Fisheries Assessment

Introduction

Ten lakes in Portage County were sampled in the late summer and fall of 2002 and 2003 to assess fish distribution and abundance, structural cover including vegetation and littoral bottom type. The ten lakes were selected primarily on the existence of public access and the lack of a recent fishery survey by Wisconsin Department of Natural Resources (WDNR). Most natural lakes in Portage County are classified as small (<80 acres) and have been given lower priority for management in recent years by WDNR because of budget constraints. Several of the larger natural lakes in the county notably Collins, Emily, Helen and Sunset were excluded from this study because there had been at least some level of fisheries assessment completed in recent years. Several of the ten selected lakes had not been sampled in over 20 years.

The sampling procedure employed followed a "small lake protocol" recommended by WDNR and was not intended to provide the level of information needed to make management recommendations for sport fish. The purpose of this sampling protocol was to survey the fish fauna, characterize structural cover and identify critical areas believed to be necessary for protection of the fish fauna in these lakes.

Fish sampling methods

The small lake survey used to sample the ten lakes consisted of setting mini-fyke nets, shoreline seining and electrofishing between August and November of 2002 and 2003. A minimum of four mini-fyke net sets were made on each lake during daylight hours, left overnight and run the following day. The mini-fyke nets consisted of two 2x3 foot rectangular frames with four 2 foot hoops and ¼ inch mesh constructed to WDNR specifications. The mini-fyke nets had one inch mesh excluders on the throats and were used to assess reproduction by surveying young fish that were hatched earlier the same year. These small individuals, collectively known as young of year (YOY), give some indication of the presence and reproductive success of the various adult species present in

a lake. It should be noted that YOY production is not necessarily correlated with abundance of adults. Good survival of young from a few successful breeding adults may be sufficient to maintain an abundance or overabundance of young in these small lakes. Similarly, a small number of YOY may also be unrelated to adult abundance as a consequence of unfavorable weather during spawning.

The shoreline was also sampled with a 6 x 25 foot bag seine having 3/16 inch mesh during daylight hours. A minimum of 400 feet of shoreline was sampled in most lakes. Seining was not practical in Lime, Spring and Jacqueline lakes because soft sediments prevented wading. On these lakes, a second set of four mini-fyke nets was collected. Lakes with wadable shoreline were also sampled for YOY with a towed electroshocker barge. Typically, 500 feet of shoreline was sampled with a 230Volt DC generator with two hand-held mobile electrodes. A minimum of two individuals were used as dippers to collect fish that were attracted to the positive electrodes. In lakes that were not wadable because of soft sediments, a boat mounted Smithroot 230 volt 500CCP boom electrofisher, was used. The entire perimeter of each lake was electrofished during daylight hours with a minimum of two dippers capturing stunned fish from the bow of the boat. This was the only sampling device employed in this study that could effectively catch large adult fish in shallow water during late summer and fall sampling periods. Water deeper than 6 feet cannot be sampled well by any of the methods used here and some of the larger species may not have been detected at all unless they were unusually abundant. Because of the various collection methods used on different lakes, particularly the boom shocker, which effectively allowed sampling of large-sized fish from shallow water from four of the ten lakes, caution is urged when comparing size distributions of fish among lakes.

Historical records from previous fisheries surveys on Portage County lakes were obtained from the regional fisheries management biologist of the Wisconsin Department of Natural Resources. Reported angler catches on lakes often obtained from old newspaper clippings may be noted in lake narratives, but were not included in the historical records summarized here in tables because they could not be verified.

Bottom type and vegetative cover mapping

Structural cover such as woody debris, aquatic vegetation and bottom type was also mapped once for each lake during the summer of 2003. Aquatic vegetation was mapped as structural cover for fish. A canoe was used to cruise the littoral shoreline area and dominant vegetative structural forms and bottom sediments that represented distinct morphological cover types for fish were mapped on aerial photographs. Areas that were believed to be important spawning habitat were identified. Emergent vegetative forms were grouped into taxa assemblages such as cattails, rush and/or sedges and spike rush. Floating vegetative forms were mostly represented by the yellow pond-lily, white water-lily and water shield and submersed forms were mostly represented by water milfoil, Chara and pondweed taxa. Some additional taxa that might be of special concern were also mapped such as purple loostrife because of its nuisance status. The purpose of this type of structural characterization was to provide an indication of the abundance of cover for different species and life history stages of fish rather than a complete inventory of lake vegetation.

Historical overview

The fish communities present in Portage County lakes could best be described as a product of the natural history of the landscape and the people who lived in it. The rivers that drained the melting glaciers some 10,000 year ago served as corridors for the original colonization of the kettle lakes that formed in place of melting ice blocks lodged in the terminal moraine. The original fauna undoubtedly was dominated by a few cold water species that could tolerate the climatic conditions of the time. For lakes that were formed with stream outlets, corridors were open from the Great Lakes and Mississippi River drainages allowing continuous migration of new fauna into the lakes as the glaciers melted and the climate slowly warmed over centuries. For seepage lakes without natural outlets, changes in fauna would have occurred more slowly. It remains somewhat a mystery how isolated lakes across vast expanses of land become stocked with fish. There are anecdotal reports of fish being swept up into water spouts and carried great distances

before falling from the sky seemingly unharmed. Although these events would be expected to be exceedingly rare, given sufficient time, this may be plausible explanation for the appearance of fish in some isolated water bodies. Movement of fish among lakes by piscivorous birds such as eagles and ospreys would probably be a more likely explanation of transfer over short distances as these species commonly forage in multiple lakes and occasionally drop fish while feeding young. In recent times, human activities would account for most movements of fish between otherwise isolated lakes. Decisions on what species might be beneficial in a lake were probably made by the first Americans who could have easily carried live fish over short distances with full intent of stocking them elsewhere. Intentional fish transfers have continued in greater earnest since European settlement by groups or individuals intent on improving recreational fisheries. Unsanctioned transfers continue today. Almost any fish enthusiastic with a pole, can of worms and a bucket can account for the appearance of an occasional new fish species in any lake.

Organized efforts to manage fish in Portage County lakes dates back to the 1930s based on WDNR records. Historical records indicate that most of the lakes have been periodically stocked with a variety of native and non-native fish. In the past, indiscriminant stocking of fish had been a common management practice of resource agencies around the country and to some extent continues today. The assumption was that natural reproduction was limited and any stocked fish would supplement natural populations. Numerous studies in recent years in Wisconsin and throughout the country have shown that in most instances stocking of native species into waters where they were already present has had no measurable impact on numbers of adult fish or angler success. Notable exceptions include stocking of non-native salmonids because they often exploit new resources or out-compete native fish for existing resources.

In addition to the official stocking, any lake with public access has no doubt been stocked with an occasional fish by anglers intent on “improving” the fishery. Lake associations may have also stocked fish, but left no official records. Several Portage County lakes have had their native fish populations removed by poisoning in an attempt to establish a trout fishery. This practice was common beginning in mid 1900s when fisheries

management in Wisconsin was synonymous with trout management. A more holistic management philosophy is practiced today and focuses more on preserving the biological integrity of the entire natural fish community.

Results

Thirty one species of fish have been reported historically from the ten Portage County lakes sampled in this study (Table 1). Twenty-one species were found in the current study. No species new to the county were reported, but nearly every lake had several newly documented species. Ten species previously reported were not found in the present study including, the mottled sculpin, common shiner, black bullhead, smallmouth bass, banded darter, Johnny darter, walleye and the brook, brown and rainbow trout. The absence of these species from the current study may be due to a variety of factors including limitations of sampling gear, environmental disturbance or simply natural changes that occur in fish communities over long periods of time.

The overall sampling effort in any given lake in this study was generally less than the collective effort applied in all previous surveys dating back over 70 years for some lakes. Although three different sampling techniques including seining, trapnetting and electrofishing were used on each lake in the present study, none of these techniques effectively sample deep water habitats where species such as walleye and salmonids are likely to be found in late summer and early fall when the sampling took place. In addition, the salmonids and walleye would not be expected to be present in any lake unless they were recently stocked because they would not normally reproduce or live year round in these limited lake environments. The apparent loss of other species such as the banded and Johnny darters may be due to the difficulty in capturing species that are generally uncommon throughout their native range. However, these species have comparatively restrictive ecological requirements and the loss of these two species could also be attributed to environmental degradation in some of the lakes.

Table 1. Fish species occurrence in the 2002/2003 study, historical record and WDNR stocking records. Note: P = occurred in 2002/2003 study H = historically documented occurrence and S = previously stocked by WDNR.

	Adams Lake	Bear Lake	Fountain Lake	Jacqueline Lake	Lime Lake
Brook Trout	HS				
Brown Trout	HS		H		
Rainbow Trout	H		HS		
Northern Pike		PH	H	PHS	PH
Walleye	S		H		HS
Yellow Perch	H	PH	PH	PH	PHS
Iowa Darter	PH		PH	P	H
Johnny Darter	H				
Banded Darter			H		
Largemouth Bass	PHS	PH	PH	PHS	PHS
Smallmouth Bass					
Rock Bass	PH		PH		
Bluegill	PH	PH	PH	PHS	PHS
Bluegill x Pumpkinseed hybrid	P	P			P
Pumpkinseed	H	H			PH
Bluegill x Green Sunfish hybrid					
Green Sunfish	PH	H	PH		PH
Warmouth		PH			
Black Crappie	H	PH	H	H	PH
Crappie sp.	H				
Yellow Bullhead	PH	P			PH
Black Bullhead	H		H	H	
Bullhead sp.		H			
White Sucker	PH	H	H		PH
Sucker sp.					
Bluntnose Minnow			PH		
Fathead Minnow				P	
Golden Shiner	P		H		PH
Blackchin Shiner	P	P			
Blacknose Shiner			PH		
Common Shiner					
Brook Silverside					
Brook Stickleback			PH		
Banded Killifish					
Central Mudminnow	P	P	H	P	PH
Mottled Sculpin					

continued

Table 1 (cont.) Fish species occurrence in the 2002/2003 study, historical record and WDNR stocking records. Note: P = occurred in 2002/2003 study H = historically documented occurrence and S = previously stocked by WDNR.

	Onland Lake	Rhinehart Lake	Spring Lake	Thomas Lake	Wolf Lake
Brook Trout			HS	S	
Brown Trout			HS	HS	
Rainbow Trout			HS	HS	
Northern Pike	H	PHS	PH	H	PHS
Walleye		HS	H	H	HS
Yellow Perch	PH	PHS	PH	PH	PHS
Iowa Darter	P		PH	P	
Johnny Darter					
Banded Darter			H		
Largemouth Bass	PH	PHS	PH	PHS	PHS
Smallmouth Bass				H S	
Rock Bass	H	H	PH		PH
Bluegill	PH	PHS	PH	PHS	PHS
Bluegill x Pumpkinseed hybrid		P		P	P
Pumpkinseed	H	H	H	PH	PH
Bluegill x Green Sunfish hybrid		P			
Green Sunfish		PH	PH	H	
Warmouth	P	PH			
Black Crappie	PH	HS	PH		
Crappie sp.	H				H
Yellow Bullhead		PH		P	
Black Bullhead					
Bullhead sp.	H	HS		H	H
White Sucker		H	PH	H	H
Sucker sp.			H	H	
Bluntnose Minnow	P	P	PH		
Fathead Minnow					S
Golden Shiner		H	PH		H
Blackchin Shiner	P	PH	P		
Blacknose Shiner	P	PH			
Common Shiner				H	
Brook Silverside		PH			
Brook Stickleback			PH		
Banded Killifish	P	H	P	H	
Central Mudminnow		H	P		
Mottled Sculpin			H		

Other factors that affect species occurrence include past fisheries management practices such as whole-lake poisoning to remove native fish and restocking with large predatory fish such as brown and rainbow trout, the presence of a permanent lake inlet or outlet that provide corridors for fish migration, accidental or intentional introductions of live bait or sport fish by anglers and the possible occurrence of recent winterkills from low dissolved oxygen.

The number of fish species found in each lake in this study appeared to be correlated with physical characteristics of the lake and to human disturbance. The number of species in the ten lakes was better correlated with depth (0.63 correlation coefficient on a scale of 0 to +/-1) than lake area or volume. Deeper and larger lakes generally support more species because of the likelihood of greater habitat diversity. Most of the ten lakes sampled were of similar size (28-72 acres), but maximum depth varied from 11-61feet. The number of species in the ten lakes was negatively correlated (-0.45) with percent of moderate or severe lake shoreline disturbance as measured in this study indicating that as lake shoreline disturbance increased the number of species generally decreased. Lakes that were categorized as having high development (Jacqueline, Rhinehart, and Thomas) had on average about 20% fewer species than the remaining lakes categorized as having low to moderate development. Lakes with a permanent inlet or outlet had about 20% more species than those without these natural corridors for fish migration.

