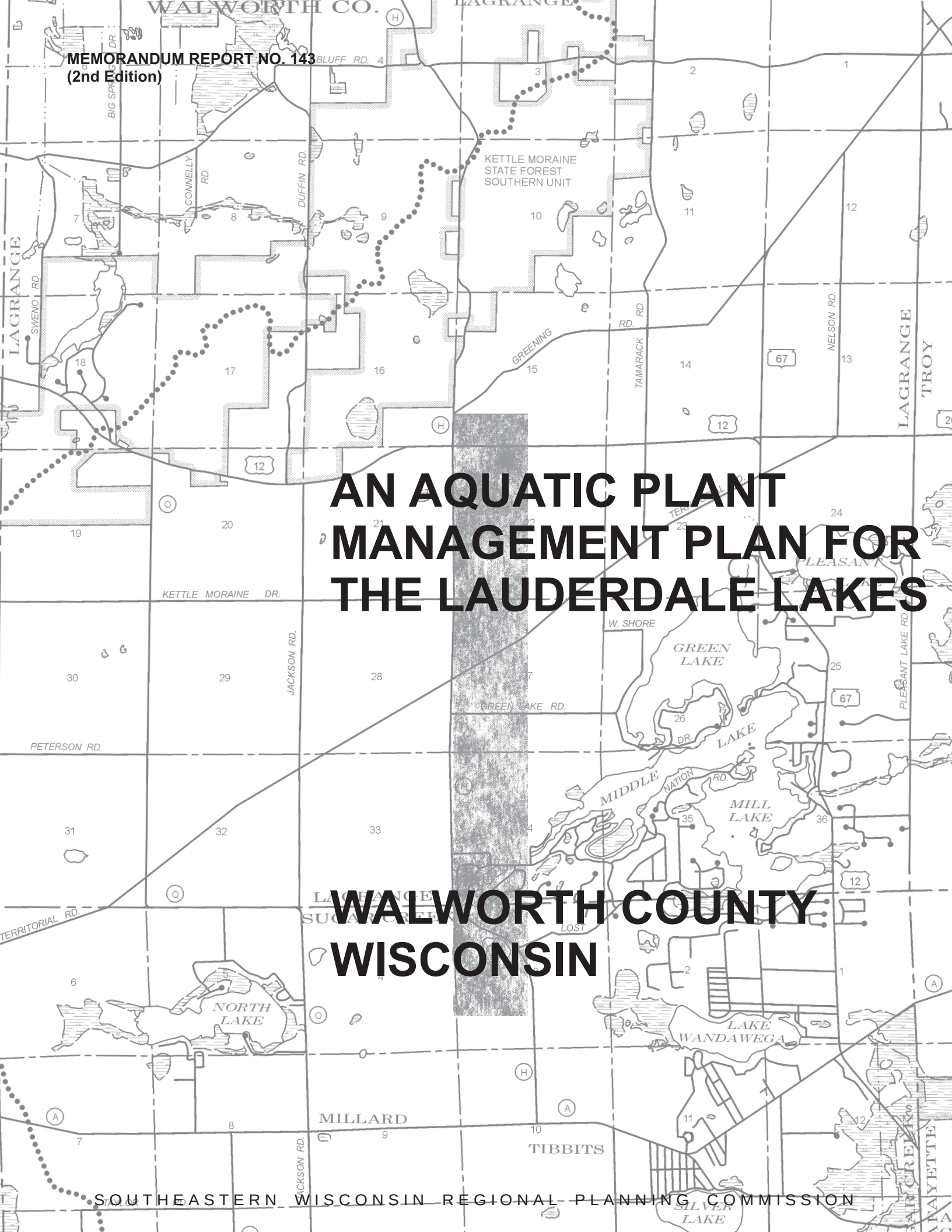

MEMORANDUM REPORT NO. 143
(2nd Edition)

AN AQUATIC PLANT MANAGEMENT PLAN FOR THE LAUDERDALE LAKES

WALWORTH COUNTY WISCONSIN

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MEMORANDUM REPORT
NUMBER 143, 2nd Edition

AN AQUATIC PLANT MANAGEMENT PLAN FOR THE LAUDERDALE LAKES

WALWORTH COUNTY, WISCONSIN

Prepared by the

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July 2010

$10.00

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Chapter I

INTRODUCTION

The Lauderdale Lakes, located in the Towns of LaGrange and Sugar Creek, both in Walworth County, Wisconsin, are an 841-acre, multiple-lake system comprised of three waterbodies: Green Lake, Middle Lake, and Mill Lake. These Lakes together form the headwaters of Honey Creek, a tributary stream to the Fox River. The Lakes are located within U.S. Public Land Survey Township 4 North, Range 16 East, Sections 25 and 26, and 34 through 36, in the Town of LaGrange; and, Township 3 North Range 16 East, Sections 1 and 2, in the Town of Sugar Creek, both in north-central Walworth County.

The Lauderdale Lakes system is a heavily used, recreational water resource, and the central feature of a residential community situated within easy reach of the Milwaukee metropolitan area. The lake system is a popular year-round residential area, and also is a popular destination for weekend recreational users. Several camps are located along the lakeshores, providing a water-oriented get-away for city dwellers particularly during the summer months. In recent years, the lake residents have become increasingly concerned about present and future impacts of development and increasing recreational use on the Lakes and their ecosystems. These concerns have related to a perceived decrease in water clarity, increase in growths of aquatic plants and the spread of nonnative aquatic plant species, contamination of the lake waters by nonpoint source pollutants, user-related aesthetic degradation, and surface water use conflicts. Seeking to improve the usability of the Lakes and to prevent the deterioration of its natural assets and recreational potential, residents have created a number of civic organizations, including the Lauderdale Lakes Improvement Association, Inc. (LLIA) and the Lauderdale Lakes Conservancy, now the Kettle Moraine Land Trust (KMLT). In addition, residents have formed a Chapter 33, *Wisconsin Statutes*, public inland lake protection and rehabilitation district, the Lauderdale Lakes Lake Management District (LLLMD), which continues to undertake annual programs of lake and aquatic plant management in the basin. Collectively, these organizations form the Lauderdale Lakes Partnership, described more fully at the end of this chapter.

BACKGROUND

The Lauderdale Lakes have been the subject of earlier lake management-related investigations, including a 2001 study conducted jointly by the LLLMD, the Wisconsin Department of Natural Resources (WDNR), and the Southeastern Wisconsin Regional Planning Commission (SEWRPC);[1] a WDNR *Lake Use Report* published in

[1]*SEWRPC Memorandum Report No. 143,* An Aquatic Plant Management Plan for the Lauderdale Lakes, *Walworth County, Wisconsin,* August 2001.

1969;[2] and, a nonpoint source pollution abatement planning program, documented in a WDNR Priority Watershed Plan for the Honey-Sugar Creeks watershed.[3] Collectively, these plans have formed the foundation for specific lake-oriented interventions by the community, including installation of stormwater management facilities at strategic locations around the Lakes, ongoing water quality monitoring programs, and an active program of aquatic plant management. In addition, the KMLT, in partnership with the other lake organizations and local communities, have purchased a number of critical wetland systems around the Lakes, placed these areas into conservancy zoning, and undertaken onsite remediation of the riparian vegetation within the sites.

With respect to the aquatic plant communities in the Lakes, the LLLMD has pursued an active program of aquatic plant management, seeking to moderate the impacts of nonnative species in the Lakes, while promoting the growths of native aquatic plants. A healthy native aquatic plant community in the Lakes provides the basis for the continued recreational use of the Lakes, including a healthy lake fishery and adequate open water areas for recreational boating and associated activities. To this end, the Regional Planning Commission assisted the LLLMD in developing an aquatic plant management strategy and plan for the Lakes during 2001.[4] This plan refines the issues of concern, evaluates the range of potential remedial options, provides information on the condition of the aquatic plant communities in the Lauderdale Lakes during 2008, includes relevant tributary area and waterbody data, and provides recommendations for the ongoing management of aquatic plants within the Lauderdale Lakes.

Specifically, this report represents part of the ongoing commitment of the Lauderdale Lakes community, through the LLLMD and its sister agencies and organizations, to sound planning with respect to the Lakes. The report sets forth inventories of the aquatic plant communities present within the Lauderdale Lakes during July and August of 2008. These inventories were prepared by SEWRPC in cooperation with the LLLMD, and include the results of field surveys conducted by the SEWRPC staff. The aquatic plant surveys were conducted using the modified Jesson and Lound transect method developed by the WDNR,[5] which, when used over a number of years, allows quantitative assessment of the effectivity of the management measures employed.[6] This planning program was funded by the LLLMD.

The scope of this report is limited to a consideration of the current water quality conditions and aquatic plant communities present within the Lauderdale Lakes, the documentation of historical changes in the plant communities based upon currently existing data and information, and the refinement of those management measures which can be effective in the control of aquatic plant growth in the Lake. Recommendations are made with respect to the potential management measures proposed to be implemented by the LLLMD, in cooperation with the Towns of LaGrange and Sugar Creek and the various other lake management and conservation organizations—the Lauderdale Lakes Partnership—serving the Lauderdale Lakes community.

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[2]*Wisconsin Department of Natural Resources Publication Lake Use Report Nos. FX-17, FX-18, and FX-20*, The Lauderdale Lakes, Walworth County, Wisconsin, *1969.*

[3]*Wisconsin Department of Natural Resources Publication No. WT-478-97,* Nonpoint Source Control Plan for the Sugar/Honey Creek Priority Watershed Project, *February 1997.*

[4]*SEWRPC Memorandum Report No. 143,* op. cit.

[5]*R. Jesson, and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6,* An Evaluation of a Survey Technique for Submerged Aquatic Plants, *1962.*

[6]*Memorandum from Stan Nichols, to J. Bode, J. Leverence, S. Borman, S. Engel, and D. Helsel, entitled "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes example," Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, February 4, 1994.*

AQUATIC PLANT MANAGEMENT PROGRAM GOALS AND OBJECTIVES

The aquatic plant management goals and objectives for the Lauderdale Lakes were developed in consultation with the LLLMD and the Lauderdale Lakes Partnership. The agreed-upon goals and objectives are to:

1. Protect and maintain public health, and promote public comfort, convenience, necessity, and welfare, in concert with the natural resource, through the environmentally sound management of native vegetation, fishes, and wildlife populations in and around the Lauderdale Lakes;

2. Effectively control the quantity and density of aquatic plant growths in portions of the Lauderdale Lakes basins to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the natural resource value of the waterbody;

3. Effectively maintain the water quality of the Lauderdale Lakes to better facilitate the conduct of water-related recreation, improve the aesthetic value of the resource to the community, and enhance the resource value of the waterbody; and,

4. Promote a quality, water-based experience for residents and visitors to the Lauderdale Lakes consistent with the policies and objectives of the WDNR as set forth in the regional water quality management plan.[7] The inventory and aquatic plant management plan elements presented in this report conform to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes.*[8] Implementation of the recommended actions set forth herein should continue to serve as an important step in achieving the stated lake use objectives over time.

THE LAUDERDALE LAKES PARTNERSHIP

The Lauderdale Lakes community has a long history of active involvement in lake management. From the early days of the Lauderdale Lakes Improvement Association in the late 1800s to the recent formation of the Kettle Moraine Land Trust in 2000, the Lauderdale Lakes community has evidenced a commitment to sound lake management and community development, with the protection of the Lakes and their natural resources forming the primary institutional objectives of the community. With the formation of the public inland lake protection and rehabilitation district in 1991, the three community institutions focused on the management of the Lauderdale Lakes have worked cooperatively with local, county, and State government to minimize the potentially deleterious impacts of human development on the Lakes, while simultaneously promoting the safe recreational use of these waterbodies for a wide range of recreational purposes, including both active and passive recreational pursuits, such as boating, angling, and scenic viewing. By creating an innovative public-private partnership for lake management, the Lauderdale Lakes Partnership continues to play an active role in the management of the Lakes and their natural resources, based on the relative strengths of each of the partner organizations, as summarized below.

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[7]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, *June 1979, as amended; see also SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

[8]*This plan has been prepared pursuant to the standards and requirements set forth in the following chapters of the* Wisconsin Administrative Code*: Chapter NR 1, "Public Access Policy for Waterways;" Chapter NR 103, "Water Quality Standards for Wetlands;" Chapter NR 107, "Aquatic Plant Management;" and Chapter NR 109, "Aquatic Plants Introduction, Manual removal and Mechanical Control Regulations."*

Lauderdale Lakes Improvement Association, Inc.

The Lauderdale Lakes Improvement Association, Inc., was formed in 1892 to encourage and assist in the general work of protecting and improving the Lauderdale Lakes, and their banks and shores in the Towns of LaGrange and Sugar Creek.[9] The Association was empowered to purchase, own, and sell personal property, and make contracts for dredging, weed cutting and clearing, and any and all other work which may be incidental to its general purposes. It also was empowered to aid in and attend to the restocking of the Lakes with fishes from time-to-time as may be necessary; to attend to and assist in the prosecution of any persons engaged in illegal activities on or about the Lauderdale Lakes; and prosecute or defend actions in its corporate name in the several Courts of State of Wisconsin or the United States, especially in response to actions affecting the physical conditions of the Lakes and their riparian properties that might alter or change conditions in the Lakes. In general, the Association shall have all the powers incidental to associations of like character organized under the laws of the State of Wisconsin. To this end, the Association has a number of standing committees, including communications, membership, planning and zoning, property, water quality, fish, and water safety.

Lauderdale Lakes Lake Management District

The Lauderdale Lakes Lake Management District was created in 1991 pursuant to Chapter 33 of the *Wisconsin Statutes* to undertake projects relating to environmental lake protection, lake management, and other statutory responsibilities related to the Lakes, including enhancement of the recreational use of the Lakes and conservation projects within the Lauderdale Lakes watershed.[10] Since its inception, the District has undertaken a number of lake improvement projects under its own auspices and in partnership with the other lake-oriented organizations serving the Lauderdale Lakes community, including the Lauderdale Lakes Improvement Association and the Kettle Moraine Land Trust. In 1996, the LLLMD purchased the Lauderdale Lakes Country Club, a nine-hole golf course, to maintain the property in open space use. The Lake District continues to operate this property as a daily fee public golf course, and has enrolled the course in the Audubon Society Cooperative Sanctuary Program. During 2000, the LLLMD purchased a lot in the Gladhurst subdivision on the north side of Green Lake for the purpose of reducing nonpoint pollution loads to the Lakes. A large detention pond was constructed on this site to capture surface runoff water allowing it to gradually perk into the pond instead of running into the Lake through an established tributary. The District also has entered into agreements with several farmers in its drainage area to reduce sediment- and nutrient-loads entering the Lakes, and has purchased a six-acre wetland adjoining the golf course property with about 700 feet of shoreline, to preserve and protect the SEWRPC-delineated primary environmental corridor. This shoreland area provides both habitat and a filter strip for stormwater runoff. In 2003, the District implemented a wetland restoration project in the shoreland wetlands adjacent to Don Jean Bay in Mill Lake to stabilize eroding shorelands and provide additional habitat. The LLLMD operates a water safety patrol in cooperation with the Town of LaGrange.

Kettle Moraine Land Trust

Founded in 2000 through the efforts of the Lauderdale Lakes Improvement Association, the Kettle Moraine Land Trust, formerly the Lauderdale Lakes Conservancy, serves to promote resource conservation and preserve important lands by building partnerships throughout Walworth County. Beginning with the acceptance of the title to the 35-acre Island Woods, the Land Trust has a history of active participation in advocating responsible stewardship of important lands in the Lauderdale Lakes area, as well as countywide. The Land Trust has played a key role in a number of significant contributions to the protection of the natural heritage of the area, including sponsoring workshops on conservation subdivisions, and assisting in the addition of two sensitive area sites to the WDNR report for the Lauderdale Lakes. Since its inception, the KMLT has accepted a conservation easement for the Lauderdale Lakes Country Club, protecting 57 acres of open space, over 1,500 feet of shoreline, and six acres of wetlands; purchased a five-acre marsh with over 1,000 feet of shoreline as an addition to the

[9]*Lauderdale Lakes Improvement Association website, http://www.llia.org/index.php.*

[10]*Lauderdale Lakes Lake Management District website, http://lllmd.org/index.htm.*

Island Woods site; donated a Conservation Easement on Island Woods to the Lauderdale Lakes Improvement Association and the Lauderdale Lakes Lake Management District; constructed a public overlook on the southern edge of the Island Woods preserve; accepted the North Lake Conservation Easement donation of 14 lakefront lots; worked with the Town of LaGrange to pass a mandatory Conservation Subdivision Ordinance; and, received the 2007 Wisconsin Lake Stewardship Award as part of the Lauderdale Lakes Partnership.[11] This Partnership includes both the LLIA and LLLMD.

[11] *Kettle Moraine Land Trust website,* http://www.kmlandtrust.org/history.htm.

