Rice Lake and Echo Lake Environmental Information Review & Adaptive Management Plan (Iron County, Wisconsin)

Submitted to:

Wisconsin Lake Planning Grant Sponsor
Rice Lake Property Owners Association
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Rice Lake, 2005


Echo Lake, 2005


Painted Turtle


Bluegill


Pickerelweed

Date: December 31, 2005

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INTRODUCTION

In this document, we report findings of an environmental information review and baseline water quality monitoring on Rice Lake and Echo Lake in Iron County, Wisconsin. This document also forms the initial adaptive management plan for these lakes. This work was conducted under contract with the Rice Lake Property Owners Association. This organization is the sponsor for the Lake Planning Grant provided by the Wisconsin Department of Natural Resources (WDNR). Partners in this project include the Rice Lake Property Owners Association, the Echo Lake Association, the University of Wisconsin Cooperative Extension Service (UWEX), the WDNR, and White Water Associates, Inc.[1]

Rice and Echo Lakes are part of one larger system that is knit together by the Turtle River. Those interested in the health and conservation of these two lakes form a natural alliance because of that water connection. Other lakes in the system could also be included in a more comprehensive view of the river-lake-landscape ecosystem. Nevertheless, the focus of this document is Rice and Echo Lakes.

Property owners on Rice and Echo Lakes have invested in ecosystems. The reasons that they own property are linked to environmental quality. The economic value of their investment is linked to the health of the lakes and surroundings. If the ecological health declines, so does the economic value of the property. People other than landowners also have serious interests in having Rice Lake and Echo Lake be "all that they can be." The enjoyment for fishermen, wildlife watchers, swimmers, and other recreationists has a basis in environmental quality. Iron County's economy is based in part on tourism and healthy lakes attract tourists as well as new residents.

Beside this section (Introduction), this document is organized in four principal sections: Study Area, Methods, Results and Discussion, and Adaptive Management For Rice And Echo Lakes. Six appendices complete this document. Appendix A contains maps. Appendices B and C respectively contain excerpts from the Town of Mercer comprehensive plan and shoreland guide. Appendix D contains Property Owner Surveys conducted by UWEX. Appendix E contains the WDNR Sensitive Area Survey Report For Echo Lake. Finally, Appendix F contains a letter written by resident Raymond Johnson who spent his first year on Echo Lake in 1917.

1 *White Water Associates, Inc., an independent ecological consulting firm and analytical laboratory from the western Upper Peninsula of Michigan, conducted this study and prepared this report. White Water has significant experience and expertise in aquatic and riparian ecology and chemistry in the Great Lakes states.*

STUDY AREA

Echo Lake and Rice Lake are located in the Town of Mercer in Iron County, Wisconsin within the Turtle River system (see Figure 1). The Turtle River enters Echo Lake at its northeastern terminus and exits the lake on its western edge. The Turtle River flows about one-quarter mile before opening up into Rice Lake at the southeastern part of the lake. About one-half mile due west of the entry point, the river exits Rice Lake and flows about two miles before entering Pike Lake. The Turtle River is navigable upstream and downstream of both lakes, although a rapids exists on the river between the two lakes. According to "Surface Water Resources of Iron County" (WDNR 1970), the Turtle River is a medium hard water stream having slightly alkaline, light brown water. It is a tributary to Lake of the Falls and the Flambeau Flowage. It is a warm water stream. The stream gradient is about three feet per mile.

Echo Lake is located at T43N, R3E, Sections 24 and 25. Its area is 220 acres with a reported maximum depth of twenty-five feet. Echo Lake is a long and narrow with its long axis oriented north-south. It is a little less than one and one-half mile in length and has an average width of about one-third mile. It shoreline length is about 4.3 miles. Echo Lake has a shoreline development factor[2] of 2.22. Echo Lake has an improved public boat landing with twelve parking spaces available as well as an unimproved access site. Residential development along the shoreline is moderately heavy, although some undeveloped areas exist, especially in wetlands areas. According to lake association members, about half of Echo Lake has municipal sewer service (east and south shores). The entire west side and north end still rely on septic systems some of which are close to shore and quite old. Echo Lake was the first of the Mercer area lakes to be populated (the community known as "Old Mercer" was built on Echo Lake).

Rice Lake is located at T43N, R3E, Sections 23, 24, 25, and 26. It is 125 acres in size and has a reported maximum depth of twenty feet. It has a shoreline length of about 3.8 miles and a shoreline development factor of 2.43. It has one undeveloped public access site. The development of this lake is moderately low consisting of residential homes, however an increase in development has occurred in recent years.

2 *The shoreline development factor (SDF) is the ratio of the length of the shoreline to the length of the circumference of a circle of area equal to that of the lake. The SDF is an indicator of littoral zone processes on the lake with an SDF of 1.0 describing a perfect circle. As the value of this index increases there will be greater irregularity of available shoreline in relation to water area. The greater relative amount of littoral zone and associated shoreline is usually indicative of greater biological productivity. The SDF information comes from "Surface Water Resources of Iron County, Wisconsin Department of Natural Resources, 1970, 191 pages.*

METHODS

The work effort resulting in this document took place during 2005, including an initial meeting with the lake associations and two bouts of fieldwork at the lakes (one in July and one in September). Six goals guided the overall effort: (1) gather and review existing information about Echo and Rice Lakes and their surroundings, (2) augment existing water quality data with 2005 water sampling, (3) identify issues and opportunities based on an assessment of existing and new information, (4) integrate new and existing information to formulate an assessment, and (5) prepare an initial adaptive management plan that establishes a framework for lake planning for Rice and Echo Lakes and serves as a vehicle for continued cooperation between landowners and other stakeholders in these two closely related lake ecosystems.

We obtained existing information on Rice and Echo Lakes on topics such as water quality, aquatic and riparian vegetation, fish and wildlife, rare organisms and habitat, non-native organisms, biologically sensitive or unique areas, and pollution sources by contacting resource agencies and lake volunteers. During 2005 water sampling bouts we became familiar with overall characteristics of the lakes and watershed as well as a made a general evaluation of obvious features and threats to the lakes. White Water Associates conducted work on Rice Lake in 1995 under contract with the property owners association. The report resulting from the 1995 work was a valuable source of baseline information about Rice Lake.

During summer and fall of 2005, we conducted two bouts of field-monitoring and lake volunteer education on Echo and Rice Lakes. On Rice Lake, we selected one location for water quality sampling at a deep point in the lake (N046.18787°, W090.07727°). This spot was in the northern portion of the lake about 0.3 mile southwest of Bear Creek. At Echo Lake we selected two locations for sampling. The first was located about 0.5 mile from the southern terminus of the lake and near the east shore (N046.17712°, W090.05951°). The second was near the entry of the Turtle River in a particularly deep hole (N046.18967°, W090.05737°). Dr. Dean Premo, Senior Ecologist for White Water Associates conducted the fieldwork in 2005 with assistance from lake volunteers from both Rice and Echo Lakes. For each field bout, pontoon boats and motors were made available for sampling. The boat owners provided operated the watercraft.

At the water quality sampling points, we anchored the boat with a long line in order to conduct water quality observations and obtain water for testing at the laboratory. We measured water transparency using a Secchi disk. We measured specific conductance and pH of the water using a handheld Myron L Ultrameter^{TM} 6P. We also measured dissolved oxygen and temperature

(in the form of a depth profile) using a handheld YSI Model 51B meter. Each of the instruments used during the study was done so in accordance with the manufacturers' suggested methods.

Since we observed temperature and dissolved oxygen stratification, we collected water samples from both the epilimnion (surface) and hypolimnion (bottom). A Kemmerer sampler was used for collecting hypolimnion samples. Water samples were tested by the Water and Environmental Analysis Laboratory (University of Wisconsin Stevens Point) for pH, conductivity, alkalinity, total hardness, calcium hardness, ortho-phosphorus, total phosphorous, ammonia nitrogen, nitrate-nitrite nitrogen, total Kjeldahl nitrogen, chloride, sulfate, sodium, potassium, turbidity, and color. A chlorophyll "a" sample was collected as an integrated sample of the photic zone (two times the Secchi disk transparency depth).

During both summer and fall sampling visits to Rice and Echo Lakes, Dr. Premo demonstrated and described all field sampling techniques and measurements to lake volunteers.

RESULTS AND DISCUSSION

In this results and discussion section we present and discuss findings and observations in fourteen subsections: (1) Land Use, (2) Views from the People, (3) Aquatic Habitat, (4) Aquatic Vegetation, (5) Riparian Habitat and Aesthetics, (6) Fishes, (7) Wildlife, (8) Unwanted Invaders, (9) Potential Sources of Pollution, (10) Historical Water Quality, (11) 2005 Water Quality Monitoring: Field Measures, (12) 2005 Water Quality Monitoring: Chemistry, (13) Important Ecosystem Features, and (14) Possible Threats.

Land Use

Residential development around Echo Lake is fairly dense. The town of Mercer is part of the extended riparian zone making the human development "footprint" at the south end of Echo Lake quite large (see Figure 1 Appendix A). Echo Lake is classified as a Class 1 lake in Iron County's two-tiered lake classification system. This is the least restrictive category using the minimum shore land setback required by the State of Wisconsin. According to Echo Lake riparian owners, there are ninety-five residences on the lake. Despite the density of riparian homes on Echo Lake there appears to be a good quality riparian zone of upland forest and some wetlands (approximately 55 adjoining wetland acres according to WDNR Surface Water Resources of Iron County). This natural vegetation gives the impression that Echo Lake is less developed than it actually is. Old and possibly faulty septic systems at the older residences on Echo Lake are a concern for lake health.

The residential development around Rice Lake is less than Echo Lake, but has seen increased number of residences in the last several years through subdivision and sale of formerly larger land tracks. Currently, there are twenty-three residences, seven of which have full-time occupancy. More of this development on the lake is likely to occur. Rice Lake is classified as a Class 2 lake providing relatively more restrictive building requirements and greater protection to the aquatic resource than the Class 1 designation of Echo Lake. The riparian area around Rice Lake consists of healthy appearing upland forest and wetlands (approximately 45 adjoining wetland acres according to WDNR Surface Water Resources of Iron County). Old and possibly faulty septic systems at the older residences on Rice Lake are a concern for lake health. North of Rice Lake there is a commercial cranberry production operation that discharges into Bear Creek. Effluent from the cranberry operation can enter Rice Lake through Bear Creek.

From the perspective of the immediate landscape that includes both lakes, the land use is quite diverse. Figure 1 (Appendix A) is a land use map. In 2005, the Town of Mercer adopted a "Comprehensive Management Plan" that contains language pertaining to the stewardship of aquatic ecosystems. Excerpts germane to stewardship of Rice and Echo Lakes are included herein as Appendix B. In addition, the Town of Mercer published a "Shoreland Development and Management Guide" in 2002. Excerpts apropos to Echo and Rice Lakes stewardship are presented herein as Appendix C.

Views from the People

In 2005, the University of Wisconsin Cooperative Extension Service worked with the two lake associations in the development of an opinion survey for property owners on Rice Lake and Echo Lake. The purpose of the survey was to determine the perspectives of the people potentially most connected to these lakes. These surveys are included as Appendix D in this report.

Aquatic Habitat

Echo Lake is a 220-acre lake with a moderately irregular shoreline of somewhat over four miles in length. It is reported to be twenty-five feet deep. About 13% of the lake surface area is less than three feet deep. According to the WDNR Surface Water Resources of Iron County, Echo Lake littoral zone substrate is dominated by sand (65%) followed by rubble (28%), boulder (5%), and some muck. Echo Lake is one in a series of lakes on the Turtle River system with the Turtle River entering and exiting the northern basin of Echo Lake from Oxbow Lake and flowing on to Rice Lake. There are no other inlets or outlets to Echo Lake. According to WDNR fish monitoring the fish community in Echo Lake has remained relatively stable over the years. Aquatic vegetation is fairly abundant and diverse in the littoral zone and forms a primary habitat structure. Large woody material is not abundant along the edges of the lake but according to a WDNR 2003 Sensitive Area Survey Report (see Appendix E) some areas have large woody cover at a density of one to two pieces per 100 feet of shoreline. According to lake association members log fish cribs were placed in Echo Lake in 1965. In 2001 or 2002 an additional forty-one fish cribs were installed in about 13 feet of water. Water levels in the lake fluctuate normally

with typical seasonal and annual variability. A WDNR Lake Survey Map for Echo Lake is displayed as Figure 2 (Appendix A).

A WDNR team composed of wildlife biologist Bruce Bacon, water management specialist Dan Houston, water quality biologist Craig Roesler, and fisheries biologist Jeff Roth conducted a sensitive area survey on Echo Lake on August 25 and 26, 2003 using the WDNR guidelines for sensitive area surveys. Four sensitive areas were designated in the lake. These were mapped and described in the report included in this document in Appendix E.

Rice Lake is a 125-acre lake with a fairly irregular shoreline of nearly four miles in length. It has a reported maximum depth of about twenty feet. About 18% of the surface area is less than three feet deep. According to the WDNR Surface Water Resources of Iron County, Rice Lake littoral zone substrate is dominated by muck (75%) with gravel and sand making up the remainder. Rice Lake has two inlet streams with the larger flow being contributed by the Turtle River. Bear Creek is a smaller warm water stream that enters Rice Lake at the north end. Aquatic vegetation is abundant in the lake and forms the primary habitat structure. Large woody material is not abundant along the edges of the lake. Water levels in the lake fluctuate normally with typical seasonal and annual variability. A WDNR Lake Survey Map for Rice Lake is displayed as Figure 3 (Appendix A).

Aquatic Vegetation

According to riparian owners, Rice Lake has experienced an increase in abundance and density of aquatic plants over that last several years. In the 1970 WDNR Surface Water Resources of Iron County description of Rice Lake it describes aquatic vegetation as "moderate in density and in some places dense." This was the observation of White Water Associates scientists during a 1995 water quality study of Rice Lake. Nevertheless, and 1973 WDNR fisheries report documented that the public was complaining about "abundant aquatic weed growth in the large bays." In 2004 and 2005 the lake owners association contracted for mechanical aquatic vegetation harvesting for the purposes of improving boat navigation and access to boat docks for recreational boats. In 2004, eleven tons of plants were removed. The 2005 effort yielded a smaller harvest (five tons). Non-native plants have not been documented in Rice Lake, although a systematic survey of aquatic vegetation survey has not been conducted. An invoice from Schmidt's Landscaping & Nursery Inc. (mechanical plant harvester) to the Rice

Lake Home Owners Association stated that curly-leaf pondweed and Eurasian water milfoil were observed (both are non-native). During our water quality monitoring on Rice Lake on July 20, 2005, we collected and identified nine species of native aquatic plants including *Ceratophylum demersum* (Coontail or hornwort), *Elodea Canadensis* (common waterweed), *Najas flexilis* (slender naiad), *Myriophyllum sibiricum* (northern water milfoil), *Utricularia geminiscapa* (twin-stemmed bladderwort, a Wisconsin Special Concern species), *Potamogeton zosteriformis* (flat-stem pondweed), *P. richardsonii* (clasping-leaf pondweed), *P. robbinsii* (fern pondweed or Robbins pondweed), and *P. vaseyi* (Vasey's pondweed, a Wisconsin Special Concern species).

Echo Lake has also experienced changes in aquatic plant abundance as observed by riparian residents. According to long-time resident Jack Jacobs, during the 1960's and 1970's there was no aquatic vegetation growing on the east side of the lake and this is not the case today. Another long-time observer of Echo Lake is Raymond Johnson who spent his first year on Echo Lake in 1917. He states that the vegetational changes that he has observed in Echo Lake in his 80+ years have been substantial first with the loss of wild rice beds and later with the replacement of the yellow water lily with the white water lily. Mr. Johnson's 1999 letter with many valuable observations about Echo Lake is in Appendix F. According to lake association members, the south end of the lake has a higher growth of aquatic vegetation and is getting to be at a nuisance level. So far no aquatic plant management has occurred in Echo Lake. Non-native plants have not been reported in Echo Lake, although no systematic aquatic vegetation survey has been conducted. During our water quality monitoring on Echo Lake on July 20, 2005, we collected and identified five species of native aquatic plants including *Ceratophylum demersum* (Coontail or hornwort), *Elodea Canadensis* (common waterweed), *Potamogeton epihydrus* (Ribbon-leaf Pondweed), *P. amplifolius* (Large-leaf Pondweed or "musky weed"), *Ceratophylum echinatum* (spiny hornwort, a Wisconsin Special Concern species).

As part of a WDNR Sensitive Area Survey on Echo Lake (Appendix E), thirty-two species of aquatic plants were identified in four sensitive areas on the lake. All were native plants and exhibited a good mixture of emergent, floating leaf, and submergent plants. The sensitive area survey report described the overall aquatic plant densities in Echo Lake as moderate although some areas (especially shallow bays) exhibited a higher density. The maximum depth of rooted aquatic plant growth was found to be about eight feet.

Given the importance and abundance of aquatic plants in both Echo and Rice Lakes, it is important that systematic aquatic vegetation surveys following WDNR protocol be conducted on

both of lakes. This is essential to establish a true baseline against which change can be measured and a foundation on which to base good decisions regarding aquatic plant management.

Riparian Habitat and Aesthetics

The natural upland and wetland areas surrounding the northern portion of Rice Lake consist of a mixture of upland hardwoods, tag alder and swamp conifer lowlands, and some ericaceous (bog) shrubs. This zone of vegetation extending back from the lake for several hundred feet is the riparian ecosystem. In much of the lake's perimeter the ground rises quickly from the lake edge leaving only a narrow wetland fringe. The upland hardwoods are quite diverse and include some good sized white and red pine. Vertical structure is diverse in the riparian ecosystem with good vegetation layers (herbaceous, deciduous and coniferous shrub, 15-25 foot young trees of several species, and an upper canopy of hardwoods and conifers). Boreal wetland vegetation (spruce, birch, tag alder and other bog species) dominates the southern part of Rice Lake. Overall, the diverse riparian area gives a northwoods character to Rice Lake. The moderate development that has occurred on the lake has not fragmented this riparian habitat to a great extent.

Echo Lake has a similar diverse riparian habitat although a longer history of development and human use on the lake has tended to fragment this habitat to a greater extent than observed on Rice Lake. The wetland areas (bog-swamp habitat) on Echo Lake tend to be confined to the northern tip of the lake and near the entry of the Turtle River. A variety of vegetation and vertical structure is evident all around the lake. The 2003 Sensitive Area Survey Report (see Appendix E) rated the natural scenic beauty of one of the four identified sensitive areas as "outstanding."

From a landscape perspective, both Rice and Echo Lakes are in an area that is dense with others lakes and streams. This density is such that almost the entire terrestrial matrix is a riparian zone. Riparian ecosystems are known to be diverse of species and productive of plants and wildlife. This haven for native biodiversity conveys unique characteristics to both Echo Lake and Rice Lake. Appendix A contains maps of forest cover (Figure 4), wetlands (Figure 5), and topography (Figure 6) for the landscape containing Rice and Echo Lakes.

Fishes

Various WDNR reports and correspondence are the source of information for this discussion of the fishes in Echo Lake. Species include walleye, largemouth bass, smallmouth bass, muskellunge, northern pike, yellow perch, rock bass, bluegill, pumpkinseed, black crappie, black bullhead, white sucker, redhorse, and burbot. Walleye, musky, and northern pike are the predominant gamefish species. Active fisheries management on Echo Lake began with a fish stocking in 1950. Alternate year stocking of muskellunge and walleye occurred from 1950 through 1976. Fisheries surveys were conducted in 1958, 1972, 1978, and 1999. Fall recruitment assessments were performed during those surveys and in 1989-1991 and 1996-1999. Musky and walleye management has been the focal point. After 1978 managers discontinued walleye stocking and began an annual musky stocking program. All stocking was discontinued in 1996.