The greatest number of fish species (15) found in the 2002-2003 study was from Spring Lake located at the headwaters of Spring Creek a cold water designated stream (Table 2). The least number of species in the 2002-2003 study (7) were found in Wolf, Thomas and Jacqueline lakes with the least historical number of species (9) reported from Jacqueline Lake. Lakes with the greatest percentage of species lost when comparing 2002-2003 data to historical records were Thomas (59%), Fountain (53%) and Adams at 45%. The lakes with the lowest percentage of species lost were Lime (14%) and Bear and Onland at 23%.

Table 2. Species richness in the 2002/2003 study, species previously documented in WDNR records, newly documented species from the current study, lost or undocumented species, total species richness (past and present), and percentage of species lost or undocumented 2002/2003.

	Adams Lake	Bear Lake	Fountain Lake	Jacqueline Lake	Lime Lake	Onland Lake	Rhinehart Lake	Spring Lake	Thomas Lake	Wolf Lake
Species Richness 2002/2003	11	10	9	7	12	10	13	15	7	7
Newly Documented Species 2002/2003	4	4	0	3	1	6	3	3	3	1
Previously Documented Species Richness	16	9	19	6	13	9	18	19	14	10
Lost/Undocumented Species	9	3	10	2	2	3	8	7	10	4
Total (Past and Present) Species Richness	20	13	19	9	14	13	21	22	17	11
Percent Species Lost/Undocumented 2002/2003	45%	23%	53%	22%	14%	23%	38%	32%	59%	36%

Recommendations

Most of the lakes have extensive beds of submersed aquatic vegetation. Submerged vegetation provides essential cover for young fish, but excessive vegetation along with too few large predators may contribute to overpopulation and stunting of fish size. Small bluegill sunfish were overly abundant in many of the lakes and large predators were uncommon. The most common predator in Portage County lakes is the largemouth bass and although abundant in most lakes, few individuals greater than 13 inches were sampled. Another large predator that could help reduce sunfish populations, the northern pike, is easily over-fished in small lakes and was uncommonly found. Although the sampling intensity was insufficient to make specific sport fish management recommendations on individual lakes, strategies to increase the number and size of large fish, would tend to reduce the population of small sunfish and generally enhance angler experience. Strategies to increase fish size could include some form of catch restrictions or size limits and their potential use should be explored further on a lake by lake basis with the regional WDNR fisheries management biologist.

There was little woody cover observed in most of the lakes, particularly seepage lakes. Downed trees in littoral areas represent the most permanent and often only year-round cover for fish. Water levels fluctuate widely in seepage lakes following changes in groundwater elevation and in 2002-2003 water levels were near record lows with water receding far beyond where falling trees could reach water. Fish populations in most seepage lakes would benefit from the addition of woody cover below the lowest reported water levels where it would remain continuously submerged. Minimally, trees that fall on the shoreline during low water periods should be left in place and not removed so they will provide cover during high water periods. Tree lined shores in drainage lakes, which tend to maintain more constant water levels, should be protected and trees that fall into the water should be left in place to provide cover. Some lakes had more natural shorelines and associated cover than others. Fountain Lake and Spring Lake had minimally developed shorelines and more near-shore woody cover than most other lakes and the shoreline areas of these lakes could serve as models of a more natural lake setting.

The fish communities in several Portage County lakes have undergone substantial change. The communities were altered most in lakes that were poisoned and restocked in an effort to improve the sport fishery. Most lakes in the county are small, easily over fished and may never support a self sustaining high intensity hook and line consumptive fishery for large predatory fish. The greatest fishery value of some lakes may be the genetic diversity preserved in species of fish often unseen by anglers. It is possible some species of fish in landlocked lakes have been largely isolated since the retreat of glaciers 10,000 years ago and may represent unique genetic strains. Although no rare or endangered fish were found in any of the least impacted lakes, several species found are glacial relics, restricted to the unique habitat left by the retreating glaciers. Restoration of these species in lakes where they were eliminated by poisoning may be possible and enhance the overall ecological value of these unique environments.

Adams Lake

The Fishery

A total of 20 species of fish have been reported from Adams Lake since 1943 (Table 3).

Table 3. Species occurrence in Adams Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Brook Trout. 1985, 1971, 1967. **S**; 1977.
Brown Trout. 1985, 1971, 1967. **S**; 2003-1978, 1976, 1975, 1973, 1972.
Rainbow Trout. 1966, 1961, 1960, 1953.
Bluegill. 2003, 2002, 1987, 1985, 1971, 1967, 1966, 1961, 1960, 1953.
Bluegill/Pumpkinseed hybrid. 2003.
Pumpkinseed. 1985.
Green Sunfish. 2003, 2002, 1987, 1985, 1967, 1966, 1961.
Rock Bass. 2003, 2002, 1987, 1985, 1971, 1967, 1960.
Largemouth Bass. 2003, 2002, 1985, 1971, 1967, 1966, 1961, 1960, 1953. **S**; 1944.
Black Crappie. 1985, 1971, 1967.
Crappie sp. 1966, 1961.
Walleye. **S**; 1943.
Yellow Perch. 1985, 1971, 1967, 1966, 1961, 1960, 1953.
Iowa Darter. 2002, 1948.
Johnny Darter. 1961.
Yellow Bullhead. 2002, 1985, 1967.
Black Bullhead. 1985.
White Sucker. 2002, 1985, 1966, 1961, 1960, 1953.
Golden Shiner. 2002.
Blackchin Shiner. 2003.
Central Mudminnow 2002.

Adams Lake supports a two story fishery. The native fish population is warm water dominated by bluegill, green sunfish and largemouth bass, but the lake is deep enough to provide a cold water environment for stocked salmonids for at least part of the year. The potential for a cold water fishery was first noted in 1948 and rainbow trout were stocked shortly thereafter. Native brook trout have been stocked with the nonnative brown trout stocked on an annual basis since 1978. In a 1979 study on this lake, it was reported that few stocked trout survive beyond the fishing season with 70% caught in the first month after stocking. Year-round survival may be limited by the low dissolved oxygen in deeper cooler waters. The dissolved oxygen level below 8 meters is too low to support

salmonids in the late summer and early fall and may force stocked trout into the warmer surface water that may also present lethal conditions. The lake also has a history of stocking largemouth bass and walleye in the 1940s, but neither occurred after 1950.

Eleven species of fish were collected from Adams Lake in 2002-2003 compared to 16 from rather extensive historical records dating back to the 1940s (Table 2). The most recent survey prior to this study was conducted in 1987. Taxa not previously reported from this lake include the bluegill/pumpkinseed hybrid, golden shiner and blackchin shiner. As in several other area lakes the bluegill/pumpkinseed hybrid has appeared as the pure pumpkinseed has been lost. The golden shiner although native, is also a common bait bucket introduction. The blackchin shiner may have been previously overlooked as many of the old fishery surveys had often ignored smaller species or lumped them into unidentified categories. For example, "shiners" were reported to be present in a 1961 survey, but that could include one of several small species from the minnow family.

Species lost from the lake or not detected included walleye, yellow perch, Johnny darter, pumpkinseed, black crappie, black bullhead and white sucker as well as the three salmonid species. Several "trout" were collected in late fall 2003 with mini-fyke nets set in a more extensive sampling of the lake for mudpuppy salamanders, but were not included in the fishery data tables because the species of trout was not verified. Presumably they were brown trout. The walleye was only known from Adams lake from the early stocking records and it is likely those fish quickly disappeared. Yellow perch and black crappie were only noted in small numbers and never appeared to be important to the sport fishery here. The Johnny darter was noted only in 1961 and may no longer be present in the lake. Because Adams Lake has an intermittent outlet to the headwaters of Bear Creek, species present in Tomorrow River watershed such as the black bullhead, white sucker and yellow perch, previously reported from Adams Lake, could possibly migrate back into the lake in the future.

Although the annual stocking of trout in Adams Lake has allowed the development of a cold water recreational fishery, it may have a negative impact on native warm water fish populations. Possible adverse effects would be most severe with stocking of the non-

native brown or rainbow trout that would have the potential to grow much larger than the native brook trout. Adams Lake also has a notable population of mudpuppy salamanders, the only lake where they were found in the present study. They are known from the Wolf River watershed and have been found in other glacial lakes in central Wisconsin. They are carnivorous and would potentially eat small benthic fish, but their feeding habits in this lake are unknown. They appear to be part of the natural fauna in this lake and may have been there since the retreat of the glaciers.

For a complete list of all fisheries data from the present study including numbers caught, gear used and size distributions of sport fish and more detailed stocking records please refer to Appendix 1.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in Adams Lake is mostly marl overlaid with organic detritus along the southern shore (Fig. 1a). In the absence of sand and gravel, largemouth bass and sunfish are known to build nests on marl. Depressions are deepened until small amounts of more course substrate, mostly fragments of snail shells, accumulate in the bottom of the nest. In areas of soft substrate, largemouth bass are also reported to nest on woody debris swept clear of sediments. The presence of young bass and overabundance of sunfish indicate reproduction is successful in this lake. Adams Lake is dominated by Chara throughout the littoral zone (Fig 1b). Beds up to several feet think blanket the bottom and extend down to the secchi depth in much of the lake providing substantial cover for most small fish. Pondweeds along the western shore provide more sparse cover, but extend to the water surface by midsummer. Emergent beds of rush, sedge and cattail are in the northeast portion of the lake and provide more permanent cover. There are two small, but important areas with downed trees along the southeast and northwest shoreline. Because this is a drainage lake and water levels are more stable than in seepage lakes, trees that fall into the lake are likely to remain permanently submerged. These downed trees should be left in place and if possible supplemented with additional woody cover as

there are few remaining large trees near enough to the waters edge to provide cover should they naturally fall.

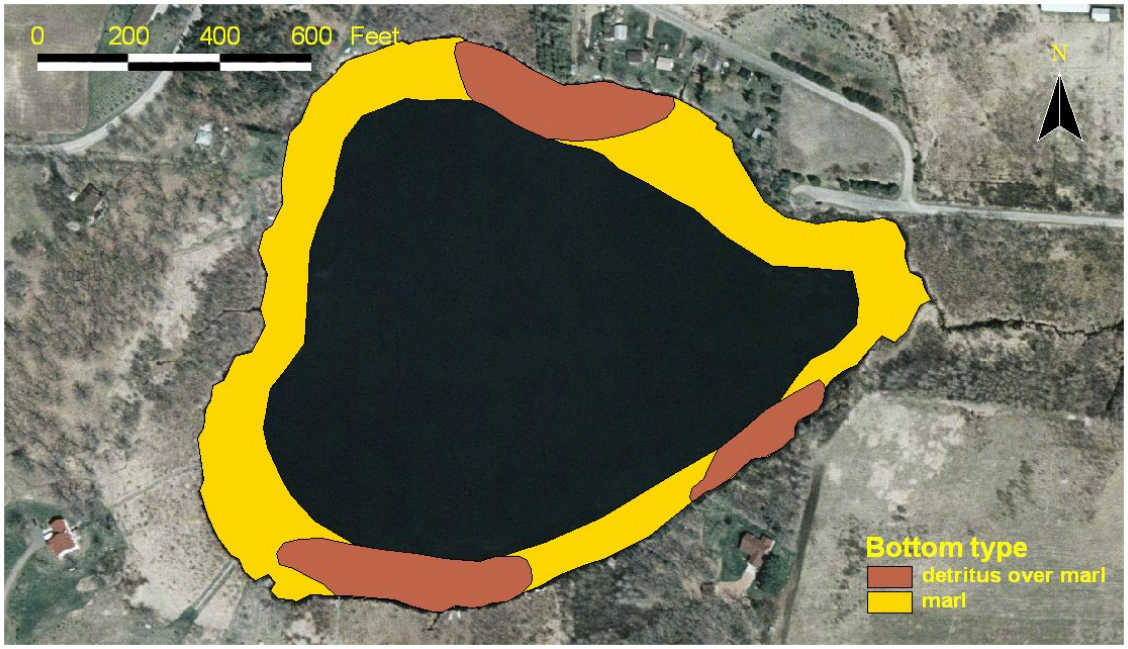

Figure 1a. Littoral bottom map of Adams Lake 8/20/03.