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Chapter II

INVENTORY FINDINGS

INTRODUCTION

The Lauderdale Lakes are located in the Towns of LaGrange and Sugar Creek, Walworth County, Wisconsin, as shown on Map 1. The Lakes are comprised of three natural basins linked as a result of the impoundment of the outlet to Mill Lake, which forms the headwaters of Honey Creek. The Lakes have a combined surface area of 841 acres, and include the 311-acre spring-fed Green Lake, the 259-acre flow-through Middle Lake, and the 271-acre drained Mill Lake. The Lauderdale Lakes are a heavily used, recreational water resource, forming the centerpiece of a large residential community comprised of both year-round and seasonal residents. The Lakes, situated within easy reach of the Milwaukee metropolitan area, also are a popular destination for weekend recreational users who utilize the public recreational boating access sites on the Lakes. These sites are located on the southwestern shore of Green Lake, the southwestern shore of Middle Lake, and the eastern shore of Mill Lake at Sterlingworth Bay. In addition, private access to the Lakes is provided at four sites on the Lakes: Lutherdale Lutheran Bible Camp on Green Lake, Lauderdale Landings on Middle Lake, and Sterlingworth Inn and Lauderdale Lakes Marina on Mill Lake. The Lauderdale Lakes Lake Management District also owns the municipal golf course located on the eastern shores of Mill Lake.

WATERBODY CHARACTERISTICS

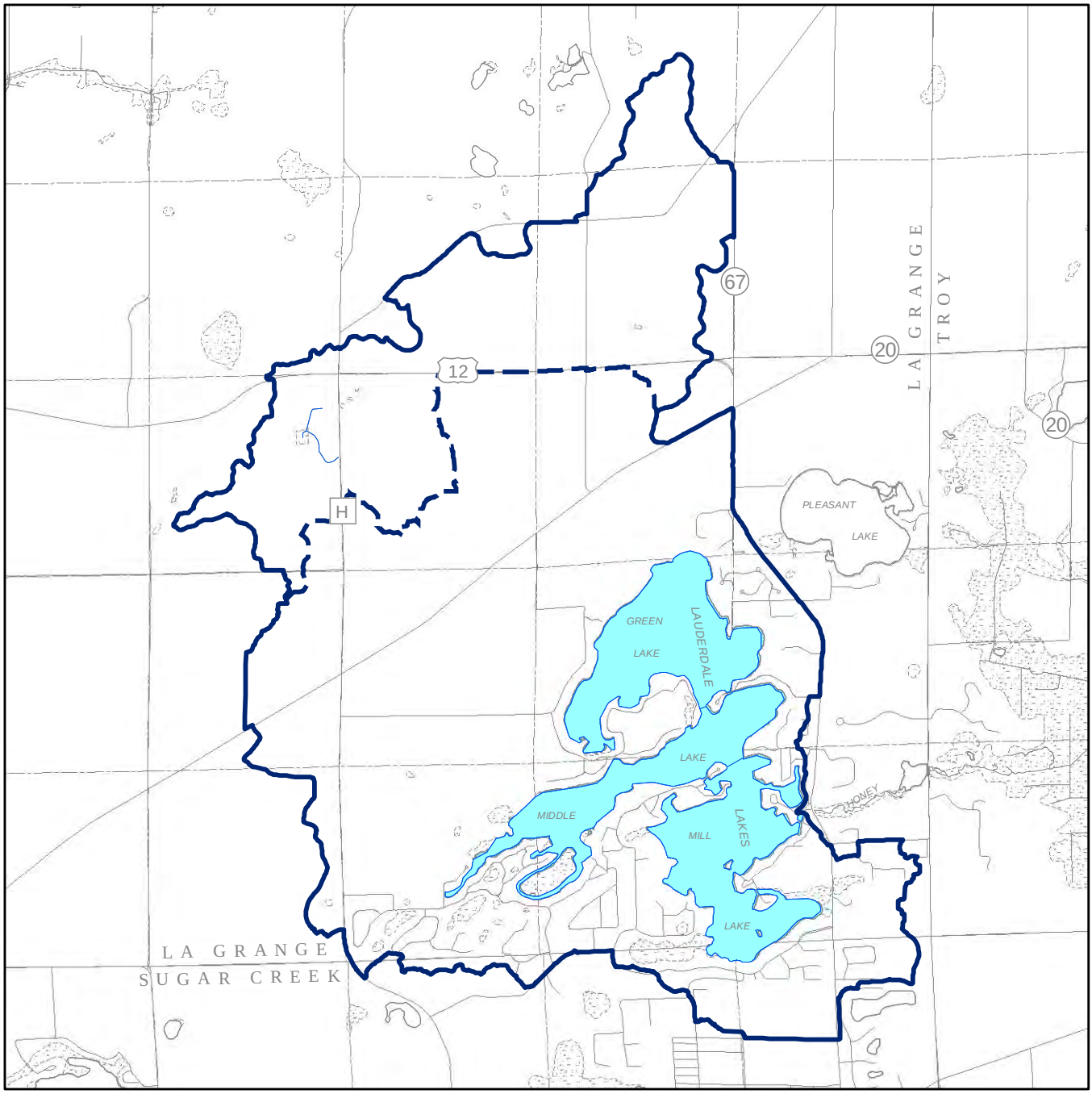
Hydrographical characteristics of the Lauderdale Lakes system are set forth in Table 1. As mentioned above, the Lakes consist of three natural basins, each oriented in approximately a northeast-southwest orientation: Green Lake has a surface area of 311 acres and a maximum depth of approximately 55 feet; Middle Lake has a surface area of 259 acres and a maximum depth of 42 feet; and, Mill Lake has a surface area of 271 acres and a maximum depth of 44 feet. The bathymetries of the three lake basins are shown on Maps 2 through 4, respectively.

As a whole, the Lauderdale Lakes system has a surface area of 841 acres, a total volume of 11,560 acre-feet, a mean depth of 14.3 feet, and a shoreline 14.7 miles in total length. The system has a shoreline development factor (SDF) of 3.6, indicating that, due to its many irregularities, bays, and points, the shoreline is about three and one-half times longer than that of a perfectly circular lake of the same area. By contrast, nearby Pleasant Lake has a development factor of about 1.6, reflecting that Lake's more-circular shape.[1] Shoreline development factor is often related to the level of biological activity in a lake: the greater a lake's SDF (due to greater shoreline contour

[1]*See SEWRPC Memorandum Report No. 174,* An Aquatic Plant Management Plan for Pleasant Lake, Walworth County, Wisconsin*, December 2009.*

Map 1

LOCATION MAP OF THE LAUDERDALE LAKES



Total Tributary Area Boundary

Internally Drained Area Boundary Where Not Coincident with the Total Tributary Area Boundary

Surface Water

Source: SEWRPC.

N

0 2,000 4,000 Feet

Table 1

HYDROLOGY AND MORPHOMETRY OF THE LAUDERDALE LAKES

Parameter	Measurement
Lauderdale Lakes System	
Surface Area	841 acres
Total Tributary Area[a]	6,435 acres
Lake Volume	11,560 acre-feet
Shoreline Length	14.7 miles
Shoreline Development Factor[b]	3.6
Maximum Depth	55 feet
Mean Depth	14.3 feet
General Orientation	N-S
Green Lake	
Surface Area	311 acres
Maximum Depth	55 feet
Middle Lake	
Surface Area	259 acres
Maximum Depth	42 feet
Mill Lake	
Surface Area	271 acres
Maximum Depth	44 feet

[a]The total tributary area for the Lauderdale Lakes was recorded in the earlier SEWRPC report as 6,217 acres. The current measurement is based on elevation refinements made possible through Commission digital terrain modeling analysis and includes the 1,547-acre internally drained area located in the northern portion of the total tributary area.

[b]Shoreline development factor is the ratio of the shoreline length to the circumference of a circular lake of the same area.

Source: Wisconsin Department of Natural Resources, U.S. Geological Survey, and SEWRPC.

irregularity), the greater is the likelihood of the lake to contain shallow, nearshore areas—the places usually containing habitat more suitable for plant and animal life. In other words, lakes with highly irregular shorelines usually provide more shallow-water, nearshore areas (or "littoral zone" areas) suitable for plant and animal life. With a development factor of 3.6, one of the higher development factors in the area, the Lauderdale Lakes would be expected, therefore, to have a fairly high level of biological activity compared to most other lakes in the area.

Biological activity in a lake can also be influenced by other physical factors, such as bottom sediment composition and lake-basin contours. A preponderance of soft bottom sediments and flatness of bottom contour are conditions consistent with lakes of high biological activity. As shown on Map 2, the northern shoreline of Green Lake and the majority of its northwestern shoreline, as well as its southern shoreline along the main point, are areas of hard lake bottom sediment types, such as rock, sand, and gravel, and are also areas of relatively steeply sloped bottom contours; whereas, the shallower bays in the southwestern and southeastern corners of Green Lake are comprised mainly of soft sediments with much flatter bottom contours. In Middle Lake, as shown on Map 3, rock and gravel bottom sediments along with somewhat steeply sloped bottom contours typify the nearshore areas around most of the main lake basin at the eastern half of the Lake; the western half of the Lake exists as an elongated bay comprised of an expansive area of soft bottom sediments and flat bottom contour. Mill Lake, as shown on Map 4, is largely a lake of flat bottom contours and vast expanses of soft bottom sediments in the southern half of the Lake, although, sand and gravel do appear along much of the shoreline that rings the single main basin in the northern half of the Lake.

TRIBUTARY AREA AND LAND USE CHARACTERISTICS

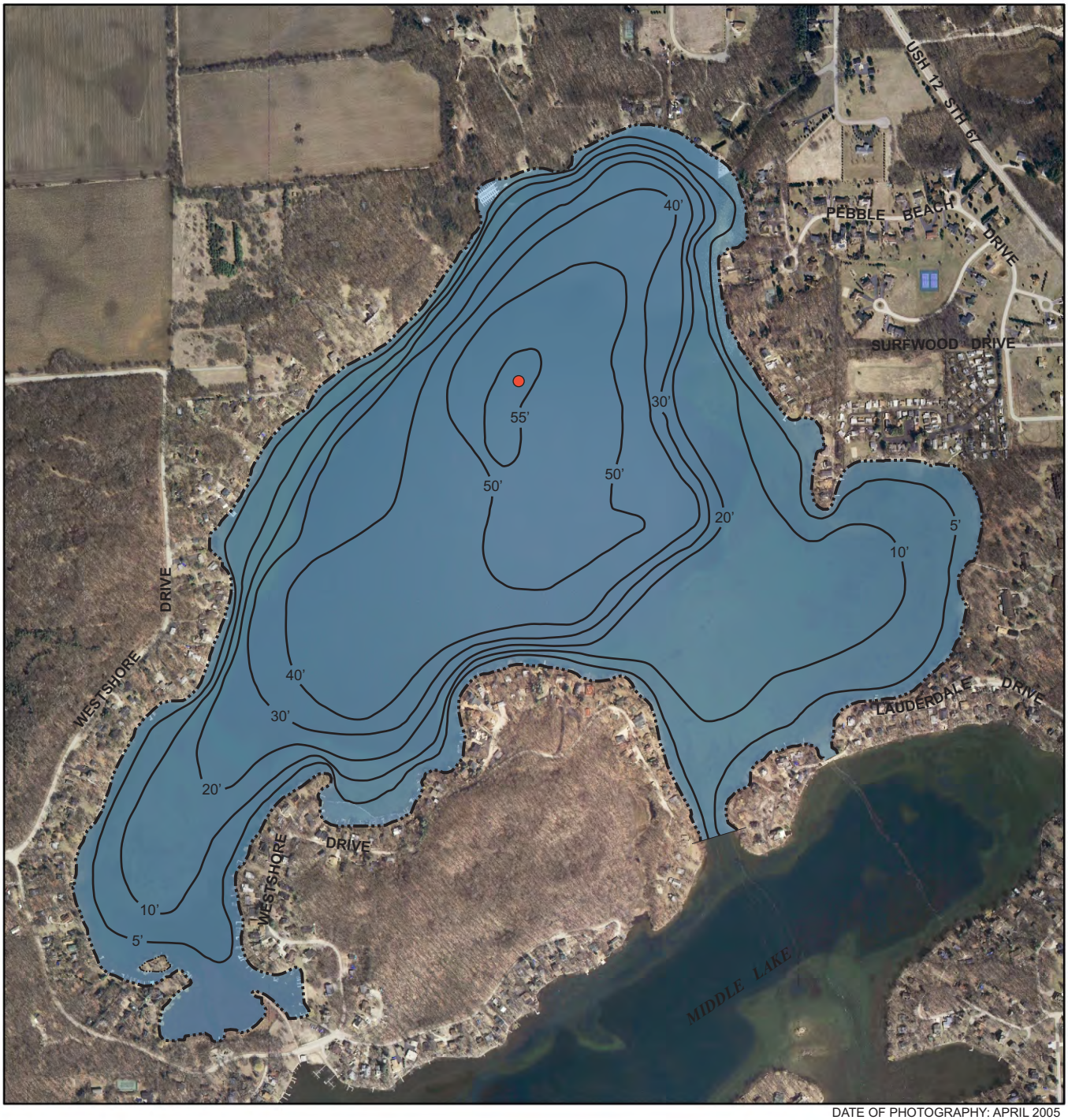
As shown on Map 5, the area tributary to the Lauderdale Lakes is situated mostly within the Town of LaGrange, with a small portion of the extreme southern edge of the tributary area being situated in the Town of Sugar Creek, both in Walworth County. This area, which drains directly to the Lauderdale Lakes system, is approximately 6,435 acres, or about 10.1 square miles, in areal extent. The Lake system and its tributary area are situated in the north-central portion of Walworth County.

Population

The population and the numbers of households and housing units within the Lauderdale Lakes tributary area have all generally shown a relatively steady increase since 1960, as documented in Table 2. The greatest increases in population occurred between 1970 and 1980 when the number of people increased by nearly 96 percent, increasing from 696 persons to 1,361 persons. The numbers of households also increased during this period by

Map 2

BATHYMETRIC MAP OF GREEN LAKE



DATE OF PHOTOGRAPHY: APRIL 2005

—20'— WATER DEPTH CONTOUR IN FEET

MONITORING SITE

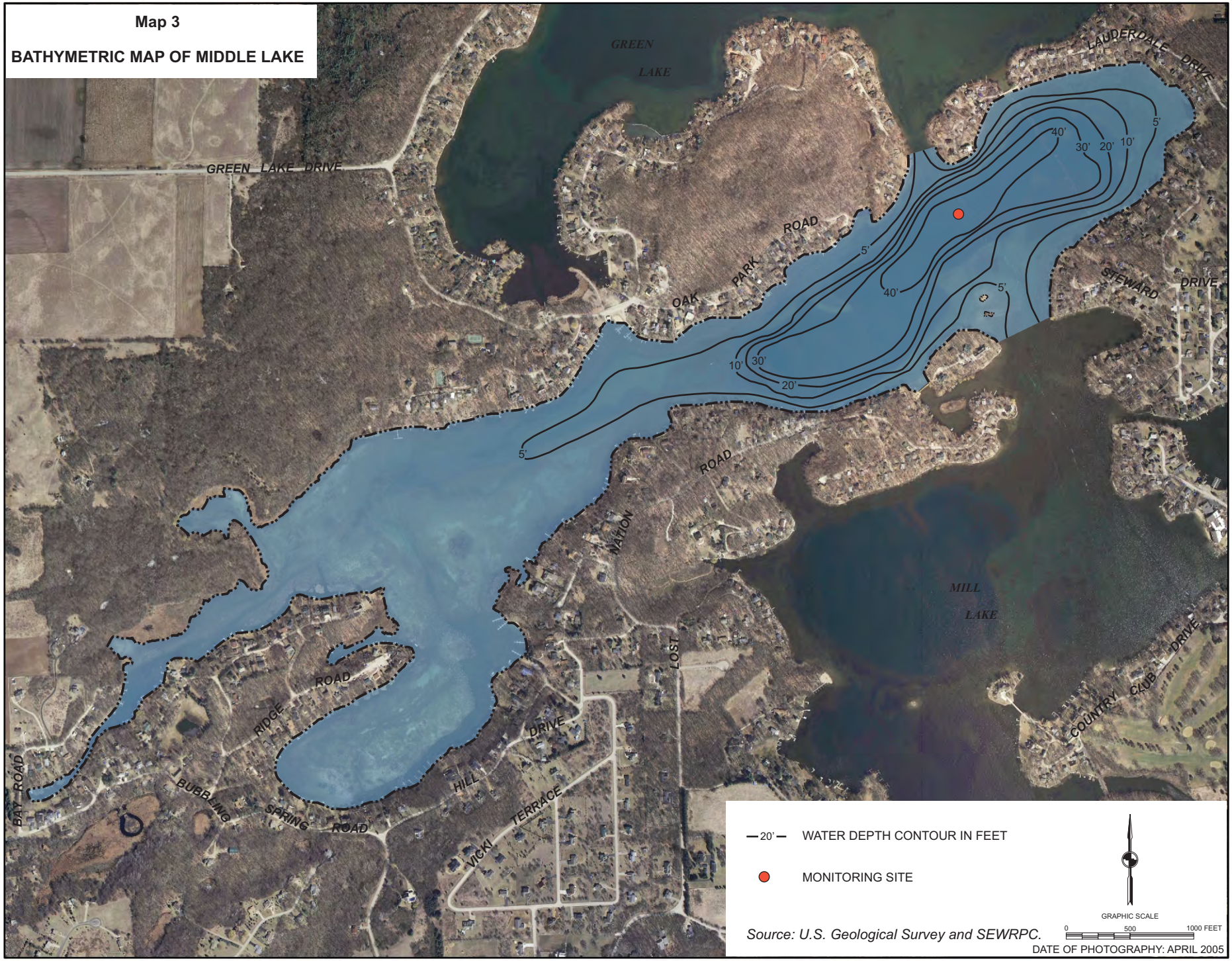
Source: U.S. Geological Survey and SEWRPC.

