These figures show that Jordan Lake has low levels overall for the three parameters often used to describe water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events.

According to these results, Jordan Lake scores as **“mesotrophic”** in its phosphorus level, and “**oligotrophic**” in chlorophyll-a readings, and Secchi disk readings. With such phosphorus readings and chlorophyll a readings, dense plant growth and frequent algal blooms would not be expected.



IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

An aquatic plant survey was completed on Jordan Lake in the summer of 2006 by staff from the WDNR and the Adams County LWCD. The results verified that Jordan Lake is a mesotrophic lake with good water quality and very good water clarity, although nutrient level and algae frequency have increased since 1997. Filamentous algae are found in Jordan Lake, but only in the shallowest zone (0 to 1.5 feet) and with a 26.09% frequency there.

97.8% of the littoral zone covered to a maximum rooting depth of 19 feet. The 0 to 1.5 foot depth zone supported the most abundant aquatic plant growth. The Jordan Lake aquatic plant community is characterized by high quality and very good species diversity. The plant community has a below average sensitivity to disturbance and is closer to an undisturbed condition than the average lake in the state.

Chara spp (muskgrass), a plant-like algae, was the most common species found during the aquatic plant survey. Second in frequency was *Najas flexilis* (bushy pondweed). *Chara* spp. was also the densest plant found during the survey. However, a number of plants were found at higher than average density of growth where they were present: *Brasenia schreberi* (common watershield, a rooted floating-leaf plant), *Certaophyllum demersum* (coontail, a submergent species), *Chara* spp., *Phalaris arundinacea* (reed canarygrass, an emergent invasive), *Potomogeton foliosus* (leafy pondweed, a submergent), *Sagitarria latifolia* (arrowhead, an emergent species), *Scirpus validus* (softstem bulrush, an emergent), *Typha latifolia* (narrow-leaf cattail, an emergent) and *Zosterella dubia* (water stargrass, a submergent).

Chara spp was the dominant species. *Najas flexilis* was sub-dominant. Three invasive aquatic plants were found: *Myriophyllum* spicatum (Eurasian watermilfoil, a submergent), *Phalaris arundinacea* (reed canarygrass, an emergent), and *Potamogeton crispus* (curly-leaf pondweed, a submergent). Of the invasives, Eurasian watermilfoil was the most commonly occurring species and was found in all four depth zones.

Figure 41: Jordan Lake Aquatic Plant Species 2006

Scientific Name	Common Name	Type
Brasenia schreberi	Watershield	Floating-Leaf
Carex spp	Sedges	Emergent
Ceratophyllum demersum	Coontail	Submergent
Chara spp	Muskgrass	Submergent
Elodea canadensis	Waterweed	Submergent
Impatiens capensis	Jewelweed	Emergent
Lemna minor	Small Duckweed	Free-Floating
Myriophyllum sibiricum	Northern Milfoil	Submergent
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent
Najas flexilis	Bushy Pondweed	Submergent
Nitella spp	Brittlewort	Submergent
Nymphaea odorata	White Water Lily	Floating-Leaf
Phalaris arundinacea	Reed Canarygrass	Emergent
Polygonum aquaticum	Water Smartweed	Floating-Leaf
Potamogeton amplifolius	Large-Leaf Pondweed	Submergent
Potamogeton crispus	Curly-Lead Pondweed	Submergent
Potamogeton foliosus	Leafy Pondweed	Submergent
Potamogeton gramineus	Variable-Leaf Pondweed	Submergent
Potamogeton illinoensis	Illinois Pondweed	Submergent
Potamogeton natans	Floating Pondweed	Submergent
Potamogeton pectinatus	Sago Pondweed	Submergent
Potamogeton pusillus	Small Pondweed	Submergent
Potamogeton praelongus	White-Stem Pondweed	Submergent
Potamogeton richardsonii	Clasping-Leaf Pondweed	Submergent
Potamogeton zosteriformis	Flat-Stem Pondweed	Submergent
Ranunculus longirostris	Longbeak Buttercup	Emergent
Sagittaria latifolia	Arrowhead	Emergent
Salix spp	Willow	Emergent
Scirpus americanus	Chairmaker's Bulrush	Emergent
Scirpus validus	Soft-Stem Bulrush	Emergent
Solanum ptycanthum	Nightshade	Emergent
Solidago spp	Goldenrod	Emergent
Typha latifolia	Narrow-Leaf Cattail	Emergent
Vallisneria americana	Water Celery	Submergent
Zosterella dubia	Water Stargrass	Submergent