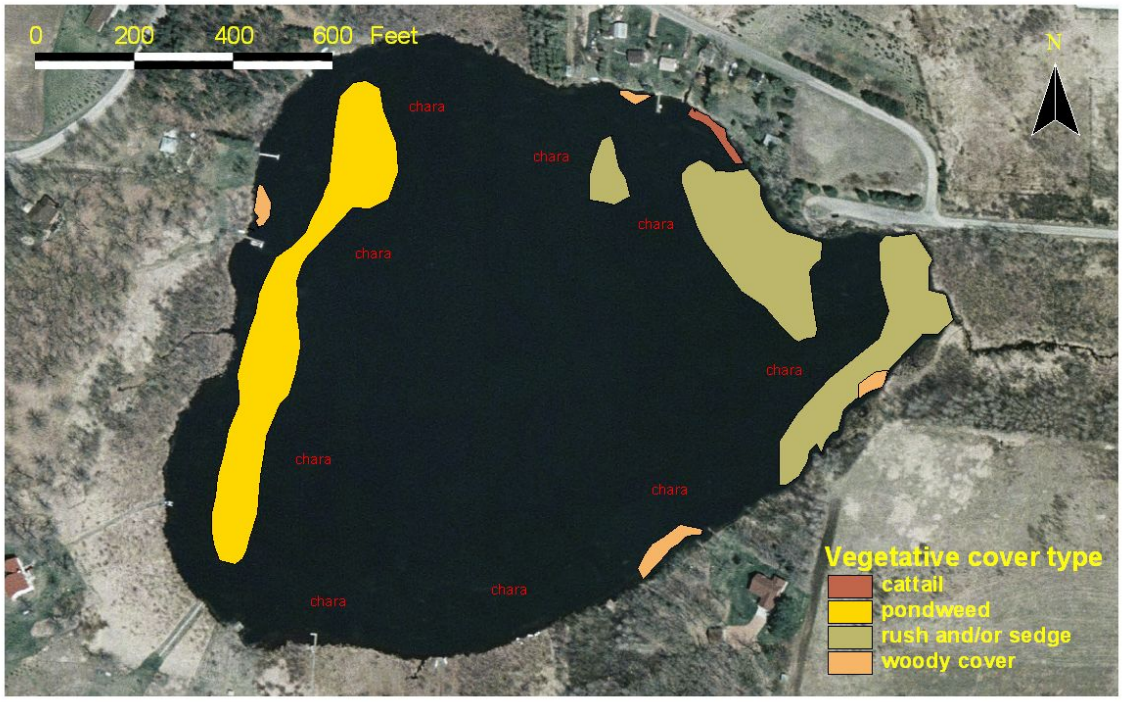

Figure 1b. Vegetative cover map of Adams Lake 8/20/03.

Bear Lake

The Fishery

A total of 13 species of fish have been reported from Bear Lake since 1960 (Table 4).

Table 4. Species occurrence in the Bear Lake in the 2002/2003 study and historical WDNR records.

Bluegill. 2003, 2002, 1985, 1968, 1962, 1960.
Bluegill/Pumkinseed hybrid. 2003, 2002.
Pumpkinseed. 1985, 1968.
Green Sunfish. 1962.
Warmouth. 2002, 1985.
Largemouth Bass. 2003, 2002, 1968, 1962, 1960.
Black Crappie. 2003, 1985, 1968, 1962, 1960.
Yellow Perch. 2002, 1985, 1968, 1962.
Northern Pike. 2003, 2002, 1985, 1968.
Yellow Bullhead. 2003.
Bullhead sp. 1962.
White Sucker. 1962.
Blackchin Shiner. 2003.
Central Mudminnow. 2002.

Bear Lake supports a warm water fish community. Ten species of fish were collected from Bear Lake in 2002-2003 compared to 9 from historical records (Table 2). Taxa not previously reported from this lake include yellow bullhead, blackchin shiner, central mudminnow and the bluegill/pumpkinseed hybrid. Species lost from the lake or not detected include pumpkinseed, green sunfish and white sucker. The most abundant species in Bear Lake as in other Portage County lakes is the bluegill. There are no official records of stocking Bear Lake, but it would be unusual if this public access lake had not received state propagated fish at some time.

A 1962 WDNR report indicated an excellent bluegill and crappie sport fishery present in the lake with largemouth bass and northern pike present. A WDNR survey performed in 1985 again substantiated the excellent bluegill and black crappie population. The report also noted that Bear Lake had the largest pumpkinseed fishery seen in any central Wisconsin Lake with individuals up to 9.5 inches (possible state record at the time). In

the 2002-2003 survey more sizable largemouth bass were caught in Bear Lake than in any of the other lakes sampled, but the notable population of pumpkinseed sunfish had disappeared, apparently lost though hybridization with bluegill. Populations of pumpkinseed sunfish appear to have significantly decreased or have been lost to hybridization in a number of Portage County lakes. These species commonly hybridize in some lakes and in others remain isolated. Hybridization between sunfish in some lakes has been attributed to overcrowding, limited spawning habitat or environmental disturbance. The average size of these hybrids and bluegill was small indicating overcrowding and possible stunting, a typical condition in most of the lakes sampled. Black crappie appear to be less abundant and smaller in size than in the past, but anglers reportedly still specifically fish the lake for crappie. The warmouth sunfish is near the northern extent of its range in Wisconsin and continues to be found in Bear Lake. It is uncommon to rare throughout its range in Wisconsin, but appears to have become well established in a number of the small lakes in Portage County that lie near the headwaters of tributaries to the Wolf River. It is reported to prefer densely vegetated areas and has a greater tolerance to low dissolved oxygen than other species of sunfish which may account for its continued presence in Bear Lake.

Newly reported species in this lake such as the yellow bullhead and central mudminnow are common residents of central Wisconsin lakes and streams. The blackchin shiner is a glacial relict of lakes and streams in Wisconsin. It is rare or endangered throughout much of its range in the U.S. and has been extirpated in some states. It was once much more abundant throughout Wisconsin but has been eliminated from most streams because of increased turbidity. Its distribution is mostly restricted to small relatively undisturbed glacial lakes. Because Bear Lake does not have an inlet or outlet it is possible a small undetected population of this species has existed here in relative isolation since glaciation. Although it is not classified as a rare fish in Wisconsin, a potentially isolated population such as this is possibly unique and should be given consideration for protection.

For a complete list of all fisheries data from 2002-2003 study including numbers caught, gear used and size distributions of sport fish as well as complete stocking records refer to Appendix 2.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is mostly muck and sand with one small area of gravel and another with widely scattered boulders (Fig. 2a). The small area of sand and gravel noted along the southeast shore is unique and should be protected from disturbance. Although largemouth bass and sunfish species commonly nest on sand, gravel or mixed sand and gravel is the preferred substrate for nest building. The sandy shoreline habitat is more extensive, but still limited and is probably critical for sustaining reproduction in the blackchin shiner. Increased turbidity from disturbance of the lake bed or from runoff within the watershed will also adversely affect this species.

Bear Lake has extensive beds of emergent and floating aquatic vegetation (Fig. 2b). The emergent sedges and rush in shallow water less than one foot in depth along all but the northern shore are the preferred spawning habitat for northern pike. Limitations to the northern pike population in this lake may be more related to fishing pressure than to lack of suitable spawning habitat. The deep water edge provided by the water lilies and pondweed along the north shore provide excellent habitat for largemouth bass, and northern pike to ambush prey. However, the percentage of the lake with extensive vegetative cover is large and may contribute to overpopulation of small bluegill. There was no woody cover noted on this lake. Downed trees in littoral areas represent the most permanent and often only year-round cover for fish. As in many seepage lakes water levels fluctuate widely and in 2002-2003 water levels were at near record lows with water receding far beyond where falling trees could reach water. Fish populations in this lake would benefit from the addition of woody cover below the lowest reported water levels where it would remain continuously submerged. Minimally, trees that fall on the shoreline during low water periods should be left in place and not removed so they will

provide cover during high water periods.

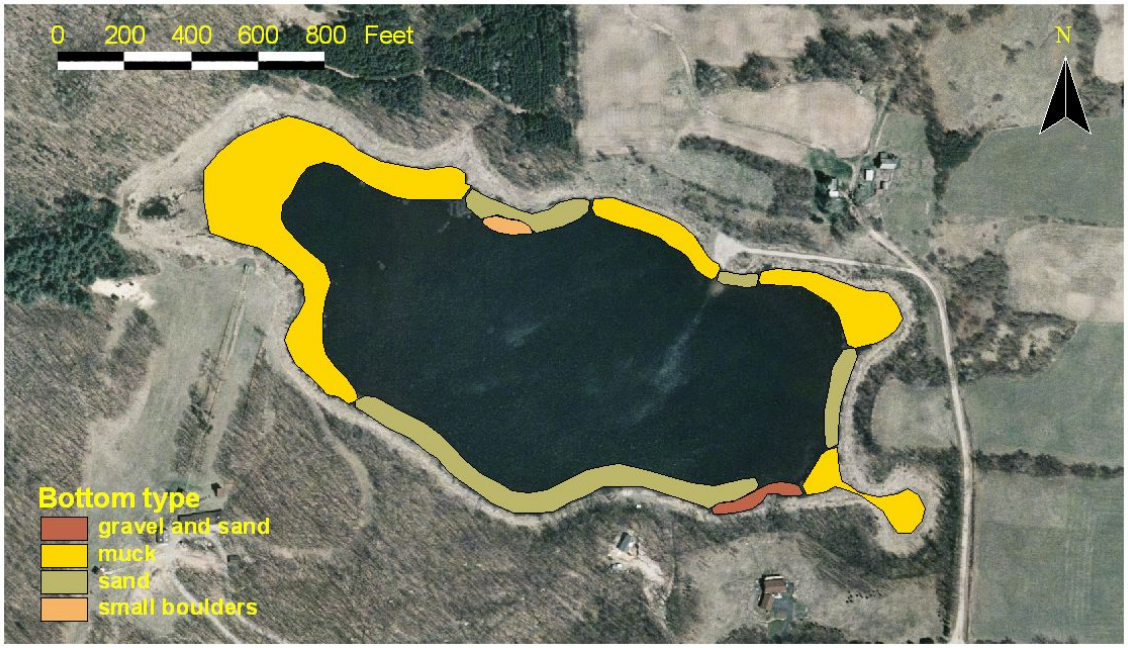

Figure 2a. Littoral bottom map of Bear lake 6/21/03.

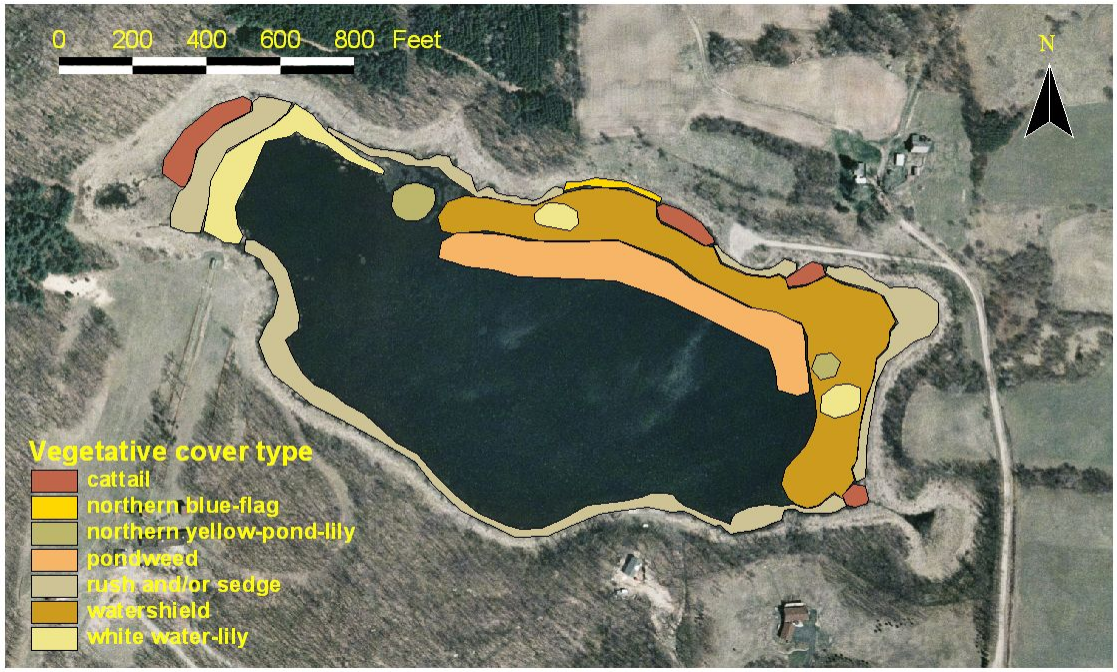

Figure 2b. Vegetative cover map of Bear Lake 6/21/03.

Fountain Lake

The Fishery

A total of 19 species of fish have been reported from Fountain Lake since 1952 (Table 5).