GRAPHIC SCALE

0 450 900 FEET

Map 3

BATHYMETRIC MAP OF MIDDLE LAKE

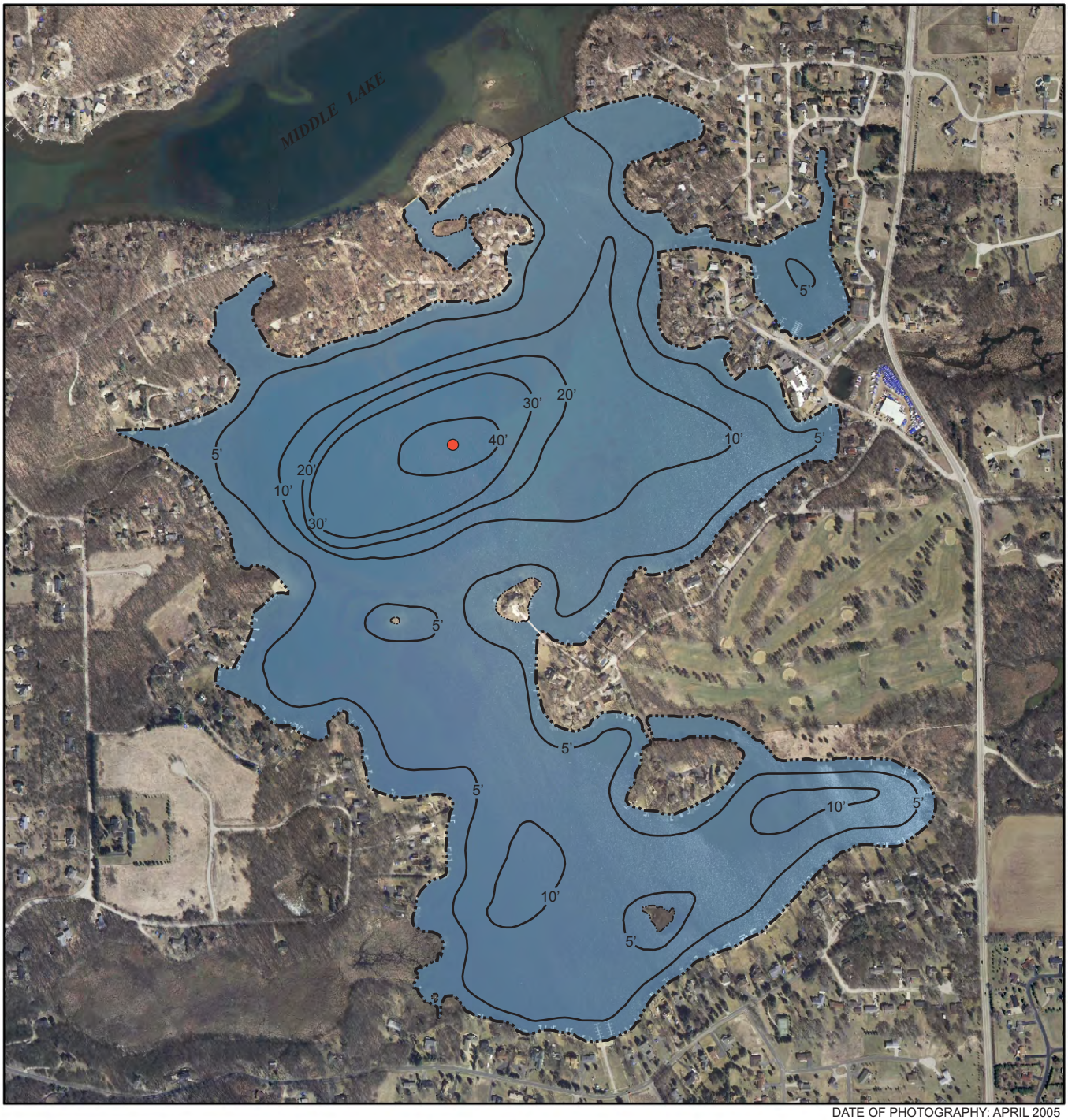


Source: U.S. Geological Survey and SEWRPC.

DATE OF PHOTOGRAPHY: APRIL 2005

Map 4

BATHYMETRIC MAP OF MILL LAKE



DATE OF PHOTOGRAPHY: APRIL 2005

—20'— WATER DEPTH CONTOUR IN FEET

MONITORING SITE

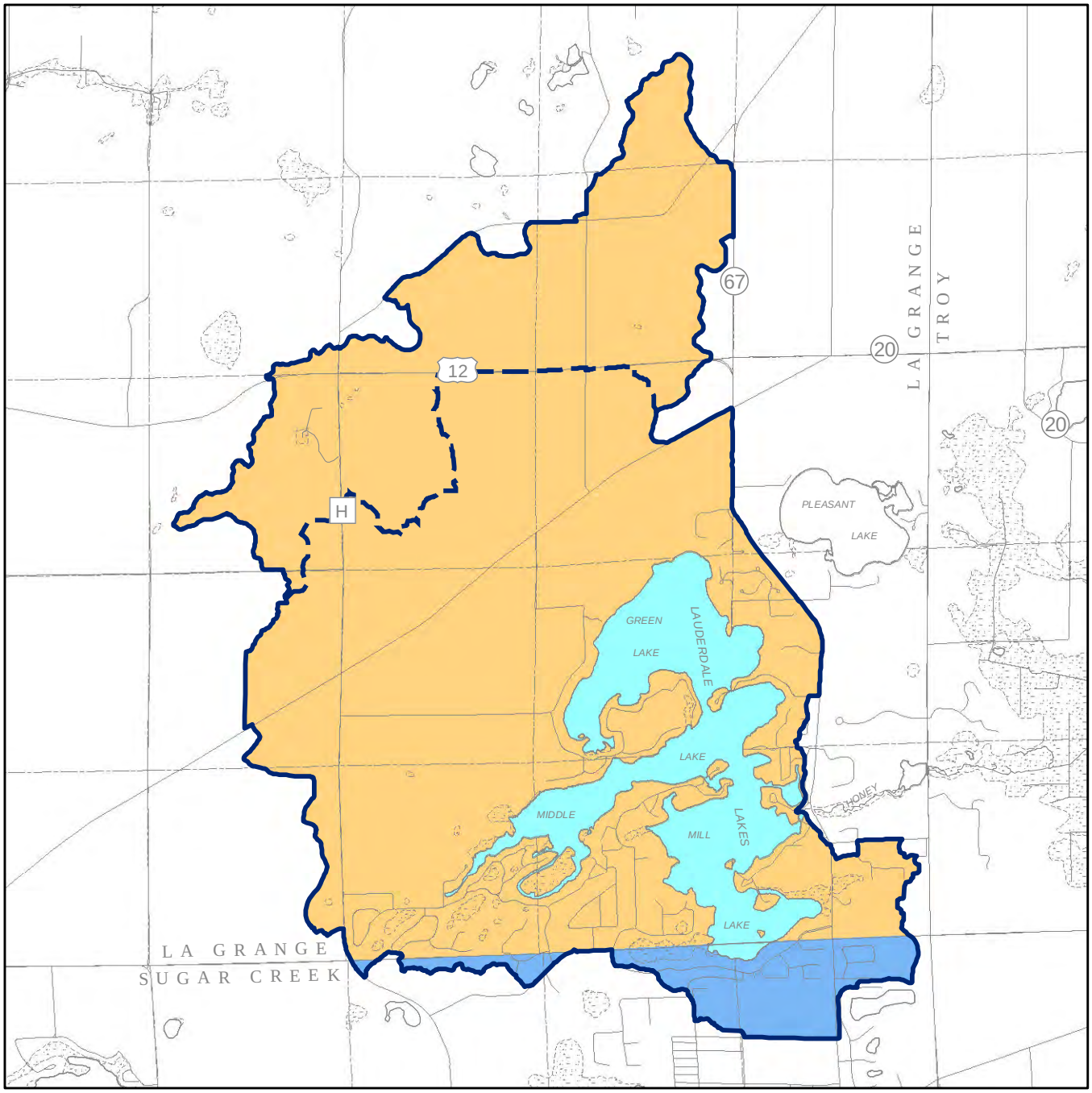
Source: U.S. Geological Survey and SEWRPC.

GRAPHIC SCALE

0 450 900 FEET

Map 5

CIVIL DIVISION BOUNDARIES WITHIN THE LAUDERDALE LAKES TRIBUTARY AREA



Town of LaGrange

Town of Sugar Creek

Source: SEWRPC.

N

0 2,000 4,000 Feet

Table 2

POPULATION AND HOUSEHOLDS WITHIN THE AREA TRIBUTARY TO THE LAUDERDALE LAKES: 1960-2000

Year	Total Tributary Area			
	Population	Households	Housing Units (year-round)	Housing Units (seasonal)
1960	436	111	507	N/A
1970	696	229	661	N/A
1980	1,361	476	981	323
1990	1,276	469	1,257	757
2000	1,936	742	1,491	735

NOTE: 1970 total housing units is an estimate.

Source: U.S. Bureau of the Census and SEWRPC.

nearly 108 percent, from 229 households to 476 households. After a slight decline in both population and the numbers of households between 1980 and 1990, further increases in numbers occurred between 1990 and 2000—the population gained almost 52 percent, increasing from 1,276 to 1,936 individuals; the numbers of households increased almost 60 percent, from 469 to 742 households.

The numbers and types of housing units, as shown in Table 2, reflect the popularity of the Lauderdale Lakes as a recreational destination for seasonal, as well as year-round residents. In 1980, there were about 323 seasonal housing units compared with the 981 year-round housing units in the Lauderdale Lakes tributary area. Seasonal housing units comprised nearly one-third of the total number of housing units. In 1990, the numbers of seasonal housing units increased slightly, comprising about two-fifths of all housing units. However, by 2000, the numbers of seasonal housing units had diminished slightly, forming about one-third of all housing units. It would be expected that the majority of these seasonal housing units would be concentrated in close proximity to the Lakes themselves.

Land Uses

The land uses within the total area tributary to the Lauderdale Lakes are primarily rural, with agricultural uses being the dominant rural land use. The shoreline of the Lakes, however, is largely developed for residential uses. Wetland areas are located along the western shores of Middle and Mill Lakes, with several isolated woodland areas being located along the southern shoreline of Green Lake and the northern shoreline areas of Middle Lake. Map 6 shows the existing land uses within the tributary area as of 2000; those uses also are summarized in Table 3.

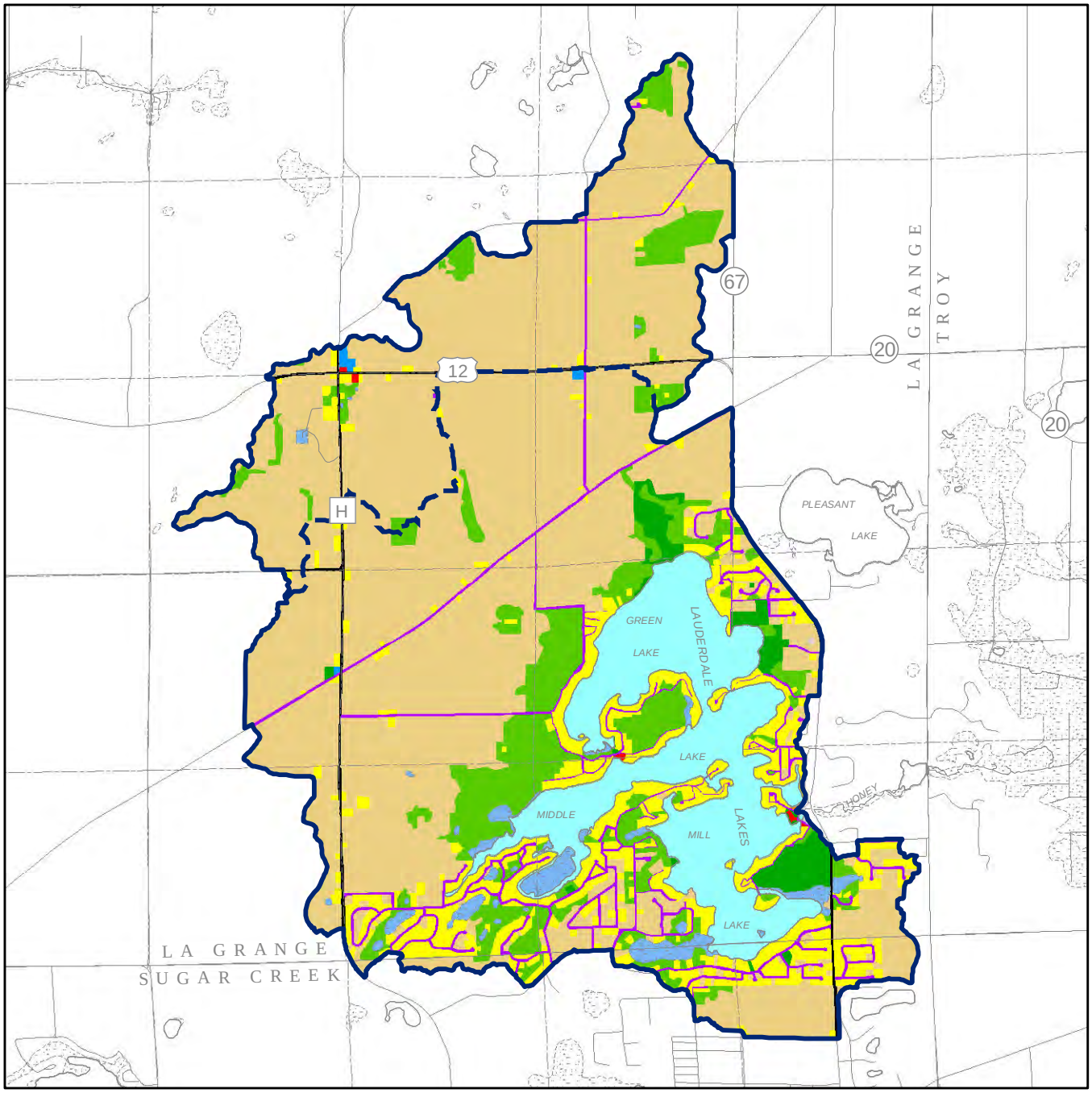
Future changes in land use within the area tributary to the Lakes may include limited further urban development, infilling of already platted lots, and possible redevelopment of existing properties. Under proposed year 2035 conditions, as shown on Map 7 and summarized in Table 3, urban land uses are expected to further increase, from about 18 percent of the land coverage in 2000 to about 24 percent of the land coverage in 2035. Agricultural uses are anticipated to decrease from about 83 percent of the land coverage in the year 2000, to about 77 percent of the land coverage under planned year 2035 conditions. These land use changes have the potential to modify the nature and delivery of nonpoint source contaminants to the Lakes, with concomitant impacts on the aquatic plant communities within the waterbody.

SHORELINE PROTECTION STRUCTURES

Erosion of shorelines results in the loss of land, damage to shoreline infrastructure, and interference with lake access and use. Wind-wave erosion, ice movement, and motorized boat traffic usually cause such erosion. About

Map 6

EXISTING LAND USE WITHIN THE LAUDERDALE LAKES TRIBUTARY AREA: 2000



- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
- GOVERNMENT AND INSTITUTIONAL
- RECREATION
- WETLANDS
- WOODLANDS
- SURFACE WATER
- AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS
- EXTRACTIVE AND LANDFILL

N

0 2,000 4,000 Feet

Source: SEWRPC.