The fish population in Echo Lake has remained relatively stable over time. Walleye and northern pike are the primary gamefish species, but smallmouth bass and musky also offer fishing opportunities. Walleye numbers are below what is considered optimal, despite good habitat, lake size, and productivity. Panfish and other forage fish numbers may be too low to support better growth rates in walleyes. Enhancement of habitat for these food fishes was recommended to increase their availability. Black crappie and bluegill offer the best panfish opportunities, but enhanced cover in the form of log cribs were recommended to increase panfish abundance. The WDNR Fisheries Management Program for Echo Lake has three objectives: (1) improve walleye density, size structure, growth, and natural reproduction; (2) improve panfish abundance while maintaining above average growth rates; and (3) maintain other existing gamefish population features. Strategies to achieve these objectives include (1) walleye stocking until appropriate natural recruitment is evident; (2) install whole-tree and/or log fish cribs in combination with panfish stocking; and (3) basic management for remaining primary gamefish species. The Echo Lake Sensitive Area Survey Report (see Appendix E) identified four sensitive areas in Echo Lake that, among other values, were important for fisheries.

Various WDNR reports and correspondence are the source of information for this discussion of the fishes in Rice Lake. Species include walleye, largemouth bass, smallmouth bass, muskellunge, northern pike, yellow perch, rock bass, bluegill, black crappie, pumpkinseed, black bullhead, white sucker, redhorse, and burbot. Active fish management has been occurring in Rice Lake since 1951 when frequent plantings of muskellunge and walleye commenced and continued through 1973 (14 plantings during 22 years). After that stocking was discontinued

(WDNR cited lack of public access as the reason). In 1972, Rice Lake was surveyed with electrofishing and fyke nets. During that survey gamefish included walleye, muskellunge, northern pike, and smallmouth bass. It was determined that natural reproduction of walleye was successful in maintaining the population (citing excellent fingerling and yearling representation). This survey also indicated that muskellunge and northern pike were common in Rice Lake (muskys ranged from 8.5 to 56 inches). Limited natural reproduction of smallmouth bass was indicated. Black crappies were the most abundant panfish in the 1972 survey. Forage species such as common shiners, golden shiners, and creek chubs were common. Redhorse and white suckers were numerous and of large size. In 1985 and 2001, the WDNR conducted fish survey work using fyke nets (1985 only) and electrofishing techniques with consistent results.

Wildlife

The diverse vegetation in the riparian ecosystem of Rice Lake likely provides habitats for many species of vertebrate and invertebrate animals. As long as this ecosystem diversity is maintained, a good diversity of resident, North American migrant, and Neotropical migrant birds will use this area for breeding and/or migration stopover. The bog-swamp habitat on the south portion of the lake adds to the diversity by providing unique habitat for plants and animals. We observed common loons on the lake during both of our sampling bouts in 2005. Several supercanopy trees in the riparian area provide good perches for raptors including bald eagles. A bald eagle nest has been active on the east side of the lake. Freshwater mussels were observed during our sampling bouts. We also observed painted turtles, mallards, and blue heron.

Except for a greater human presence, Echo Lake and its surroundings has similar habitat for vertebrate and invertebrate organisms. Common loons were observed during 2005 visits. Bald eagle nests in the vicinity of Echo Lake have been active in the past and adults use the lake for fishing. Freshwater mussels and freshwater sponges were observed. The 2003 Echo Lake Sensitive Area Report (see Appendix E) cites that an osprey nest has been active on the north end of Echo Lake for many years and that bullfrogs and green frogs are common on the lake's edges and wetland habitats.

Unwanted Invaders

Non-native invasive species of plants and animals are a major concern in inland lakes in Wisconsin. For the most part Echo Lake and Rice Lake have avoided these "exotic" species. No known non-native aquatic plants occur in either lake.

The WDNR has confirmed that the banded mystery snail has colonized Echo Lake. The banded mystery snail (*Viviparus georianus*) is native to the southeastern United States but considered non-native in Wisconsin. It is capable of large population booms with potential negative consequences for other organisms within the ecosystem. Some Echo Lake residents have described minor population booms of this species. Banded mystery snails occur in some other Wisconsin. The probable mechanism for introduction of the snail into lakes is by way of aquarium owners who sometimes empty the contents of aquaria into lakes rather than dispose of them properly. Snails (including the banded mystery snail) can be purchased in pet stores and are used in cleaning aquaria glass.

Not far north of Rice and Echo Lakes is the Gile Flowage. Another exotic species called the Spiny Water Flea (*Bythotrephes cederstroemi*) was discovered in the Gile Flowage in 2003 as part of a 64-lake survey conducted by the Limnology Center at Trout Lake (University of Wisconsin). This is the first and only known occurrence of the animal in a Wisconsin inland lake. It is not known how long spiny water fleas have been in the Gile Flowage. Concern exists that this species may colonize other lakes through transport on fishing equipment. Spiny water fleas are predatory crustaceans. They eat smaller native planktonic crustacea such as *Daphnia* and *Ceriodaphnia*. The native planktonic crustacea are the food source of juvenile fish and adult sunfish and bluegills. Great numbers of the spiny water fleas could crop the forage base for these fishes and render the ecosystem less productive of fish species. Spiny water fleas are capable of rapid population increases and their long spiny tails make them difficult for small fishes to eat. In fact, their sharp spines can pierce the lining of a fish's gut and cause potential harm to individual fish. Informational fliers advising lake users of the potential spread of spiny water fleas have been posted at each of Gile Flowage's boat landings and in local bait and boating stores.[3]

3 *Additional info can be found at http://limnology.wisc.edu/personnel/pieter/Hidden%20Stuff/Bytho.htm and http://www.wnrmag.com/supps/2005/jun05/edge.htm#2*

Potential Sources of Pollution

Several potential sources of non-point source (NPS) pollution for the Rice Lake and Echo Lake. Since both lakes share a common source of water (the Turtle River), they also share this conduit as a potential source of pollution. In the case of Rice Lake, Bear creek is another possible source for unwanted materials and/or organisms to enter Rice Lake. Erosion and deposition of sediment from roadways and earth exposed during development projects is a potential source of NPS. Erosion and sediments can also originate from sloping terrain near the lakes, although in the cases of both Echo Lake and Rice Lake slopes in the immediate vicinity are not severe and are well-vegetated (see Appendix A, Figure 7 for a map of slope). Streams have potential to carry loads of sediment that emanate from bank erosion or poorly constructed stream crossings. Sediments that are mobilized in the lakes can deposit on spawning habitat and degrade the extent and quality of these areas.

NPS pollution could also emanate from runoff of sediment and nutrients from agricultural or forestry practices, although given the landscape and topography these are of minimal consequence (although see below for a discussion of commercial cranberry production). In rare instances spills of fuel or other materials carried on nearby roads could drain into the lakes. Runoff of oils and grease from roadways is also a possibility as is spillage of fuels from watercraft.

Airborne pollutants arising from distance sources can fall into Rice and Echo Lakes through particulate matter, rain, and snowfall. This is a potential source for acid precipitation and even metals like mercury.

Biological pollution, that is the introduction of non-native species, also has potential to impact Rice and Echo Lakes. The banded mystery snail is an example of a species that has already invaded Echo Lake. Other species with high potential for introduction are Eurasian milfoil, purple loosestrife, and spiny water flea. These organisms could also come from lake and river sources upstream on the Turtle River and (in the case of Rice Lake) Bear Creek.

Rice Lake receives waters from Bear Creek that have been used in commercial cranberry production operation located north of Rice Lake. Cranberry production requires large volumes of water at different times during the season. Both phosphorous and nitrogen are used in cranberry production, but typically in fairly small amounts. Various pesticides and fungicides are also used. These materials potentially enter Rice Lake through Bear Creek.

The existing sediments of both Rice Lake and Echo Lake are potential sources of pollutants that have entered the aquatic system in the past (sometimes distant past) and are now contained in the sediment. For example, according the Raymond Johnson's letter (see Appendix F), Echo Lake has been the recipient of "significant quantities" of "several of man's effluents." These consisted of "soapy discharges from Ball's store and Fed Lee's barber shop (where the school gym now is), and the nitrogen-rich seepage from many septic tanks and fields around the lake." In addition, a large sawmill at the south end of the lake dumped sawdust in large quantities into the lake. Nutrients, metals, and other pollutants could still reside in the sediments and possibly become mobilized by mechanical action of boat engines and waves.

Historical Water Quality

In 1995 White Water Associates, Inc. was contracted to conduct some basic limnological work on Rice Lake in association with a proposed development on the lake. The measurements from 1995are summarized in Table 1.

Table 1. Water Quality Measurements Taken on Rice Lake on August 30, 1995.

Location	Temp (°C)	PH (SU)	Dissolved Oxygen	Conductivity (umhos/cm)	Total Phos-phorus (mg/L)	Nitrate-Nitrite Nitrogen (mg/L)	Alkalinity (mg/L)
Rice Lake Surface	21.0	7.1	6.7	99	0.003	Non-detect	50
Rice Lake Bottom	10.0	7.1	0.2	150	0.027	Non-detect	68
Bear Creek	20.5	6.6	5.7	104	0.055	Non-detect	55
Turtle River upstream of lake	24.0	7.4	7.8	97	Non-detect	Non-detect	45
Turtle R. down-stream of lake	23.0	6.9	8.2	96	Non-detect	Non-detect	45

On August 30, 1995 the Secchi disk transparency was measured at 1.5 meters (about 5 feet). The lake was stratified (temperature and dissolved oxygen). The pH measures indicated neutral conditions and the alkalinity indicated that the lake was fairly well-buffered against acidification. Rice Lake was in a eutrophic category based on the 1995 measures and indications were that it was a phosphorus-limited system.

Rice Lake has undergone water quality sampling and analyses for basic limnological parameters since 1997 through lake sampling by volunteers. The University of Wisconsin

Stevens Point Environmental Task Force Lakes Program provides periodic reports of these data (summaries presented in Table 2). The water chemistry over this period of time has not shown any dramatic trends.

Table 2. Water Quality Measures on Rice Lake 1997 through 2005.

Date	04/05	04/04	05/03	05/02	04/01	11/00	11/99	11/98	11/97	05/97	MEAN
pH (SU)	7.63	7.80	7.62	7.02	7.17	7.67	7.65	7.55	7.10	6.04	7.3
Conductivity (umhos/cm)	87	55	68	44	56	100	105	101	69	28	68
Alkalinity (mg/L CaCO3)	40	28	40	20	28	55	48	48	31	13	35.1
Magnesium (mg/L)	13.0	8.0	11.0	13.0	4.0	24.0	12.0	14.0	--	8.0	11.9
Calcium (mg/L)	32.0	19.0	25.0	15.0	24.0	32.0	36.0	38.0	32.0	8.0	26.1
Total Hardness (mg/L)	45.0	27.0	36.0	28.0	28.0	56.0	48.0	52.0	32.0	16.0	36.8
Turbidity (NU)	2.3	0.8	1.7	2.4	1.0	1.3	3.3	3.4	0.9	2.0	1.91
Color (SU)	53.6	45.0	67.0	157.0	100.0	40.0	47.0	22.0	67.0	132.0	73.1
Reactive Phos. (mg/L)	0.010	0.009	0.004	<.003	0.016	0.007	0.007	0.008	0.006	0.004	0.007
Total Phosphorus (mg/L)	0.020	0.028	0.007	0.027	0.062	0.067	0.030	0.033	0.017	0.026	0.032
Ammonium (mg/L)	0.03	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	0.02
Nitrate-nitrite (mg/L)	<0.02	0.02	0.02	0.10	0.10	<0.01	<0.02	0.06	0.04	0.06	0.045
Total Inorganic Nitrogen	0.03	0.02	0.05	0.10	0.10	--	--	0.13	0.04	0.06	0.066
Tot. Kjeldahl N. (mg/L)	0.55	0.62	0.84	0.80	0.63	0.81	0.54	0.35	0.60	0.55	0.63
Total Nitrogen (mg/L)	0.55	0.64	0.86	0.90	0.73	0.81	0.54	0.41	0.64	0.61	0.67
Nitrogen:Phospho. Ratio	27.5	22.9	122.9	33.3	11.8	12.1	18.0	12.4	37.6	23.5	32.2
Chloride (mg/L)	0.5	0.5	0.5	0.5	0.5	<0.5	1.8	0.4	<0.5	<0.1	0.48
Sulfate (mg/L)	2.9	2.9	2.4	2.5	2.2	2.6	4.5	2.0	4.3	5.5	3.18
Sodium (mg/L)	1.2	0.7	1.4	1.8	1.0	1.8	1.6	1.7	1.2	0.9	1.33
Potassium (mg/L)	0.9	0.9	1.0	0.7	0.8	0.8	0.8	0.6	0.7	0.6	0.78
Secchi Depth (feet)	4.5	--	--	3.5	--	5.0	--	4.5	4.0	5.0	4.4

Echo Lake has undergone Secchi sampling since 1992. There has been no consistent trend in the water transparency over that time. The range of readings is between 4 feet and 8 feet and the average is 5.6 feet.

In the 2003 Echo Lake Sensitive Area Survey Report (see Appendix E), some representative summer water chemistry data was reported (summarized below in Table 3). The Sensitive Area Survey Report characterized Echo Lake as a softwater, moderately fertile lake. The report concluded that based on total phosphorus and chlorophyll "a" concentrations it is mesotrophic or slightly eutrophic.

Table 3. Representative Summer Water Quality Data for Echo Lake (2003).	
Secchi Depth	4-7 feet
Total Phosphorus	21-27 micrograms per liter
Chlorophyll "a"	5-9 micrograms per liter
True color (water color)	55 platinum-cobalt units
pH	7.2-7.5 (SU)
Hardness	39 milligrams per liter
Conductivity	105 micromhos per cm

2005 Water Quality Monitoring: Field Measures

As indicated in the methods section, we conducted our water quality sampling work at one location in Rice Lake and two locations at Echo Lake. In this section, we describe the field measures collected at these sites during the summer and fall sampling bouts.

Based on visual inspection, the water in Rice Lake has rather low transparency. The Secchi disc depth was 5 feet on both July 20 and September 11, 2005. Secchi disc depths at Echo Lake were 6 feet and 5 feet on July 20 and September 11, respectively. Water clarity results from two main influences: water color (materials actually dissolved in the water) and turbidity (materials suspended in the water such as silt or algae). In the case of both Rice and Echo Lakes the water is tannin stained (tea-colored) and there is also some suspended material in the water. Secchi disc values vary throughout the summer as algal populations fluctuate. In a river-influenced system,

suspended particles can be imported to the system from upstream. Year to year changes can result from weather and nutrient changes.

Oxygen gas dissolves in water and is crucial to the survival of most aquatic organisms. The amount of oxygen that can dissolve in the water depends on the water temperature (colder water can hold more oxygen in solution). For example, in water that is well mixed with air at 32 degrees Fahrenheit the solubility of oxygen in water is 15 mg/L (or ppm – parts per million). At 50 degrees, the oxygen solubility is 11 ppm. At 77 degrees, the oxygen solubility is 8 ppm. Despite this, oxygen levels in water often differ from these figures as mixing is seldom complete and biochemical processes in the lake consume or release oxygen. Photosynthesizing plants produce oxygen during daylight hours, but these same plants use oxygen in their respiration (at night oxygen consumption by plants far exceeds production). Decomposition of dead organic material uses oxygen. At deeper spots in a lake (below where light can penetrate) oxygen can become depleted because of decomposition of organic material.

Lakes that are at least moderately deep often undergo summer stratification – the less dense warmer water stays near the surface and the denser colder water stays near the bottom. Thus the deep-water areas do not mix with the surface and therefore have no source of oxygen. Lower, colder levels of the lake become oxygen depleted. With stratified lakes, fall temperatures cool the surface water making it denser. Eventually, the surface water sinks to the bottom and mixes the lake. Both Rice Lake and Echo Lake demonstrated stratification in the temperature and dissolved oxygen profile during the summer sampling (see Table 4).

Table 4. Summer Temperature & Dissolved Oxygen for Rice and Echo Lakes.								
DEPTH	Summer Sampling (7/20/05) at Rice Lake				Summer Sampling (7/20/05) at Echo Lake			
	Primary Sampling Station		Hickey Sampling Station		South Sampling Station		North Sampling Station	
	TEMP°C	DO mg/L	TEMP°C	DO mg/L	TEMP°C	DO mg/L	TEMP°C	DO mg/L
Surface	24.2	7.2			24.5	6.8	25.3	7.4
0.5m	24.2	6.6			24.2	6.5	25.0	7.0
1.0m	24.2	7.0			24.2	6.5	25.0	6.9
1.5m	24.0	6.8			24.0	6.1	25.0	6.5
2.0m	24.0	6.2			24.0	6.1	24.5	6.2
2.5m	23.0	5.2			24.0	6.4	24.0	5.9
3.0m	21.8	1.4			24.0	6.2	23.5	5.9
3.5m	18.5	0.5			23.0	5.7	23.3	5.8
4.0m	16.1	0.5			20.0	0.8	23.0	5.4
4.5m	14.0	0.4			19.0	0.5	20.0	0.8
5.0m	11.5	0.4			16.5	0.5	19.0	0.7
5.5m	10.8	0.4			15.0	0.4	18.5	0.5
6.0m	10.5	0.2			15.5	0.4	18.5	0.5

In September, Rice Lake demonstrated stratification at the deeper location, but not at a second site[4] that was a more shallow location (see Table 5, below). September profiles in Echo Lake showed no stratification at either of the sampling stations (see Table 5, below). The minimum amount of oxygen needed for "warm water" fish to survive and grow is 5 mg/L. During July waters deeper than 3 meters in Rice Lake and 4-5 meters in Echo Lake did not have sufficient oxygen for warm water fish species. During September, Rice Lake water deeper than 3.5 meters was still depleted of sufficient oxygen for fish, whereas Echo Lake had mixed and held sufficient oxygen for fish throughout the water column.

4 *During the fall sampling bout, a second profile was made at the request of landowner Gene Hickey in front of his property on Rice Lake.*

Table 5. Fall Temperature & Dissolved Oxygen for Rice and Echo Lakes.								
DEPTH	Fall Sampling (9/11/05) at Rice Lake				Fall Sampling (9/11/05) at Echo Lake			
	Primary Sampling Station		Hickey Sampling Station		South Sampling Station		North Sampling Station	
	TEMP°C	DO mg/L	TEMP°C	DO mg/L	TEMP°C	DO mg/L	TEMP°C	DO mg/L
Surface	21.5	7.6	21.5	8.0	21.5	6.7	22.0	7.8
0.5m	21.3	7.0	21.3	7.8	21.2	7.8	22.0	7.7
1.0m	21.0	7.0	21.2	7.7	21.1	7.6	22.0	7.7
1.5m	21.0	7.3	21.1	7.5	21.1	7.7	21.5	7.4
2.0m	21.0	7.3	21.0	8.1	21.0	7.7	21.5	7.3
2.5m	20.5	6.9	21.0	7.6	21.0	7.7	21.5	7.8
3.0m	20.3	6.4	21.0	3.2	21.0	7.8	21.2	7.6
3.5m	20.0	5.8	21.0	2.8	21.0	7.4	21.0	6.3
4.0m	18.0	0.3			20.9	7.2	19.0	5.1
4.5m	15.2	0.1			20.9	7.5	18.5	4.2
5.0m	14.0	0.1			20.5	5.5	18.0	3.8
5.5m	12.2	0.1			18.5	0.2	20.0	1.2
6.0m	12.0	0.0						

Field measured conductivity and pH values for Rice Lake and Echo Lake for both sample bouts are presented in Table 6. These compare closely with historical data.