Table 5. Species occurrence in Fountain Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Brown Trout. 1966.
Rainbow Trout. 1952. **S**; 1964-1955.
Bluegill. 2002, 2001, 1983, 1975, 1966, 1959, 1952.
Green Sunfish. 2002, 2001, 1983, 1975.
Rock Bass. 2002, 2001, 1983, 1975, 1966, 1959.
Largemouth Bass. 2002, 2001, 1983, 1975, 1966, 1959.
Black Crappie. 1983, 1975, 1966.
Walleye. 1983, 1975.
Yellow Perch. 2002, 1983, 1975, 1966, 1959.
Iowa Darter. 2002, 2001.
Banded Darter. 1959.
Northern Pike. 1983, 1975.
Black Bullhead. 1983.
White Sucker. 1975, 1959.
Bluntnose Minnow. 2002, 2001, 1959.
Golden Shiner. 1975.
Blacknose Shiner. 2002, 2001, 1975.
Brook Stickleback. 2002, 2001, 1959.
Central Mudminnow. 2001, 1975, 1959.

Fountain Lake is a natural lake, but was deepened and enlarged with the addition of a small concrete dam across the outlet in 1938. Because it is located at the headwaters of Emmons Creek, a cold water stream, it was stocked with salmonids beginning in 1955. Stocking stopped in 1964 because of poor angler success. Trout have not been recorded there since 1966. The lake is relatively shallow at 24 feet and may not provide well-oxygenated cold water necessary for salmonid survival. Alternatively, the fish may have simply moved over the dam to more favorable habitat downstream. The sport fish population in this lake is largemouth bass, bluegill and yellow perch. The lake had the best population of rock bass of the ten lakes sampled in this study. Nine species of fish were collected from Fountain Lake in 2002-2003. The most recent survey prior to this study was conducted in 2001 with essentially the same species collected as in the present study. There were no newly documented species. Ten species or 59% of the total known

fauna, more than any other lake, was lost or not observed in the 2002-2003 survey. This large percentage loss of species may in part be the result of the addition of the small dam which would effectively block upstream movement of stream species that would only occasionally be found in the lake environment. This could explain the loss of the banded darter, a stream fish, which could only be sustained in a lake environment if a population had access to riverine spawning habitat. Other species not found include black crappie, black bullhead, white sucker, golden shiner and central mudminnow which are all common inhabitants of central Wisconsin waters. Another species not found in 2002-2003, the northern pike, was previously known by only one individual and it is unlikely the lake has a self sustaining population of this species.

For a complete list of all fisheries data from the 2002-2003 study including numbers caught, gear used and size distributions of sport fish as well as stocking records refer to Appendix 3.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in Fountain Lake is mostly marl with some small areas of sand and gravel. Suitable substrate is present for spawning of most sport fish species present in the lake as indicated by abundant young of year for all species except yellow perch. Fountain Lake is dominated by Chara which blankets much of the lake bottom and provides substantial cover for small fish. Pondweed and pond-lily beds provide a diversity of submerged and floating cover for larger fish. Much of the southern shoreline is forested and several areas of partially submersed standing timer were noted. Because this lake has not been developed, it would serve as a good example for shoreline restoration efforts in other area lakes that have undergone more extensive shoreline

disturbance.

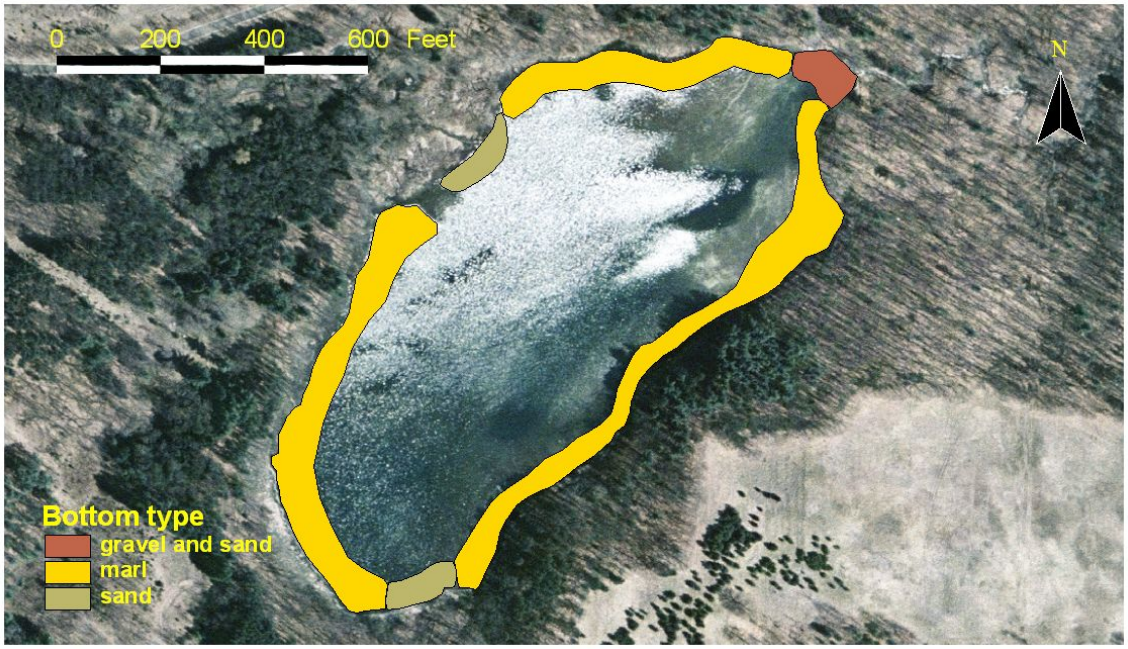

Figure 3a. Littoral bottom map of Fountain Lake 6/21/03.

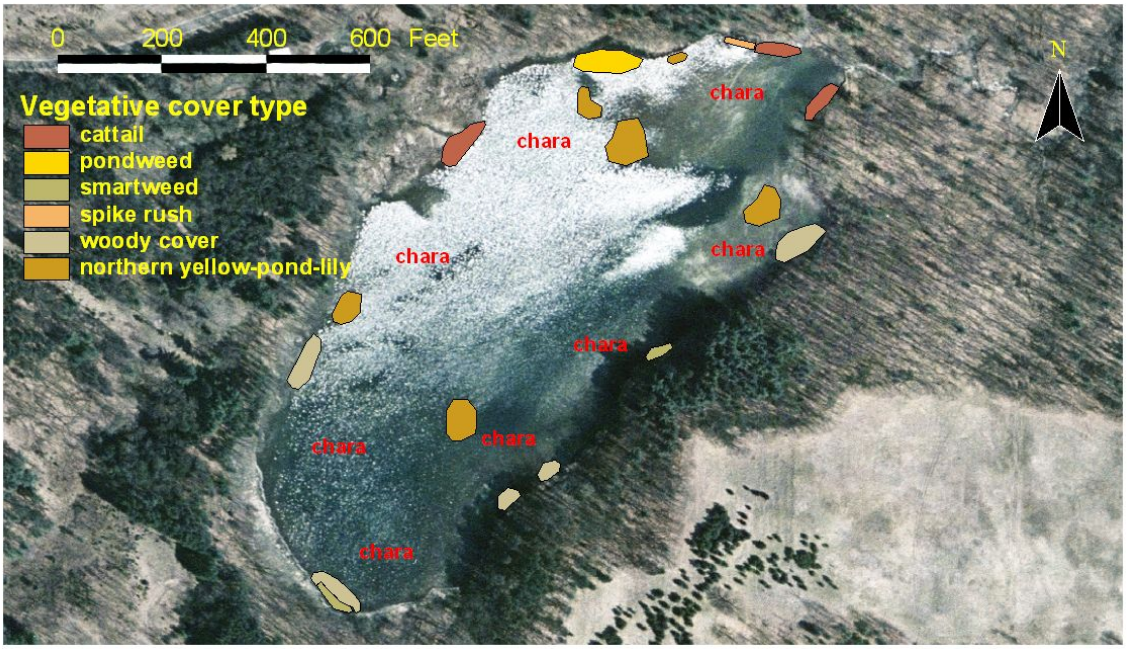

Figure 3b. Vegetative cover map of Fountain Lake 6/21/03.

Jacqueline Lake

The Fishery

A total of nine species of fish have been reported from Jacqueline Lake since 1950 (Table 6).

Table 6. Species occurrence in Jacqueline Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Bluegill. 2003, 2002, 1999. **S**; 1979, 1972, 1971.
Largemouth Bass. 2003, 2002, 1999. **S**; 1994-1992, 1972, 1969, 1950.
Black Crappie. 1999.
Yellow Perch. 2003, 2002, 1983.
Iowa Darter. 2002.
Northern Pike. 2003, 1999, 1983. **S**; 1994-1992, 1979, 1975, 1973, 1969.
Black Bullhead. 1983.
Fathead Minnow. 2002.
Central Mudminnow. 2003.

Jacqueline Lake supports a warm water fish population. Because of the extensive development around the lake and recreational pressure, this fishery has been extensively surveyed. The lake has experienced a long history of winterkills from low dissolved oxygen, occurring almost ever year between 1968 and 1986. An aerator was installed in 1993 and apparently has prevented winterkills since. Seven species of fish were collected in 2002-2003 compared to six from historical records (Table 2). The low number of fish species present in the lake is probably a result of past episodes of low dissolved oxygen. Three new species were reported including the Iowa darter, fathead minnow and central mudminnow. Species not collected in the most recent sampling include black crappie and black bullhead.

The lake was stocked repeatedly with bluegill, largemouth bass, yellow perch and northern pike beginning in 1950, but was reportedly ineffective because of winterkill. Stocking ceased after the aerators were installed in the 1990s and has been unnecessary since because of natural reproduction. The lake has been subject to extensive fishing pressure and most sport fish caught are small. No largemouth bass greater than 13 inches

were collected by electrofishing in 2003, although a few unusually large bluegill were caught. For a complete list of all fisheries data from the 2002-2003 study including numbers caught, gear used and size distributions of sport fish as well as complete stocking records, please refer to Appendix 4.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is almost entirely muck (Fig. 4a). A previous study measured depths of muck up to 33 feet by probing with a long metal rod to the original lake bottom. The muck was flocculent with a 3-5% solids content and will not support the weight of an individual wading. It is believed to have accumulated from the decomposition of the luxuriant growth of aquatic plants in the lake over a long period of time. There is no ideal spawning substrate for bass or sunfish. In the absence of sand and gravel, largemouth bass will excavate a bed to a hard substrate such as accumulations of sticks and twigs that have fallen into the water to lay their eggs. The lack of suitable spawning habitat for sunfish may not be detrimental to the sport fishery as sunfish typically overpopulate and stunt. The presence of some rather large bluegill in this lake suggests the population may be limited thus the increased size. Yellow perch are present and there is evidence of recent reproduction. The spawning requirements of this species are rather nonspecific and adults will usually deposit eggs on submerged branches or in dense aquatic vegetation. Northern pike are present in the lake and although there is an abundance of spawning habitat no young of year were collected in 2002 and 2003.

Jacqueline Lake has extensive beds of emergent and floating aquatic vegetation including a large area in the northern part of the lake covered with a floating bog (Fig. 4b). Management of the luxuriant growth of aquatic vegetation began in 1968 with herbicides including the currently banned 2,4,5-T and Silvex. Reports in 1982 indicated only 2-3 acres were weed free and as many as 85 tons of vegetation were removed in 1986. Spraying ceased in the early 1990s following purchase of a weed harvester. The lake presents an ideal environment for growth of aquatic plants and annual cutting will be needed to maintain open

water.