Table 3

EXISTING AND PLANNED LAND USE WITHIN THE TOTAL AREA TRIBUTARY TO THE LAUDERDALE LAKES: 2000 AND 2035

Land Use Categories[a]	2000		2035	
	Acres	Percent of Tributary Area	Acres	Percent of Tributary Area
Urban				
Residential	708	11.0	950	14.8
Commercial	4	0.1	26	0.4
Industrial	1	<0.1	1	<0.1
Governmental and Institutional	7	0.1	7	0.1
Transportation, Communication, and Utilities	285	4.4	291	4.5
Recreational	120	1.9	241	3.7
Subtotal	1,125	17.5	1,516	23.5
Rural				
Agricultural and Other Open Lands	3,730	57.9	3,347	52.1
Wetlands	110	1.7	110	1.7
Woodlands	674	10.5	666	10.3
Surface Water	796	12.4	796	12.4
Extractive	- -	- -	- -	- -
Landfill	- -	- -	- -	- -
Subtotal	5,310	82.5	4,919	76.5
Total	6,435	100.0	6,435	100.0

[a]*Parking included in associated use.*

Source: SEWRPC.

70 percent of the shoreline of the Lauderdale Lakes is developed. A survey of the shorelines of the Lauderdale Lakes, conducted by Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff for the previous SEWRPC report, identified the shoreline, at that time, as having a combination of riprap, bulkhead, and natural shoreline, with small scattered areas of beach; no obvious erosion-related problems were encountered. During the current study period, few significant changes in the shoreline protection techniques were observed since the previous report, with the primary methods of shoreline protection utilized being riprap, bulkhead, and naturalized shoreline, with a few small beaches, as shown on Maps 8 through 10. There were no severe erosion-related problems observed during the 2008 survey.

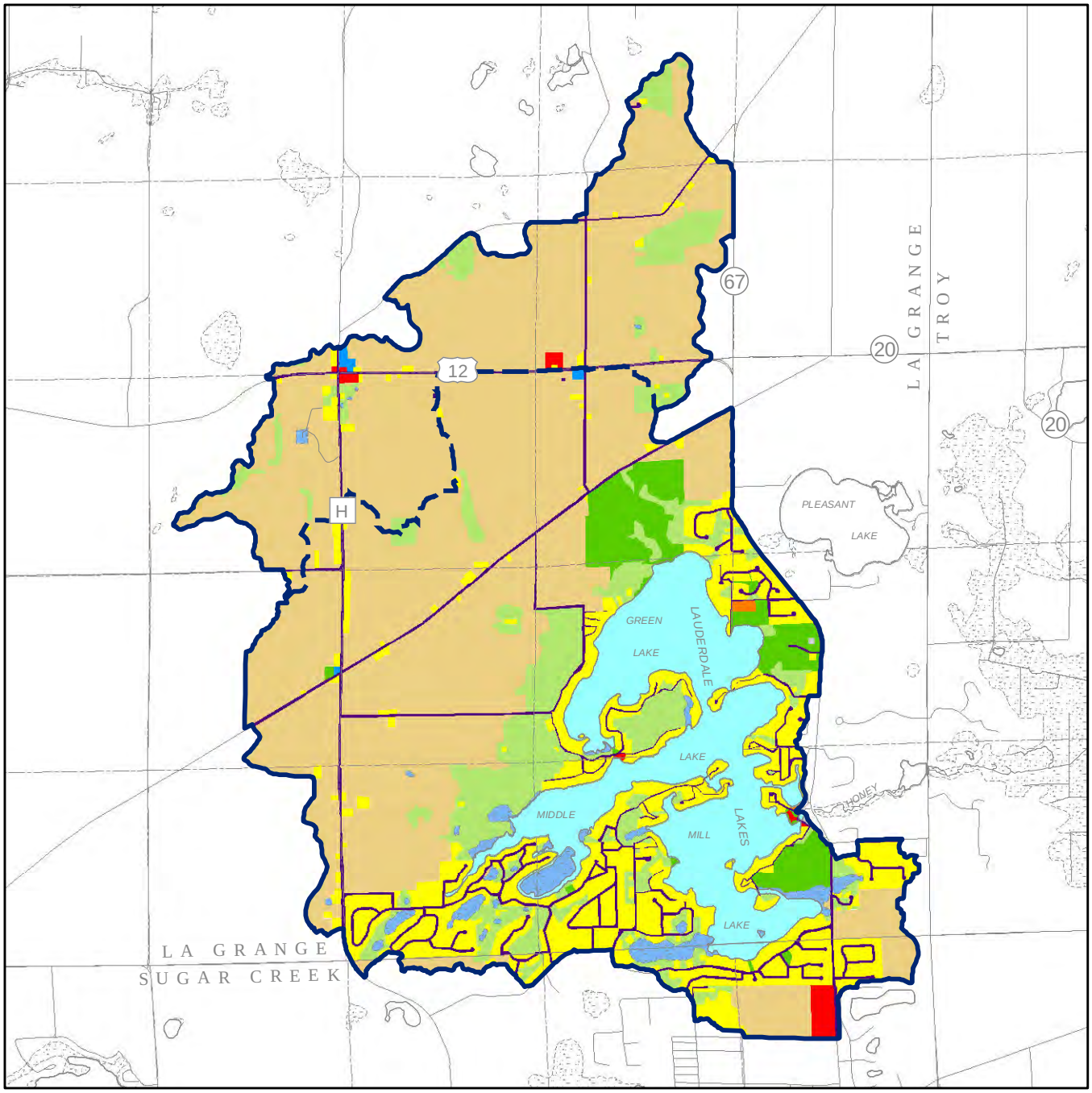
WATER QUALITY

Water quality data for the Lauderdale Lakes were collected in 1966 by the Wisconsin Department of Natural Resources (WDNR) and was presented in the WDNR Lake Use Report of 1969.[2] Additional data were acquired between September 1973 and February 1975, under the National Eutrophication Survey (NES) program of the U.S. Environmental Protection Agency (USEPA), and between November 1993 and October 1999, under the Trophic State Index (TSI) monitoring program of the U.S. Geological Survey (USGS). These data were used to

[2]*Wisconsin Department of Natural Resources Publication Lake Use Report Nos. FX-17, FX-18, and FX-20,* The Lauderdale Lakes, Walworth County, Wisconsin, *1969.*

Map 7

PLANNED LAND USE WITHIN THE LAUDERDALE LAKES TRIBUTARY AREA: 2035



- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
- GOVERNMENT AND INSTITUTIONAL
- RECREATION
- WETLANDS
- WOODLANDS
- SURFACE WATER
- AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS
- EXTRACTIVE AND LANDFILL

N

0 2,000 4,000 Feet

Source: SEWRPC.

Map 8

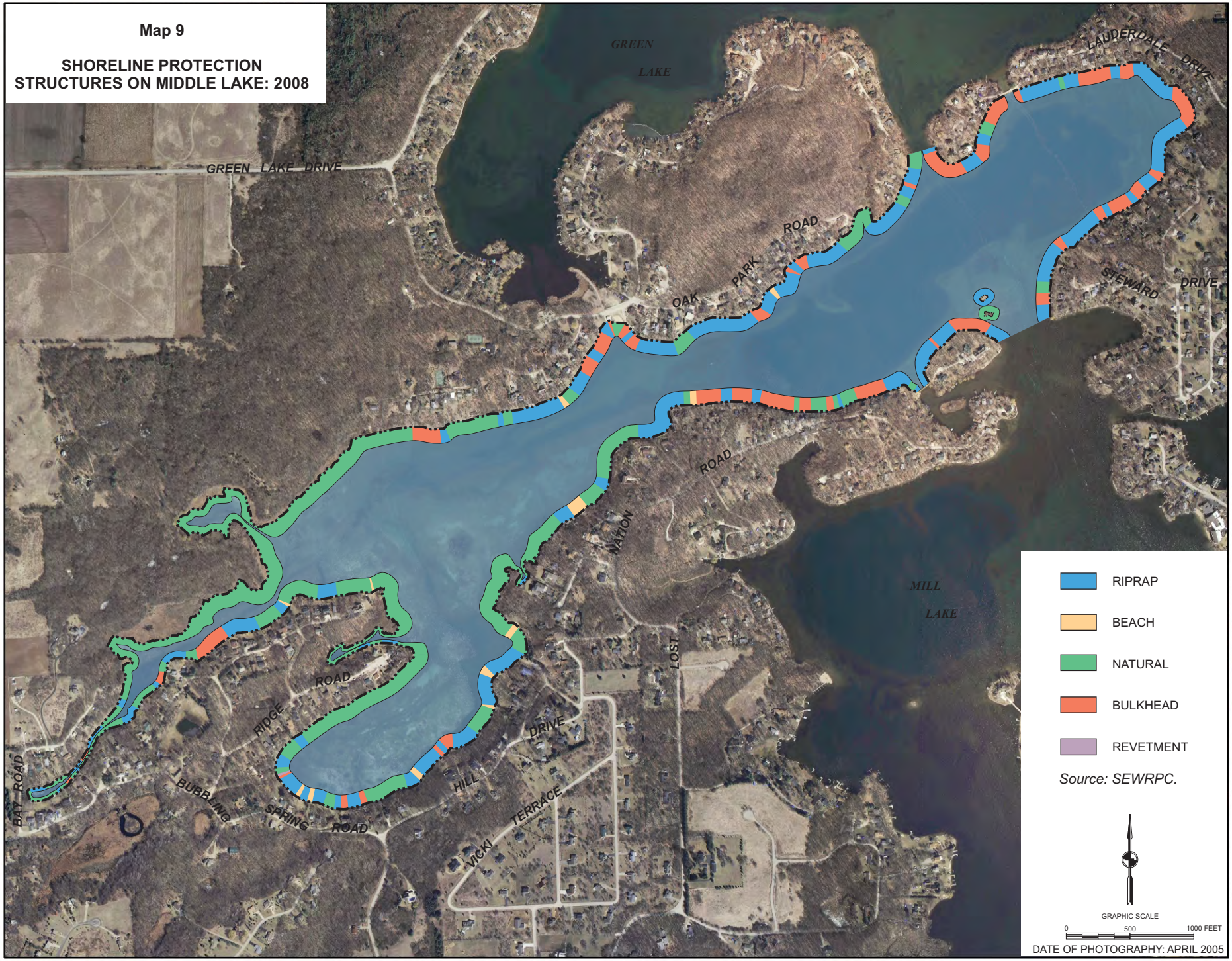
SHORELINE PROTECTION STRUCTURES ON GREEN LAKE: 2008

DATE OF PHOTOGRAPHY: APRIL 2005

RIPRAP
BULKHEAD
BEACH
REVETMENT
NATURAL

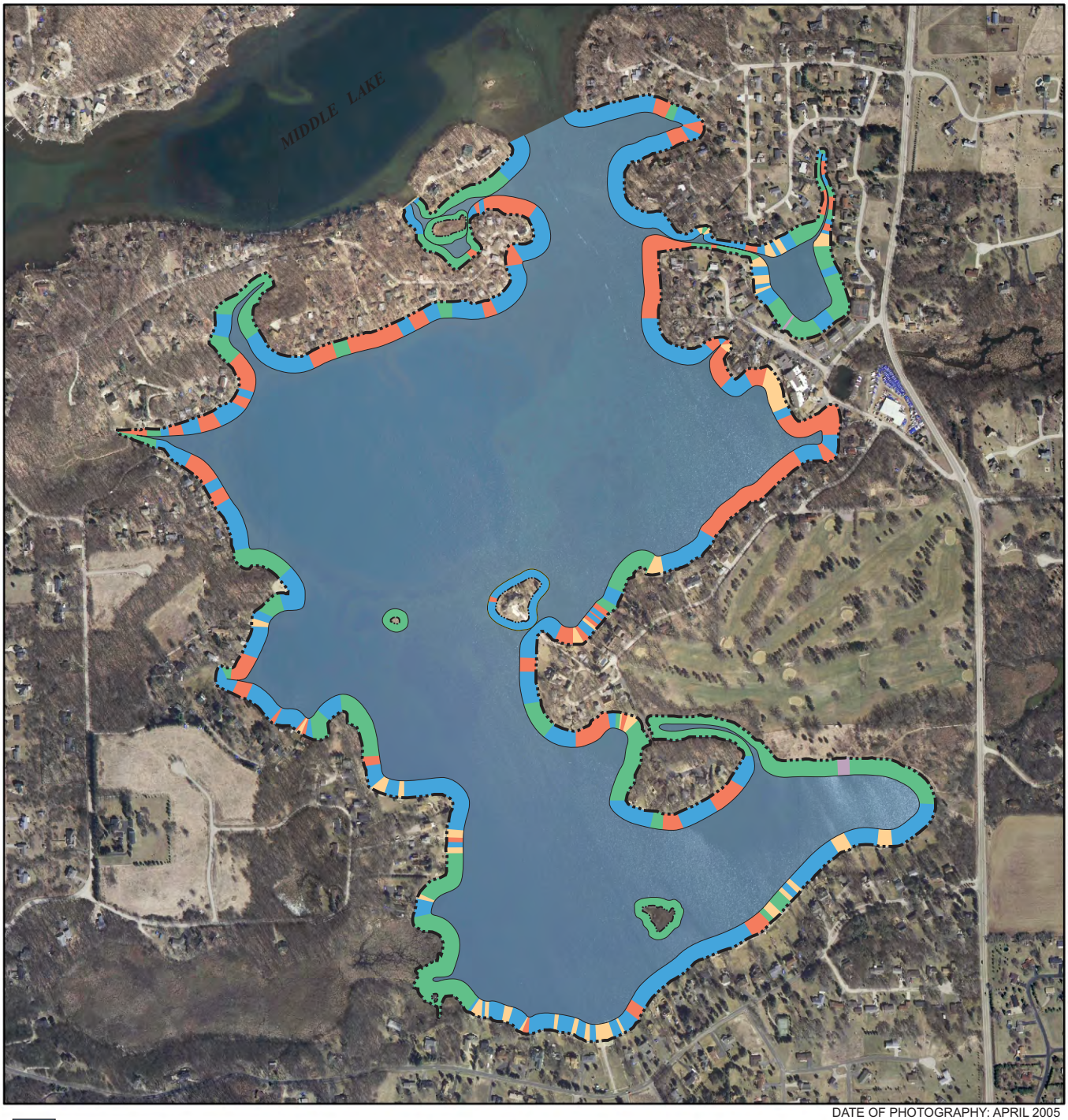
GRAPHIC SCALE
0 450 900 FEET

Source: SEWRPC.


Map 9
SHORELINE PROTECTION STRUCTURES ON MIDDLE LAKE: 2008
GREEN LAKE
GREEN LAKE DRIVE
LAUDERDALE DRIVE
OAK PARK ROAD
STEWARD DRIVE
NATION ROAD
MILL LAKE
LOST DRIVE
RIDGE ROAD
BAY ROAD
BUBBLING SPRING ROAD
HILL TERRACE
VICKI
RIPRAP
BEACH
NATURAL
BULKHEAD
REVETMENT
Source: SEWRPC.
GRAPHIC SCALE
0 500 1000 FEET
DATE OF PHOTOGRAPHY: APRIL 2005

Map 10

SHORELINE PROTECTION STRUCTURES ON MILL LAKE: 2008



DATE OF PHOTOGRAPHY: APRIL 2005

RIPRAP

BEACH

NATURAL

BULKHEAD

REVETMENT

GRAPHIC SCALE

0 450 900 FEET

Source: SEWRPC.

Table 4

WATER QUALITY CONDITIONS IN THE LAUDERDALE LAKES BY MAJOR BASIN: 2006-2009

Water Quality Parameter	Green Lake	Middle Lake	Mill Lake
Secchi-Disk Transparency (feet).....	6.5-26.0	6.0-27.0	4.5-14.2
Mean.....	14.7	13.4	10.1
Chlorophyll-*a* (µg/l).....	1.8-4.6	2.2-5.1	3.8-9.9
Mean.....	3.0	4.0	3.9
Total Phosphorus (µg/l).....	7-13	9-16	6-23
Mean.....	10	13	16
Dissolved Oxygen At Surface (mg/l)	8.5-10.2	8.4-11.3	8.2-11.0
Dissolved Oxygen At Bottom (mg/l)	0.03-10.3	0.01-7.8	0.0-11.0
Water Temperature At Surface (°F)	43.0-78.9	42.0-80.5	43.0-80.1
Water Temperature At Bottom (°F)	40.8-69.0	43.0-54.3	42.0-55.3

Source: SEWRPC.

determine water quality conditions in the Lakes for the previous SEWRPC report.[3] Based upon those data, Green Lake and Middle Lake were rated as having very good water quality, while Mill Lake was considered to have very good to fair water quality.

More recently, data on Green Lake and Mill Lake have been acquired under the auspices of the University of Wisconsin-Extension (UWEX) Citizen Lake Monitoring Network (CLMN) program, formerly known as the WDNR Self-Help Monitoring Program, since March 2006, while the volunteer data collection effort on Middle Lake has been ongoing since May 1994. For the purposes of this plan, water quality data gathered between 2006 and 2009 have been used to characterize the water quality of the three lakes that comprise the Lauderdale Lakes. These water quality data are summarized in Table 4 and shown in Figure 1. Sampling locations used for data collection are shown on Maps 2 through 4.