Table 6. Conductivity and pH Readings for Rice Lake and Echo Lake in 2005						
NOTE: pH in standard units Conductivity in micromsiemens/cm	Rice Lake		Echo Lake			
	July 20, 2005	Sept. 11, 2005	July 20, 2005		Sept. 11, 2005	
	Primary Sampling Station	Primary Sampling Station	South Sampling Station	North Sampling Station	South Sampling Station	North Sampling Station
pH surface	7.56	6.45	6.67	6.41	5.99	6.19
pH bottom	7.32	6.31	6.79	6.57	5.70	5.81
Conductivity surface	93.46	95.0	214.2	133.5	81.0	131.2
Conductivity bottom	93.91	94.1	124.0	112.9	86.0	359.0

2005 Water Quality Monitoring: Chemistry

Tables 7 and 8 present the analytical chemistry data from water samples collected from Rice Lake and Echo Lake, respectively. Samples from both the summer (July 20, 2005) and fall (September 11, 2005) sampling bouts are included. This subsection interprets and discusses the results.

Alkalinity acts as a buffer against acidification and the alkalinity levels measured historically in Rice Lake (see Table 2) and during 2005 in Echo Lake (Table 8) indicate that both lakes are well-buffered and insensitive to acid rain. The pH (a measure of acidity) for Rice Lake is slightly on the basic side of neutral (for context, neutral pH is 7 and an acidic lake would be pH=5). Echo Lake tends to be just on the acid side of neutral. Minerals in the soil and watershed bedrock influence surface water alkalinity. If a lake gets groundwater from aquifers containing limestone minerals, alkalinity will be high.

The total phosphorus concentrations measured in both Rice Lake and Echo Lake during 2005 were below average for Wisconsin lakes. This places both lakes in the category of "very good" water quality as published in *Understanding Lake Data*.[5]

The values for nitrate-nitrite nitrogen were very low in both lakes (below laboratory detection levels) indicating that whatever nitrogen that was present was sequestered in algae and plants. Total Kjeldahl nitrogen was found to be consistent with historic data on the lakes. The ratio of total nitrogen (nitrate-nitrite nitrogen + Total Kjeldahl Nitrogen) to total phosphorus is an indicator or whether a lake is "nitrogen limited" or "phosphorus limited." Ratios for both Rice and Echo Lakes are presented in Table 9 and indicate that both lakes are "phosphorus limited" – a typical condition in Wisconsin lakes.

Chlorophyll "a" concentration is a measure of the amount of algae particles in the water column. Chlorophyll "a" measurements in Rice Lake and Echo Lake were not high and would likely place these lakes in an intermediate category between *mesotrophic* and *oligotrophic*.

Measures of chloride, sulfate, sodium, and potassium (both 2005 data and historical data are consistently low and typical for the lakes in northern Wisconsin.

5 *The University of Wisconsin Extension publication "Understanding Lake Data" can be obtained online at http://s142412519.onlinehome.us/uw/pdfs/G3582.PDF*

Table 7. Water Chemistry for Rice Lake Summer and Fall Samples (2005).				
PARAMETER	July 20, 2005 Sampling Bout		Sept. 11, 2005 Sampling Bout	
	Primary Station Surface	Primary Station Bottom	Primary Station Surface	Primary Station Bottom
Reactive Phosphorus (mg/L)	<0.003	0.004	0.004	<0.003
Total Phosphorus (mg/L)	<0.008	<0.008	<0.012	0.020
Ammonium Nitrogen (mg/L)	<0.01	<0.01	0.02	0.02
Nitrate+Nitrite Nitrogen (mg/L)	<0.02	<0.02	<0.02	<0.02
Total Kjeldahl Nitrogen (mg/L)	0.36	0.32	0.83	0.59
Chloride (mg/L)	2.0	2.0	0.5	0.5
Chlorophyll “a” (µg/L)	Primary Station: 5.79		Primary Station: 3.15	

Table 8. Water Chemistry for Echo Lake Summer and Fall Samples (2005).								
PARAMETER	July 20, 2005 Sampling Bout				Sept. 11, 2005 Sampling Bout			
	South Station Surface	South Station Bottom	North Station Surface	North Station Bottom	South Station Surface	South Station Bottom	North Station Surface	North Station Bottom
Alkalinity (mg/L)	48	48	56	48	48	44	48	48
Total Hardness (mg/L)	48	52	48	52	44	48	48	52
Calcium Hardness (mg/L)	35	35	35	34	35	35	36	39
Reactive Phosphorus (mg/L)	0.008	<0.003	0.007	0.012	0.003	0.009	0.003	0.007
Total Phosphorus (mg/L)	<0.008	<0.008	<0.008	<0.008	0.013	0.019	0.015	0.031
Ammonium Nitrogen (mg/L)	<0.01	<0.01	<0.01	<0.01	0.01	0.04	0.01	<0.01
Nitrate+Nitrite Nitrogen (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Kjeldahl Nitrogen (mg/L)	0.42	0.23	0.32	0.21	0.53	0.47	0.50	0.53
Chloride (mg/L)	1.5	1.5	1.5	2.0	0.5	0.5	0.5	0.5
Sulfate (mg/L)	2.80	2.81	2.79	2.83	3.80	3.62	9.44	5.44
Sodium (mg/L)	1.4	1.5	1.4	1.6	1.4	1.4	1.7	1.8
Potassium (mg/L)	0.6	0.7	0.6	0.7	0.7	0.7	0.9	0.9
Turbidity (NTU)	2.8	3.3	2.5	3.1	2.6	2.5	2.2	2.6
Color (CU)	52.0	64.8	58.3	53.5	42	41	41	38
Chlorophyll “a” (µg/L)	South Station 5.53		North Station (none sampled)		South Station <1.0		North Station 3.47	

The Carlson Trophic State Indices[6] (TSI) are calculated measures using total phosphorus, chlorophyll "a", and Secchi depth to calculate indicators of trophic status. The calculated values are presented in Table 9. Values from the Rice Lake range from 34 to 54 (mean value of 45) and this generally places Rice Lake in the mesotrophic status. Echo Lake values also place it in mesotrophic status.

Table 9. N-P Ratios and Trophic Status Indices[7] for Rice and Echo Lakes.

Lake, Sampling Station, and Parameter	7/20/05	9/11/05
Rice Lake Primary Sampling Station – Ratio Total N:Total P	47:1	71:1
Echo Lake South Sampling Station – Ratio Total N : Total P	55:1	42:1
Echo Lake North Sampling Station – Ratio Total N : Total P	42:1	35:1
Rice Lake Primary Sampling Station – Trophic State Index (Phosphorus)	34	40
Rice Lake Primary Sampling Station – Trophic State Index (Chlorophyll "a")	48	42
Rice Lake Primary Sampling Station – Trophic State Index (Sechhi Depth)	54	54
Rice Lake Primary Sampling Station – Trophic State Index (Average)	45	45
Echo Lake South Sampling Station – Trophic State Index (Phosphorus)	34	41
Echo Lake South Sampling Station – Trophic State Index (Chlorophyll "a")	47	31
Echo Lake South Sampling Station – Trophic State Index (Sechhi Depth)	52	54
Echo Lake South Sampling Station – Trophic State Index (Average)	44	42
Echo Lake North Sampling Station – Trophic State Index (Phosphorus)	34	43
Echo Lake North Sampling Station – Trophic State Index (Chlorophyll "a")	--	43
Echo Lake North Sampling Station – Trophic State Index (Sechhi Depth)	52	54
Echo Lake North Sampling Station – Trophic State Index (Average)	--	47

6 *TSI 30-40: Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer. TSI 40-50: Water moderately clear, but increasing probability of anoxia in hypolimnion during summer. TSI 50-60: Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only. TSI 60-70: Dominance of blue-green algae, algal scums probable, extensive macrophyte problems. TSI 70-80: Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic. TSI >80: Algal scums, summer fish kills, few macrophytes, dominance of rough fish.*

7 Carlson Trophic State Indices were calculated with formulae published in Carlson and Simpson (1996). *TSI (Secchi) = 60 - 14.41 ln Secchi disk (meters); TSI (Chlorophyll a) = 9.81 ln Chlorophyll a (µg/L) + 30.6; TSI (Phosphorus) = 14.42 ln total phosphorus (ug/L) + 4.15; where TSI = Carlson trophic state index and ln = natural logarithm*

Important Ecosystem Features

In order to plan for management and conservation of aquatic resources, it is crucial to identify those features of the ecosystem and landscape that are of exceptional quality and importance. Natural features, wildlife, and high environmental quality are often traits identified by the public as needing protection or restoration treatment in resource management plans.

Rice Lake, Echo Lake, and the surrounding landscape contain some outstanding ecosystem features that deserve consideration in future stewardship and management. These are listed and briefly described in this subsection.

Good water quality – Both Rice Lake and Echo Lake are productive aquatic ecosystems with neutral pH and sufficient alkalinity to protect against acid precipitation. Each would best be described as mesotrophic (moderately fertile).

High quality riparian area – Both Echo Lake and Rice Lake have high quality riparian forest and wetlands. These riparian areas exhibit moderate fragmentation, but continue to serve many functions to the environment ranging from terrestrial habitat for plants and animals to protection from run-off (by way of filtering) to contributing large woody material habitat to the aquatic habitat.

Diverse fish communities – Both Rice Lake and Echo Lake host diverse communities of fishes that supports a good recreational resource for fishermen and a food base for piscivorous animals such as osprey, bald eagle, common loons, blue heron, and river otter. The fish community is composed of warm-water species whose populations are supported by natural reproduction as well as periodic WDNR stocking.

Diverse aquatic plant communities – Both Echo Lake and Rice Lake are home to diverse communities of aquatic and plants fishes that support fisheries and wildlife production in the lakes. All attempts should be made to maintain these native, well-functioning plant communities.

Sensitive Areas – Echo Lake has four sensitive areas as identified by the WDNR. These contain high quality aquatic, wetland, and/or terrestrial vegetation and other habitat features (such as gravel spawning substrate or fallen trees and logs) that give these areas exceptional value to the overall ecosystem and landscape. Although no sensitive area survey has been conducted on Rice Lake, it most certainly contains several "sensitive areas" of habitat. These areas deserve special stewardship attention.

Reasonable levels of human recreation – Recreational pressures on Rice Lake and Echo Lake are for the time being at a reasonable level. Rice Lake has far less recreational use than the more populated Echo Lake. Nevertheless, even the more used Echo Lake affords a high quality recreational experience to fishermen, boaters, canoeists, and kayakers.

Bald eagle, osprey, and common loon nesting and use – Bald eagles, osprey, and common loons are top predators in the aquatic ecosystems of northern Wisconsin. Their presence in the Rice Lake-Echo Lake complex for breeding and feeding is a great indicator of environmental quality. Beyond being "canaries in the coal mine," the value of their presence cannot be over-estimated – they are symbols of the north that attract people to a special environment.

Engaged and interested residents and lake users – Human stakeholders in the Echo Lake and Rice Lake landscape are valuable assets in the stewardship process for both lakes. These people are potential monitors and watchdogs of the ecosystem. They should be engaged in the planning and management process.

Ecosystem restoration experts are quick to point out that it is hugely more economical to protect and maintain healthy ecosystems then to try to restore those that are degraded. Echo Lake and Rice Lake are both basically healthy ecosystems.

Possible Threats

It is also essential for stewards of Rice Lake and Echo Lake to be aware of potential threats to these ecosystems and surrounding areas. Active lake management programs and citizen involvement in overall land-use planning can often serve to curtail these threats in a direct and effective way. Below we list and briefly describe potential threats to the Rice Lake and Echo Lake ecosystems.

Lake classification status – Echo Lake is classified as a *Class 1 lake* in Iron County's 2-tiered Lake Classification System. This is the least restrictive category using the minimum state shoreline setbacks and lot size restrictions. This classification leaves Echo Lake riparian area vulnerable to fragmentation and degradation from greater development. Although Rice Lake has the *Class 2* designation, it too is likely to see increased development (see next category).

Increasing development – Shoreland development pressures are burgeoning in northern Wisconsin. Minimally developed shorelands such as Rice Lake are especially attractive as places to be exploited.

Increasing recreational use – Although current levels of recreation on Rice and Echo Lakes seem reasonable, more and more people are discovering the lakes of northern Wisconsin. Small lakes have a finite capacity to withstand the effects of high intensity human use.

Exotic / aggressive species – Rice Lake and Echo Lake are unusual in the virtual absence of non-native, invasive species. One non-native invader (the banded mystery snail) has colonized Echo Lake, but does not seem to be causing a problem. Nevertheless, the number of invasive species in the region continues to increase and threaten colonization of Rice and Echo Lakes. Constant vigilance is required. Alien species such as spiny water flea, Chinese mystery snail, purple loosestrife, and Eurasian milfoil are among the most likely invaders and should be carefully monitored.

"Weed Control" – Both Echo Lake and Rice Lake have aquatic vegetation that is dense in certain areas of the lake. In some cases this is perceived as detracting from recreational use and/or enjoyment. In the case of Rice Lake, two bouts of mechanical control of vegetation have taken place for the purposes of improving navigation. Although, the current amount of "weed control" is at a moderate level, the threat comes when aquatic plant management is done without thoughtful consideration and ecological evaluation. This is especially true if more extensive mechanical control or herbicide treatments are considered for either Rice Lake or Echo Lake. Serious negative side-effects can result that can upset the balance of an aquatic ecosystem. With the strong concern for aquatic invasive species such as Eurasian milfoil, the question of whole-lake herbicide treatments[8] is frequently raised and is reason for environmental concern.

Non-point source pollution – NPS pollution is a concern for both Rice Lake and Echo Lake. Because streams enter the lakes (Turtle River and Bear Creek) the possibility of a toxic spill or sediments from poor stream crossings, poor forestry practices, agricultural runoff, or other upstream disturbance can come to the lakes from many points upstream. NPS pollution can also enter the lakes from shoreline runoff from lawns, roadways, and boat ramps. Finally, the sediments of both lakes form potential sources of pollution that has been deposited in the past and subsequently covered by sediments and held in place.

8 *A recent article in Lake Tides (Volume 30, No. 4, Fall 2005) covered the whole-lake herbicide question. This article can be accessed on-line at http://www.uwsp.edu/cnr/uwexlakes/laketides/vol30-4/Text-only.htm*

Leaking or overburdened septic systems – It goes without saying that older cottages and homes on Rice Lake and Echo Lake have older septic systems that may be prone to passing nutrients on to the lake without sufficient treatment. Septic systems that were designed for weekend or less frequent use can be overburdened when a cottage is transformed into a full-time residence. Enrichment of Rice Lake or Echo Lake by addition of nitrogen and phosphorous would have undesirable effects. Fortunately, about half of Echo Lake has public sewer service (the west and north sides are not sewered).

Cranberry Industry Effluent – Rice Lake is potentially vulnerable to discharges from the commercial cranberry agriculture that exists upstream on Bear Creek. The cranberry industry uses a large amount of water in several stages of cranberry production. Pesticides, herbicides, and fertilizers are also used (although, according the cranberry industry literature, only in small quantities).

ADAPTIVE MANAGEMENT FOR RICE AND ECHO LAKES

Rice Lake and Echo Lake associations have come together in a unique collaboration to work together in promoting stewardship of healthy ecosystems in both lakes. Rice Lake and Echo Lake are not only connected because of this human collaboration, waters of the Turtle River literally and functionally connect them. These factors make an integrated adaptive management plan for both lakes not just theoretically possible, but ecologically sensible.

The land influences the water and the water influences the land. The ecosystems are elaborately connected. Yet often aquatic and terrestrial ecosystems are treated as completely separate entities when it comes to planning and management. As a society we tend to compartmentalize and often ignore connectivity. The Rice Lake and Echo Lake integrated approach is a strong attempt to recognize the interdependence of not only aquatic ecosystems, but aquatic and terrestrial ecosystems.

This section lays out the framework for an integrated adaptive management plan for Rice Lake and Echo Lake. The first subsection defines adaptive management and describes why it is the correct model for lake stewardship. It describes five kinds of management actions that can be useful in stewardship of Rice and Echo Lakes. The next subsection presents management goals for Rice Lake and Echo Lake. The final subsection lays out some initial management objectives and actions that can be undertaken by lake volunteers, public agencies, and consultants. These can be augmented in future iterations of the adaptive plan.

Adaptive Management

An adaptive management process (Walters, 1986[9]) is the most appropriate model to use in lake and watershed management. In adaptive management, a plan is made and implemented based on best available information and well-defined goals and objectives. Outcomes of management actions are monitored to ascertain whether they are effective in meeting stated goals and objectives. Based on this evaluation the plan is "adapted" (modified) in a process of continuous learning and refining.

9 *Walters, C. 1986. Objectives, constraints, and problem bounding. In W.M. Getz, ed., Adaptive Management of Renewable Resources. Macmillan Publishing Company. New York. p. 13+.*

Adaptive management acknowledges uncertainty. Because natural systems are so diverse, so complex, and so variable, almost all management actions will have uncertain outcomes. An adaptive management approach essentially takes a position that says, "We will make our best attempt and get better as we go along - we'll listen to what the natural system tells us." Monitoring is crucial in adaptive management. Adaptive management uses information from monitoring to continually evaluate and refine management practices. Monitoring measures the success of management actions. Well-designed monitoring should indicate how effectively management actions are working and give new insights into ecosystem structure and function. Monitoring should provide needed information to adapt management goals.

The Rice and Echo Lake Adaptive Management Plan can be implemented through five kinds of management actions: rehabilitation, education, protection, research, and support. These five work in concert to perpetuate healthy ecosystems. Monitoring actions can serve all five of these overall management actions. Each kind of action is summarized in the following bullets.

- ***Rehabilitation actions*** are those that manipulate site-specific elements of ecosystems. Examples include planting lakeside natural vegetation, placing a fish structure, and healing an area of active erosion. Rehabilitation actions are local. Individual rehabilitation projects contribute to overall lake and watershed restoration.

- ***Education actions*** are all of those activities that serve to promote lake and watershed stewardship and educate people about the natural ecosystems. These actions can be very local (e.g., a field trip with a class of 6th graders) or watershed-wide (such as a newsletter). Education actions can extend beyond the borders of the watershed as well such as presentations at the Wisconsin Association of Lakes annual conventions. In fact, education actions are potentially global in scope via the world-wide-web.

- ***Protection actions*** are used when high quality areas or elements are identified and need to be safeguarded. There are numerous forms that protection actions can take including protecting water quality, maintaining the native fish populations, protecting loon nesting areas, creating conservation easements, zoning, buffer zones as part of voluntary best management practices (BMPs), restrictive deeds, and prescribed green-space in new developments.

- ***Research actions*** are important to learn about the system being managed. So often we know very little about the plants, animals, habitats, and ecosystems that our management actions are affecting. Echo and Rice Lakes and the surrounding landscape are great candidates for research actions.

- ***Support actions*** are those that serve to perpetuate the infrastructure and funding for implementation and upgrading of the management plan. These could include meetings of the lake associations, attendance at regional lakes conferences, soliciting new volunteers, recognizing long-time volunteers, fund-raising, and grant writing.

Our society typically thinks a long term planning horizon is twelve months. Unfortunately, this is "out of sync" with the way an ecosystem functions. An ecological clock ticks off time in years, decades, centuries, and even millennia. Ecosystem management must be viewed from this perspective. In fact the final outcomes of some of the work put in place today might not be apparent until a new generation of lake stewards is on the scene.

The adaptive management plan will be successful if it allows and organizes meaningful stewardship work for Rice and Echo Lakes. It needs to make provision for different kinds of approaches and different kinds of people who want to be part of the process. It has to be strategic and integrated so that various actions complement one another, and are consistent with the lakes' natural processes. The plan should discourage management actions that work at cross-purposes or whose outcomes are undesirable.

Management Goals

"Protect the Best and Restore the Rest" is the credo of successful watershed managers across the country. Its simplicity is profound because it acknowledges that watershed restoration is more than identifying the worst areas and trying to rehabilitate them. It recognizes that of equal or greater importance is identifying those areas that are of high or moderate quality in the watershed and establishing mechanisms to maintain that quality. "Protect the Best and Restore the Rest" also implies the importance of identifying imminent threats to watershed health and working to eliminate them. This simple principle, is founded on the restoration ecology fact that the most certain way to successfully restore the structure and function of part of a broken

watershed ecosystem is to rely on intact areas of the watershed to serve as the donors of healthy "parts" (such as aquatic insect species or good quality water). "Protecting the Best" allows us to "Restore the Rest" more effectively and economically.