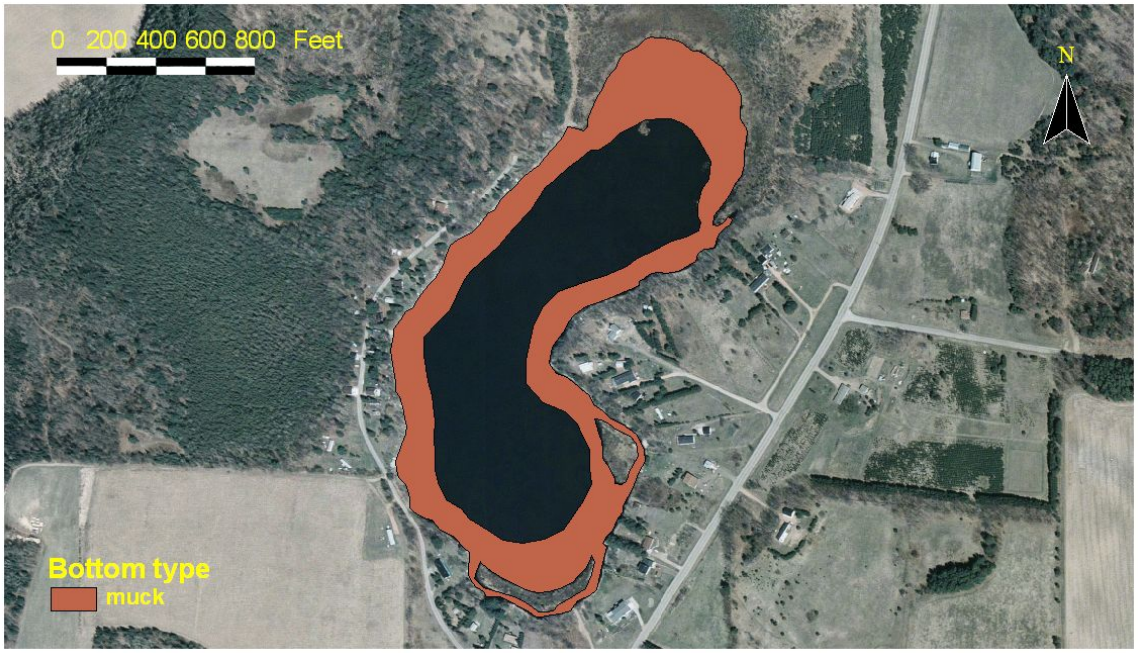

Figure 4a. Littoral bottom map of Jacqueline Lake 10/25/03.

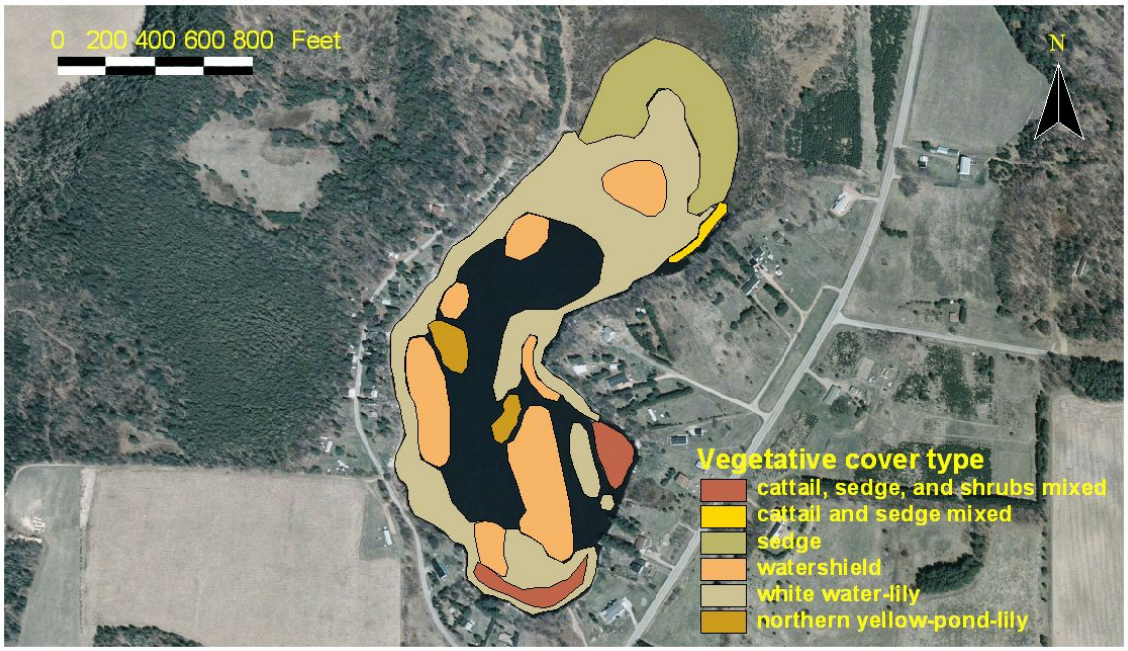

Figure 4b. Vegetative cover map of Jacqueline Lake 10/25/03.

Lime Lake

The Fishery

A total of 14 species of fish have been reported from Lime Lake since 1950 (Table 7).

Table 7. Species occurrence in Lime Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Bluegill. 2003, 1985, 1976. **S**; before 1950.
Bluegill/Pumpkinseed hybrid. 2003.
Pumpkinseed. 2003, 1985, 1976.
Green Sunfish. 2003, 1976.
Largemouth Bass. 2003, 1985, 1976. **S**; before 1950.
Black Crappie. 2003, 1985, 1976.
Walleye. 1985, 1976. **S**; 1977, 1976.
Yellow Perch. 2003, 1985, 1976. **S**; before 1950.
Iowa Darter. 1976.
Northern Pike. 2003, 1985, 1976.
Yellow Bullhead. 2003, 1985.
White Sucker. 2003, 1976.
Golden Shiner. 2003, 1976.
Central Mudminnow. 2003, 1976.

Lime Lake supports a warm water fishery. The fish population is dominated by bluegill, largemouth bass and yellow bullheads. The lake has had a long history of stocking largemouth bass, bluegill and yellow perch dating back to 1930. In 1976, walleye were stocked, but there has been no evidence of reproduction and the population has apparently disappeared. The lake was considered to have potential as a trout fishery in 1958, but the lake also has been subject to winterkill and would be a poor choice for trout stocking because of periodic low dissolved oxygen.

Twelve species of fish were collected in Lime Lake in 2002-2003 compared to 13 from historical records (Table 2). The only new taxa found not previously reported from this lake include the bluegill/pumpkinseed hybrid. Pure pumpkinseed parentals are still found in the lake unlike several other lakes where they have been lost through introgression with bluegill. Species lost or not documented include the walleye which would only be sustained through stocking, and the Iowa darter a small bottom dwelling fish that is best caught by seine, which could not be used because of the soft bottom. Decline in the population of black crappie has occurred since the last WDNR sampling in 1986 when it

was the second most abundant sport fish after bluegill. None were collected during daytime electrofishing in 2003 and only one was collected in 2002. There were also a lot fewer northern pike collected in 2002-2003 compared to 1986, but that difference may be due to our less effective daytime electrofishing. A substantial number of largemouth bass less than 13 inches are present in the lake. Yellow perch were more common than in the other lakes sampled in the 2002-2003 study. There is also a large population of sizeable yellow bullheads. The abundance of bullheads along with the high number of mudminnows suggests the lake may have been subject to low dissolved oxygen and possibly periodic winterkill.

For a complete list of all fisheries data from the 2002-2003 study including numbers caught, gear used and size distributions of sport fish please refer to Appendix 5.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in Lime Lake is mostly marl mixed with small amounts of sand (Fig. 5a). Deeper areas near the north and south shore appear to have been dredged, a sign of the marl removal that occurred in 1954. This soft bottom prevented wading in most of the lake and prevented use of seines. In the absence of sand and gravel, largemouth mouth bass and sunfish build nests on marl, especially if they can excavate a depression to a coarser substrate such as woody debris. The presence of young bass and overabundance of sunfish indicate adequate reproduction. There is an abundance of emergent vegetation that would provide spawning habitat for northern pike, but no young of year were collected. Newly hatched northern pike are preyed upon by bluegill and other sunfish and their absence could as well be from competition as lack of spawning success.

Vegetation in the lake presents a variety of cover types for fish. Extensive emergent beds of cattail ring the lake with an expanse of rush and sedge in slightly deeper water along the eastern shore (Fig. 5b). Water lilies provide excellent edge habitat in deeper water along the south and west shores. Extensive beds of pondweed and common milfoil

provide deep water cover. Chara is present but does not appear to be as dominant as in other area marl lakes. There was little woody cover along the shoreline. The wooded steep banks along the north and west shores should provide a source of permanent cover in the future as trees occasionally fall into the water.

Figure 5a. Littoral bottom map of Lime Lake 8/2/03.

Figure 5b. Vegetative cover map of Lime Lake 8/2/03.

Onland Lake

The Fishery

A total of 13 species of fish have been reported from Onland Lake since 1949 (Table 8).

Table 8. Species occurrence in Onland Lake from the 2002/2003 study and WDNR records.

Bluegill. 2002, 1962, 1949.
Pumpkinseed. 1962.
Warmouth. 2002.
Rock Bass. 1962.
Largemouth Bass. 2002, 1962.
Black Crappie. 2002, 1949.
Crappie sp. 1962.
Yellow Perch. 2002, 1962, 1949.
Iowa Darter. 2002.
Northern Pike. 1962.
Bullhead sp. 1962.
Bluntnose Minnow. 2002.
Blackchin Shiner. 2002.
Blacknose Shiner. 2002.
Banded Killifish. 2002.

Onland Lake supports a warm water fish population. Ten species of fish were collected from Onland Lake in 2002-2003 compared to 9 from historical records (Table 2). Six newly documented fish were found here in 2002, more than any other Portage Co. lake sampled including the warmouth, Iowa darter, bluntnose minnow, blackchin shiner, blacknose shiner, and banded killifish. The warmouth is generally uncommon throughout Wisconsin and the later five species are small and may have been overlooked in the two previous surveys dating back to 1949 and 1962. The sport fish population was dominated by bluegill and yellow perch. Because public access is somewhat limited by a steep trail, this lake probably has not been subjected to the same intensity of management and fishing pressure as other area lakes with public access. There are no official records of stocking or intentional management-directed lake poisoning and the fish assemblage appears to be more similar to what would be expected in an unimpacted lake setting. The lake supports blackchin and blacknose shiners both glacial relics. Because this is a

seepage lake without inlets or outlets, these populations may be somewhat unique because they have had the potential to have been reproductively isolated for a long period of time.

Species lost include northern pike and rock bass. Only shallow water was sampled and it is possible these species had already moved to deeper water because of the mid October sampling date. For a complete list of all fisheries data from Onland Lake in 2002 including numbers caught, gear used and size distributions of sport fish please refer to Appendix 6.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is mostly sand with two small areas of sand and gravel on the western shore (Fig. 6a). The clean sandy and gravel substrate may be essential for maintaining populations of the blackchin shiner and blacknose shiner as well as providing spawning habitat for largemouth bass. These sand and gravel areas should be maintained and protected from disturbance or sedimentation. Marl is common in deeper water beyond the littoral zone. Although a portion of the lake is developed, the banks behind the beach are steep and mostly wooded. There are some downed trees in the lake that provide permanent cover for fish.

Onland Lake has moderate vegetative coverage (Fig. 6b). There are a number of beds of emergent vegetation located around the lake that would provide limited spawning habitat for northern pike, although no adults or young of year were collected. A small area of water lilies along the western shore and a larger area of pondweeds near the southern shore provide excellent cover adjacent to deep water for a variety of species. Chara is widely distributed, but not dominant as in other marl lakes.

Figure 6a. Littoral bottom map Onland Lake 6/22/03.

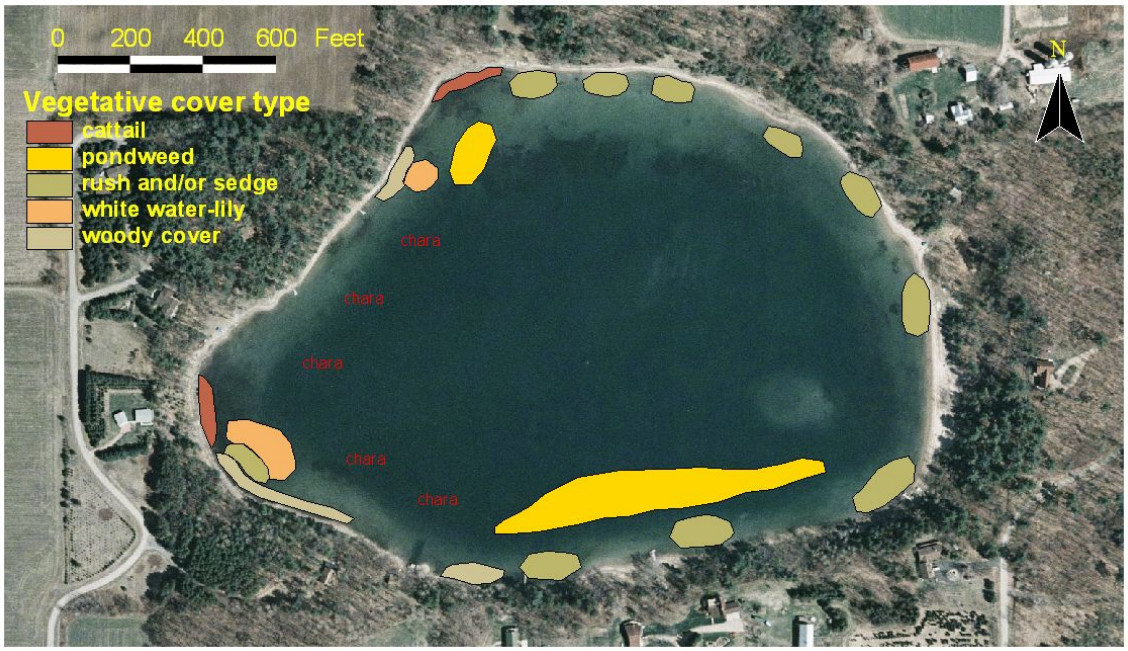

Figure 6b. Vegetative cover map of Onland Lake 6/23/03.