Water Clarity

Water clarity, or transparency, is often used as an indication of water quality. Transparency can be affected by physical factors, such as water color and suspended particles, and by various biologic factors, including seasonal variations in planktonic algal populations living in the lake. Water clarity is measured typically with a Secchi disk, a black-and-white, eight-inch-diameter disk, which is lowered into the water until a depth is reached at which the disk is no longer visible. This depth is known as the "Secchi-disk reading." Such measurements comprise an important part of the aforementioned CLMN program in which citizen volunteers assist in lake water quality monitoring efforts.

Secchi-Disk Data

Historically, Secchi-disk transparencies in the three Lakes has ranged from 8.5 to 19.7 feet, with water clarity diminishing from North to South—Green Lake having the greatest water clarity, Middle Lake having an intermediate water clarity, and Mill Lake having the lowest water clarity. Water clarity in Green and Middle Lakes was indicative of very good water quality, while water clarity in Mill Lake was indicative of good water quality.

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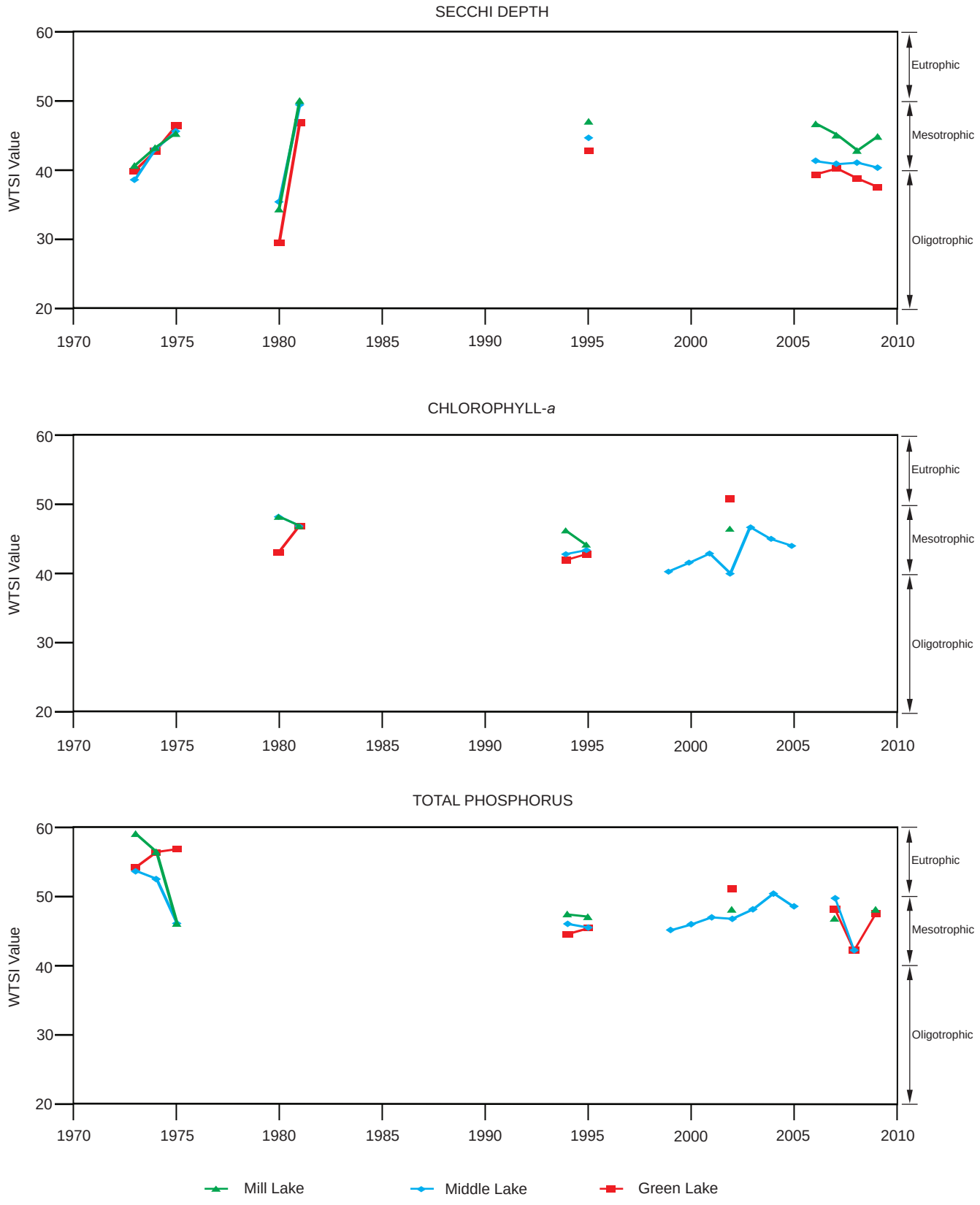
[3]*SEWRPC Memorandum Report No. 143,* An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, *August 2001.*

Figure 1

TROPHIC STATE INDICES FOR THE LAUDERDALE LAKES: 1970-2010



Source: Citizen Lake Monitoring Network, WDNR Surface Water Information Management System, and SEWRPC.

During the current study, similar trends were observed, with water clarity ranging from 4.5 feet to 26.0 feet, with the deepest water clarity occurring in the deeper northernmost two lakes—Green Lake and Middle Lake—and slightly lower water clarity occurring in the shallower Mill Lake. The least clarity occurred during June and July 2007 in all three lakes.

The National Weather Service (NWS) reported that June 2007 and July 2007 averaged near or slightly below normal for precipitation in Milwaukee, with precipitation for the two month period totaling 5.04 inches, or 2.10 inches below normal. Temperatures were at or above normal during this period. Scattered severe thunderstorms occurred every day during the first six days of June 2007, while late-July 2007 and early-August 2007 were periods of record breaking precipitation totals over much of southern Wisconsin. Similar situations were reported during the summers of 2008, when the NWS reported a record monthly rainfall value of 12.27 inches of precipitation during June 2008, and 2009 when the NWS reported a record daily rainfall value of 2.25 inches on June 19, 2009. These data would suggest that the reduced Secchi-disk transparencies observed during these summers might have been related to exceptional weather conditions which resulted in the wash off of plant nutrients and particulate matter, among other contaminants, from the land surface around the Lakes. Reported summer chlorophyll-*a* concentrations during these years were generally equal to or exceeding those previously reported from the Lakes. The highest chlorophyll-*a* concentrations coincided with the lowest Secchi-disk transparency values.

Remote Sensing Water Clarity Data

In addition to in-lake direct measurements of water clarity using a Secchi disk, the transparencies of many Wisconsin lakes have been measured using remote sensing technology. The Environmental Remote Sensing Center (ERSC), established in 1970 on the University of Wisconsin-Madison campus, was one of the first remote sensing facilities in the United States. Using data gathered by satellite remote sensing over a three-year period, the ERSC generated a map based on a mosaic of satellite images showing the estimated water clarity of the largest 8,000 lakes in Wisconsin. The WDNR, through its volunteer Self-Help Monitoring Program (now the CLMN), was able to gather water clarity measurements from about 800 lakes, or about 10 percent of Wisconsin's largest lakes. Of these, the satellite remote sensing technology utilized by ERSC was able to accurately estimate clarity, providing a basis for extrapolating water clarity estimates to the remaining 90 percent of lakes. Measurements collected through the ERSC remote sensing program from 1999 through 2005, estimated the average water clarity of Green Lake to be 8.2 feet, a value indicative of generally good water quality; Middle Lake was estimated to have an average water clarity of 5.4 feet, indicative of generally fair water quality; and Mill lake was estimated to have an average water clarity of 4.3 feet, indicative of poor water quality. Such data are lower than the in-lake measured transparencies observed during the previous study period; however, the trend of declining transparency from north to south within the Lauderdale Lakes is essentially consistent with the abovementioned Self-Help Monitoring Program and CLMN Secchi-disk measurements during the current study period.

Zebra Mussel Impacts

The Lauderdale Lakes are listed by the WDNR as having an established population of zebra mussels (*Dreissena polymorpha*) since 1998. Zebra mussels, a nonnative species of shellfish with known negative impacts on native benthic organism populations, are having a varied impact on the inland lakes of the Upper Midwest, disrupting the food chain by removing significant amounts of bacteria and smaller phytoplankton which serve as food for a variety of other aquatic organisms, including larval and juvenile fishes and many forms of zooplankton. As a result of the filter feeding proclivities of these animals, many lakes have experienced improved water clarity. This improved water clarity, in turn, has led to increased growths of rooted aquatic plants, including Eurasian water milfoil. Curiously, within the Southeastern Wisconsin Region, and specifically within the Lauderdale Lakes, zebra mussels have been observed attaching themselves to the stalks of the Eurasian water milfoil plants, dragging the stems out of the zone of light penetration due to the weight of the zebra mussel shells, and interfering with the competitive strategy of the Eurasian water milfoil plants. This has contributed to improved growths of native aquatic plants in some cases, and to the growths of filamentous algae too large to be ingested by the zebra mussels in others. Regardless as to the seeming beneficial impacts of these animals, the overall effect is that, as zebra mussels and other invasive species spread to inland lakes and rivers, so do the environmental, aesthetic, and economic costs to water users.

Dissolved Oxygen

Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. Generally, dissolved oxygen levels are higher at the surface of a lake, where there is an interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels are usually lowest near the bottom of a lake, where decomposer organisms and chemical oxidation processes utilize oxygen in the decay process.

When a lake becomes stratified—that is, when a thermal gradient (called a "thermocline") or chemical gradient ("chemocline") of sufficient intensity produces a barrier separating upper waters, called the epilimnion, from lower waters, known as the hypolimnion—the surface supply of oxygen to the hypolimnion is cut off. Eventually, if there is not enough dissolved oxygen to meet the demands from the bottom dwelling aquatic life and decaying organic material, the dissolved oxygen levels in the bottom waters may be reduced to zero, a condition known as anoxia or anaerobiasis.

Where oxygen levels are depleted in the hypolimnion, fish tend to move upward, nearer to the surface of the lake, where higher dissolved oxygen concentrations exist. This migration, when combined with temperature, can select against some fish species that prefer the cooler water temperatures that generally prevail in the lower portions of the lake. When there is insufficient oxygen at these depths, these fish are susceptible to summerkills, or, alternatively, are driven into the warmer water portions of the lake where their condition and competitive success may be severely impaired. Additionally, this condition, common to many shallow lakes in Wisconsin, can lead to winter fish kills if oxygen stores are not sufficient to meet the total demand.

Information on dissolved oxygen levels during 1966 was presented in the earlier WDNR lake use report.[4] Due to the presence of deep water in all three basins, all three Lakes were found to be stratified by mid-summer, with thermoclines developing at a depth of about 18 feet in Green and Middle Lakes, and at a depth of about 12 feet in Mill Lake. Water samples taken at that time indicated that during the summer, all three Lakes had sufficient oxygen to support fish and other aquatic life in Green Lake to a depth of about 35 feet, Middle Lake to a depth of about 28 feet, and Mill Lake to a depth of about 23 feet. In Green Lake, the deep thermoclinal maximum of oxygen was attributed to the transparency of the Lake's waters; increased transparency allowing deeper light penetration with subsequent higher levels of oxygen-producing photosynthesis at those depths. Data also indicted that all three Lakes did become anoxic—depleted of oxygen—at bottom depths during summer. Winter levels of dissolved oxygen were not presented as part of the 1969 WDNR report.

Dissolved oxygen levels presented in the previous SEWRPC report [5] were collected by the USGS for the period from November 1993 through August 1999 for Middle Lake, and for the period from November 1993 through November 1994 for Green and Mill Lakes.[6] At that time, the Green Lake data indicated the establishment of a thermocline at a depth of 25 to 35 feet by July with anoxia in bottom waters of that Lake from July through November; oxygen levels near the surface remained mostly within the range of about 8.0 to 9.0 milligrams per liter (mg/l) throughout the sampling period. In Middle Lake, thermal stratification took place by early July with the thermocline becoming established at depths of 25 to 35 feet and, as summer progressed, gradually moving higher in the water column to depths in the 15 to 25 foot range by late summer; anoxic conditions became evident

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[4] *Wisconsin Department of Natural Resources Publication Lake Use Report Nos. FX-17, FX-18, and FX-20,* op. cit.

[5] *SEWRPC Memorandum Report No. 143,* op. cit.

[6] *U.S. Geological Survey Open-File Reports No. 95-190 through 00-89,* Water Quality and Lake-Stage Data for Wisconsin Lakes, Water Years 1994 through 1999, *published annually from 1995 through 2000.*

in bottom waters by early-July and persisted until mid-October. Year 1999 data for Middle Lake showed a similar pattern. Surface waters in Middle Lake showed good levels of dissolved oxygen throughout the sampling periods both in 1994 and in 1999. In Mill Lake, stratification occurred by early June at a depth of 25 to 35 feet, gradually moving higher in the water column to a depth of 12 to 20 feet by the end of August; anoxic conditions in the bottom waters persisted from early July to mid-October, although surface waters in the Lake showed good oxygen levels throughout the sampling period.

During the current study, dissolved oxygen data were acquired from the three Lakes since June 2007, with data being available through the WDNR Surface Water Information Management System (SWIMS) through October 2009. These data reflect a similar seasonal pattern as previously reported, with the onset of dissolved oxygen concentration stratification at the 40 feet depth in Middle Lake at the end of June 2007, when dissolved oxygen concentrations of less than 5.0 mg/l were observed. This oxycline, or zone of transition from dissolved oxygen concentrations greater than 5.0 mg/l to concentrations approaching zero, moved upwards during the summer and the volume of the hypolimnion increased with the 5.0 mg/l dissolved oxygen concentration level occurring at about 20 feet depth by the end of July. This oxycline remained at this level through early September. During 2008, Middle Lake was well mixed during April, but stratification began to occur at the end of May. By July 2008, the oxycline was again at about 20 feet. During 2009, an oxycline appeared as early as late-March and persisted through mid-October. A similar seasonal pattern was observed in Green Lake, although the oxycline occurred at depths of below 40 feet in June 2007, with the greatest extent of hypolimnetic deoxygenation including depths below 30 feet. During 2008, deoxygenation of the hypolimnion occurred only in late-June and at depths below 25 feet. The distribution of dissolved oxygen in Green Lake during 2009 was similar to that observed in 2007. Mill Lake was stratified with respect to dissolved oxygen concentrations, with dissolved oxygen concentrations of less than 5.0 mg/l occurring at depths below 35 feet in June 2007. In later summer of that year, Mill Lake was deoxygenated below 20 feet in depth. During 2008, deoxygenation was first observed during late-May with the extent of the hypolimnion including lake waters at depths of 20 feet and greater by late-June 2008. These conditions persisted through late-October. Dissolved oxygen concentrations in Mill Lake during 2009 followed a similar pattern. Surface water dissolved oxygen concentrations ranged from about 8.0 mg/l to about 10.0 mg/l in the upper waters, or epilimnion, of the Lakes.

In addition to the biological consequences of deoxygenation, the lack of dissolved oxygen at depth can enhance the development of chemoclines, or chemical gradients, with an inverse relationship to the dissolved oxygen concentration. For example, the sediment-water exchange of elements, such as phosphorus, iron, and manganese, is increased under anaerobic conditions, resulting in increased hypolimnetic concentrations of these elements. Under anaerobic conditions, changes in iron and manganese oxidation states enable the release of phosphorus from the iron and manganese complexes to which they were bound under aerobic conditions. This “internal loading” can affect water quality significantly if these nutrients and salts are mixed into the epilimnion, especially during early summer, when these nutrients can become available for algal and rooted aquatic plant growth. Water quality data presented in the previous SEWRPC report showed good agreement between predicted and observed levels of phosphorus in the Lauderdale Lakes; such agreement would suggest that the estimated phosphorus load was a reasonable representation of the loads actually entering the Lakes, and that other pollution sources, including internal, atmospheric, groundwater, and onsite sewage disposal system sources, were relatively small compared to the loading from external sources. For the current reporting period, CLMN data reported for the period from 2006 through 2009 are consistent with these observations.

Chlorophyll-*a*

Chlorophyll-*a* is the major photosynthetic (“green”) pigment in algae. The amount of chlorophyll-*a* present in the water is an indication of the biomass or amount of algae in the water. The mean chlorophyll-*a* concentration for lakes in the Southeastern Wisconsin Region is about 43.3 micrograms per liter (μg/l), with a median concentration

of about 9.9 µg/l.[7] Chlorophyll-*a* levels above about 10 µg/l generally result in a green coloration of the water that may be severe enough to impair recreational activities, such as swimming or waterskiing.[8]

Although chlorophyll-*a* measurements were not presented in the initial WDNR report,[9] for the previous SEWRPC report,[10] measurements for Green Lake averaged 3.18 milligrams per cubic meter (mg/m^3 = µg/l) annually, averaged 2.95 µg/l annually for Middle Lake, and averaged 4.94 µg/l annually in Mill Lake. Such concentrations were not indicative of water quality problems in any of the three Lakes.