Developing goals for a lake management and protection program should begin with envisioning a desired future condition. This desired future condition should reflect the common vision of the participants. This vision serves as a foundation for goals and objectives. The primary goal of the management plan is to foster and perpetuate the health of Rice and Echo Lakes and the surrounding watershed. Sometimes this will mean protecting what is good and sometimes it may mean rehabilitating some feature that has been degraded.

By definition, an adaptive plan, adopts new goals as the plan evolves. This initial version of the Rice Lake and Echo Lake Adaptive Management Plan establishes several supporting goals. We conclude this section by presenting these goals under topical headings.

Restoration - Apply rehabilitation, protection, and education actions under the direction of specific objectives. Gather information that is useful in planning and monitoring rehabilitation and protection actions and devising education actions.

Monitoring - Establish monitoring actions that will provide data that reveal the quality of the ecosystem and the effectiveness of management efforts.

Cultural Climate - Encourage a political and cultural atmosphere that allows and promotes good watershed stewardship including cooperation between citizens, businesses, public agencies, and municipalities.

Sustainability - Foster an environment that promotes a sustainable economy, provides a diversity of economic options for the residents of the watershed, and does not diminish opportunities for future generations of watershed residents.

Recreation - Promote a sustainable recreation for Echo and Rice Lakes where citizens can enjoy the opportunities offered by the natural and human-sustained environment while respecting the natural environment as well as the rights of fellow citizens and property owners.

Program Maintenance - Provide for continual infrastructure and funding to support the implementation and periodic update of the adaptive management plan and its implementation.

In the next section, we present possible objectives and actions that will serve to make progress toward these goals. This is not an exhaustive treatment, but a starting point, integrated with monitoring so that the adaptive management process can take place.

Management Objectives and Actions

Rice Lake and Echo Lake display attributes of both healthy and degraded ecosystems. The challenge is to perpetuate healthy conditions into the future and repair (where possible) degraded conditions. Critical to the success of this long-term adaptive management is fostering a set of lake stewards who will apply their time and talents toward the realization of the plan's goals. Given the long-term nature of lake management, this also means inspiring the interest of young people to become involved in the process.

In keeping with the spirit of an adaptive management plan, we present several objectives and associated actions that could be undertaken in the initial implementation of the adaptive management plan. Recommended monitoring actions are also described. Each action, objective, and monitoring needs to be further developed so that appropriate methodology and accurate estimates of required effort can be described. Keep in mind that the plan is flexible and allows the insertion of new ideas and actions at any point along the path of lake and watershed management.

Action (Research): Conduct aquatic plant surveys for both Rice Lake and Echo Lake using the standard WDNR protocol.

Objective: To develop a better inventory of aquatic plants and an understanding of their distribution within the lakes. This is especially important for Rice Lake where mechanical harvesting of aquatic plants has occurred.

Monitoring: A consultant would likely conduct the survey work. The lake associations oversee these surveys and maintain data.

Action (Research): Talk to the "old-timers" knowledgeable about Rice Lake and Echo Lake and create an archive of this history. The Johnson letter (see Appendix F) is an example of the valuable information that might be obtained by such an action.
Objective: Document the known human history and natural history from those associated with the lakes for long periods of time.
Monitoring: Document the meetings and interviews and prepare a written report.

Action (Research): Conduct an assessment of mollusks in both Rice and Echo Lakes.
Objective: To understand the diversity of the mollusk communities and distribution within the lakes of individual species. A second objective is to monitor for non-native species.
Monitoring: A written report should document the findings.

Action (Education): Establish a kiosk at the public beach/boat launch that describes the dangers of non-native species introductions to Rice and Echo Lakes (and the Turtle River) and outlines how such introductions can be minimized.
Objective: Prevent new introductions of non-native species to Rice and Echo Lakes.
Monitoring: Lake Association members ensure that the kiosk is maintained with literature and educational material.

Action (Research): Conduct periodic assessments of Rice Lake and Echo Lake for non-native aquatic plants.
Objective: To provide an early warning of introductions of non-native plant species to allow rehabilitation actions to occur when populations are still small.
Monitoring: Document the number and timing of surveys and maintain record of findings.

Action (Research): Continue to track Secchi Depth transparencies in both Rice and Echo Lakes.
Objective: To document any changes in transparency that indicate some other ecosystem change.
Monitoring: A written report should document the findings over.

Action (Research): Study water chemistry, discharge, and parameters such as pH and conductivity on Bear Creek over a typical annual cycle.
Objective: To to elucidate the contribution of nutrients and other non-point-source materials to Rice Lake from Bear Creek.
Monitoring: A written report should document the findings along with a methodology for follow up monitoring.

Action (Support): Develop a system that helps to organize and coordinate the many kinds of actions that will take place on Rice Lake and Echo Lake.
Objective: To organize and track projects and archive findings in a single repository.
Monitoring: The lake associations should oversee and document this process.

Action (Research): Document the state of development of Rice Lake and Echo Lake shoreline using digital photography and written field notes. This documentation should include a count of piers along the Lake shoreline.
Objective: To create a baseline for today's state of shoreline development against which to monitor long term changes.
Monitoring: The findings should be documented in a report.

Action (Rehabilitation): Check on the feasibility of adding loon nesting habitat (in the form of artificial floating islands) to appropriate site(s) on Echo and Rice Lakes. If feasible, install.
Objective: To encourage use of Black Oak Lake for breeding of common loons.
Monitoring: Monitor loon use of the artificial island(s).

Action (Education): Establish an award or recognition of riparian owners that preserve or rehabilitate "natural shoreline" habitat on their property. This could be recognized in lake association newsletters along with an article about the ecological benefits of natural shorelines.
Objective: To encourage good shoreline stewardship by riparian owners.
Monitoring: Monitor by general awareness of landowners and changes in shoreline maintenance behavior.

Action (Protection): Develop limnological, ecological, and sociological indicators for future monitoring.
Objective: To establish measurable benchmarks against which long term monitoring can be measured.
Monitoring: Develop a written protocol describing indicators and how they are to be measured and monitored.

Action (Research): Conduct a survey of large woody material in the littoral zones of both Echo and Rice Lakes.
Objective: To understand the density of these important components of aquatic habitats.
Monitoring: Develop a written report on the findings.

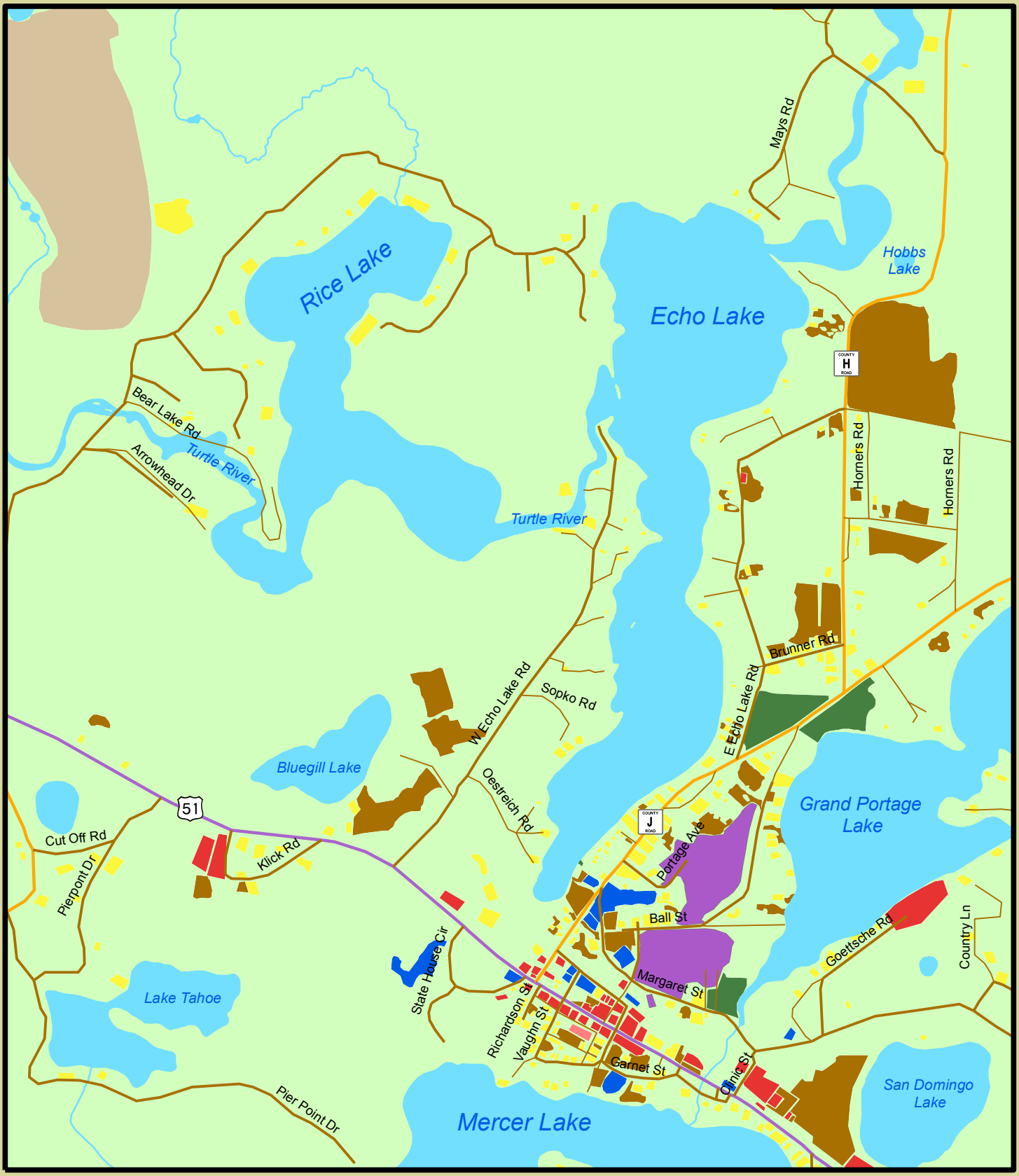
Aquatic ecosystems and their surrounding landscape ecosystems are enormously complex. Our understanding of how they work is not complete. Our ability to predict outcomes from specific actions is uncertain. Human impacts on aquatic resources from recreation, development, and other activities are significant, but not easily quantified. This is why the adaptive management approach is appropriate to the stewardship of lakes. This means that ongoing monitoring is critical to any future management actions on Rice and Echo Lakes in order to know that our management actions are having the anticipated outcome(s)

Rice Lake and Echo Lake and the surrounding watershed serve the human residents well. Nevertheless, in order for future generations to enjoy all of the opportunities and free services that the watershed can provide, this adaptive plan should be embraced, developed, and implemented. It may seem slow at first, but considerable momentum already exists because of the work that has already occurred.

Appendix A

Maps

Figure 1. Land Use, Echo & Rice Lake



0 0.125 0.25 0.5 Miles

Source: WDNR
NWRPC

Northwest Regional Planning Commission

FIGURE 1

- Residential
- Commercial
- Abandoned Commercial
- Agriculture
- Governmental/Institutional
- Communication/Utilities
- Industrial
- Open Space
- Parks & Recreation
- Woodlands/Other Natural Area

Figure 2

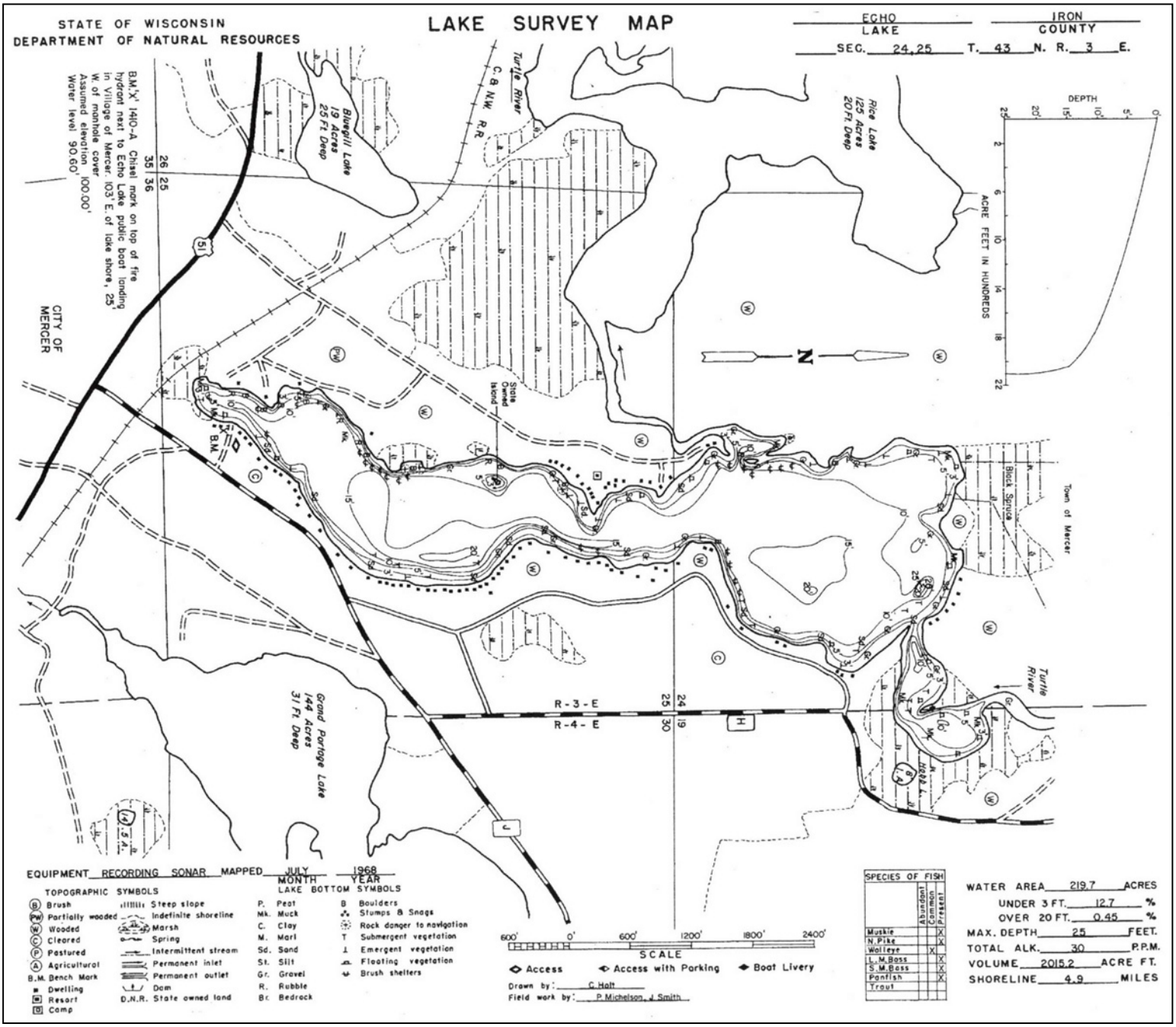

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
LAKE SURVEY MAP
ECHO LAKE
IRON COUNTY
SEC. 24,25 T. 43 N. R. 3 E.
B.M. 'X' 1410-A Chisel mark on top of fire hydrant next to Echo Lake public boat landing in Village of Mercer. 103' E. of lake shore, 25' W. of manhole cover. Assumed elevation 100.00' Water level 90.60'
Bluegill Lake 19 Acres 25 Ft. Deep
Turtle River
C. & N.W. R.R.
Rice Lake 125 Acres 20 Ft. Deep
DEPTH
ACRE FEET IN HUNDREDS
CITY OF MERCER
State Owned Island
Black Spruce
Town of Mercer
Turtle River
Grand Portage Lake 144 Acres 31 Ft. Deep
R-3-E
R-4-E
EQUIPMENT RECORDING SONAR MAPPED JULY 1968
MONTH YEAR
TOPOGRAPHIC SYMBOLS
LAKE BOTTOM SYMBOLS
SCALE
Access
Access with Parking
Boat Livery
Drawn by: C. Holt
Field work by: P. Michelson, J. Smith
SPECIES OF FISH
Abundant
Common
Present
Muskie
N. Pike
Walleye
L. M. Bass
S. M. Bass
Panfish
Trout
WATER AREA 219.7 ACRES
UNDER 3 FT. 12.7 %
OVER 20 FT. 0.45 %
MAX. DEPTH 25 FEET.
TOTAL ALK. 30 P.P.M.
VOLUME 2015.2 ACRE FT.
SHORELINE 4.9 MILES