The study used the results of the 2006 field survey to evaluate Jordan Lake by using several standard community measurements. For example, the Simpson's Diversity Index was 0.93, indicating excellent species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index (AMCI) for Jordan Lake is 63. This is in the upper quartile of lakes in Wisconsin and the North Central Hardwoods Region of the state. This value places Jordan Lake in the top 25% of lakes in the state and region with the highest quality aquatic plant communities.

The Average Coefficient of Conservatism for Jordan Lake was 4.52, below average for Wisconsin lakes (6.0) and lakes in the North Central Hardwood (5.6) Region. This suggests that the aquatic plant community in Jordan Lake is less sensitive to disturbance than the average lake in the state or region. This is likely due to selection of species by past disturbance.

The Floristic Quality Index of the aquatic plant community in Jordan Lake was 25.14, in the upper quartile of Wisconsin lakes (average 22.2) and North Central Hardwood Region lakes (average 20.9). This indicates that the plant community in Jordan Lake is within the group of lakes in the state and region closest to an undisturbed condition.

Of the invasives, Eurasian watermilfoil, a non-native, invasive plant species, has been the most critical threat to habitat and native plant species of Jordan Lake. Results from the 2006 survey show it continued to be present in occurrence and density sufficient to require the lake district to treat it chemically to reduce its presence. However it did not have more than average growth density anywhere on the lake. Two other non-native, exotic species (curly-leaf pondweed and narrow-leaf cattail) occurred less frequently and less densely than the Eurasian watermilfoil. In the past few years, Jordan Lake has had much increased recreational use by water skiers, jet skiers, watertubers and speed boats, increasing the disturbance in the lake. Such disturbance creates an ideal condition for exotic species to colonize and spread.

Plant distribution, frequency and density varied considerably within Jordan Lake, depending on the plant types (see Figure 42).