During the current study period, chlorophyll-*a* concentrations in the Lakes ranged between 2.0 µg/l and about 10 µg/l, with the higher concentrations occurring in Mill Lake; in Green Lake and Middle Lake, the maximum concentrations of chlorophyll-*a* were less than about 5.0 µg/l. These suggest that the Lakes are not subject to regular algal blooms.

Nutrient Characteristics

Aquatic plants and algae require such nutrients as phosphorus and nitrogen for growth. In hard-water alkaline lakes, most of these nutrients are generally found in concentrations that exceed the needs of growing plants. However, in lakes where the supply of one or more of these nutrients is limited, plant growth is limited by the amount of the nutrient that is available in the least quantity relative to all of the others. The ratio (N:P) of total nitrogen (N) to total phosphorus (P) in lake water indicates which nutrient is the factor most likely to be limiting aquatic plant growth in a lake.[11] Where the N:P ratio is greater than 14:1, phosphorus is most likely to be the limiting nutrient. If the ratio is less than 10:1, nitrogen is most likely to be the limiting nutrient.

During the study period for the previous SEWRPC report,[12] the N:P ratio was always 16:1 or greater, indicating plant growth at that time was consistently limited by phosphorus, which is common in most inland lakes in Wisconsin. Nitrogen data were not available for the current study period.

Total phosphorus concentrations include the phosphorus contained in plant and animal fragments suspended in the lake water, phosphorus bound to sediment particles, and phosphorus dissolved in the water column, and is, therefore, usually considered a good indicator of nutrient status in a lake.

For lakes, the guideline value set forth in the adopted regional water quality management plan is 20 µg/l of total phosphorus or less during spring turnover. This is the level considered as necessary to limit algal and aquatic plant growths to levels consistent with recreational water use objectives, as well as water use objectives for maintaining

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[7]*R.A. Lillie and J.W. Mason, Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *1983*.

[8]*J.R. Vallentyne, 1969 "The Process of Eutrophication and Criteria for Trophic State Determination." in* Modeling the Eutrophication Process—Proceedings of a Workshop at St. Petersburg, Florida, *November 19-21, 1969, pp. 57-67.*

[9]*Wisconsin Department of Natural Resources Publication Lake Use Report Nos. FX-17, 18 and 20,* op. cit.

[10]*SEWRPC Memorandum Report No. 143,* op. cit.

[11]*M.O. Allum, R.E. Gessner, and T.H. Gakstatter, U.S. Environmental Protection Agency Working Paper No. 900,* An Evaluation of the National Eutrophication Data, *1976.*

[12]*SEWRPC Memorandum Report No. 143,* op. cit.

a warmwater fishery and other aquatic life. In the Lauderdale Lakes, as described in the Priority Watershed Plan,[13] the 1995 spring total phosphorus concentrations ranged narrowly from 20 μg/l to 23 μg/l; the summer phosphorus concentrations ranged from 7.0 μg/l to 13 μg/l.

Total phosphorus concentrations since that time have been about the same as the 1995 summer average. In Green Lake, total phosphorus concentrations reported by the CLMN ranged from 7.0 μg/l to 13 μg/l; in Middle Lake, the total phosphorus concentrations ranged from 9.0 μg/l to 16 μg/l; and in Mill Lake, the total phosphorus concentrations ranged from 6.0 μg/l to 22 μg/l, during the period from March 2006 through November 2009. These levels generally were found to be below the levels necessary to support nuisance algae blooms, although total phosphorus concentrations in excess of 20 μg/l are considered to be above the level necessary to sustain algal blooms in lakes.[14]

Seasonal gradients of phosphorus concentrations between the epilimnion and hypolimnion of a lake reflect the biogeochemistry of this growth element. When aquatic organisms die, they usually sink to the bottom of the lake, where they are decomposed. Phosphorus from these organisms is then either stored in the bottom sediments or rereleased into the water column. Because phosphorus is not highly soluble in water, it readily forms insoluble precipitates with calcium, iron, and aluminum under aerobic conditions and accumulates, predominantly, in the lake sediments. As aforestated, if the bottom waters become depleted of oxygen during stratification, certain chemical changes occur, including the change in the oxidation state of iron from the insoluble Fe^{3+} state to the more soluble Fe^{2+} state. The effect of these chemical changes is that phosphorus becomes soluble and is more readily released from the sediments in a process known as *internal loading*. This process also occurs under aerobic conditions, but generally at a slower rate than under anaerobic conditions. As the waters mix, this phosphorus may be widely dispersed throughout the lake waterbody and become available for algal growth.

Although the significant concentration gradients between surface and bottom concentrations of total phosphorus observed in all three Lakes during the previous study, concurrent with the onset of anoxic conditions in the hypolimnion, might be construed as indicative of internal loading, the absence of accompanying increases in levels of chlorophyll-*a* or marked decreases in water transparency would tend to favor the view that such hypolimnetic phosphorus releases are not dispersing to any significant degree in the water column and are not, therefore, practically contributing to increased plant growth in the Lakes, thereby supporting the notion that total phosphorus levels in the Lakes are likely the result of external, not internal, sources.

Should any such loading occur, the magnitude of the release and its subsequent effects in contributing to algal growth in the surface waters of the Lakes may be moderated by a number of circumstances, including the rates of mixing during the spring and fall overturn events. Slow mixing generally results in any phosphorus released into the bottom waters of the Lakes being reprecipitated and unavailable to aquatic plants.[15]

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[13]*Wisconsin Department of Natural Resources Publication No. WT-478-97,* Nonpoint Source Control Plan for the Sugar/Honey Creek Priority Watershed Project, *February 1997.*

[14]*During 2007 and 2008, surface water total phosphorus concentrations in Mill Lake exceeded the 20 μg/l threshold during mid-summer. These periods were coincident with the occurrence of chlorophyll-*a *concentrations in approaching 10 μg/l, which is considered to be the level at which most observers will report a greenish coloration of the water.*

[15]*See, for example, R.D. Robarts, P.J. Ashton, J.A. Thornton, H.J. Taussig, and L.M. Sephton, "Overturn in a hypertrophic, warm, monomictic impoundment (Hartbeespoort Dam, South Africa),"* Hydrobiologia, *Volume 97, 1982, pp. 209-224.*

POLLUTION LOADINGS AND SOURCES

Pollutant loads to a lake are generated by various natural processes and human activities that take place in the area tributary to a lake. These loads are transported to the lake through the atmosphere, across the land surface, and by way of inflowing streams. Pollutants transported by the atmosphere are deposited onto the surface of the lake as dry fallout and direct precipitation. Pollutants transported across the land surface enter the lake directly as surface runoff and, indirectly, as groundwater inflows, including drainage from onsite wastewater treatment systems. Pollutants transported by streams also enter a lake as surface water inflows.

In drained lakes, like the Lauderdale Lakes system, pollutant loadings transported by inflowing streams, by precipitation falling directly onto the Lakes' surfaces and runoff from the tributary areas immediately surrounding the Lakes, in the absence of identifiable or point source discharges from industries or wastewater treatment facilities, comprise the principal routes by which contaminants enter the waterbodies.[16] Currently, there are no significant point source discharges of pollutants into the Lauderdale Lakes. For this reason, the discussion that follows is based upon nonpoint source pollutant loadings to the Lakes.

Nonpoint sources of water pollution include urban sources, such as runoff from residential, commercial, transportation, construction, and recreational activities; and rural sources, such as runoff from agricultural lands and onsite sewage disposal systems.

Nonpoint source phosphorus, suspended solids, and urban-derived metals inputs to the Lauderdale Lakes were estimated using the Wisconsin Lake Model Spreadsheet (WILMS version 3.3),[17] and the unit area load-based models developed for use within the Southeastern Wisconsin Region.[18]

Phosphorus Loadings

During the current study, as shown in Table 5, existing year 2000 phosphorus loads to the Lauderdale Lakes were identified and quantified using SEWRPC land use inventory data.[19] It was estimated that, under year 2000 conditions, the total phosphorus load to the Lauderdale Lakes was 2,690 pounds. Of the annual total phosphorus load, it was estimated that 2,085 pounds per year, or about 77 percent of the total loading, were contributed by runoff from rural lands, mostly agricultural, and 500 pounds per year, or about 19 percent, were contributed by runoff from urban lands, mostly from residential sources. About 105 pounds, or about 4 percent, were contributed by direct precipitation onto the lake surface.

Phosphorus release from the lake bottom sediments, or internal loading, as discussed above, does not appear to have been a contributing factor to the total phosphorus loading to the Lakes.

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[16] *Sven-Olof Ryding and Walter Rast,* The Control of Eutrophication of Lakes and Reservoirs*, Unesco Man and the Biosphere Series, Volume 1, Parthenon Press, Carnforth, 1989; Jeffrey A. Thornton, Walter Rast, Marjorie M. Holland, Geza Jolankai, and Sven-Olof Ryding,* The Assessment and Control of Nonpoint Source Pollution of Aquatic Ecosystems*, Unesco Man and the Biosphere Series, Volume 23, Parthenon Press, Carnforth, 1999.*

[17] *John C. Panuska and Jeff C. Kreider, Wisconsin Department of Natural Resources Publication No. PUBL-WR-363-94,* Wisconsin Lake Modeling Suite Program Documentation and User's Manual, Version 3.3 for Windows, *August 2002*.

[18] *SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; and Volume Three,* Recommended Plan, *June 1979.*

[19] *SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006.*

Table 5

ESTIMATED ANNUAL POLLUTANT LOADINGS TO THE LAUDERDALE LAKES BY LAND USE CATEGORY: 2000

Land Use Category	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	6.6	135.8	0.0	1.5
Commercial	0.8	2.4	0.4	3.0
Industrial	0.4	1.2	0.2	1.5
Governmental	<0.1	0.3	0.0	0.0
Transportation	62.3	329.4	17.1	24.8
Recreational	1.4	32.4	0.0	0.0
Subtotal	71.5	501.5	17.7	30.8
Rural				
Agricultural	538.6	2,058.8	- -	- -
Wetlands	0.2	4.2	- -	- -
Woodlands	1.0	21.7	- -	- -
Water	74.8	103.5	- -	- -
Subtotal	614.6	2,188.2	- -	- -
Total	686.1	2,689.7	17.7	30.8

[a]*Includes the contribution from onsite sewage disposal systems. The contribution from onsite sewage disposal systems, based upon the* per capita *phosphorus contribution contained within wastewater estimated within the WILMS model, could range from approximately 25.5 pounds per year to as much as about 681.5 pounds per year, depending upon soil type, system condition, and system locations. For purposes of this analysis, 25.5 pounds per year were used as that value provided the loading that was best correlated to the measured in-lake phosphorus concentration.*

Source: SEWRPC.

Under 2035 conditions, as set forth in the adopted regional land use plan,[20] the annual total phosphorus load to the Lakes is anticipated to diminish as agricultural activities within the area tributary to the Lauderdale Lakes are replaced by urban residential land uses. Table 6 shows the estimated phosphorus loads to the Lauderdale Lakes under planned year 2035 conditions. The most likely annual total phosphorus load to the Lakes under the planned conditions is estimated to be 2,475 pounds.[21] Of the forecast total annual phosphorus load to the Lauderdale Lakes, 1,760 pounds per year, or about 71 percent of the total loading, are estimated to be contributed by runoff from rural land, and 610 pounds per year, or about 25 percent, from urban land. About 105 pounds, or about 4 percent, are expected to be contributed by direct precipitation onto the lake surface. Thus, it may be anticipated that not only will the amount of the phosphorus load decrease, but that the distribution of the sources of the phosphorus load to the Lakes may change, with the amount of phosphorus being contributed from urban sources experiencing an increase from 19 percent of the total in 2000 to about 25 percent of the total in 2035, while the amount of phosphorus from rural sources will decrease from 77 percent of the total in 2000 to about 71 percent of the total in 2035.

[20]Ibid.

[21]*Wisconsin Department of Natural Resources Publication No. WT-478-97,* Nonpoint Source Control Plan for the Sugar-Honey Creeks Priority Watershed Project, *February 1997, set a phosphorus load reduction goal of 14 percent of the then-estimated total annual phosphorus load of 1,880 pounds per year estimated to be entering the Lauderdale Lakes.*

Table 6

ESTIMATED ANNUAL POLLUTANT LOADINGS TO THE LAUDERDALE LAKES BY LAND USE CATEGORY: 2035

Land Use Category	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	8.9	184.2	0.0	1.6
Commercial	7.0	21.6	4.0	3.0
Industrial	0.4	1.2	0.2	1.5
Governmental	<0.1	0.3	0.0	0.0
Transportation	63.9	337.5	17.5	24.8
Recreational	2.9	65.1	0.0	0.0
Subtotal	83.1	609.9	21.7	30.9
Rural				
Agricultural	453.8	1,734.6	- -	- -
Wetlands	0.2	4.2	- -	- -
Woodlands	1.0	21.4	- -	- -
Water	74.8	103.5	- -	- -
Subtotal	529.8	1,863.7	- -	- -
Total	612.9	2,473.6	21.7	30.9

[a]*Includes the contribution from onsite sewage disposal systems. The contribution from onsite sewage disposal systems, based upon the* per capita *phosphorus contribution contained within wastewater estimated within the WILMS model, could range from approximately 25.5 pounds per year to as much as about 681.5 pounds per year, depending upon soil type, system condition, and system locations. For purposes of this analysis, 25.5 pounds per year were used as that value provided the loading that was best correlated to the measured in-lake phosphorus concentration.*

Source: SEWRPC.

While the trends forecast for year 2035 land use conditions may be offset by the increasing utilization of agro-chemicals in urban landscaping, the stormwater management requirements set forth in Chapter NR 151 of the *Wisconsin Administrative Code*, and the limits established by the Wisconsin Legislature on the use and sale of fertilizer containing phosphorus in turf fertilizers to be used in urban areas pursuant to 2009 Wisconsin Act 9 and on the amount of phosphorus in certain cleaning agents pursuant to 2009 Wisconsin Act 63, may be expected to further decrease the phosphorus loads to Honey Creek and its Lakes.

Sediment Loadings

For the current study period, the estimated sediment loadings to the Lauderdale Lakes under existing year 2000 conditions are shown in Table 5. Based upon estimated sediment loadings from various classes of land usage within the tributary area, as shown in Table 5, a total annual sediment loading of 685 tons was estimated to be contributed to the Lauderdale Lakes.[22] Of the likely annual sediment load, it was estimated that 540 tons per year, or about 79 percent of the total loading, were contributed by runoff from rural lands, mostly from agricultural sources, and 70 tons, or about 10 percent, contributed by urban lands. Approximately 75 tons, or about 11 percent of the annual sediment load, were contributed by atmospheric deposition onto the lake surface.

[22]*Wisconsin Department of Natural Resources Publication No. WT-478-97,* Nonpoint Source Control Plan for the Sugar-Honey Creeks Priority Watershed Project, *February 1997, set a sediment load reduction goal of 30 percent of the then-estimated total annual sediment load of 2,605 tons per year estimated to be entering the Lauderdale Lakes.*

Under 2035 conditions, as set forth in the adopted regional land use plan and as shown in Table 6, the annual sediment load to the Lakes is anticipated to diminish. The most likely annual sediment load to the Lakes under buildout conditions is estimated to be 610 tons. Of the forecast sediment load anticipated for the Lauderdale Lakes, about 455 tons of sediment are estimated to be contributed to the Lakes from rural sources and 80 tons from urban sources. Approximately 75 tons of sediment per year are estimated to continue to be contributed by direct precipitation onto the lake surface.

Urban Heavy Metals Loadings

Urbanization brings with it increased use of metals and other materials that contribute pollutants to aquatic systems.[23] The majority of these metals become associated with sediment particles[24] and, consequently, are likely to be encapsulated into the bottom sediments of a lake.

The estimated loadings of copper and zinc likely to be contributed to the Lauderdale Lakes under existing year 2000 and forecast year 2035 land use conditions are shown in Tables 5 and 6, respectively. In 2000, 18 pounds of copper and 31 pounds of zinc were estimated to be contributed annually to the Lauderdale Lakes, all from urban lands. Under planned year 2035 conditions, as set forth in the adopted regional land use plan,[25] the annual zinc loads to the Lakes are anticipated to remain about the same as those estimated under existing year 2000 conditions. The copper load is anticipated to increase slightly to about 22 pounds per year as a consequence of ongoing urban-density development in the watershed.

TROPHIC STATUS

Lakes are commonly classified according to their degree of nutrient enrichment, or trophic status. The ability of lakes to support a variety of recreational activities and healthy fish and other aquatic life communities is often correlated to the degree of nutrient enrichment that has occurred. There are three terms generally used to describe the trophic status of a lake: oligotrophic, mesotrophic, and eutrophic.