Figure 3 Part A

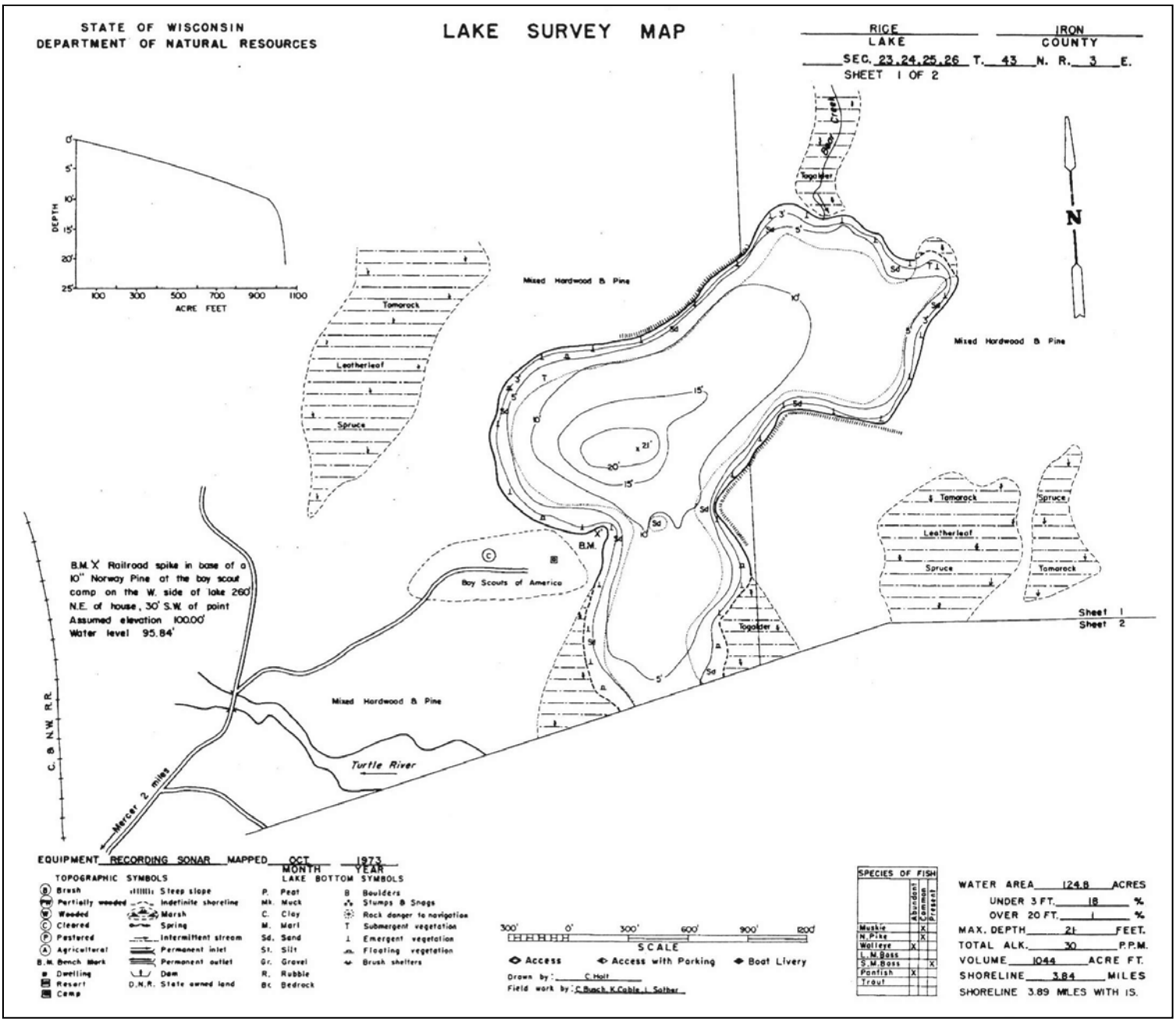


Figure 3 Part B

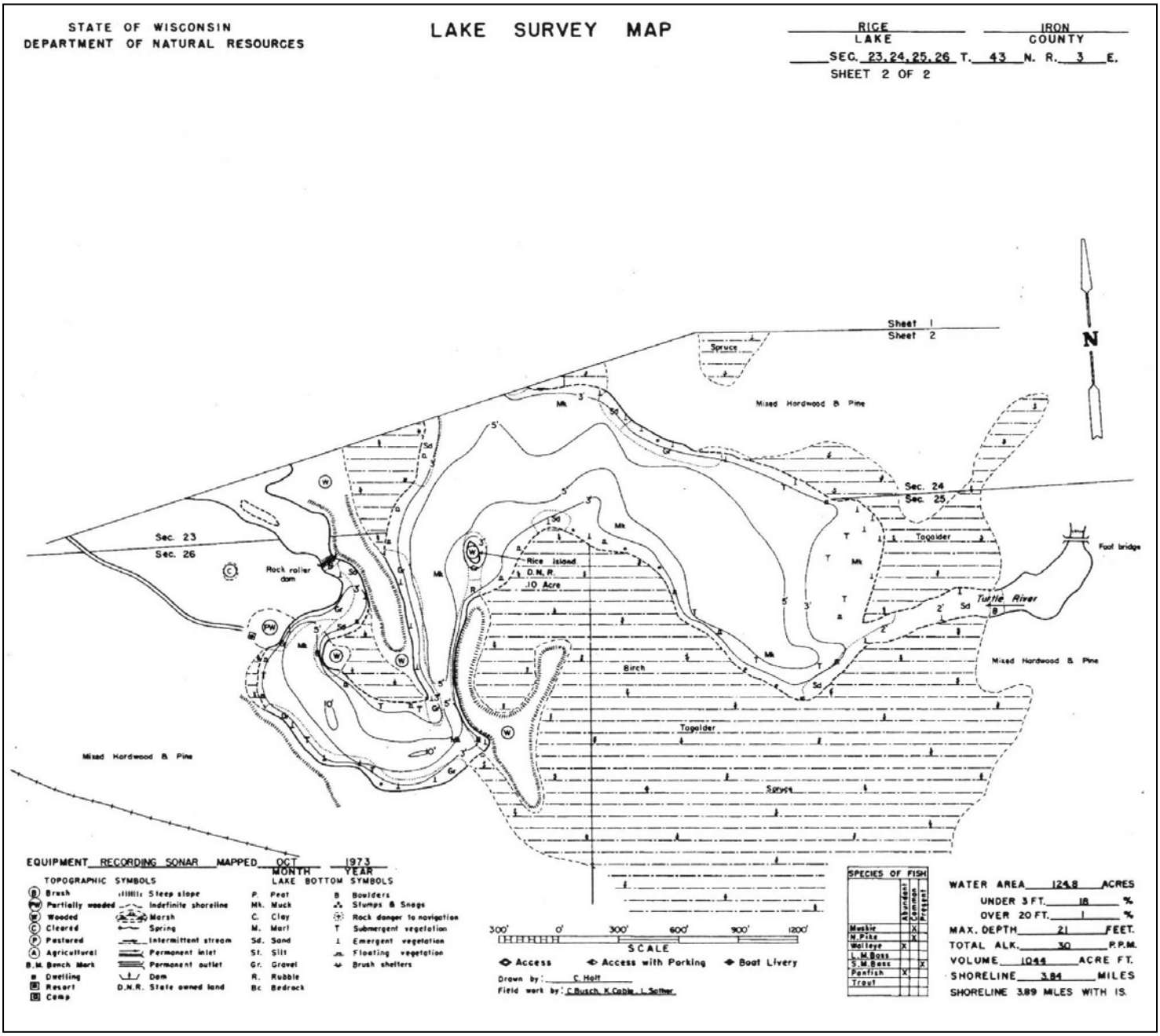


Figure 4. Forest Cover, Echo & Rice Lake

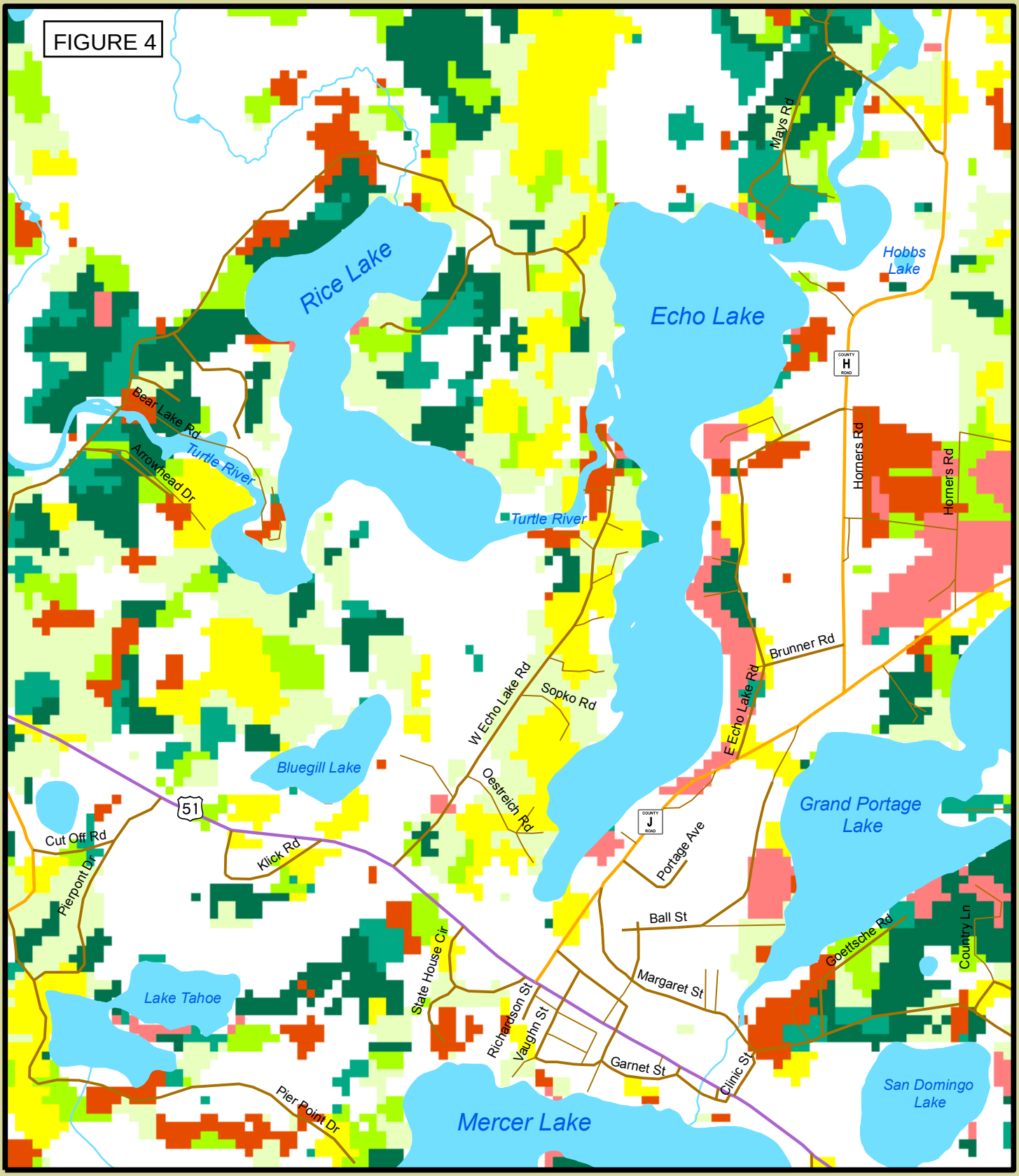
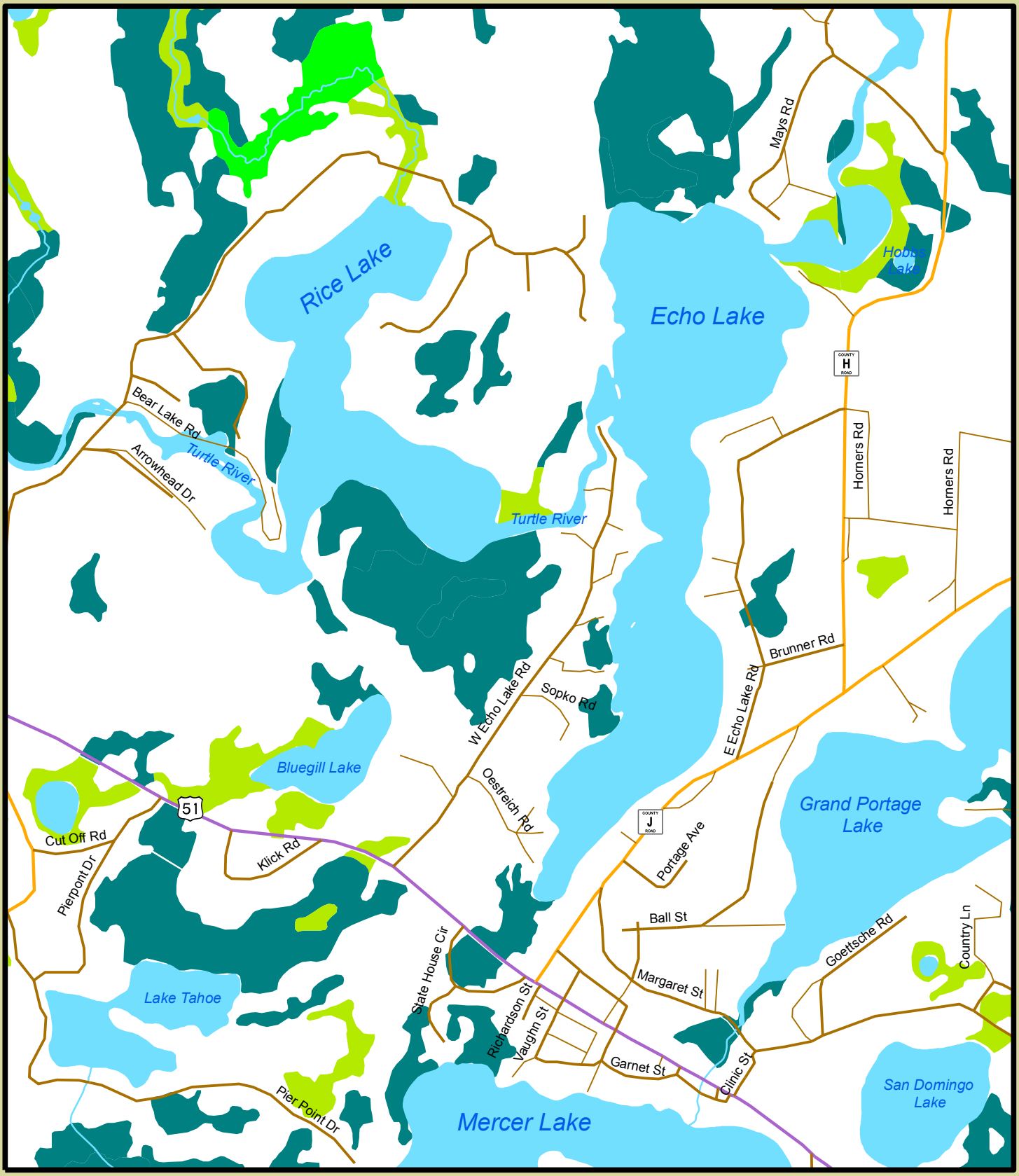


Figure 5. Wetlands, Echo & Rice Lake



0 0.125 0.25 0.5 Miles

Source: WLINS

Northwest Regional Planning Commission

FIGURE 5

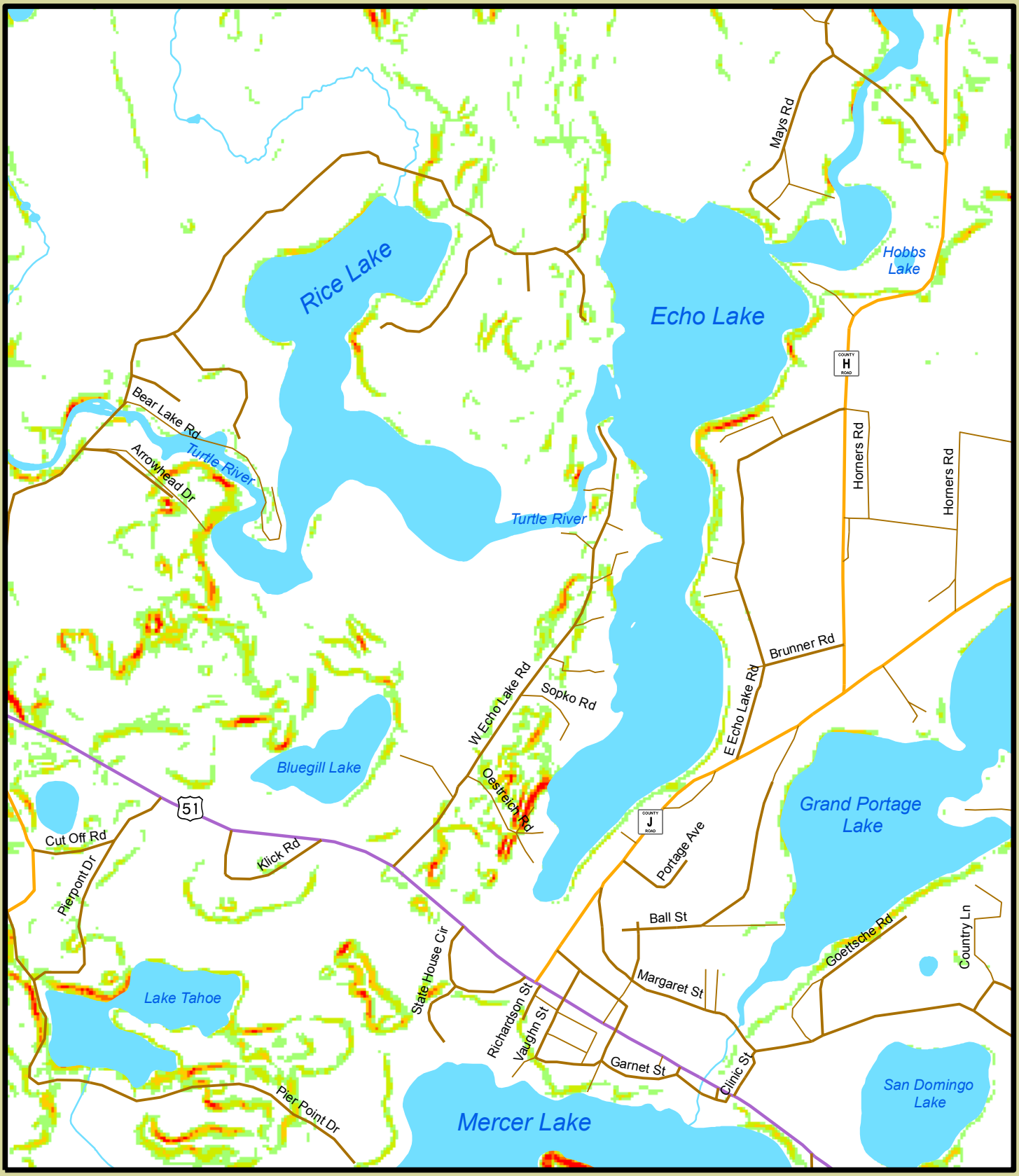
Wetland Type

- Emergent/wet meadow
- Flats/unvegetated wet soil
- Forested
- Scrub/shrub

Figure 6. Topography, Echo & Rice Lake

FIGURE 6

Figure 7. Slope, Echo & Rice Lake



0 0.125 0.25 0.5 Miles

Source: WDNR

Northwest Regional Planning Commission

FIGURE 7

Percent Slope

- 0 - 10 %
- 10- 15 %
- 15 - 20 %
- 20 - 25 %
- 25- 30 %
- Greater than 30 %

Appendix B

Excerpts from the Town of Mercer Comprehensive Plan (2005)

The following excerpts are extracted from the "Town of Mercer Comprehensive Plan" which was adopted 3 months ago by the Mercer Town Board. These excerpts were compiled by Bonnie Banaszak (Rice Lake Property Owners Association).

ELEMENT 5: NATURAL, AGRICULTURAL, AND CULTURAL RESOURCES

5.1 NATURAL RESOURCES

Topography and Slope

The Town of Mercer is located within the northern highland geographic province, a region characterized as pitted outwash plain of heavily forested terrain with many lakes, potholes, and wetlands. The topographic features of the town are resultant from the last glacial age that occurred about 15,000 years ago. As the ice retreated, large blocks of ice broke off and become buried in the drift and melted forming deep pits or kettles. The town contains a significant number of lakes, most of which are of kettle origin.

Town of Mercer Geologic Characteristics

The underlying bedrock geology has a significant influence on local topography, hydrology, and soil conditions. The Town of Mercer is generally underlain by a Precambrian basement complex consisting of metamorphic and igneous formations of massive granite, quartzite, and traprock. The Penokean and Keweenawan Thrust Faults bisect the town.

Existing Land Cover

Forestland is the dominant land cover type in the Town of Mercer, with 50.2 percent of the community classified as forest. Wetlands are also a significant land cover type within the community, comprising 34.7 percent of the landscape…

Forests provide a range of benefits including protecting and enhancing water quality. Wisconsin's Forestry Best Management practices for Water Quality is a WI DNR program that promotes environmentally sound forestry practices. These practices minimize solid exposure and compaction in order to protect ground vegetation… Nearly 54 percent of the Town of Mercer is public land as part of the Iron County Forest, or state-owned lands as part of the Turtle-Flambeau Flowage or the Northern Highland American Legion State Forest.

Surface Water Resources and Wetlands

Water resources are an important component of the natural landscape in the Town of Mercer. The dynamic resources provide many benefits to both humans and wildlife. Lakes, rivers, streams, and groundwater aquifiers are part of a natural cycle called the hydrologic cycle, in which water is cycled through the environment via natural processes.

The quality and quantity of these resources of these resources is strongly dependent upon how land is used. Activities on the landscape can introduce sediments and pollutants, affecting the usability of water for drinking and harming wildlife. Activities that disrupt the natural flow of water systems, … can alter natural processes and cause habitat loss. Arguably, the most significant concern facing northern lakes is overuse and development. Over the past 30 years, nearly two-thirds of all lakes ten acres and larger were developed in northern Wisconsin. Continuing pressures are being placed on water resources and the number of people using these resources continues to grow annually.

By definition, a watershed is an interconnected area of land draining from surrounding ridge tops to a common point, such as a lake or stream confluence with a neighboring watershed. The Town of Mercer lies within two major drainage basins, the Lake Superior and Mississippi River Basins. These broad hydrologic units are comprised of several individual watersheds. Within Mercer, there are portions of five watersheds.

Floodplains

Areas that are subject to periodic inundation by water are considered floodplains.

Physical development within designated floodways is strongly discouraged. …FEMA has determined areas of flood susceptibility in the Town of Mercer. Both Echo and Rice Lakes have Mapped Floodplain areas.

Section 87.30 WI State Statutes and Chapter NR 116 of the WI Administrative Code define the state's regulations with respect to floodplains. Iron County adopted floodplain zoning maps prepared by the U.S. Department of Housing and Urban Development dated April 1, 1988. Zoning Ordinances regulate uses within Iron County floodplains. Determination as to whether a building site is located in a flood plain must be made through zoning office review of flood plain maps or through field verification of flood boundary.