Rhinehart Lake

The Fishery

A total of 21 species of fish have been reported from Rhinehart Lake since 1935 (Table 9).

Table 9. Species occurrence in Rhinehart Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Bluegill. 2003, 2002, 1995, 1992, 1983, 1977, 1971, 1956. **S**; 1935
Bluegill/Pumpkinseed hybrid. 2003.
Pumpkinseed. 1995, 1992, 1983, 1977, 1971.
Bluegill/Green Sunfish hybrid. 2003.
Green Sunfish. 2003, 1977, 1971.
Warmouth. 2003, 1983, 1977, 1956.
Rock Bass. 1995.
Largemouth Bass. 2003, 1995, 1992, 1983, 1977, 1971, 1956. **S**; 1996, 1983-1981, 1935.
Black Crappie. 1995, 1983, 1956. **S**; before 1982.
Walleye. 1983, 1971. **S**; 1959.
Yellow Perch. 2003, 1995, 1992, 1983, 1977, 1971, 1956. **S**; before 1982.
Northern Pike. 2003, 1995, 1992, 1983, 1977, 1971, 1956. **S**; 1977, 1975, 1973, 1935.
Yellow Bullhead. 2003, 1995, 1977.
Bullhead sp. 1971. **S**; before 1982.
White Sucker. 1995, 1956.
Bluntnose Minnow. 2003, 2002.
Golden Shiner. 1956.
Blackchin Shiner. 2003, 2002,1977.
Blacknose Shiner. 2003, 2002, 1977.
Brook Silverside. 2003, 1977.
Banded Killifish. 1977.
Central Mudminnow. 1977.

Rhinehart Lake supports a warm water fishery. Thirteen species were found in 2002 and 2003 compared to 18 from historical records (Table 2). Three newly documented taxa were found, but two were hybrids, bluegill/green sunfish and bluegill/pumpkinseed and the third was the bluntnose minnow. The sport fish population is presently dominated by bluegill, largemouth bass, yellow bullheads and yellow perch. Because of the extensive development around the lake and public access, the lake has been sampled frequently and there is a long history of stocking dating back to the 1930s. A number of warm water sport fish species had been stocked including largemouth bass, northern pike and walleye.

Few of these fish ever appeared in the creel prompting WDNR biologists to note in the early 1980s that stocking did not appear to be worthwhile. The most recent WDNR survey in 1995 noted an absence of sunfish possibly from poor spawning success and no bass over 14 inches probably from over fishing. The population of bluegill appeared to have recovered in numbers by 2003, but individuals were small in average size indicating stunting. Young of year largemouth bass were sampled in 2002-2003 indicating spawning is successful, but no adults were collected. A floating electofishing barge was used to sample the wadable portions of the lake shoreline which cannot reach deep water where adult largemouth would be found in late fall. Typically, the average size of largemouth bass in most lakes in Portage County is small because of high fishing pressure.

Eight species previously known from the lake were lost or not documented in the present study. These include the walleye which would only be present from stocking as there is no spawning habitat for this species in the lake, the rock bass, pumpkinseed, black crappie, white sucker, golden shiner, banded killifish, and central mudminnow. Several of these species could naturally find their way back into the lake through the semi-permanent outlet, the headwaters of Nace Creek. Several species with restricted distributions were also found in the lake including the blackchin shiner, blacknose shiner and the brook silverside which was the only lake where the latter species was found.

For a complete list of all fisheries data from Rhinehart Lake in 2002 and 2003 including numbers caught, gear used and size distributions of sport fish as well as stocking records refer to Appendix 7.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is mostly marl or marl over sand (Fig 7a). There was a small area of clean sand and gravel not indicated on the map that may have been created during construction or maintenance of the public boat landing. This area was attractive to schools of blackchin and blacknose shiners and bluntnose minnows and may be important

to the continued presence of these fish in the lake because other areas are mostly covered with marl sediment. Largemouth bass successfully excavate through the marl down to the sandy substrate for their nests. Following abandonment of the nests by adults, the newly exposed clean substrate around the nests is attractive to schools of the above mentioned minnow species and may also be critical to their existence in this lake as clean sand and gravel is scarce. Areas of sand and gravel in the lake should be protected from sedimentation. This might be a good lake to investigate the value of creating additional spawning habitat for forage fish though the construction of sand and gravel bars.

A moderate growth of Chara covers much of the bottom of Rhinehart Lake (Fig 7b). The southwestern shore, with an expanse of emergent and floating vegetation, provides excellent spawning habitat for northern pike, yet the population appears small and no young of year were collected in 2002-2003. The developed northeastern shore is bounded by nearly featureless marl covered shallow flats. There is virtually no cover for fish in this area. Records indicate herbicides were used to remove shoreline vegetation in 1997, but the location in the lake was not noted. This would be an ideal area to promote growth of natural wetland vegetation. A freshwater sponge, not seen in other area lakes, appearing as a green to brown coral-like branched projection growing upright from the bottom substrate was observed in this lake.

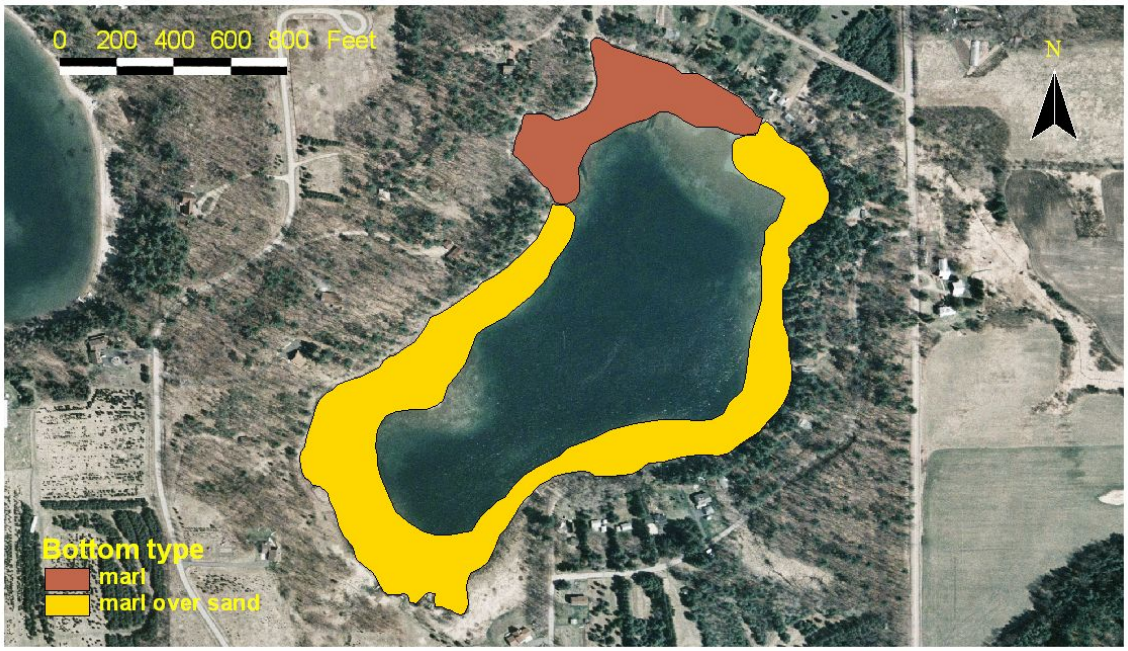

Figure7a. Littoral bottom map of Rhinehart Lake 6/22/03.

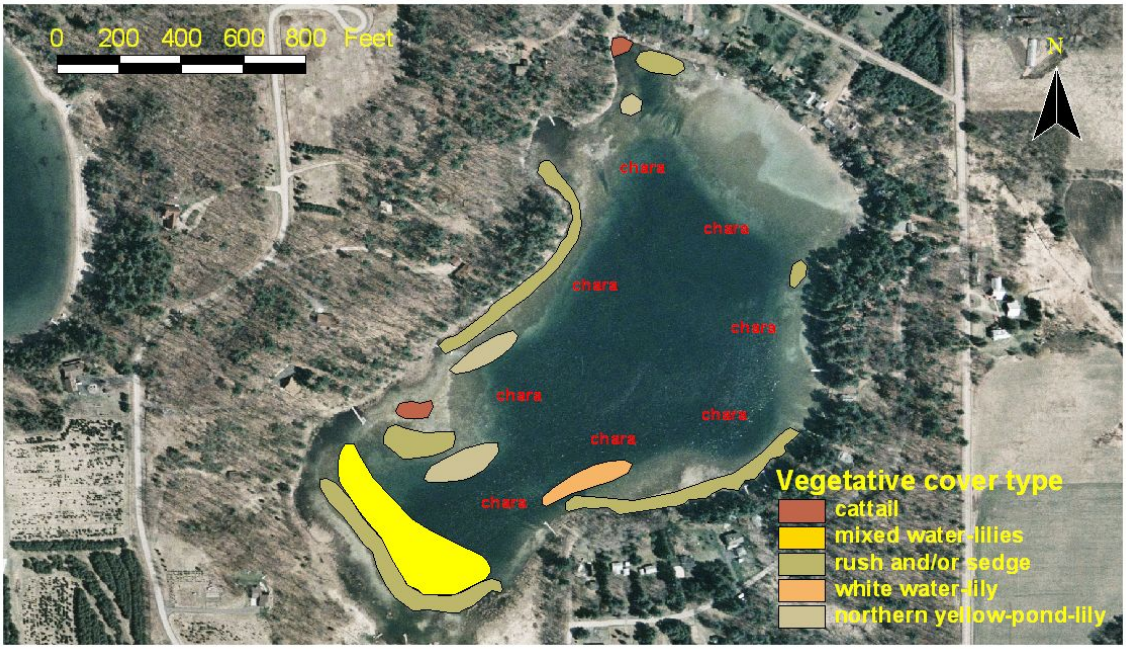

Figure 7b. Vegetative cover map of Rhinehart Lake 6/22/03.

Spring Lake

The Fishery

A total of 22 species of fish have been reported from Spring Lake since 1948 (Table 10).

Table 10. Species occurrence in Spring Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Brook Trout. 1964. **S**; 1982-1972.
Brown Trout. 1966, 1964. **S**; 1980, 1972.
Rainbow Trout. 1985, 1958, 1948. **S**; 2003-1998, 1996-1983, 1979.
Bluegill. 2003, 1985, 1960, 1959, 1948.
Pumpkinseed. 1985, 1960, 1959, 1948.
Green Sunfish. 2003, 1959.
Rock Bass. 2003, 1960, 1959, 1948.
Largemouth Bass. 2003, 1985, 1966, 1960, 1959, 1948.
Black Crappie. 2003, 1985, 1948.
Walleye. 1985.
Yellow Perch. 2003, 1985, 1959, 1948.
Iowa Darter. 2003, 1959.
Banded Darter. 1960, 1959.
Northern Pike. 2003, 1985.
White Sucker. 2003, 1959, 1948.
Sucker sp. 1964.
Bluntnose Minnow. 2003, 1960, 1959.
Golden Shiner. 2003, 1960.
Blackchin Shiner. 2003.
Brook Stickleback. 2003, 1960, 1959.
Banded Killifish. 2003.
Central Mudminnow. 2003.
Mottled Sculpin. 1960, 1959.

Spring Lake supports a warm water fishery and stocked cold water fishery. Fifteen species were found in 2002 and 2003 compared to 19 from historical records dating back to the 1940s (Table 2). Three newly documented species were found including blackchin shiner, banded killifish and central mudminnow. The sport fish community is dominated by bluegill, largemouth bass, and rock bass. All three of these species were more numerous and larger in size than in most other area lakes. The lake has been repeatedly stocked with brown, rainbow and brook trout, but none were found in the fall 2002-2003 survey. They undoubtedly are present at times as they are periodically caught by anglers. The lake has had little development, and other than the water level being raised by a low dam downstream about one mile on the outlet stream, it retains much of its natural

characteristics. Seven species previously documented over the years were not found in the present survey including the three trout species, walleye, banded darter, pumpkinseed, and mottled sculpin. There is no spawning habitat for walleye in this lake and the record was just one individual reported in 1985. It does not appear walleye were ever present in any numbers here. The pumpkinseed, last reported in 1987, has declined in many area lakes because of hybridization with bluegill, although no hybrids were found in Spring Lake in 2002 and 2003. The banded darter is a stream fish and may have been more abundant when fish could more freely move into the lake before the low dam on the outlet stream was built. The mottled sculpin is also a stream fish, but restricted to colder water and would not find suitable spawning habitat in a small lake. Several of these species and others could naturally find their way back into the lake through the outlet at high water or perhaps through the inlet, although this stream is very small and probably supports a low diversity of fish.