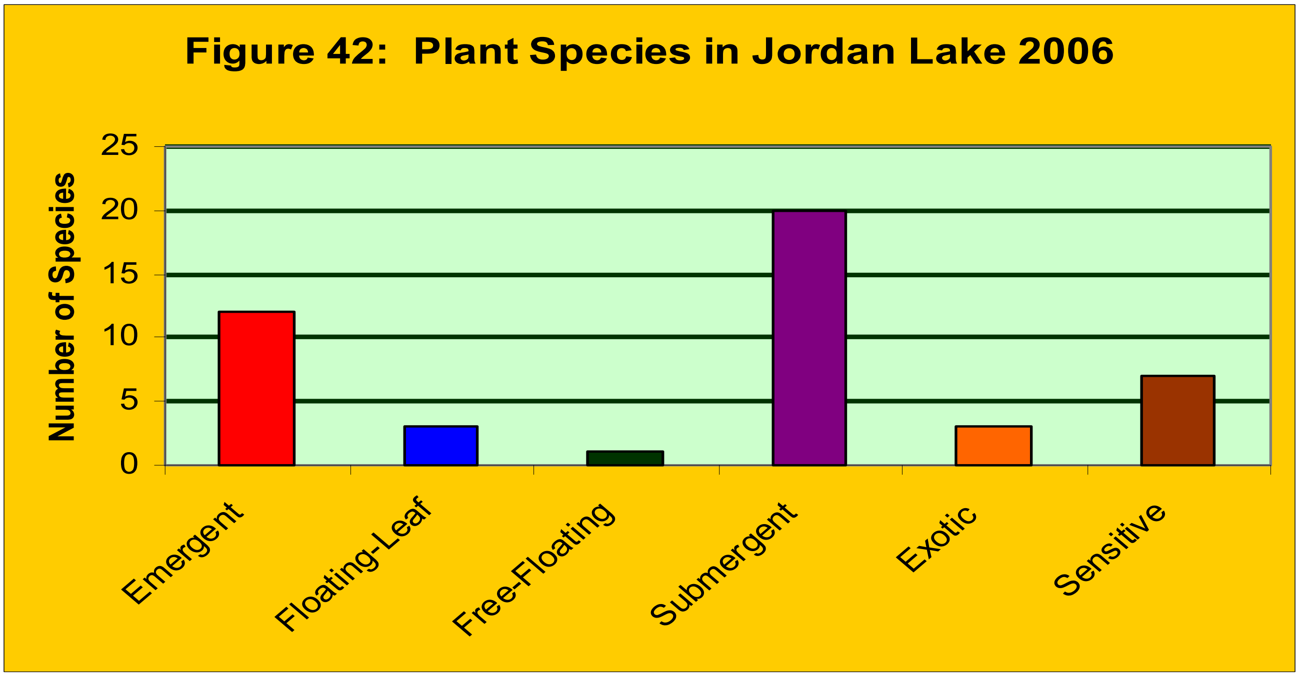
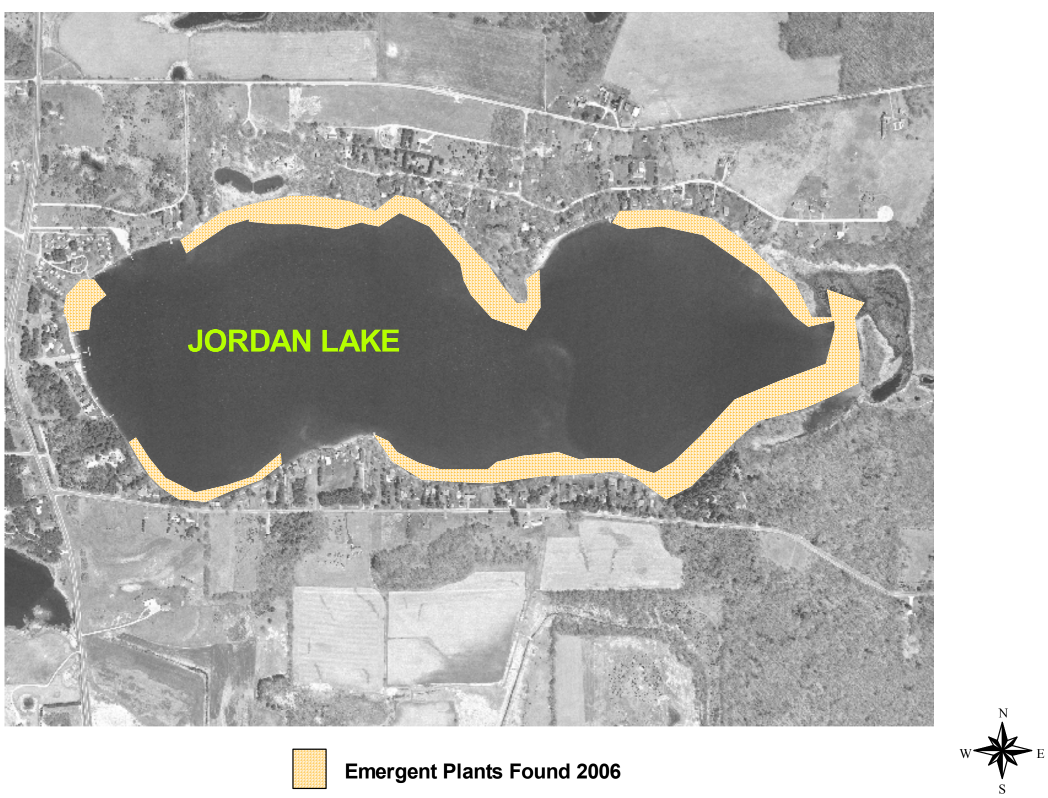
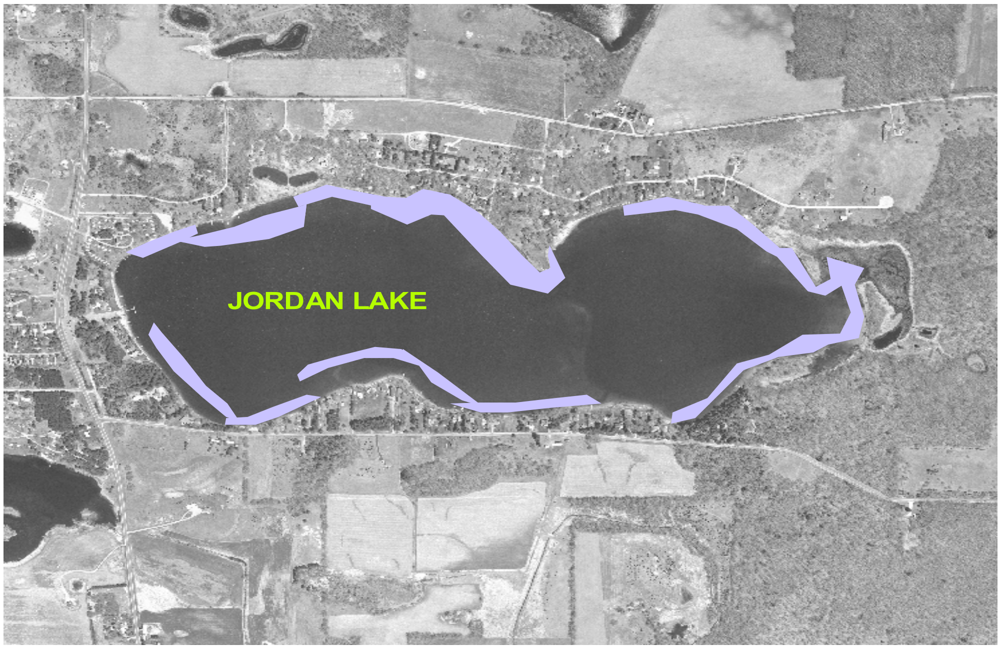