5.5 TOWN OF MERCER NATURAL, AGRICULTURAL, & CULTURAL GOALS, OBJECTIVES, ACTIONS, POLICIES, & PROGRAMS

The following set of recommended goals, objectives, and actions have been developed to assist the town in the conservation and promotion of effective management of the local natural resources:

Goal 1: Protect, conserve, enhance, and maintain a high level of environmental quality of land and waters in Mercer.

Objective 1: Protect the quality of both surface water and groundwater.

Action: Encourage compliance with state best management practices for town construction projects (Action as needed by WI DNR & Mercer Sanitary District)

Goal 2: Preserve the natural and scenic qualities of lakes and shorelines in the Mercer area.

Objective 1: Protect and balance the environmental and aesthetic qualities of the Town of Mercer, while promoting responsible stewardship of private property when planning for future development.

Action: Develop and adopt town ordinances that reflect the concerns of the Natural Resource goals. (Action as needed by the Mercer Town Board)

Action: Encourage the use of shoreland buffers and vegetative planting to reduce the impact of surface runoff. (Action is ongoing by WI DNR & Mercer Area Lake Associations.)

Action: Cooperate with other townships and governmental bodies regarding shared responsibility for natural resources. (Action as needed by WI DNR & Neighboring Municipalities)

Objective 2: Protect valuable wetlands, and lake, river, and stream shorelines in the Mercer area for the benefit of current residents and visitors, as well as for future generations.

Action: Support and encourage the enforcement of Iron County Zoning Ordinances. (Ongoing action by Mercer Town Board and WI DNR)

Action: Support the activities and address the concerns of Mercer Area Lake Associations. (Ongoing action by WI DNR & Iron County Lakes Alliance).

Appendix C

Excerpts the Town of Mercer Shoreland Development and Management Guide (2002)

The following excerpts are from the "Town of Mercer Shoreland Development and Management Guide" which was produced in December 2002, in collaboration with the Mercer Planning Commission and Northwest Regional Planning Commission with funding provided by the WI DNR. These excerpts were compiled by Bonnie Banaszak (Rice Lake Property Owners Association).

GOALS

The Iron County Shoreland Regulations offer a set of goals that provide a pattern for shoreline development and protection. The goals are not a specific set of instructions but provide more of an idea of where the county wants to end up. The theme of these goals is present in documents such as the ordinances and lake classification system found in this guide.

For the purpose of promoting the public health, safety, convenience, and welfare, the Iron County Shoreland Regulations establishes the following goals: (Sec. 9-1-20)

1. Further the maintenance of safe and healthful conditions and prevent and control water pollution through: (a) limiting structures to those areas where soil and geological conditions will provide a safe foundation; (b) establishing minimum lot sizes to provide adequate area for private sewage disposal facilities; and (c) controlling filling and grading to prevent serious soil erosion problems.

2. Protect spawning grounds, fish, and aquatic life through (a) preserving wetlands and other fish and aquatic habitat; (b) regulating pollution sources; and (c) controlling shoreline alterations, dredging, and lagooning.

3. Control building sites, placement of structures, and land uses through (a) separating conflicting land uses; (b) prohibiting certain uses detrimental to the shoreland area; (c) setting minimum lot sizes and widths; and (d) regulating side yards and building setbacks from waterways.

4. Preserve shore cover and natural beauty through (a) restricting the removal of natural shoreland cover; (b) preventing shoreline encroachment by structures; (c) controlling shoreland excavation and other earth moving activities; and (d) regulating the use and placement of boathouses and other structures.

SHORELAND DEFINITIONS

Many plots of land abut bodies of water in the Town of Mercer, and may more surround those plots. A "shoreland" plot is defined by the Iron County Shoreland Protection Ordinance as:

All the land in the unincorporated areas which are:

· Within one thousand (1,000) feet of the ordinary high water mark of navigable lakes, ponds, or flowages. Lakes, ponds, or flowages in Iron County shall be presumed to be navigable if they are listed in the WI DNR publication "Surface Water Resources of Iron County."

· Within three hundred (300) feet of the ordinary high water mark of navigable rivers and streams or to the landward side of the floodplain, whichever distance is greater…

Determinations of navigability and ordinary high water mark shall initially be made by the zoning administrator. When questions arise, the zoning administrator shall contact the appropriate district office of the WI DNR for a final determination of navigability of ordinary high water make.

SURFACE WATERS

The topographic features of the Town of Mercer stem from the last glacial age that occurred about 15,000 years ago. Most of the lakes in the town are of kettle origin. Mercer has 101 named and about 100 unnamed lakes totaling about 10,700 acres or 10.8 percent of the total land area of the town.

LAKES CLASSIFICATION SYSTEM

The Iron County lakes classification system uses a combination of natural and man-made factors in order to determine the vulnerability or environmental sensitivity of a lake. Factors used in determining the lake's vulnerability are lake surface area, maximum depth, lake type, watershed area, and shoreline development factors. Based on these, values are added up, and the lake is given a vulnerability score of "Class 1" which represents less vulnerability to the pressures of development. A score of "Class 2" means that the lake is more vulnerable to the pressures of development. The Lake's classification determines the amount and type of development allowed on its shoreline. (Echo Lake is a Class 1 Lake; Rice Lake is Class 2)

County Ordinances

Iron County Ordinances: Sec. 9-1-70: Shoreland Regulations

Setback. For lots that abut on navigable waters, the following setback regulations shall apply:

1. All permanent structures, except piers, boat hoists, and boathouses, shall be set back 75 feet from the ordinary high water mark of navigable waters…

2. A setback equal to the average setback of existing principal building with 500 feet of a proposed building site shall be permitted where such existing building do not conform to the appropriate setback line. A minimum setback of 40 feet shall be required in all such cases.

3. The County Zoning Administrator shall determine the ordinary high water mark where not established.

Removal of Shoreline Cover: The cutting of trees and shrubbery shall be regulated to protect scenic beauty, control erosion, and reduce the flow of effluents and nutrients from the shoreland. In the strip, 35 feet inland from the ordinary high water mark, no more than 30 feet in any one designated 100 feet shall be clearcut. In other areas, trees and shrub cutting shall be governed by consideration of the effect on water quality and should be in accord with accepted forestry management practices…

Commercial Forestry: From the inland edge of the 35-foot strip to the outer limits of the shoreland, the commercial harvesting of trees shall be allowed when accomplished under accepted forest management practices. The maintenance and improvement of water quality shall be emphasized in all timber harvesting operations…

Land Alteration:
1. Filling grading, lagooning, dredging, ditching, and excavating shall require an Iron County Land Use Permit in accordance with Section 13-1-141 and may be permitted only in accord with state law and where protection against erosion, sedimentation, and impairment of fish and aquatic life has been assured.

2. Filling grading, lagooning, dredging, ditching, or excavating in a shoreland-wetland district may be permitted only if the requirements listed in Section 1`3-1-209(b)(2) and (3) of the Shoreland-Wetland District are met.

3. A state or federal permit may be required, in addition to a permit under this chapter, if state or federal laws are applicable to the filling grading, lagooning, dredging, ditching, or excavating that is proposed.

4. A stairway, walkway, or lift is permitted in the shoreland setback area only when it is essential to provide pedestrian access to the pier because of steep slopes, rocky or wet unstable soils, and when the following conditions are met:

a. There are no other locations or facilities on the property that allow adequate access to a pier. Only one stairway or lift is allowed, not both, except where there is an existing stairway, and the lift will be mounted to or is immediately adjacent to the existing stairway.

b. Such structures shall be placed on the most visually inconspicuous route to the shoreline and shall avoid environmentally sensitive areas.

c. Vegetation, which stabilizes slopes or screens structural development from view, shall not be removed…

TOWN RECOMMENDATIONS

A. Lake Class Development Standards

Parcels of land existing and of record shall meet the minimum requirements of Section 9-1-70 and lots existing and of records but of substandard size to the Lake Class Development Standards are hereby not nonconforming to the parcel size. The construction of new dwellings or replacement dwellings, additions to existing structures, and the construction of accessory buildings when a principal structure exists on the premises may be allowed by permit provided all other requirements, regulations, and setbacks can be met….

B. Setbacks from Navigable Water

(Summary) The minimum setback distance must conform to Iron County regulated standards. The minimum setback distance can be less than the normal distance if the surrounding buildings (within 200 feet) are already closer than the minimum setback distance… The minimum setback distance cannot be closer than 40 feet.

C. Lake Access

1. (Summary) A keyhole lot is a shoreland lot shared by numerous off shore landowners that allows group access to the waterfront. Keyhole lots have to meet the normal lot size requirements. The sides of keyhole lots must have a 25-foot thick buffer of vegetation.

2. The number of single-family lots, buildings sites, single-family units, or single-family condominium units should be limited to four.

3. Only one accessory building will be allowed on the lake access parcel meeting the requirements of Section 9-1-66(3); except that actual boat storage and/or the connection of any pressurized water system is prohibited.

4. The creation or use of land for a lake access shall be by conditional use only in the R-1 and RR-1 zone districts in accordance with Sections 9-1200 and 9-1-201.

Appendix D

Property Owner Surveys

RICE LAKE SURVEY RESULTS

In the early summer of 2005, the Echo and Rice Lake Associations sent surveys to all property owners on the two lakes. This document is a summary of the results from the Rice Lake property owners.

A total of 24 surveys were distributed to Rice Lake property owners with 14 returned surveys, for a response rate of 58.3%.

Seven of the respondents were full-time residents, five were seasonal residents, one owned undeveloped property and one was undeclared.

General Satisfaction

1. What do you value most about your property? (Please check your top three choices.)

28.6% Recreational Use of the Lake
78.8% Scenic Beauty of the Lake and Shoreline
50.0% Natural Environment of the Watershed
21.4% Property Values as an Investment
35.7% Fishing
0% Winter Recreation
57.1% Undeveloped Northwood's Character/Solitude
7.1% Other

2. In general, how satisfied are you with your lake at this time? (Circle your response.)

Not At All Satisfied	*Not Satisfied*	*Neutral*	*Satisfied*	*Very Satisfied*
0%	**7.7%**	**15.4%**	**61.5%**	**15.4%**

Recreational Use

3. How important to you is the issue of recreational use on your lake? (Circle your response.)

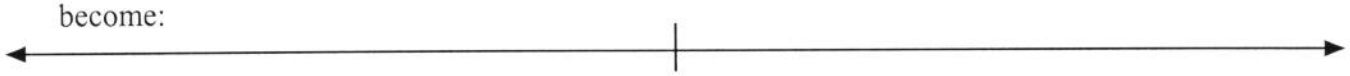
Not Important—15.4% *Somewhat Important—53.8%* *Very Important—30.8%*

4. How do you use your lake for recreation? (Please check all that apply.)

23.1% Motor Boating
46.2% Shore Fishing
61.5% Fishing from a Boat
38.5% Ice Fishing
38.5% Swimming
0% Jet Skiing
0% Sailing or Windsurfing
92.3% Canoeing, Kayaking, Rowing
46.2% Pontoon Boating
84.6% Viewing Lake from the Shore

7.7% Other

5. Looking back over the last several years do you believe that the recreational use of your lake has become:



Less Frequent—0% *About the Same—27.3%* *A Little More Frequent—63.6%* *Much More Frequent—9.1%*

6. How would you best describe how the current amount and type of recreational use affects you?

0% It greatly diminishes my use and enjoyment.
63.6% It diminishes my use and enjoyment to a limited degree.
36.4% It doesn't diminish my use and enjoyment.

7. Would you support an ordinance for your lake that would:

	Yes	No	Unsure
Limit the Size of Motors Allowed	**83.2%**	**16.7%**	**0%**
Prohibit the Use of Jet Skis	**92.3%**	**7.7%**	**0%**
Limit Jet Skis to Select Areas or Times	**44.4%**	**55.6%**	**0%**
Limit Water Skiing to Select Areas	**80.0%**	**20.0%**	**0%**
Limit Permitted Times for Motorized Uses	**36.4%**	**45.5%**	**18.2%**
Prohibit "Wakes" in Selected Areas	**66.7%**	**25.0%**	**8.3%**
Provide for Non-Motorized Areas	**54.5%**	**36.4%**	**9.1%**

8. Would you support efforts to improve fishing in your lake through the construction of fish cribs, baiting fish or stocking fish?

76.9% Yes **7.7%** No **15.4%** Unsure

Water Quality

9. How important to you is the quality of water in your lake?

Not Important—0% *Somewhat Important—15.4%* *Very Important—84.6%*

10. How does the present quality of water in your lake affect you?

16.7% It greatly diminishes my use and enjoyment.
25.0% It diminishes my use and enjoyment to a limited degree.
58.3% It doesn't diminish my use and enjoyment.

11. Looking back over the last several years do you believe that your lake has become:

More Polluted—37.5% *About the Same—62.5%* *Less Polluted—0%*

Exotic Species

12. How important to you is the issue of exotic species in your lake?

Not Important—0% *Somewhat Important—15.4%* *Very Important—84.6%*

13. Does the existence of exotic species negatively affect enjoyment of your lake?

No, Not At All—50.0% *Yes, to a Limited Degree—30.0%* *Yes, Very Much So—20.0%*

14. Have you noticed the presence of exotic species in your lake over the past several years?

No, not at all—70.0% *Yes, a little bit—30.0%* *Yes, quite a bit—0%*

15. If yes, please check which of the following exotic species you have seen and where you have seen them.

		Location
0	Aquatic forget-me-not	_____
0	Curly-leaf pondweed	_____
0	Eurasian water-milfoil	_____
0	Flowering rush	_____
2	Purple loosestrife	_____
0	Water chestnut	_____
0	Watercress	_____
0	Yellow water flag	_____
0	Chinese apple snail	_____
2	Spiny water fleas	_____

16. Would you support an effort to improve the education and awareness of the impacts of exotic species to protect your lake?

91.7% Yes **0%** No **8.3%** Unsure

17. Would you support enhanced enforcement to reduce the introduction of exotic species into your lake?

83.3% Yes **0%** No **16.7%** Unsure

Vision for the Future

18. Looking to the future, which of the following statements best describes your vision for your lake?

50.0 % A lake with a high priority placed on protecting water quality.
50.0% A lake that balances water quality with recreational use.
0% A lake that encourages greater recreational use.

19. What do you believe are the greatest threats facing the future of your lake?

_____

_____

_____

20. Which of the following management and educational activities would you support? (Please check all that apply.)

69.2% Information at the Public Access Sites Regarding Exotic Species
61.5% Education Regarding Steps that Individual Property Owners Can Take to Reduce Water Pollution
46.1% Regulations Limiting the Use of Lawn and Garden Pesticides
53.8% Increased Zoning and Related Regulations to Limit the **Amount** of Development Along the Lake
30.8% Zoning Changes that would Increase the **Regulation** of Land Uses Along the Lake (such as increasing setbacks and shoreline buffer zones)
38.5% More Regulations Limiting the Use of Motorized Boats
30.8% Mandatory Septic Tank Inspections
46.1% Education Encouraging Voluntary Septic Tank Inspections
7 .7% Chemically Treat Weeds and Algae as Needed Periodically
53.8% Harvesting Aquatic Plants as Needed Periodically

21. What is the best way to communicate with you regarding proposed planning, management or educational projects related to Echo and Rice Lakes?

92.3% Direct Mail (letters, flyers, brochures)
30.8% E-Mail
7.7% Radio
30.8% Newspaper
15.4% Community presentations
0% Other (please list):_____

_____

Yourself

22. Which lake do you own property on?

___ Echo Lake ___ Rice Lake

23. How long have you lived or owned property on your lake?

14.3% 0-2 Years
35.7% 3-5 Years
21.4% 6-10 Years
21.4% 11-20 Years
7.1% More than 20 years

24. How would you describe your property?

53.8% Full time residence
38.5% Seasonal residence
7.7% Undeveloped

25. Would you be interested in being involved with this effort to manage Echo and Rice Lakes?

58.3% Yes **33.3%** No **8.3%** Unsure

If yes, please write your name, mailing address and/or e-mail address so we can be sure to include you in our future mailings:

Name:_____
Address:_____
E-Mail:_____

Please feel free to add any additional comments regarding Echo and Rice Lakes:

_____
_____
_____
_____
_____

ECHO LAKE SURVEY
FINAL RESULTS
(July 22, 2005)

In the early summer of 2005, the Echo and Rice Lake Associations sent surveys to all property owners on the two lakes. This document is a summary of the results from the Echo Lake property owners.

A total of 85 surveys were distributed to Echo Lake property owners with 38 returned surveys, for a response rate of 44.7%.

Twenty-three of the respondents were seasonal residents, eleven were full-time residents, one owned undeveloped property and two respondents were undeclared.

Over half (55.6%) of the respondents have lived or owned property on Echo Lake for more than 20 years.

General Satisfaction

1. What do you value most about your property? (Please check your top three choices.)

63.8% Recreational Use of the Lake
83.3% Scenic Beauty of the Lake and Shoreline
19.4% Natural Environment of the Watershed
22.2% Property Values as an Investment
41.7% Fishing
5.6% Winter Recreation
41.7% Undeveloped Northwood's Character, Solitude

2. In general, how satisfied are you with your lake at this time? (Circle your response.)

Not At All Satisfied	*Not Satisfied*	*Neutral*	*Satisfied*	*Very Satisfied*
2.7%	**18.9%**	**21.6%**	**51.4%**	**5.4%**

Recreational Use

3. How important to you is the issue of recreational use on your lake? (Circle your response.)

Not Important—2.9% *Somewhat Important—54.3%* *Very Important—42.9%*

4. How do you use your lake for recreation? (Please check all that apply.)

54.1% Motor Boating
51.4% Shore Fishing
83.8% Fishing from a Boat
16.2% Ice Fishing
64.9% Swimming
8.1% Jet Skiing
8.1% Sailing or Windsurfing
43.2% Canoeing, Kayaking, Rowing
51.4% Pontoon Boating
91.9% Viewing Lake from the Shore

8.1% Other

5. Looking back over the last several years do you believe that the recreational use of your lake has become:

Less Frequent—11.4% *About the Same—48.6%* *A Little More Frequent—37.1%* *Much More Frequent—2.9%*

6. How would you best describe how the current amount and type of recreational use affects you?

0% It greatly diminishes my use and enjoyment.
18.2% It diminishes my use and enjoyment to a limited degree.
81.8% It doesn't diminish my use and enjoyment.

7. Would you support an ordinance for your lake that would:

	Yes	No	Unsure
Limit the Size of Motors Allowed	**47.2%**	**33.3%**	**19.4%**
Prohibit the Use of Jet Skis	**41.7%**	**41.7%**	**16.7%**
Limit Jet Skis to Select Areas or Times	**83.7%**	**8.1%**	**8.1%**
Limit Water Skiing to Select Areas	**39.3%**	**42.4%**	**18.2%**
Limit Permitted Times for Motorized Uses	**11.4%**	**71.4%**	**17.1%**
Prohibit "Wakes" in Selected Areas	**54.5%**	**33.3%**	**12.1%**
Provide for Non-Motorized Areas	**11.8%**	**61.7%**	**26.5%**

8. Would you support efforts to improve fishing in your lake through the construction of fish cribs, baiting fish or stocking fish?

94.6% Yes **5.4%** No **0%** Unsure

Water Quality

9. How important to you is the quality of water in your lake?

Not Important—2.7% *Somewhat Important—2.7%* *Very Important—94.6*

10. How does the present quality of water in your lake affect you?

14.7% It greatly diminishes my use and enjoyment.
44.1% It diminishes my use and enjoyment to a limited degree.
41.2% It doesn't diminish my use and enjoyment.