Oligotrophic lakes are nutrient-poor lakes. These lakes characteristically support relatively few aquatic plants and often do not contain very productive fisheries. Oligotrophic lakes may provide excellent opportunities for swimming, boating, and waterskiing. Because of the naturally fertile soils and the intensive land use activities, there are relatively few oligotrophic lakes in southeastern Wisconsin.

Mesotrophic lakes are moderately fertile lakes which may support abundant aquatic plant growths and productive fisheries. However, nuisance growths of algae and macrophytes are usually not exhibited by mesotrophic lakes. These lakes may provide opportunities for all types of recreational activities, including boating, swimming, fishing, and waterskiing. Many lakes in southeastern Wisconsin are mesotrophic.

Eutrophic lakes are nutrient-rich lakes. These lakes often exhibit excessive aquatic macrophyte growths and/or experience frequent algae blooms. If the lakes are shallow, fish winterkills may be common. While portions of such lakes are not ideal for swimming and boating, eutrophic lakes may support very productive fisheries. Although some eutrophic lakes are present in the Region, severely eutrophic lakes are rare, especially since the regionwide implementation of recommendations put forth in the regional water quality management plan. Severely enriched lakes are sometimes referred to as being hypertrophic.

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[23] *Jeffrey A. Thornton, et al.,* op. cit.

[24] *Werner Stumm and James J. Morgan,* Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters, *Wiley-Interscience, New York, 1970.*

[25] *SEWRPC Planning Report No. 48,* op. cit.

Several numeric "scales," based on one or more water quality indicators, have been developed to define the trophic condition of a lake. Because trophic state is actually a continuum from very nutrient poor to very nutrient rich, a numeric scale is useful for comparing lakes and for evaluating trends in water quality conditions. Care must be taken, however, that the particular scale used is appropriate for the lake to which it is applies. In this case, two indices appropriate for Wisconsin lakes have been used; namely, the Vollenweider-OECD open-boundary trophic classification system,[26] and the Carlson Trophic State Index (TSI),[27] with a variation known as the Wisconsin Trophic State Index value (WTSI).[28] The WTSI is a refinement of the Carlson TSI and is designed to account for the greater humic acid content—brown water color—present in Wisconsin lakes; it has been adopted by the WDNR for use in lake management investigations.

During the previous study period, Secchi-disk transparency conditions resulted in a WTSI value of about 40 for Green Lake, of about 42 for Middle Lake, and of about 45 for Mill Lake. Data at the time suggested that water quality in each of the three individual Lake systems had remained relatively stable over the approximately 20-year period since 1980. All three values indicated that the Lauderdale Lakes were mesotrophic waterbodies.

During the current study period, Secchi-disk transparency conditions resulted in a WTSI value of about 39 for Green Lake, of about 40 for Middle Lake, and of about 45 for Mill Lake. Data at the time suggested that water quality in each of the three individual Lake systems had remained relatively stable over the approximately 20-year period since 1980. All three values indicated that the Lauderdale Lakes were mesotrophic waterbodies.

Based upon data gathered during the aforementioned ERSC satellite remote sensing study, Green Lake was estimated to have a TSI value of 51 while Middle and Mill Lakes both had an estimated TSI value of 55. A value above 50 is generally indicative of the enriched conditions associated with slightly eutrophic lakes. These values are slightly higher than those calculated from the Secchi-disk transparency values obtained under the auspices of the CLMN program, but are consistent in placing the Lauderdale Lakes at the point of transition between mesotrophic and eutrophic states.

AQUATIC PLANTS: DISTRIBUTION AND MANAGEMENT AREAS

Previous surveys and inventories of the aquatic macrophyte communities in the Lauderdale Lakes were conducted in 1967 and 1999, the latter of which formed the basis for the current aquatic plant management plan for the Lauderdale Lakes.[29] The implementation of this plan resulted in a study, conducted by SEWRPC staff during July of 2003, of the response of the aquatic plant flora in Sterlingworth Bay to the removal of the Eurasian water milfoil canopy with an aquatic plant harvester. The current study builds from these foundational aquatic plant surveys. Conducted by SEWRPC staff during July of 2008, the results of this aquatic plant survey are shown in Tables 7 through 9, and on Maps 11 through 13.

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[26]*H. Olem and G. Flock, U.S. Environmental Protection Agency Report EPA-440/4-90-006,* The Lake and Reservoir Restoration Guidance Manual, Second Edition, *Walworth, D.C., August 1990.*

[27]*R.E. Carlson, "A Trophic State Index for Lakes,"* Limnology and Oceanography, *Vol. 22, No. 2, 1977.*

[28]*See R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes,"* Research and Management Findings, *Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.*

[29]*SEWRPC Memorandum Report No. 143,* op. cit.*; see also Wisconsin Department of Natural Resources Publication Lake Use Report Nos. FX-17, 18 and 20,* op. cit.

Table 7

AQUATIC PLANT SPECIES OBSERVED IN LAUDERDALE LAKES—GREEN LAKE: JULY 2008

Aquatic Plant Species	Number of Sites Found	Frequency of Occurrence[a]	Relative Density[b]	Importance Value[c]
Ceratophyllum demersum (coontail)	7	6.6	1.4	9.4
Chara vulgaris (muskgrass)	78	73.6	2.9	213.2
Elodea canadensis (waterweed)	11	10.4	1.9	19.8
Myriophyllum sibiricum (northern water milfoil)	8	7.5	1.0	7.5
Myriophyllum spicatum (Eurasian water milfoil)	37	34.9	2.2	76.4
Najas flexilis (bushy pondweed)	21	19.8	1.8	34.9
Najas marina (spiny naiad)	9	8.5	1.3	11.3
Nuphar advena (yellow water lily)	5	4.7	2.6	12.3
Nymphaea odorata (white water lily)	4	3.8	2.0	7.5
Potamogeton crispus (curly-leaf pondweed)	7	6.6	1.3	8.5
Potamogeton gramineus (variable pondweed)	22	20.8	1.5	31.1
Potamogeton foliosis (leafy pondweed)	3	2.8	1.7	4.7
Potamogeton illinoensis (Illinois pondweed)	3	2.8	2.3	6.6
Potamogeton natans (floating-leaf pondweed)	3	2.8	2.3	6.6
Potamogeton pectinatus (Sago pondweed)	32	30.2	1.9	57.5
Potamogeton pusillus (small pondweed)	1	0.9	1.0	0.9
Potamogeton richardsonii (clasping-leaf pondweed)	1	0.9	2.0	1.9
Potamogeton zosteriformis (flat-stem pondweed)	5	4.7	1.4	6.6
Utricularia spp. (bladderwort)	4	3.8	1.0	3.8
Vallisneria americana (wild celery/eel-grass)	53	50.0	2.7	135.8
Zosterella dubia (water stargrass)	3	2.8	1.0	2.8

NOTE: Sampling occurred at 106 sampling sites along 28 transects.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

[b]*The average density is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

[c]*The importance value is the product of the relative frequency of occurrence and the average density, expressed as a percentage. This number provides an indication of the dominance of a species within a community.*

Source: SEWRPC.

During the 1967 study, at least 23 different aquatic plant genera were observed, evidence of the exceptional diversity of the aquatic plant communities in the Lakes at that time. Eel-grass, or wild celery, (*Vallisneria americana*) and muskgrass (*Chara vulgaris*) were the dominant species around the deep basins; coontail (*Ceratophyllum demersum*), water milfoil (*Myriophyllum* sp.) and muskgrass were the dominant species in the larger, shallower bays. Pondweeds (*Potamogeton* spp.) were observed scattered throughout the Lakes, while water lilies, pond lilies, and cattails were abundant in the large bays. Overall, the Lakes contained a good diversity of aquatic species with little or no reported problems from algal blooms.

During the previous SEWRPC aquatic plant survey of 1999, the Lauderdale Lakes continued to exhibit this exceptional diversity, with up to 25 species of aquatic plants being recorded during that survey. The aquatic plant communities in each of the three Lakes were discussed separately:

- Green Lake, which contained some 18 different aquatic plant species, had a high floral diversity. Eurasian water milfoil (*Myriophyllum spicatum*) was the dominant species of submergent aquatic plant in this Lake, particularly in areas where silty or sand-silt sediments were present. Muskgrass,

Table 8

AQUATIC PLANT SPECIES OBSERVED IN LAUDERDALE LAKES—MIDDLE LAKE: JULY 2008

Aquatic Plant Species	Number of Sites Found	Frequency of Occurrence[a]	Relative Density[b]	Importance Value[c]
Ceratophyllum demersum (coontail)	3	3.6	1.3	4.8
Chara vulgaris (muskgrass)	55	66.3	3.1	206.0
Elodea canadensis (waterweed)	8	9.6	1.6	15.7
Myriophyllum sibiricum (northern water milfoil)	13	15.7	1.5	24.1
Myriophyllum spicatum (Eurasian water milfoil)	15	18.1	1.4	25.3
Najas flexilis (bushy pondweed)	16	19.3	2.0	38.6
Najas marina (spiny naiad)	19	22.9	1.9	43.4
Nuphar advena (yellow water lily)	15	18.1	1.9	34.9
Nymphaea odorata (white water lily)	9	10.8	1.9	20.5
Potamogeton crispus (curly-leaf pondweed)	7	8.4	2.1	18.1
Potamogeton gramineus (variable pondweed)	11	13.3	1.3	16.9
Potamogeton foliosis (leafy pondweed)	2	2.4	1.0	2.4
Potamogeton illinoensis (Illinois pondweed)	3	3.6	1.0	3.6
Potamogeton nodosus (long-leaf pondweed)	1	1.2	1.0	1.2
Potamogeton pectinatus (Sago pondweed)	8	9.6	1.1	10.8
Potamogeton zosteriformis (flat-stem pondweed)	5	6.0	2.2	13.3
Scirpus acutus (hardstem bulrush)	7	8.4	2.7	22.9
Sparganium minima (small bur reed)	3	3.6	2.0	7.2
Utricularia spp. (bladderwort)	13	15.7	1.2	18.1
Vallisneria americana (wild celery/eel-grass)	27	32.5	2.1	68.7

NOTE: Sampling occurred at 83 sampling sites along 25 transects.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

[b]*The average density is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

[c]*The importance value is the product of the relative frequency of occurrence and the average density, expressed as a percentage. This number provides an indication of the dominance of a species within a community.*

Source: SEWRPC.

eel-grass, spiny naiad (*Najas marina*), and bushy pondweed (*Najas flexilis*) were also present in significant numbers.

- Middle Lake contained 25 different aquatic plant species and had the best floral diversity of the three Lakes. The dominant species was muskgrass, although other species present in significant numbers included bushy pondweed, Eurasian water milfoil, spiny naiad, and eel-grass. As was the case in Green Lake, Eurasian water milfoil was widespread in areas where soft or organic bottom sediments dominated, such as in the western portions of Middle Lake that had been wetland prior to construction of the dam impounding the Lauderdale Lakes.

- Mill Lake contained 21 different aquatic plant species with Eurasian water milfoil found in the highest densities of all the Lauderdale Lakes. This is not surprising considering the generally widespread dominance of soft bottom sediments especially in the southern half of the Lake. Other plant species present in Mill Lake in fairly significant numbers included muskgrass, bushy pondweed, and eel-grass.

Table 9

AQUATIC PLANT SPECIES OBSERVED IN LAUDERDALE LAKES—MILL LAKE: JULY 2008

Aquatic Plant Species	Number of Sites Found	Frequency of Occurrence[a]	Relative Density[b]	Importance Value[c]
Ceratophyllum demersum (coontail)	14	13.9	2.5	34.7
Chara vulgaris (muskgrass)	54	53.5	3.2	169.3
Elodea canadensis (waterweed)	24	23.8	2.3	53.5
Lemna spp. (duckweed)	1	1.0	1.0	1.0
Myriophyllum sibiricum (northern water milfoil)	15	14.9	1.9	28.7
Myriophyllum spicatum (Eurasian water milfoil)	48	47.5	2.8	130.7
Najas flexilis (bushy pondweed)	31	3.7	2.5	75.2
Najas marina (spiny naiad)	2	2.0	2.5	5.0
Nitella spp. (stonewort)	4	4.0	1.8	6.9
Nuphar advena (yellow water lily)	1	1.0	4.0	4.0
Nymphaea odorata (white water lily)	3	3.0	2.3	6.9
Potamogeton amplifolius (large-leaf pondweed)	1	1.0	2.0	2.0
Potamogeton crispus (curly-leaf pondweed)	4	4.0	1.8	6.9
Potamogeton gramineus (variable pondweed)	9	8.9	1.2	10.9
Potamogeton foliosis (leafy pondweed)	3	3.0	0.7	2.0
Potamogeton nodosus (long-leaf pondweed)	1	1.0	0.0	0.0
Potamogeton pectinatus (Sago pondweed)	18	17.8	1.9	34.7
Potamogeton pusillus (small pondweed)	2	2.0	1.0	2.0
Potamogeton zosteriformis (flat-stem pondweed)	5	5.0	1.2	5.9
Utricularia spp. (bladderwort)	14	13.9	1.4	18.8
Vallisneria americana (wild celery/eel-grass)	41	40.6	2.2	89.1
Zosterella dubia (water stargrass)	5	5.0	1.8	8.9

NOTE: Sampling occurred at 101 sampling sites along 25 transects.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

[b]*The average density is the sum of density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all four points sampled at a given depth and is an indication of how abundant a particular plant is throughout a lake.*

[c]*The importance value is the product of the relative frequency of occurrence and the average density, expressed as a percentage. This number provides an indication of the dominance of a species within a community.*

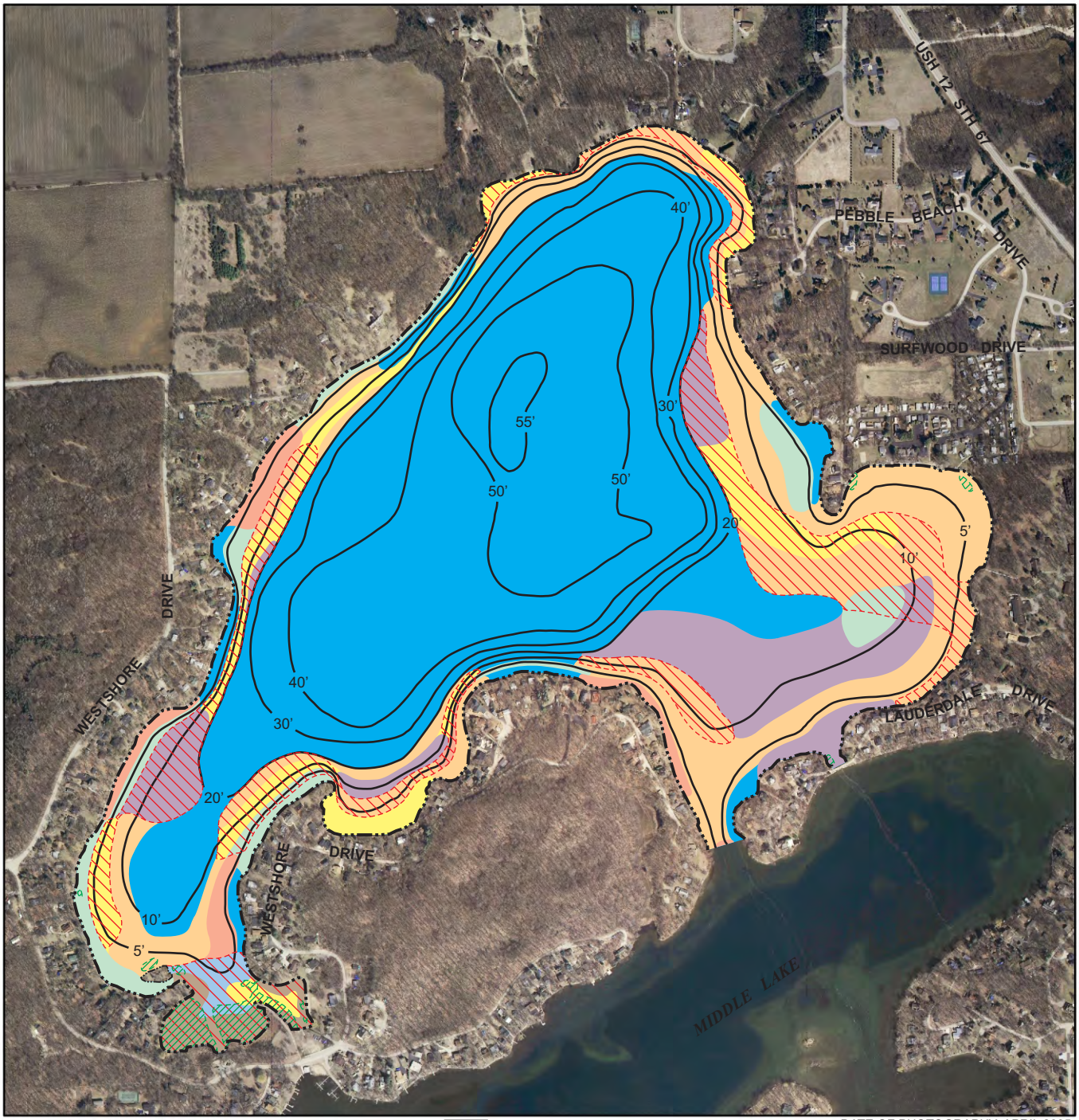
Source: SEWRPC.