Figure 43a: Emergent Aquatic Plants in Jordan Lake 2006



RE:11/06

Figure 43b: Floating-Leaf Aquatic Plants in Jordan Lake 2006



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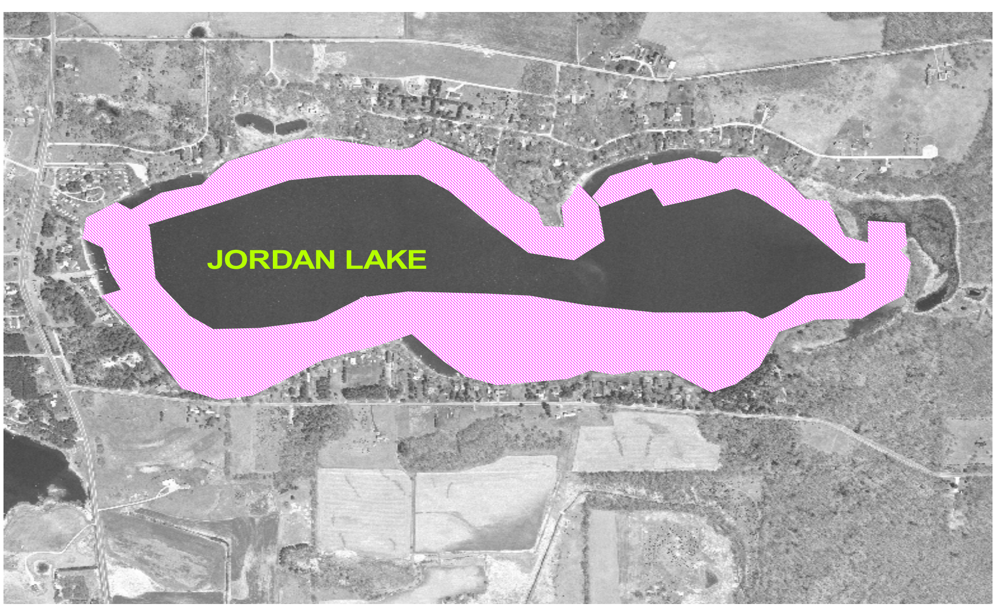
Floating-Leaf or Free-Floating Plants Found 2006