11. Looking back over the last several years do you believe that your lake has become:

More Polluted—40.6% *About the Same—59.4%* *Less Polluted—0%*

Exotic Species

12. How important to you is the issue of exotic species in your lake?

Not Important—11.1% *Somewhat Important—11.1%* *Very Important—77.8%*

13. Does the existence of exotic species negatively affect enjoyment of your lake?

No, Not At All—13.8% *Yes, to a Limited Degree—50.0%* *Yes, Very Much So—36.1%*

14. Have you noticed the presence of exotic species in your lake over the past several years?

No, not at all—28.6% *Yes, a little bit—40.0%* *Yes, quite a bit—31.4%*

15. If yes, please check which of the following exotic species you have seen and where you have seen them.

		Location
1	Aquatic forget-me-not	_____
6	Curly-leaf pondweed	_____
2	Eurasian water-milfoil	_____
3	Flowering rush	_____
2	Purple loosestrife	_____
0	Water chestnut	_____
0	Watercress	_____
0	Yellow water flag	_____
19	Chinese apple snail	_____
2	Spiny water fleas	_____

16. Would you support an effort to improve the education and awareness of the impacts of exotic species to protect your lake?

97.3% Yes **0%** No **2.7%** Unsure

17. Would you support enhanced enforcement to reduce the introduction of exotic species into your lake?

86.5% Yes **0%** No **13.5%** Unsure

Vision for the Future

18. Looking to the future, which of the following statements best describes your vision for your lake?

26.5% A lake with a high priority placed on protecting water quality.
70.6% A lake that balances water quality with recreational use.
2.9% A lake that encourages greater recreational use.

19. What do you believe are the greatest threats facing the future of your lake?

_____

_____

_____

20. Which of the following management and educational activities would you support? (Please check all that apply.)

62.2% Information at the Public Access Sites Regarding Exotic Species
83.8% Education Regarding Steps that Individual Property Owners Can Take to Reduce Water Pollution
59.5% Regulations Limiting the Use of Lawn and Garden Pesticides
67.6% Increased Zoning and Related Regulations to Limit the **Amount** of Development Along the Lake
21.6% Zoning Changes that would Increase the **Regulation** of Land Uses Along the Lake (such as increasing setbacks and shoreline buffer zones)
16.2% More Regulations Limiting the Use of Motorized Boats
54.1% Mandatory Septic Tank Inspections
59.5% Education Encouraging Voluntary Septic Tank Inspections
64.9% Chemically Treat Weeds and Algae as Needed Periodically
75.7% Harvesting Aquatic Plants as Needed Periodically

21. What is the best way to communicate with you regarding proposed planning, management or educational projects related to Echo and Rice Lakes?

94.6% Direct Mail (letters, flyers, brochures)
32.4% E-Mail
2.7% Radio
10.8% Newspaper
13.5% Community presentations
0% Other (please list):_____

_____

Yourself

22. Which lake do you own property on?

___ Echo Lake ___ Rice Lake

23. How long have you lived or owned property on your lake?

13.9% 0-2 Years
11.1% 3-5 Years
11.1% 6-10 Years
8.3% 11-20 Years
55.6% More than 20 years

24. How would you describe your property?

31.4% Full time residence
65.7% Seasonal residence
2.8% Undeveloped

25. Would you be interested in being involved with this effort to manage Echo and Rice Lakes?

38.9% Yes **27.8%** No **33.3%** Unsure

If yes, please write your name, mailing address and/or e-mail address so we can be sure to include you in our future mailings:

Name:_____
Address:_____
E-Mail:_____

Please feel free to add any additional comments regarding Echo and Rice Lakes:

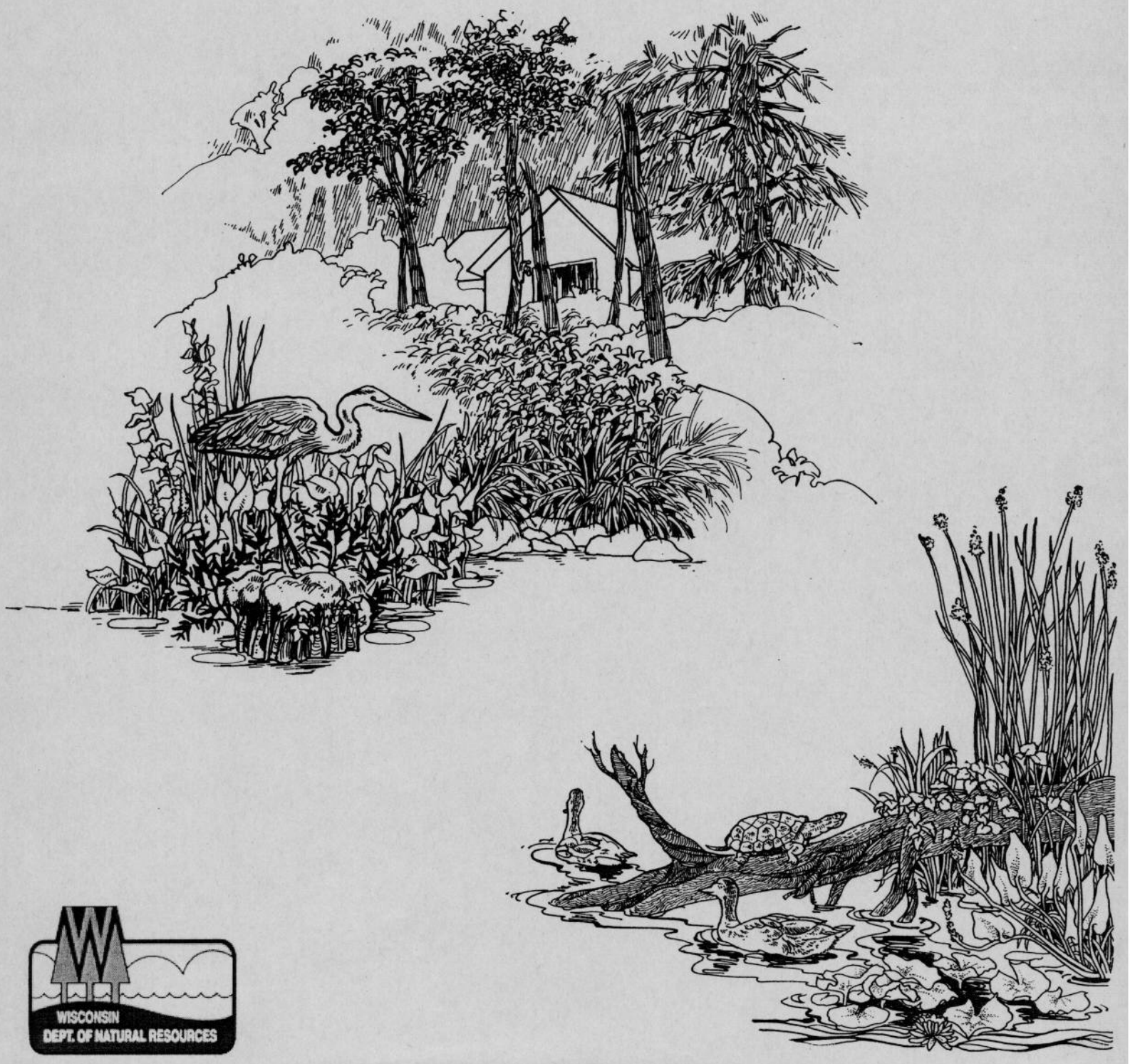
_____
_____
_____
_____
_____

Appendix E

WDNR Sensitive Area Survey Report For Echo Lake (August 2003)

ECHO LAKE
SENSITIVE AREA SURVEY REPORT

AUGUST, 2003



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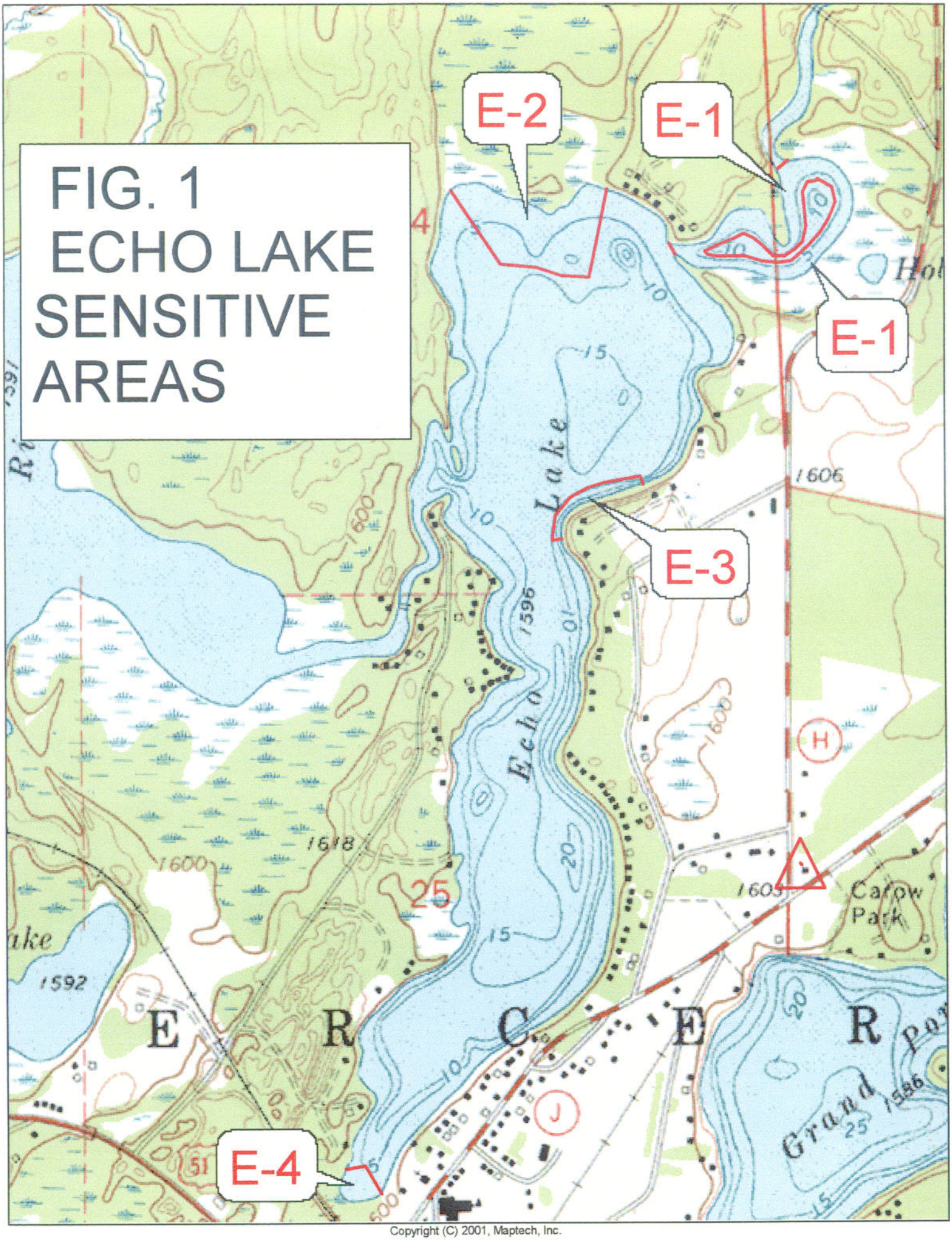

ECHO LAKE SENSITIVE AREA SURVEY REPORT

GENERAL LAKE DESCRIPTION

Physical features

Echo Lake is located in central Iron County on the north side of the City of Mercer (T43N, R3E, Sec. 24, 25 and T43N, R4E, Sec. 19) (figure 1). The lake has an area of 220 acres and a maximum depth of 25 feet. It is a drainage lake located on the Turtle River. Oxbow Lake is upstream of it and Rice Lake is downstream. A public boat landing with parking is present at the south end of the lake. Residential development along the shoreline is fairly heavy, although there a still a few sections of undeveloped shoreline, mostly where wetlands are present.

Water quality

Representative summer water quality data is listed below:

Secchi depth (water clarity) = 4-7 ft.
Total phosphorus = 21-27 micrograms per liter
Chlorophyll a = 5-9 micrograms per liter
True color (water color) = 55 platinum-cobalt units
pH = 7.2-7.5
Hardness = 39 milligrams per liter as $CaCO_3$
Conductivity = 105 micromhos per cm

Echo Lake is a softwater, moderately fertile lake. Based on total phosphorus and chlorophyll a concentrations, it is considered mesotrophic or slightly eutrophic. Water clarity is fair, with summer Secchi depths in the 4 to 7 feet range. Water color (staining) derived from wetland drainage is significant and contributes to reduced water clarity.

Aquatic plants

A good diversity of native aquatic plants is found in the lake with at least 32 species present (see appendix B). There are no exotic (non-native) species of aquatic plants present. There is a good mix of emergent, floating leaf, and submergent plants. Overall, aquatic plant densities in Echo Lake are moderate. Aquatic plant densities in shallow bay areas are moderate to high. The maximum depth of aquatic plant growth is about 8 feet in most sections of the lake.

Fishery

Echo Lake supports a fish community comprised of most native fish species found in the region. Walleye are the predominant gamefish species followed by musky and smallmouth bass. The panfish population is comprised of bluegill, pumpkinseed, yellow perch, rock bass, and black crappie, in order of abundance based on a 1999 fisheries survey.

Recent survey data suggests the walleye population is below its potential of 1.5 adults/acre. Alternate year stocking began in 2001 with an evaluation planned for 2006. Musky stocking has been discontinued based on the 1999 survey which documented good current year reproduction and past natural recruitment. The lake has a history of providing a good consistent fishery with minimal management attention. Black crappies at times provide an above average panfish fishery.

Wildlife

The shoreline and adjacent shorelands of Echo Lake provide habitat for a wide range of water dependent, wetland, and upland wildlife. Habitat is best where the shoreline is undeveloped or has been allowed to remain mostly natural. The mixture of wetland and upland shoreland present increases habitat diversity. Waterfowl make some use of the lake during spring and fall migration and for nesting. There is an active osprey nest at the north end of the lake. Frogs, including bullfrogs are abundant.

Rare/endangered and exotic species

The Natural Heritage Inventory of rare or endangered plants or animals has several listings for the sections encompassing Echo Lake. Species listed are:

- Bald eagle – a special concern species and federally listed as threatened. Two formerly active nest sites are also listed.
- Osprey – a threatened species. An osprey nest on the north end of Echo Lake has been active for many years.
- Northern black currant – a special concern species. It occurs in neutral to calcareous conifer woods and swamps.
- Common bog arrowgrass – a special concern species. It occurs in neutral to calcareous conifer swamps.

Bullfrogs, which are a special concern species, are also found at Echo Lake.

There are no known exotic species present.

SHORELAND MANAGEMENT

Activities along a lakeshore and in the immediate shoreland area can have major impacts on overall lake quality. There is growing recognition of the need to manage these areas in an environmentally conscious manner.

Shoreland management program

Wisconsin's Shoreland Management Program is a partnership between state and local government to protect clean water, habitat for fish and wildlife, and natural scenic beauty. The program establishes minimum standards for lot sizes, structural setbacks, shoreland buffers, vegetation removal, and other activities within the shoreland zone. The shoreland zone includes land within 1,000 feet of lakes, 300 feet of rivers, and floodplains. With research demonstrating that current standards may be inadequate to

protect water resources and the fish and animals that depend on them, many communities have chosen to go beyond the minimum standards to ensure our natural resources are adequately protected.

Buffers

Maintaining and restoring shoreland buffers is a key tool for lake resource protection. A shoreland buffer should extend from the water onto the land at least 35 to 50 feet. Studies have shown that buffers less than 35 feet may not be effective at preventing water pollution. Deeper buffers of 50 feet or more can help provide important habitat for songbirds, turtles, frogs, and other animals, as well as help filter out pollutants from runoff. In general, no mowing should occur in the buffer area, except perhaps in a viewing/access corridor. The buffer should contain local native vegetation suited to site conditions and include herbaceous, shrub, and tree layers.

The presence of dead wood can enhance the wildlife values of a buffer. Standing dead and dying trees (snags) provide forage sites for insect eating birds and eventually nest sites for woodpeckers and songbirds. Cavities in trees provide den sites for many species of birds and mammals. Downed and rotting logs provide homes to many types of wildlife including salamanders, small mammals, and invertebrates. Downed trees and logs in or near the water are especially valuable for resting and feeding areas.

Runoff abatement

In addition to buffers, shoreland properties can reduce the impacts of runoff flowing into the lake in other ways:

- Eliminate or reduce pesticide and fertilizer use.
- Use phosphorus free fertilizer when needed.
- Direct runoff to areas with high infiltration or retention.
- Install rain gardens.
- Minimize areas with impervious surfaces.
- Maximize areas with natural vegetative cover.

Aquatic plant values and management

Native aquatic plant communities are important for the proper functioning of a healthy lake ecosystem. Aquatic plants (macrophytes and algae) form the base of a lake's food chain. Adult and juvenile fish are dependent on aquatic plants for cover and habitat. Many fish species require aquatic plants for spawning habitat. Aquatic plants are important habitat for many aquatic invertebrates. They also serve an important function in reducing shoreline erosion from wave action and stabilizing bottom sediment.

A healthy native aquatic plant community can reduce the ability of exotic aquatic plants to become established. Eurasian water milfoil and curly leaf pondweed are two exotic species with the potential to create nuisance conditions in northern Wisconsin lakes.

Aquatic plants also provide important functional values for wildlife. Waterfowl and furbearers require aquatic vegetation for food and cover. Loons require aquatic

vegetation for their nests. Songbirds, shoreline waterbirds, frogs and other amphibians, reptiles, and a host of other wildlife utilize aquatic vegetation for some critical life cycle need.

Removal of aquatic plants should be minimized. Shoreline owners are allowed to manually remove aquatic plants from up to a 30 feet wide corridor that extends perpendicular to the shore without a permit. The 30 feet corridor must include any piers, boatlifts, swimrafts, and other recreational and water use devices. Any vegetation that is cut or dislodged must be removed from the lake. Herbicide use on aquatic plants is generally discouraged and requires a DNR permit. Any removal of aquatic plants in sensitive areas requires a DNR permit.

SENSITIVE AREA SURVEY

The Echo Lake sensitive area survey was conducted on August 25-26th, 2003 using Wisconsin DNR guidelines for sensitive area surveys. These surveys use an integrated team approach. Several DNR resource managers collaborate to identify locations around a lake that provide unique or important habitat that benefits the lake's fishery, wildlife or general water quality. The DNR resource managers who participated in this survey were:

Bruce Bacon, Wildlife Biologist (Mercer)
Dan Houston, Water Management Specialist (Park Falls)
Craig Roesler, Water Quality Biologist (Hayward)
Jeff Roth, Fisheries Biologist (Mercer)

Sensitive areas often contain high quality aquatic, wetland, and/or terrestrial vegetation. Other values such as clean gravel/rubble substrate or an abundance of downed woody cover (fallen trees or logs) may also help define sensitive areas. These areas typically provide habitat that is needed for seasonal or life stage requirements of fish, invertebrates, and wildlife, provide water quality benefits to the lake, and/or reduce shoreline erosion.
Sensitive area survey reports can be used by DNR personnel, county zoning personnel, lake organizations, shoreline property owners, and other interested groups and individuals. The reports have a variety of uses:

- They provide baseline lake data
- They guide management decisions on permit applications. Permits potentially affected include:
    - Aquatic plant management permits,
    - Permits required by chapter 30 of the Wisconsin Statutes for filling, dredging, sand blankets, rip-rap, tree drops, fish cribs, half logs, spawning substrate addition, aeration, and other alterations,
    - Wildlife control permits and rare species collection permits,
    - County zoning permits and variance requests

- They can be used by lake organizations to help guide lake use and management activities such as:
    - Educational efforts to promote environmentally conscious shoreline management,
    - Establishment of no-wake zones,
    - Shoreline protection through acquisition or use limitation agreements.

- They can provide a source of information for potential contested case hearings.