For a complete list of all fisheries data from Spring Lake in 2002 and 2003 including numbers caught, gear used and size distributions of sport fish refer to Appendix 8.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is almost entirely marl (Fig. 8a). The bottom is soft and will not support an individual wading. Although marl is a marginal spawning substrate, suitable areas exist in this lake for the largemouth bass, rock bass and bluegill to spawn as evidenced by their abundance. Woody debris and snail shells embedded in the marl are often successfully used as a spawning substrate for species that normally prefer sand and gravel. Much of the shoreline is shrub and tree-lined and down timber provides excellent permanent cover in several areas of the lake. Additional standing timber in the water that was killed by flooding from raising the stream outlet dam will provide additional habitat as it continues to fall into the water in coming years.

A luxuriant blanket of Chara covers the entire lake bottom and a few beds of water lilies provide surface cover (Fig. 8b). There are a few areas of emergent vegetation

represented by cattails and submerged grasses with rush in the shallows near the outlet stream, but spawning areas with abundant emergent vegetation for northern pike appear limited. Based on the present survey and past records, this species appears to have never been abundant in this lake.

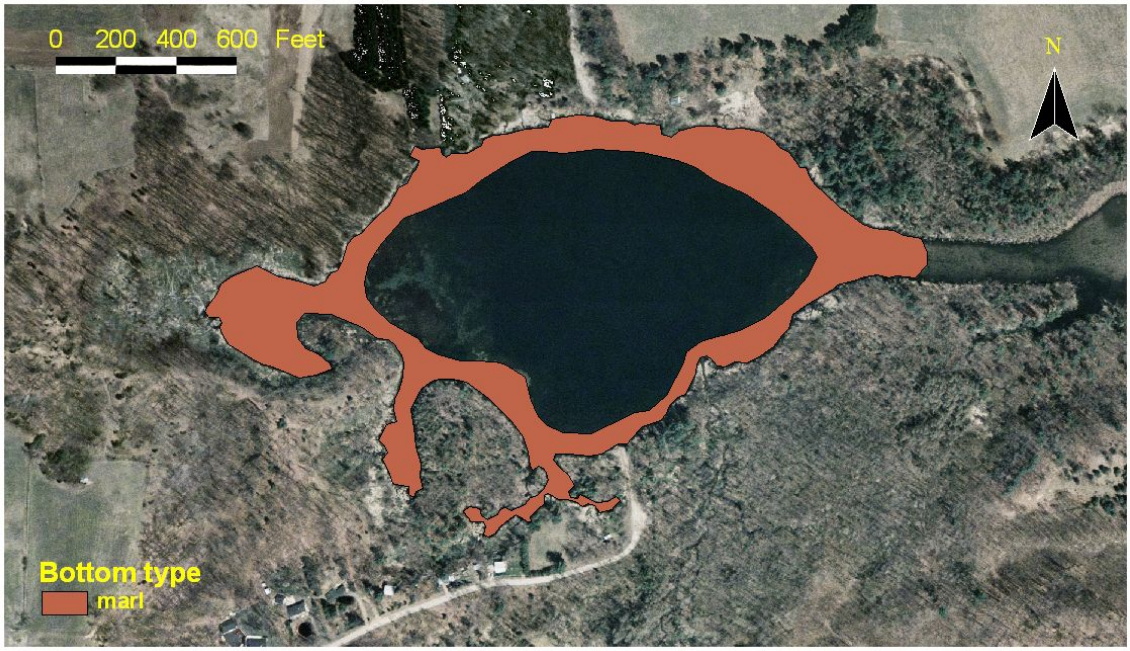

Figure 8a. Littoral bottom map of Spring Lake 8/3/03.

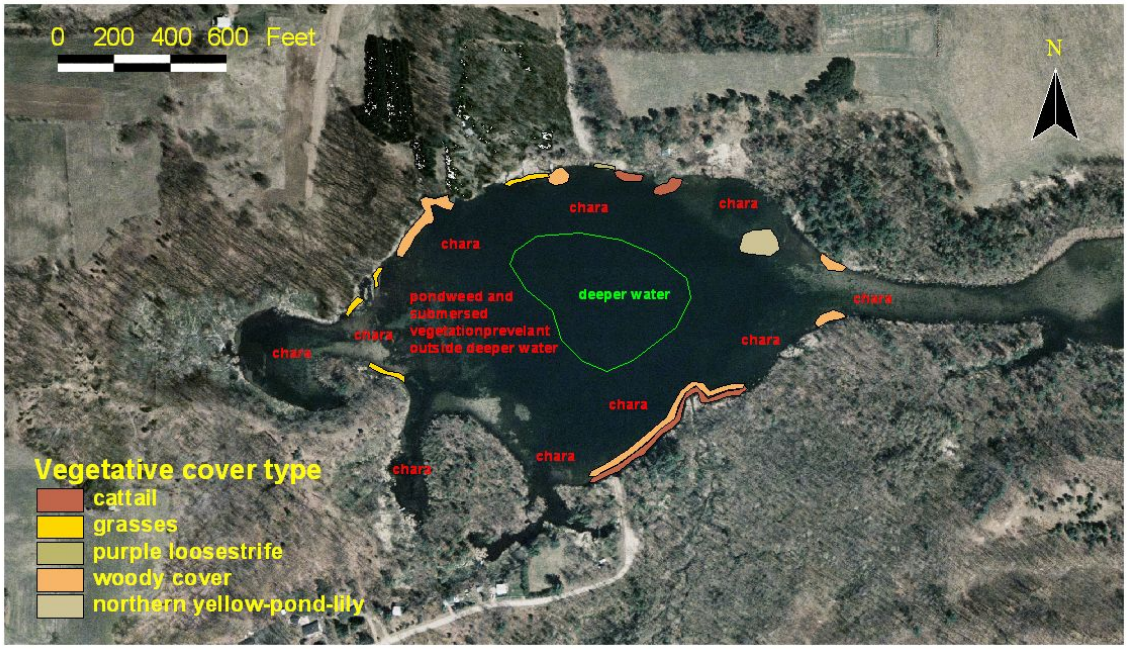

Figure 8b. Vegetative cover map of Spring Lake 8/3/03.

Thomas Lake

The Fishery

A total of 17 species of fish have been reported from Thomas Lake since 1961 (Table 11).

Table 11. Species occurrence in Thomas Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Brook Trout. **S**; 1980.
Brown Trout. 1966. **S**; 1973.
Rainbow Trout. 1968, 1966, 1965, 1961. **S**; 2003-1998, 1996-1981, 1979-1972, 1962.
Bluegill. 2003, 2002, 1970, 1968, 1967, 1965, 1961. **S**; 1962.
Bluegill/Pumpkinseed hybrid. 2003, 2002.
Pumpkinseed. 2003, 2002, 1970, 1968, 1967, 1965, 1961.
Green Sunfish. 1961.
Largemouth Bass. 2003, 2002, 1970, 1968, 1967, 1966, 1965, 1961. **S**; 1962.
Smallmouth Bass. 1965. **S**; 1962.
Yellow Perch. 2002, 1967.
Iowa Darter. 2002.
Northern Pike. 1968.
Yellow Bullhead. 2003, 2002.
Bullhead sp. 1965, 1961.
White Sucker. 1966, 1965.
Sucker sp. 1961.
Common Shiner. 1961.
Banded Killifish. 1961.

Thomas Lake supports a warm water fishery and is routinely stocked with trout. The lake presently holds only seven species of fish compared to 14 from historical records dating back to the 1950s (Table 2). Three newly documented taxa were found, including the Iowa darter, bluegill/pumpkinseed hybrids and yellow bullheads, although "bullheads" were previously commonly reported which could have been either black or yellow bullheads. The sport fish population is presently dominated by bluegill, largemouth bass and yellow perch. This lake has been subject to extensive management including removal of the entire native fish community. The lake was completely poisoned in 1957, reportedly an attempt to remove a stunted crappie population. So much toxaphene (now a banned pesticide) was reported to have been used that the water was still toxic to fish placed in water from the lake four months after treatment. The lake was poisoned again

in 1961 to kill all fish, probably to eliminate “bullheads” and “suckers” and restocked with bluegill, largemouth bass, smallmouth bass and rainbow trout in 1962. When the lake was sampled again in 1965 white suckers and bullheads were once more reported along with the remainder of the stocked species, but the stocked smallmouth bass were essentially gone and none have been reported since. The futility of this heavy-handed approach to fisheries management was beginning to be recognized about this time and no further fish removal efforts were reported on this lake, although unwarranted stocking for some species has continued. This lake has been stocked historically with trout, but there is no evidence that they can survive more than a few months because of high summer temperatures and low dissolved oxygen. This lake is probably the least suited of all Portage County lakes that now receive an annual allotment of trout and there is no biological reason that it should continue other than public expectation that it has been stocked in the past.

A greater percentage of species have been lost in Thomas Lake (59%) than in any other lake sampled, presumably an outcome of the fish removal efforts. Species lost or not documented in 2002 and 2003 include the trout species, northern pike, walleye smallmouth bass, green sunfish, white sucker, banded killifish and common shiner. There is very little habitat for the trout, walleye and smallmouth bass and these stocked species would not be expected to be self-sustaining. The Lake is bounded by high banks and has no inlets or outlets that could serve as natural corridors for movement of fish back into the lake. Because this lake appears to have been poisoned completely, probably before a complete survey had been completed, the original community of fishes cannot be entirely known.

For a complete list of all fisheries data from Thomas Lake in 2002 and 2003 including numbers caught, gear used and size distributions of sport fish refer to Appendix 9.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is mostly muck along the western shore with sand and detritus covered sand elsewhere (Fig. 9a). These sandy areas would probably be suitable for establishment of a population of blackchin, blacknose or bluntnose shiners should they be introduced. These species are present in several of the least impacted Portage County lakes and may have been present in Thomas Lake prior to poisoning and may have been overlooked as often happened in early sport fish based management surveys. Unlike bluegills, they would provide a forage base that could be controlled by largemouth bass. Their introduction would also result in a more natural fish assemblage typical of a small glacial lake.

Most of the open water in Thomas Lake is dominated by Eurasian water milfoil (Fig. 9b). In addition to aesthetic problems caused by this exotic plant, it provides such dense cover and protection from predators that it contributes to the problem of overpopulation by sunfish. The lake appears to be dominated by small bluegill. The western shore has an expanse of water lilies bordering beds of emergent vegetation along the shoreline. This appears to be an area where northern pike could spawn but they have only been occasionally found during surveys. With the extent of water milfoil coverage in this lake, northern pike would probably not be able to forage effectively and their fry would be heavily preyed upon by bluegill. Attention should be given to controlling this exotic plant and preventing its spread into other area lakes.

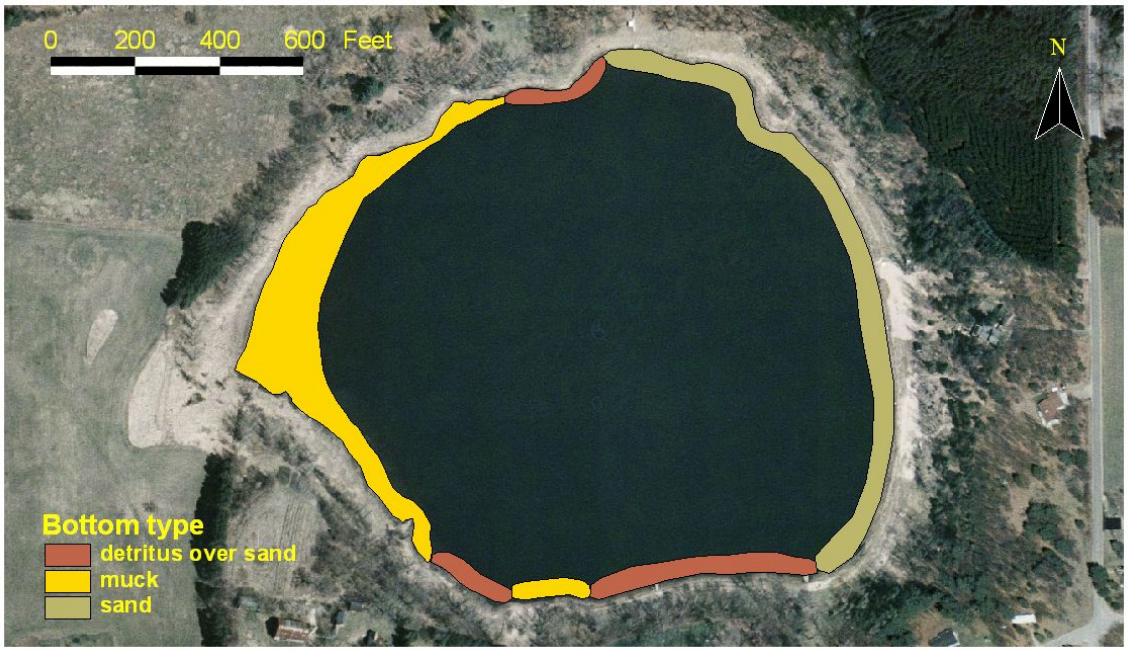

Figure 9a. Littoral bottom map of Thomas Lake August 2004.