Figure 43c: Submergent Aquatic Plants in Jordan Lake 2006



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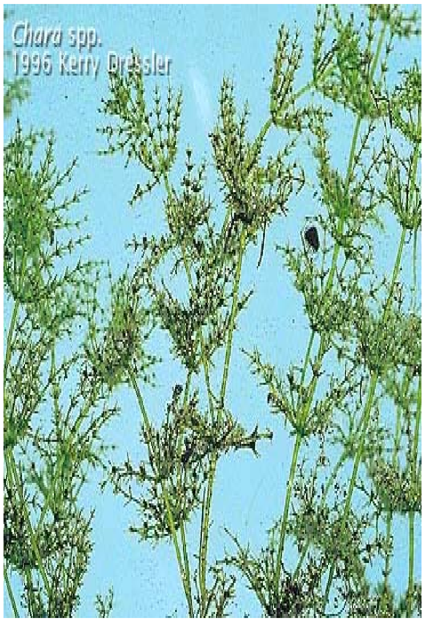
Submergent Plants Found



Chara **spp (Muskgrass)**

Figure 44: Four Most Common Native Aquatic Species in Jordan Lake

Najas flexilis
(**Bushy Pondweed)**

Potamogeton amplifolius
(Large-Leaf Pondweed)

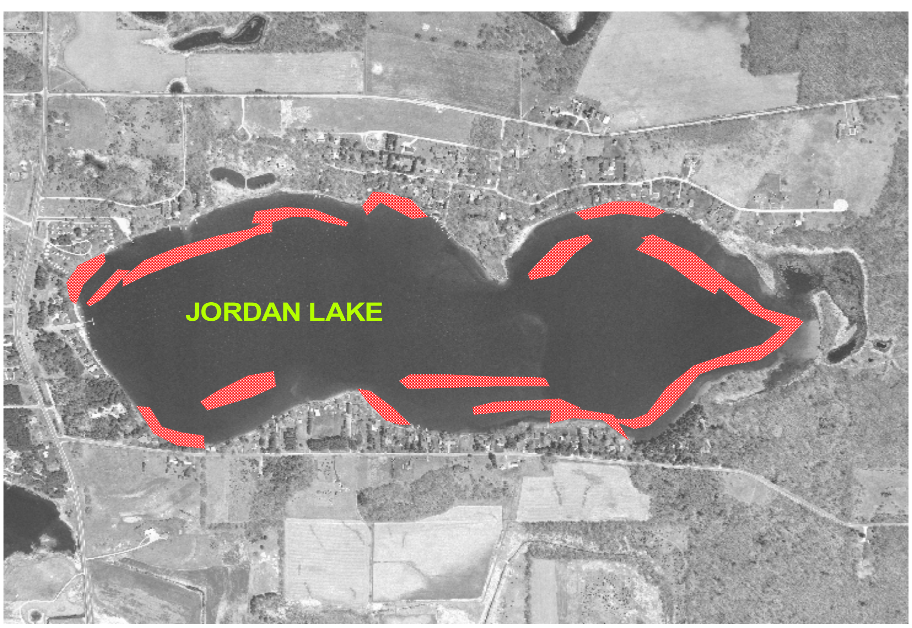
Potamogeton pectinatus
(Sago Pondweed)

Aquatic Invasives

Jordan Lake has been targeting Eurasian watermilfoil through chemical applications since 1981. Treatment was sporadic in the 1980s and 1990s, but has been steady since 1997 through 2007. In general, the number of acres to be treated has been declining, although the invasive continues to be a problem in Jordan Lake. By summer 2006, Eurasian Watermilfoil was a commonly occurring species, occurring at only average densities, in all four depth zone. It was found in 19 feet of water, along with *Cerataphyllum demersum* and *Potamogeton richardsonii* (clasping-leaf pondweed). The Jordan Lake Management Plan calls for continuing to monitor expects to continue the Eurasian Watermilfoil population and take necessary treatment steps to keep it managed.