Four sensitive areas are designated for Echo Lake. Sensitive area locations are shown in figure 1. Descriptions of these sensitive areas and their management recommendations are given below. The field data forms for these sensitive areas are contained in appendix A. Descriptions of the aquatic plant species present in the sensitive areas are contained in appendix B (appendix A and B are attached to only selected copies of this report). "The Water's Edge", a pamphlet that further describes the importance of shoreline habitat for fish and wildlife, is attached as appendix C.

LAKE-WIDE SHORELINE MANAGEMENT RECOMMENDATIONS

In addition to the sensitive area management recommendations that follow, a number of recommendations are applicable to the entire shoreline of Fireside Lakes:

1. Maintain or restore shoreland buffers with small view/access corridors.
2. Protect aquatic vegetation. Minimize any removal or control.
3. Use bioengineering for bank protection where needed. Rock rip-rap is unnecessary for most sites on this lake.
4. Do not remove coarse woody cover. Allow future treefalls to remain in the lake.
5. Eliminate or reduce pesticide and fertilizer use. Use phosphorus free fertilizer when needed.
6. Control erosion sources and prevent sediment from reaching the lake.
7. Manage runoff to maximize infilration.
8. Prevent the establishment of exotic species (signs, education, monitoring, etc.).

SENSITIVE AREA DESCRIPTIONS

SENSITIVE AREA E-1

This site is a large bay located at the northeast end of the lake where the Turtle River enters (W end = 46° 11' 22.5" N, 90° 03' 23.5" W; N end = 46° 11' 28.7" N, 90° 03' 11.5"W). The site shoreline length is 2,395 feet. There are 1,710 feet of shoreline on the north side and 2,395 feet on the south side. Water depth ranges from 0 to 6 feet (the maximum depth of aquatic plant growth).

Primary reasons for site selection were aquatic and terrestrial vegetation, fishery, wildlife, and water quality values and natural scenic beauty.

The bottom substrate is mostly silt, with some sand and gravel. Large woody cover is absent due to the lack of shoreline trees.

A dense fringe of emergent aquatic vegetation is present along the entire shoreline. There is a band of floating leaf aquatic vegetation of variable width along 90% of the shoreline. The width of this band is less than 25 feet at most locations. Submergent aquatic vegetation is present at moderate to high densities. Twenty-six species of aquatic plants were found. They are:

PRESENT	COMMON	ABUNDANT
Emergents Sedge (Carex sp.) Three-way sedge (*Dulichium arundinaceum)* Creeping spikerush (*Eleocharis palustris)* Water horsetail (*Equisetim fluviatile*) Hardstem bulrush (*Scirpus acutus*) Bur-reed (*Sparganium sp.*) Broad-leaved cattail (*Typha latifolia*)	**Emergents** Pickerelweed (*Pontederia cordata*)	
Floating leaf Watershield (*Brasenia schreberi*) Spatterdock (*Nuphar variegata*) White water lily (*Nymphaea odorata*) Floating-leaf pondweed (Pot. natans) Floating-leaf bur-reed (Sparganium fluctuans)	**Floating leaf**	
Submergents Water marigold (Bidens beckii) Northern water milfoil (Myriophyllum sibiricum) Water milfoil (Myriophyllum sp.) Bushy pondweed (*Najas flexilis*) Clasping-leaf pondweed (*Pot. richardsonii*) Fern-leaf pondweed (Pot. robbinsii) Flat-stem pondweed (*Pot. zosteriformis*) Common bladderwort (Utricularia vulgaris) Wild celery (Vallisneria americana) Water stargrass (Zosterella dubia)	**Submergents** Coontail (*Ceratophyllum demersum*) Large-leaf pondweed (*Pot. amplifolius*) Ribbon-leaf pondweed (*Pot. epihydrus*)	

Pot. = Potamogeton

The shoreland is 100% wetland. The wetland type is an alder thicket. Shrubs and herbs dominate the water's edge.

The natural scenic beauty at this site is rated as outstanding.

This site provides a spawning, nursery, and feeding area, and protective cover for northern pike, musky, bluegill, pumpkinseed, yellow perch, crappie, sucker, and forage fish. It also provides a nursery and feeding area and protective cover for walleyes. Important fish habitat components present at this site include emergent, submergent, and floating leaf aquatic vegetation.

The diversity of aquatic and shoreland vegetation site provides excellent wildlife habitat. Beaver, otter, muskrat, mink, ducks, geese, songbirds, wading birds, frogs, toads, and salamanders can use this area for cover, nesting, and feeding. Upland wildlife, turtles, and snakes can use the area for cover and feeding. The site provides feeding opportunity for eagles, and ospreys. An osprey was seen at the site during the survey. Tadpoles were abundant.

Management Recommendations:
1. Minimize shoreland disturbance (grading, cutting, mowing, placement of structures, etc.)
2. Maintain the current wetland habitat.
3. Protect aquatic and shoreland vegetation.

SENSITIVE AREA E-2

This site is located at the north end of the lake (W end = 46° 11' 26.8" N, 90° 03' 47.7" W; E end = 46° 11' 26.8" N, 90° 03' 30.7" W). The site shoreline length is 1,380 feet. Water depth ranges from 0 to 8 feet (the maximum depth of aquatic plant growth).

Primary reasons for site selection were aquatic and terrestrial vegetation, fishery, wildlife, and water quality values and natural scenic beauty.

The bottom substrate is sand, gravel, and rubble. Large woody cover is present, with 1-2 pieces /100 feet of shoreline.

The site has a band of emergent aquatic vegetation along 80% of the shoreline. The emergents extend out into the lake on the shallow, submerged point that is present. There is a band of floating leaf aquatic vegetation along 60% of the shoreline. Submergent aquatic vegetation is present at moderate to high densities. Twenty-one species of aquatic plants were found. They are:

PRESENT	COMMON	ABUNDANT
Emergents Sedge (Carex sp.) Pickerelweed (*Pontederia cordata*) Arrowhead (*Saggitaria sp.*) Bur-reed (Sparganium sp.)	**Emergents** Hardstem bulrush (*Scirpus acutus*)	

Floating leaf Water shield (*Brasenia schreberi)* Floating-leaf bur-reed (Sparganium fluctuans) Spatterdock (*Nuphar variegata)* White water lily (*Nymphaea odorata*)	**Floating leaf**	
Submergents Water marigold (*Bidens beckii*) Bushy pondweed (*Najas flexilis*) Clasping-leaf pondweed (*Pot. richardsonii*) Coontail (*Ceratophyllum demersum*) Elodea (*Elodea canadensis*) Ribbon-leaf pondweed (*Pot. epihydrus*) Flat-stem pondweed (*Pot. zosteriformis*) Wild celery (*Vallisneria americana*) Water stargrass (*Zosterella dubia*)	**Submergents** Northern water milfoil (*Myriophyllum sibiricum)* Water milfoil (*Myriophyllum sp.*) Large-leaf pondweed (*Pot. amplifolius*)	

Pot. = Potamogeton

The shoreland is 50% wooded and 50% wetland. The wetland is a mix of shrub carr, alder thicket, hardwood swamp, and bog. The shoreland has a good mix of trees, shrubs, and herbs.

The natural scenic beauty at this site is rated as good.

This site provides a spawning, nursery, and feeding area, and protective cover for northern pike, musky, bluegill, pumpkinseed, yellow perch, and crappie. It provides a feeding area and protective cover for walleye, largemouth bass, sucker, and forage fish. Important fish habitat components present at this site include emergent, submergent, and floating leaf aquatic vegetation, gravel, and over-hanging vegetation.

The diversity of aquatic and shoreland vegetation at this site provides excellent wildlife habitat. Upland wildlife, otter, muskrat, mink, songbirds, osprey, wading birds, frogs, toads, salamanders, turtles, and snakes can use this area for cover, nesting, and feeding. Ducks, loons, and geese can use the area for cover and feeding. The site provides feeding opportunities for eagles. There is an osprey nest that has been active for many years. A pair of otters was seen during the survey.

Management Recommendations:

1. Minimize shoreland disturbance (grading, cutting, mowing, placement of structures, etc.)
2. Maintain current habitat.
3. Protect aquatic and shoreland vegetation.
4. Protect existing large woody cover, and allow future treefalls to remain.
5. Maintain existing snag trees and cavity trees.
6. Maintain the existing osprey nest.

SENSITIVE AREA E-3

This site is located along a broad point on the east shoreline of the lake (S end = 46° 11' 0.7" N, 90° 03' 35.7" W; N end = 46° 11' 4.5" N, 90° 03' 26.8" W). The site shoreline length is 775 feet. Water depth ranges from 0 to 10 feet.

The primary reason for site selection was its fishery value. This site is an important walleye spawning area.

The bottom substrate is sand, gravel, and rubble. Large woody cover is present, with 1-2 pieces /100 feet of shoreline.

The site has very little aquatic vegetation due to the coarse substrate, steep bottom gradient, and exposure to wave action. There is a very small patch of emergent aquatic vegetation at the south end of the site. No floating leaf aquatic vegetation is present. There are a few scattered clumps of water milfoil and a small patch of water celery in the north half of the site. Five species of aquatic plants were found. They are:

PRESENT	COMMON	ABUNDANT
Emergents Sedge (*Carex sp.*) Creeping spikerush (*Eleocharis palustris)* Water horsetail (*Equisetum fluviatile*)	**Emergents**	
Submergents Water milfoil (*Myriophyllum sp.*) Wild celery (*Vallisneria americana*)		

The shoreland is 95% wooded and 5% developed. The undeveloped shoreland has a good mix of trees, shrubs, and herbs.

The natural scenic beauty at this site is rated as average.

This site provides a spawning area for walleye, smallmouth bass, and yellow perch. It provides a feeding area for northern pike, musky, smallmouth bass, yellow perch, and crappie. It provides protective habitat for smallmouth bass, largemouth bass, yellow perch, and crappie. Important fish habitat components present at this site include boulders, rubble, and gravel.

The shoreland vegetation, snag trees, and large rocks at this site provide fair wildlife habitat. Upland wildlife, songbirds, and snakes can use the area for cover, nesting, and feeding. Mink can use the area for cover and feeding. Turtles can use it for a nesting area. This site provides feeding opportunities for eagle and osprey.

Management Recommendations:

1. Protect the coarse bottom substrate (rubble, gravel) from erosion sources and sedimentation.
2. Minimize shoreland disturbance (grading, cutting, mowing, placement of structures, etc.)
3. Protect existing large woody cover, and allow future treefalls to remain. Create tree drops for fish cover.
4. Maintain existing snag trees and cavity trees.

SENSITIVE AREA E-4

This site is located in the bay at the south end of the lake (W end = 46° 10' 13.2" N, 90° 03' 59.5" W; E end = 46° 10' 11.4" N, 90° 03' 55.7" W). The site shoreline length is 600 feet. Water depth ranges from 0 to 5 feet.

Primary reasons for site selection were aquatic and terrestrial vegetation, fishery, wildlife, and water quality values.

The bottom substrate is mostly muck with some sand, gravel, and rubble. Large woody cover is present, with 1-2 pieces /100 feet of shoreline.

The site has a band of emergent aquatic vegetation along 40% of the shoreline. Scattered patches of floating leaf aquatic vegetation are present in about 10% of the site area. High densities of submergent aquatic vegetation are also present through most of the site. Twenty-three species of aquatic plants were found. They are:

PRESENT	COMMON	ABUNDANT
Emergents Bur-reed (*Sparganium sp.*)	**Emergents** Pickerelweed (*Pontederia cordata)*	

Floating leaf Watershield (*Brasenia schreberi*) Spatterdock (*Nuphar variegata*) Small duckweed (*Lemna minor*) Large duckweed (*Spirodela polyrhiza*)	**Floating leaf** White water lily (*Nymphaea odorata*)	
Submergents Water marigold (*Bidens beckii*) Coontail (*Ceratophyllum demersum*) Needle spikerush (*Eleocharis acicularis*) Northern water milfoil (*Myriophyllum sibiricum*) Water milfoil (*Myriophyllum sp.*) Bushy pondweed (*Najas flexilis*) Ribbon-leaf pondweed (*Pot. epihydrus*) Clasping-leaf pondweed (*Pot. richardsonii*) Fine-leaf pondweed (*Pot. sp.*) Flat-stem pondweed (*Pot. zosteriformis*) Common bladderwort (*Utricularia vulgaris*) Wild celery (*Vallisneria americana*) Water stargrass (*Zosterella dubia*)	**Submergents** Elodea (*Elodea canadensis*) Large-leaf pondweed (*Pot. amplifolius*)	**Submergents** Fern-leaf pondweed (*Pot. robbinsii*)

Pot. = Potamogeton

The shoreland is 95% wetland and 5% wooded. The wetland area is a mix of alder thicket and shrub carr. The undeveloped area of shoreland has a good mix of trees, shrubs, and herbs.

The natural scenic beauty at this site is rated as poor.

This site provides a spawning, nursery, and feeding area, and protective cover for northern pike, musky, largemouth bass, bluegill, pumpkinseed, yellow perch, crappie, and forage fish. It provides a feeding area and protective cover for walleye and sucker. Important fish habitat components present at this site include emergent, submergent, and floating leaf aquatic vegetation, and overhanging vegetation.

The diversity of aquatic and shoreland vegetation, snag trees, and large rocks at this site provide good wildlife habitat. Upland wildlife, beaver, otter, muskrat, mink, ducks, song birds, wading birds, frogs, toads, salamanders, turtles, and snakes can use this area for cover, nesting, and feeding. Geese can use the area for cover and feeding. The site provides feeding opportunities for eagles and ospreys. Green herons and wood ducks were seen during the survey. Bullfrogs and green frogs were abundant.

Management Recommendations:

1. Remove the collapsed pier and other trash from the site.
2. Minimize shoreland disturbance (grading, cutting, mowing, placement of structures, etc.)
3. Protect aquatic and shoreland vegetation.
4. Protect existing large woody cover, and allow future treefalls to remain.
5. Maintain existing shoreland habitat including snag trees and cavity trees.
6. Install additional wood duck nest boxes.

APPENDIX A.

ECHO LAKE
SENSITIVE AREA
FIELD DATA FORMS

APPENDIX B.

ECHO LAKE
SENSITIVE AREA
AQUATIC PLANT SPECIES
LIST AND DESCRIPTIONS

LIST OF AQUATIC PLANT SPECIES OBSERVED IN ECHO LAKE SENSITIVE AREAS*

Common Name	Scientific Name
Emergents	
Sedge	*Carex sp*
Three-way sedge	*Dulichium arundinaceum*
Creeping spikerush	*Eleocharis palustris*
Water horsetail	*Equisetum fluviatile*
Pickerelweed	*Pontederia cordata*
Arrowhead	*Sagittaria sp*
Hardstem bulrush	*Scirpus acutus*
Bur-reed	*Sparganium sp.*
Broad-leaved cattail	*Typha latifolia*
Floating-leaf	
Watershield	*Brasenia schreberi*
Small duckweed	*Lemna minor*
Spatterdock	*Nuphar variegata*
White water lily	*Nymphaea odorata*
Floating-leaf pondweed	*Potamogeton natans*
Floating-leaf bur-reed	*Sparganium fluctuans*
Large duckweed	*Spirodela polyrhiza*
Submergents	
Water marigold	*Bidens beckii*
Coontail	*Ceratophyllum demersum*
Needle spikerush	*Eleocharis acicularis*
Elodea	*Elodea canadensis*
Northern water milfoil	*Myriophyllum sibiricum*
Water milfoil (various-leaved)	*Myriophyllum sp.* (heterophyllum)
Bushy pondweed	*Najas flexilis*
Large-leaf pondweed	*Potamogeton amplifolius*
Ribbon-leaf pondweed	*Potamogeton epihydrus*
Clasping-leaf pondweed	*Potamogeton richardsonii*
Fern-leaf pondweed	*Potamogeton robbinsii*
Fine-leaf pondweed	*Potamogeton sp.*
Flat-stem pondweed	*Potamogeton zosteriformis*
Common bladderwort	*Utricularia vulgaris*
Wild celery	*Vallisneria americana*
Water stargrass	*Zosterella dubia*

*Only species rooted below the waterline are included.

APPENDIX C.

THE WATERS EDGE

Appendix F

Raymond Johnson Letter
May 17, 1999

RAYMOND E. JOHNSON
900 N. TAYLOR ST. APT. 1725
ARLINGTON, VA 22203
703/524-4237

Former USFWS

Re Echo Lake Mercer, Wi.

Msy 17, 1999

Dear Mr. Hildebrandt:

I'd like to add comments to three of the topics suggested in the dues notice form, and hope that whoever processes the form can get these notes to you at your residence. Perhaps I should mail a copy to you directly.

My first year on Echo Lake was 1917. My grandfather was one of the five original buyers of the north shoreline in 1912 from Dr. Hawley and his sister Kate. I became one of the six joint-owners-in-common in 1942 (the sixth co-owner joined in 1926). My house and land-share at Echo Lodge have been the most enjoyable and influential parts of my life for over 80 years; of course the lake and its plant and animal life have been one of the many great attractions, and many people in Mercer and Iron County still are my longtime friends.

Our year-round interests on the lake's north end may not coincide entirely with those of residents on the east and west sides, but we are there at all times of the year and want to be aware of what is happening politically and economically in the area. Your Association news helps. My comments in the next three sections may be controversial to some other "experts" but I like such discussions. I'll defer to the DNR managers and their opinions most of the time.

The Fishery. My first catch in 1917 was a 13-inch walleye in the mouth of the Turtle River. I'm still catching 13-15 inch fish there. As the cycles go, I see fewer crappies and rock bass now, many more bullheads and redhorse, more perch, and about the same numbers of both bass species. Northern pike and muskies don't have a chance against the numbers of fishermen these days and I see fewer of those species. The bluegills are holding their own, I believe. About 10 minnow species and darters vary from year to year according to spawning success. Th DNR samples and shock tests give good readings of all of these species, most years.

Echo Lake's ability to produce fish is limited, in comparison to other, more southern and more hard-water lakes. As a farmer would say, you can't expect 60 bushels of corn from 20-bushel land. Such fertility as Echo Lake does get from its watershed is more likely to be producing brown bullheads and redhorse than walleyes, northerns, and muskies. The growth rates are likewise slow; walleyes may take 5 years to reach a 15-inch spawning size while in southern Wisconsin they can reach that size in 3.

Aquatic Plant Control. Echo lake has matured in the 8-9,000 years since the glaciers left it, and has reached the point where it is shallow, & loaded with organic sediment. It is in a plant producing stage and within another few thousand years it will be a bog or swamp with a river through it. Effort and money will slow this trend but not stop it.

The vegetational changes in my lifetime, both in Echo and other northern lakes, are substantial. The great beds of wild rice with their flocks of coots, rails, and blackbirds and absent now. A big watershed fire, or even some as the small fires of 1924 and 1927, would bring back the water fertility and wild rice for another cycle, but we prefer forests to rice these days. In Echo Lake and many others, the yellow water lily is being replaced by the white species, and a new species of yellow is taking over much of the northwest corner of the Lake. Similar changes are showing in the other 45 or 50 plant species in the lake. Lakes as small and shallow as Echo can make such changes in a decade or less.

Water Quality. Several of man's effluents entered the lake in significant qualtities from about the 1930's to the 1960's and its chemistry changed in those years. Lately, however, my water samples indicate that the lake has overcome the influences of Hanneman's sawdust piles in the south end, the soapy discharges from Ball's store and Fred Lee's barber shop (where the school gym now is), and the nitrogen-rich seepage from many septic tanks and fields around the shore. I no longer see the "green paint" algal blooms inches thick blowing onto the north shore in summer. Those blue-green algae mats were not only toxic to dogs and horses but when they died and rotted, all oxygen was removed from the water.

Echo Lake is almost back to being the soft-water, acidic, bog-stained, low-fertility body of water it once was. I forgot to mention the motor problems we had in the '30's too. Lee Gehr's muffler-free Lockwoods and the noisy Evinrudes, Johnsons, and Cailles from the large Keewatin Resort and water slide on the northeast shore kept us awake all night. A few conditions are better now.

Sincerely,

W. E. Johnson