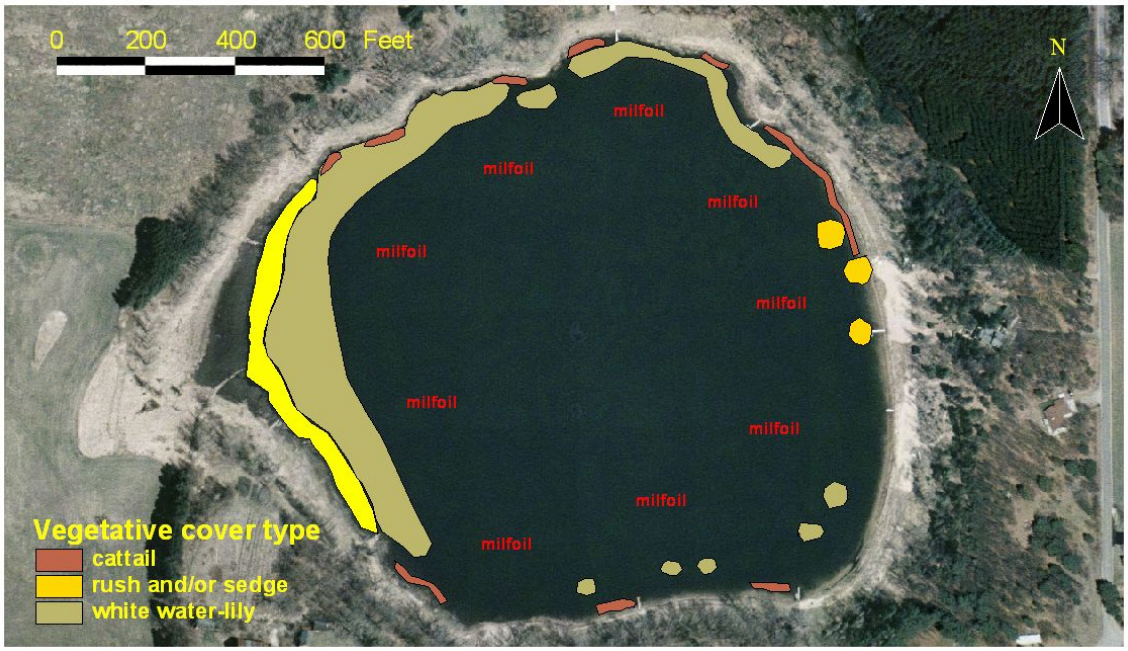

Figure 9b. Vegetative cover map of Thomas Lake August 2004.

Wolf Lake

The Fishery

A total of 11 species of fish have been reported from Wolf Lake since 1945 (Table 12).

Table 11. Species occurrence in Wolf Lake from the 2002/2003 study and WDNR records. Note: "S" indicates WDNR stocking record.

Bluegill. 2002, 1986, 1973, 1970, 1959. **S**; 1971-1963.
Bluegill/Pumpkinseed hybrid. 2002.
Pumpkinseed. 2002, 1986, 1973.
Rock Bass. 2002, 1986.
Largemouth Bass. 2002, 1986, 1970, 1959. **S**; 1969, 1965, 1961.
Crappie sp. 1959, 1956.
Walleye. 1986, 1973. **S**; 1976, 1971, 1961, 1958, 1956, 1953, 1945.
Yellow Perch. 2002, 1986, 1973, 1970, 1959. **S**;1967, 1961.
Northern Pike. 2002, 1986, 1973, 1970, 1959. **S**; 1971-1963.
Bullhead sp. 1986.
White Sucker. 1959.
Fathead Minnow. **S**; 1961.
Golden Shiner. 1959.

Wolf Lake supports a warm water fishery. The lake presently holds only seven species of fish compared to 10 from historical records dating back to the 1940s (Table 2). The only newly documented taxa were bluegill/pumpkinseed hybrids. As in Thomas Lake, this limited community is probably in part due to extensive management activities including whole-lake poisoning in 1961. The lake has also been subject to periodic winterkills. The sport fish population is presently dominated by bluegill, bluegill/pumpkinseed hybrids and largemouth bass. The lake had been repeatedly stocked with northern pike, bluegill, largemouth bass, yellow perch and walleye between 1961 and 1976. Although this lake provides little suitable habitat for walleye, stocked fish were reported to have produced five year classes of offspring by 1986. The entire population has apparently since disappeared. Presently, there is no spawning habitat for walleye in the lake, but higher water levels in the past may have inundated some additional sandy areas that are now well above the water level. Gravel is the preferred substrate for walleye spawning, but they have been reported to spawn over sand. Other species lost or undocumented in

Wolf Lake include bullhead species, white suckers and golden shiners. It is likely other non-game species were present in this lake, but not documented prior to poisoning. The lake has no outlet and thus no capacity for natural repopulation. Other than the manipulation of the fishery for anglers this lake has been yet largely unimpacted by development although several residential development schemes have been proposed in recent years.

For a complete list of all fisheries data from Wolf Lake in 2002 and 2003 including numbers caught, gear used and size distributions of sport fish refer to Appendix 10.

Bottom substrate, vegetative structure and critical habitat

Bottom substrate in littoral areas is marl and sand (Fig. 10a). Suitable substrate exists for spawning of largemouth bass and bluegill. Largemouth bass nests were concentrated in marl covered areas that were excavated down to woody debris. Woody cover is scarce and the area indicated along the north shore of the lake was well used as indicated by a concentration of largemouth bass nests. Spawning requirements for bluegill are less specific and the abundance of small bluegill habitat is not limiting. No representative species of the minnow family were found in Wolf Lake, undoubtedly eliminated by the chemical treatment. The sandy areas along the eastern shore may help sustain a native minnow assemblage more typical of other glacial lakes in the area should restoration be attempted. The lake water level appeared to have receded to near record lows leaving a 20-50 foot strip of largely unvegetated beach circling the lake. This condition was typical of most area seepage lakes in 2002 and 2003. Although the lake is surrounded by forest, presently there are no trees close enough to the water to provide cover should they fall. Trees that have fallen into that area now should be left in place as naturally rising water levels will eventually again cover this area.

Wolf Lake provides a diversity of vegetative cover types including beds of sedge and rush along the shore with pondweeds providing open water cover (Fig. 10b). The bottom in deeper areas is blanketed with dense beds of Chara. Spawning habitat for northern

pike is marginal given the low water levels, but with an additional 3-5 feet of water the now isolated bay at the western end of the lake would provide excellent spawning marsh habitat for this species.

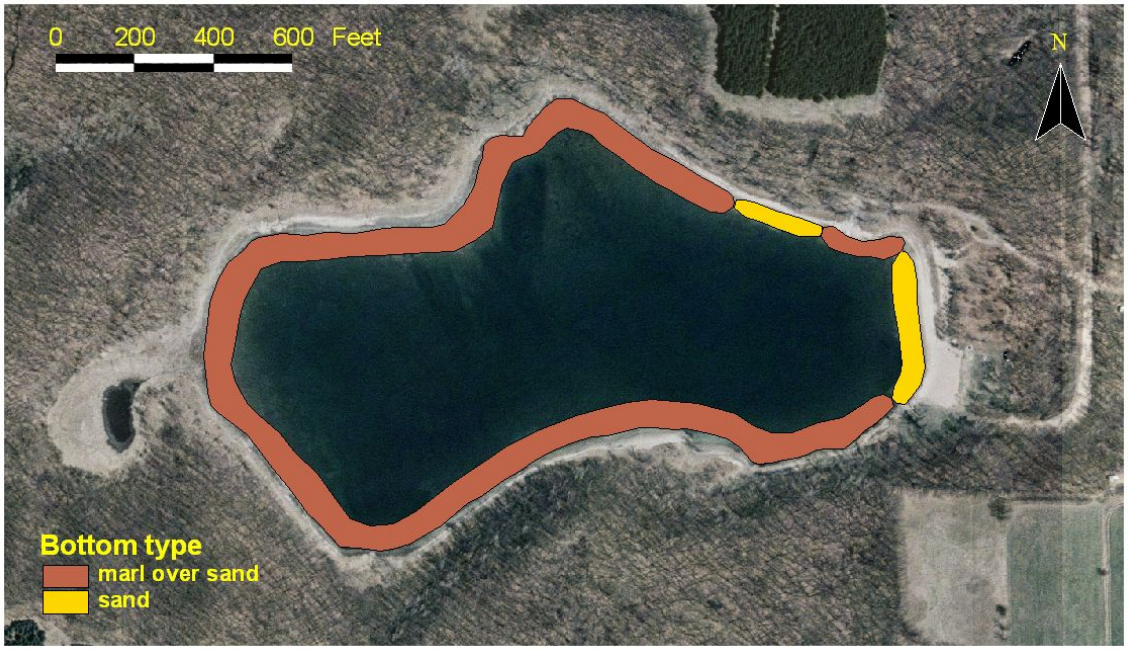

Figure 10a. Littoral bottom map of Wolf Lake 6/20/03.

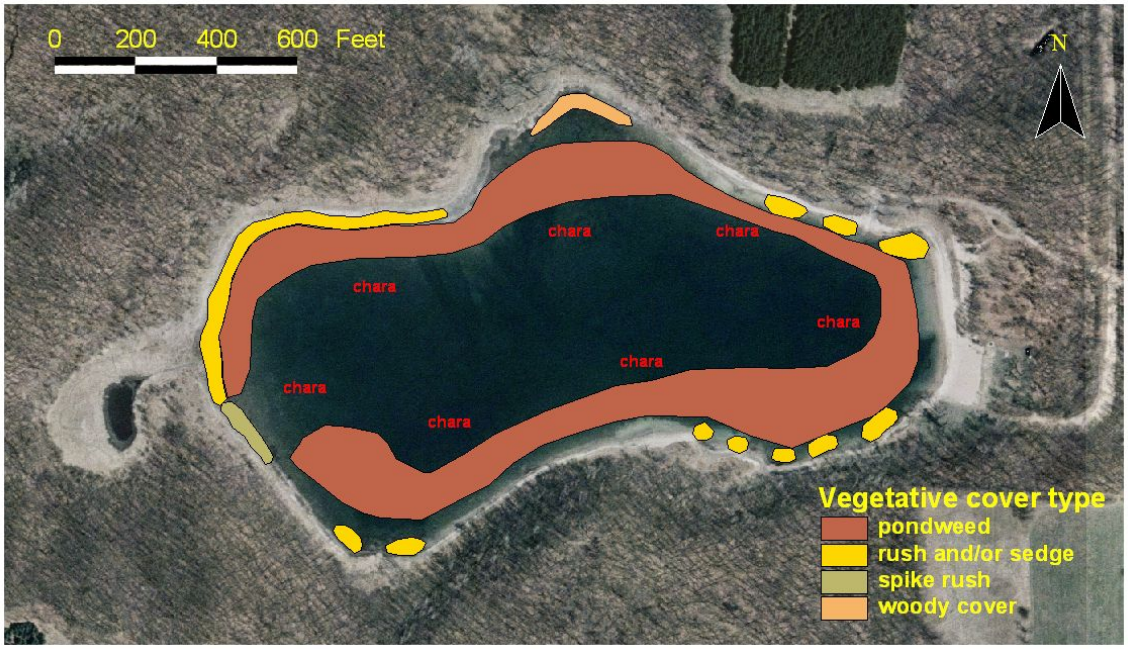

Figure 10b . Vegetative cover map of Wolf Lake 6/20/03.