In addition, a survey in 2007 indicated that the native weevil, *Euhrychiopsis lecontei*, was present in parts of Jordan Lake. This weevil, if present in sufficient density, can weaken Eurasian milfoil plants to the point of death.

Figure 45: Distribution of Exotic Aquatic Plants in 2006



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Exotic Aquatic Vegetation Found 2006

Curly-Leaf Pondweed was also found in Jordan Lake in 2006, but only at four sites in water 1.5 feet to 5 feet deep. Although it is present, it does not appear in either high frequency or density. Reed Canarygrass was also found on the shores of Jordan Lake in 2006 in three sites, but also did not appear in either high frequency or density. However, ongoing monitoring for both of these plants should occur.

Potamogeton crispus
(Curly-Leaf Pondweed)

Phalaris arundinacea
(Reed Canarygrass)

Figure 46: Three Invasive Aquatic Plants in Jordan Lake

Myriophyllum spicatum
(Eurasian Watermilfoil)

Critical Habitat

Designation of critical habitat areas within lakes provides a holistic approach for assessing the ecosystem and for protecting those areas in and near a lake that are important for preserving the qualities of the lake. Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes.

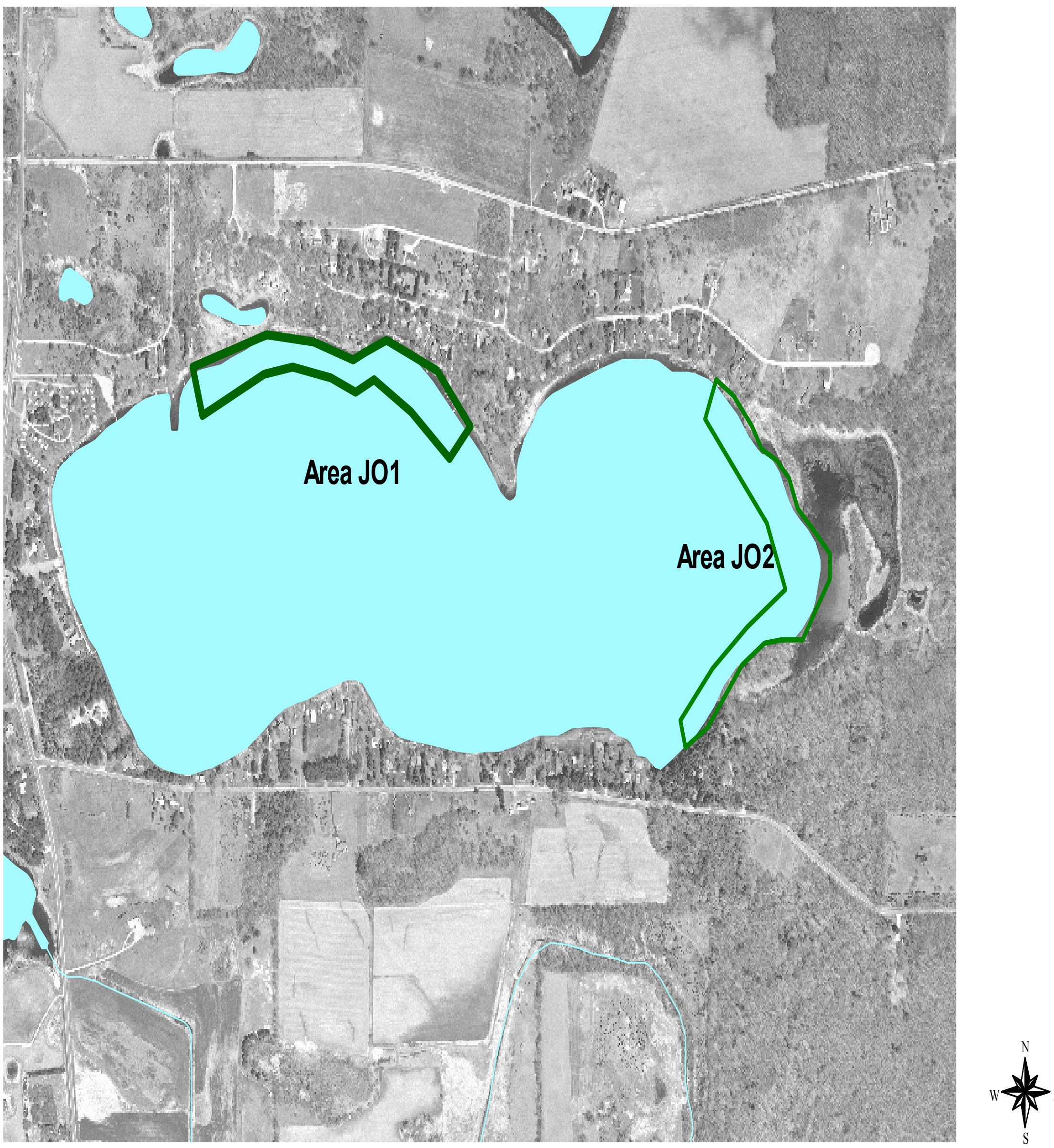
Protection of critical habitat areas must include protecting the shore area plant community, often by buffers of native vegetation that absorb or filter nutrient & stormwater runoff, prevent shore erosion, maintain water temperature and provide important native habitat. Buffers can serve not only as habitats themselves, but may also provide corridors for species moving along the shores.

Besides protecting the landward shore areas, preserving the littoral (shallow) zone and its plant communities not only provides essential habitat for fish, wildlife, and the invertebrates that feed on them, but also provides further erosion protection and water quality protection.

Field work for a critical habitat area study was performed on October 4, 2006, on Jordan Lake, Adams County. The study team included: Scot Ironside, DNR Fish Biologist; Deborah Konkel, DNR Aquatic Plant Specialist; and Reesa Evans, Adams County Land & Water Conservation Department. Areas were identified visually, with GPS readings and digital photos providing additional information. Input was also obtained from Terry Kafka, DNR Water Regulation; Jim Keir, DNR Wildlife Biologist; and Buzz Sorge, DNR Lake Manager.

Figure 47: Critical Habitat Areas on Jordan Lake

Critical Habitat Areas--Jordan



RE:8/06

Critical Habitat Area JO1

This area extends along approximately 2600 feet of the shoreline along the north side of the lake, extending up to the ordinary high water mark. Sediment includes marl, muck, peat, sand, silt and mixtures thereof. 6% of the shore is wooded; 20% is native herbaceous cover. The balance of the short is bare sand, cultivated lawn and hard structure. There is a shallow marsh area along this shoreline. Large woody cover is present for habitat.

Figure 48: Photo of Area JO1, Jordan Lake

The results of an October 2006 fish shocking survey indicated that Jordan Lake has a good panfish population of substantial size, including bluegills, black crappie and perch. More scarce were largemouth bass and northern pike, although they were present. Brown trout, cisco, bullheads, walleyes and white suckers have also been found in Jordan Lake. No exotic aquatic wildlife was noted in this area, i.e, no carp, smelt or rusty crayfish were seen.

Seen during the field survey were various types of songbirds. Frogs and salamanders are known to use this area for shelter/cover, nesting and feeding. Upland wildlife feed and nest here as well. Since human disturbance is fairly high in JO1, habitat for wildlife is somewhat limited.

Maximum rooting depth of aquatic vegetation in JO1 was 19 feet. Seven types of emergent aquatic plants were found in this area. Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife. One free-floating and three floating-leaf rooted species were present here. Floating-leaf vegetation provides cover and dampens waves, protecting the shore. Eighteen emergent species of aquatic species were also found here. Such a diverse submergent community provides many benefits. Filamentous algae were present at this site, but not abundant.

One exotic invasive plant, *Myriophyllum spicatum*, was found in this area. Most of the aquatic vegetation in this area has multiple uses for fish and wildlife. This area of all three plant structures provides a lot of habitat diversity.

Figure 49: Photo Showing Development in JO1

Critical Habitat Area JO2

This area extends along approximately 1800 feet of the shoreline on the far east end of the lake, up to the ordinary high water mark. Average water depth here is about 15', with a steep dropoff. Sediment includes peat, sand, silt and mixtures thereof. 11% of the shore is wooded; 6% has shrubs; 23% is native herbaceous cover. The remaining shore is bare sand, cultivated lawn and hard structures, which tend to be concentrated at the edges of this area. The middle area is almost entirely undeveloped and contains some shallow marsh. Large woody cover is present for habitat. With minimal human disturbance along this shoreline, the area has natural scenic beauty.

This area of some large woody cover, emergent aquatic vegetation, submergent and floating vegetation provides spawning and nursery areas for many types of fish that also feed and take cover here. No exotic aquatic wildlife was noted in this area, i.e, no carp, smelt or rusty crayfish were seen. Shore development present in JO2 was confined to the ends.

Seen during the field survey were various types of waterfowl and songbirds. It appeared that all these took cover or shelter in this area, as well as nested and fed in this area. Downed logs serving as habitat were also seen. Muskrat and mink are known to use JO2 for cover, reproduction and feeding. Frogs and salamanders are known to use this area for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well. Since human disturbance is relatively minimal in JO2, it provides high-quality habitat for many types of wildlife.

Maximum rooting depth in JO2 was 19 feet. No threatened or endangered species were found in this area. Two exotic invasives, *Myriophyllum spicatum* (Eurasian watermilfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed), were found in this area. Filamentous algae were present, but not common. Five emergent species were present here. One free-floating plant was found at this site. Two floating-leaf rooted plants were present. Fifteen submergent aquatic plant species were also found here.

Most of these plants are used by wildlife and fish for multiple purposes. Because this site provides all three structural types of vegetation, the community has a diversity of structure and species that supports even more diversity of fish and wildlife.

Figure 50: Part of Area JO2

Recommendations for preserving these areas resulted from this field survey and analysis. They included:

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove fallen trees along the shoreline nor logs in the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain snag/cavity trees for nesting.
(6) Maintain or increase wildlife corridor.
(7) Maintain sedge meadow and deep marsh areas.
(8) Maintain no-wake zone.
(9) Protect emergent vegetation for habitat and shoreline protection.
(10) Removal of submergent vegetation for navigation purposes only.
(11) Seasonal control of Eurasian Watermilfoil and other exotics, if needed, by using integrated control methods specific for exotics.
(12) Minimize aquatic plant and shore plant removal to maximum 30' wide access/viewing corridor. Leave as much vegetation as possible to protect water quality and habitat.
(13) Use forestry best management practices.
(14) No use of lawn products.
(15) No bank grading or grading of adjacent land.

(16) No pier construction or other activity except by permit using a case-by-case evaluation.

(17) No installation of pea gravel or sand blankets.
(18) No bank restoration unless the erosion index scores moderate or high.
(19) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(20) Placement of swimming rafts or other recreational floating devices only by permit.
(21) Maintain buffer of shoreline vegetation.
(22) Maintain aquatic vegetation in undisturbed condition for wildlife habitat, fish use and water quality protection.
(23) Post landing with exotic species alert and educational signs to prevent introduction and/or spread of exotic species.
(24) Keep critical habitat areas as no-wake areas.

Figure 51: Jordan Shore Showing Woody Habitat

FISHERY/WILDLIFE/ENDANGERED RESOURCES

WDNR fish stocking records for Jordan Lake extend back to 1933, when 308 black bass were stocked. Fish were stocked by that agency most years since then, through 2002. Other fish that were stocked included walleye, perch, smallmouth bass, largemouth bass, northern pike and brown & rainbow trout. The most recent shocking inventory, in October 2006, found bluegills were abundant. Prior inventories have shown the presence of bullheads, ciscos, pumpkinseeds, crappie, suckers and shiners, in addition to the fish type stocked. An endangered species, *Fundulus diaphanus (*Banded Killifish), was found in the lake previously. No other endangered resources in the Jordan Lake watersheds have been identified.

Figure 52: Abundant Fish in Jordan Lake— Bluegill

Figure 53: Banded Killifish

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