During the current study, slightly fewer species of aquatic plants were found in Green Lake, as shown in Table 7. Of the 19 submergent aquatic plant species observed during 2008, the dominant species was muskgrass. Other species present in significant numbers included eel-grass, Eurasian water milfoil, and Sago pondweed (*Potamogeton pectinatus*). In Middle Lake during 2008, 18 species of submergent aquatic plant species were observed, as shown in Table 8. The dominant species in Middle Lake was muskgrass, with eel-grass and spiny naiad also present in significant numbers. This muskgrass-dominated aquatic plant community was repeated in Mill Lake during 2008, although Eurasian water milfoil was nearly as abundant as muskgrass and eel-grass was present in significant numbers, as shown in Table 9. There were some 20 submergent aquatic plant species observed in Mill Lake during the 2008 survey.

During 2008, Green Lake, Middle Lake, and Mill Lake all contained a variety of pondweeds, ranging from nine different pondweed species in Green Lake, to seven species in Middle Lake, to eight species in Mill Lake. The presence of such a diverse community of pondweed is generally considered to be indicative of a healthy lake and good habitat for fishes and aquatic life.

Map 11

AQUATIC PLANT COMMUNITY DISTRIBUTION IN GREEN LAKE: 2008



—20'— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, AND BLADDERWORT

MUSKGRASS, WILD CELERY, AND VARIABLE PONDWEED

MUSKGRASS, WILD CELERY, VARIABLE PONDWEED, AND SAGO PONDWEED

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, WATERWEED, NATIVE MILFOIL, CURLY-LEAF PONDWEED, AND COONTAIL

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, WATERWEED, AND NATIVE MILFOIL

MUSKGRASS, WILD CELERY, AND SAGO PONDWEED

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, WATERWEED, AND COONTAIL

DATE OF PHOTOGRAPHY: APRIL 2005

GRAPHIC SCALE

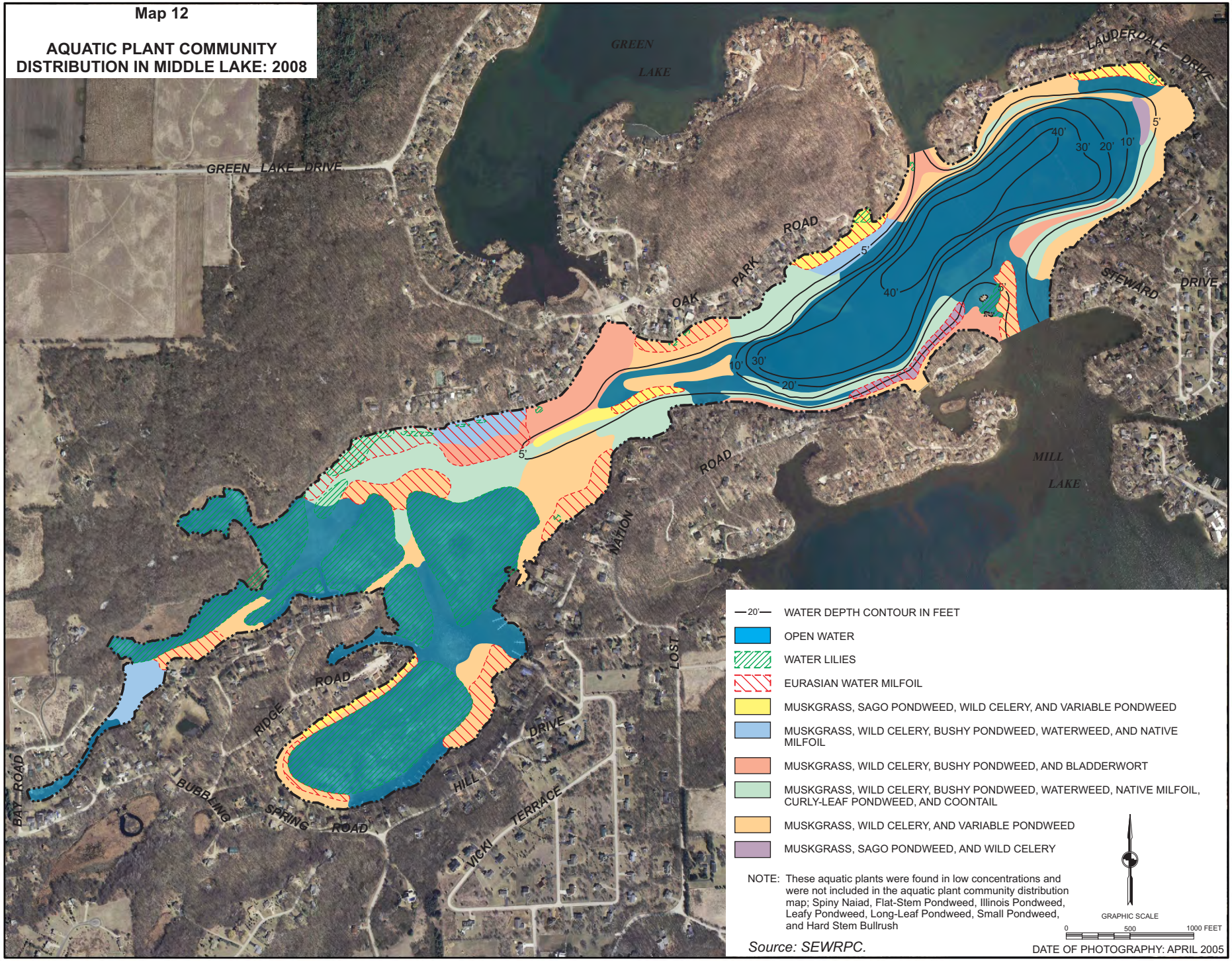
0 450 900 FEET

Source: SEWRPC.

NOTE: These aquatic plants were found in low concentrations and were not included in the aquatic plant community distribution map; Spiny Naiad, Flat-Stem Pondweed, Water Star Grass, Leafy Pondweed, Floating-Leaf Pondweed, Clasping-Leaf Pondweed, Illinois Pondweed, and Small Pondweed.

Map 12

AQUATIC PLANT COMMUNITY DISTRIBUTION IN MIDDLE LAKE: 2008

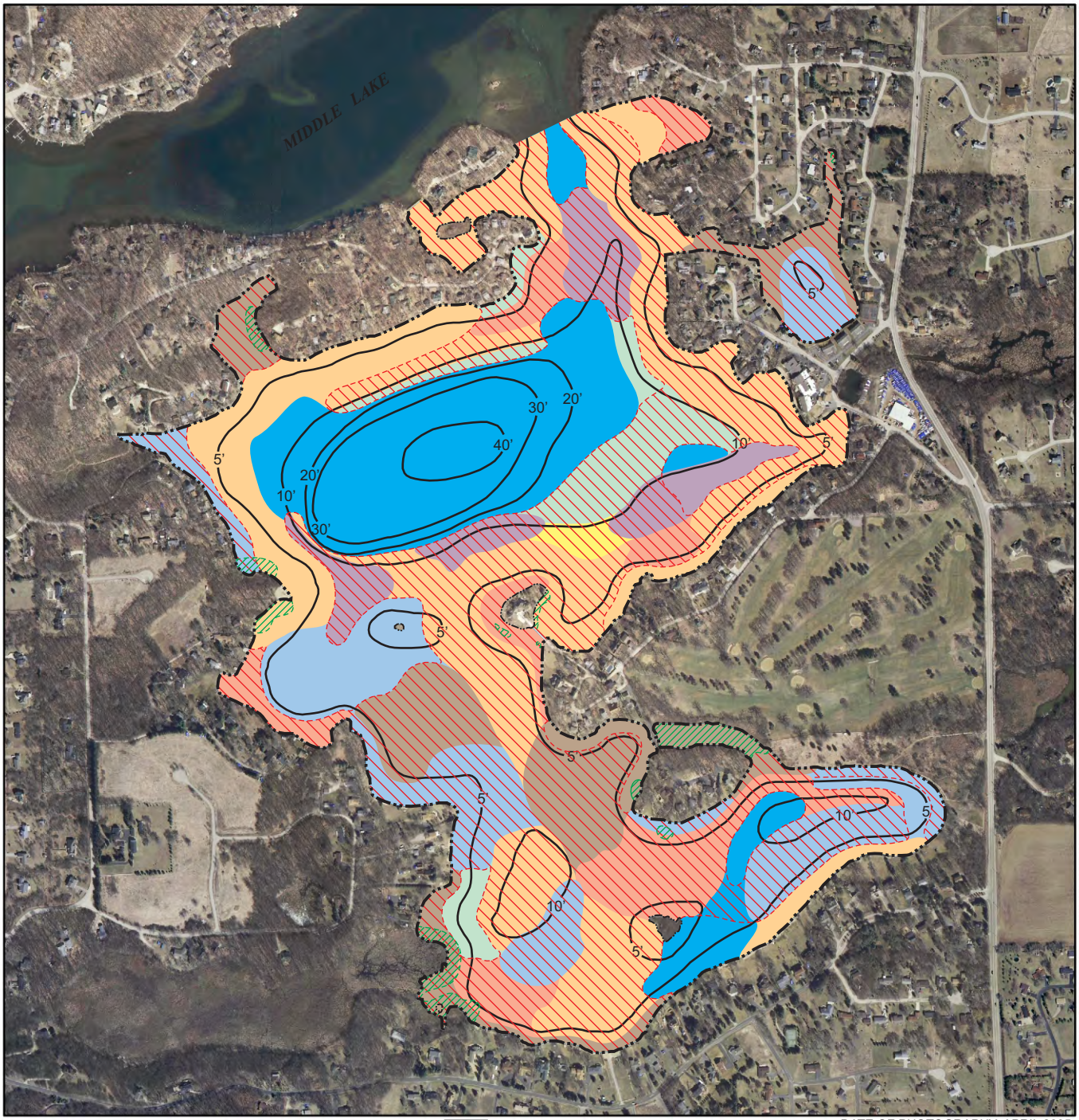


Source: SEWRPC.

DATE OF PHOTOGRAPHY: APRIL 2005

Map 13

AQUATIC PLANT COMMUNITY DISTRIBUTION IN MILL LAKE: 2008



—20'— WATER DEPTH CONTOUR IN FEET

OPEN WATER

WATER LILIES

EURASIAN WATER MILFOIL

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, AND BLADDERWORT

MUSKGRASS, WILD CELERY, AND VARIABLE PONDWEED

MUSKGRASS, WILD CELERY, VARIABLE PONDWEED, AND SAGO PONDWEED

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, WATERWEED, NATIVE MILFOIL, CURLY-LEAF PONDWEED, AND COONTAIL

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, WATERWEED, AND NATIVE MILFOIL

MUSKGRASS, WILD CELERY, AND SAGO PONDWEED

MUSKGRASS, WILD CELERY, BUSHY PONDWEED, WATERWEED, AND COONTAIL

DATE OF PHOTOGRAPHY: APRIL 2005

GRAPHIC SCALE

0 450 900 FEET

NOTE: These aquatic plants were found in low concentrations and were not included in the aquatic plant community distribution map; Spiny Naiad, Flat-Stem Pondweed, Water Star Grass, Leafy Pondweed, Long-Leaf Pondweed, Nitella, Small Pondweed, and Large Leaf Pondweed.

Source: SEWRPC.

The ecological significance of each plant species reported from the 2008 SEWRPC aquatic plant survey of the Lauderdale Lakes is set forth in Table 10. Representative illustrations of these aquatic plants can be found in Appendix A.

Aquatic Plant Diversity in the Lauderdale Lakes

A critical key to the ability of an ecosystem, such as a lake, to maintain its ecological integrity is through *biological diversity*. Conserving the biological diversity, or biodiversity, of an ecosystem helps not only to sustain the system, but preserves a spectrum of options for future decisions regarding the management of that system. During 2008, the aquatic plant communities in the Lauderdale Lakes demonstrated significant biodiversity: Green Lake with 19 species, Middle Lake with 18 different species, and Mill Lake with 20 different species of submersed aquatic plants. This numerical diversity is largely unchanged from that reported during the initial planning program. In Green Lake, the frequencies of occurrence of a number of the native aquatic plant species, specifically chara, elodea, and variable pondweed, have increased while the frequency of occurrence of the nonnative Eurasian water milfoil has decreased, as shown in Table 11, indicating the conduct of an effective aquatic plant management program in this Lake. In Middle Lake, similar changes in the frequencies of occurrence of the submergent aquatic plants can be noted, as shown in Table 12, with the frequencies of occurrence of Eurasian water milfoil decreasing relative to native species such as chara, elodea, and pondweed species. In Mill Lake, this shift is less pronounced, although the frequency of occurrence of the nonnative Eurasian water milfoil has also decreased relative to the frequency of occurrence of the native elodea, as shown in Table 13.

The distribution of this aquatic plant diversity, both in terms of the areal extent of the aquatic plant communities observed during 1999 and during 2008 in Mill Lake, is largely unchanged, although the aquatic plant communities identified during the latter survey would indicate greater diversity of species. Comparison of Map 10 of the initial aquatic plant management plan for the Lauderdale Lakes with Map 8 of this plan is indicative of the success achieved in managing the nonnative aquatic plant community of this Lake. The aquatic plant distribution in Middle Lake also illustrates this trend; comparison of Map 9 of the initial aquatic plant management plan for the Lauderdale Lakes with Map 9 of this plan indicates a reduction in the areal extent of the Eurasian water milfoil communities, as well as the expansion of the floating-leafed water lily communities. In Green Lake, a similar trend can be seen through comparison of Map 10 of this plan with Map 8 of the initial aquatic plant management plan; however, in Green Lake the Eurasian water milfoil community appears to have spread further along the southern shoreline of the Lake.

Aquatic Plant Species of Special Significance

Native Aquatic Plants

There were two native plant species observed in the 2008 and earlier surveys of the Lakes that are considered to be of exceptionally high-ecological value, muskgrass and large-leaf pondweed (*Potamogeton amplifolius*). Muskgrass is a favorite waterfowl food source and, as an effective bottom sediment stabilizer, benefits water quality. Its prevalence in the plant communities of a lake may be a significant contributing factor to establishing and maintaining good water quality of a lake and, consequently, in establishing water quality conditions that assist native plant species to successfully compete with nonnative species. Large-leaf pondweed, also known as musky weed or bass weed, is another native species of high-ecological value in natural communities. This plant was observed in Mill Lake during the 2008 and earlier surveys. Large-leaf pondweed, as anglers well know, has a reputation as a highly valuable contributor to fish habitat.

Nonnative Species

During the 2008 and earlier aquatic plant surveys of the Lauderdale Lakes, several nonnative aquatic plant species of special significance were observed. Two of these species, Eurasian water milfoil and curly-leaf pondweed (*Potamogeton crispus*), are considered to be detrimental to the ecological health of the Lakes and are declared nuisance species identified in Chapter NR 109 of the *Wisconsin Administrative Code*.

Eurasian water milfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. Because of its nonnative nature, Eurasian water milfoil has few natural enemies that can inhibit its

Table 10

POSITIVE ECOLOGICAL SIGNIFICANCE OF AQUATIC PLANT SPECIES PRESENT IN THE LAUDERDALE LAKES: 2008

Aquatic Plant Species Present	Ecological Significance
Ceratophyllum demersum (coontail)	Provides good shelter for young fish and supports insects; valuable as food for fish and ducklings
Chara vulgaris (muskgrass)	Excellent producer of fish food, especially for young trout, bluegills, small and largemouth bass; stabilizes bottom sediments; has softening effect on the water by removing lime and carbon dioxide
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food
Lemna spp. (duckweed)	Small duckweed is prized for its nutritional value as food for waterfowl; extensive rafts of duckweed can provide shelter for fish and even inhibit mosquito reproduction
Myriophyllum sibiricum (northern water milfoil)	Provides food for waterfowl; insect habitat and foraging opportunities for fish
Myriophyllum spicatum (Eurasian water milfoil)	None known; nonnative
Najas flexilis (bushy pondweed)	Stems, foliage, and seeds important wildfowl food; produces good food and shelter for fish
Najas marina (spiny naiad)	Valued as a food source for a wide variety of waterfowl; also important to muskrats and marsh birds as a food source
Nitella spp. (stonewort)	Valued as an indirect food source for waterfowl, as it harbors a myriad of insects and invertebrates that serve as food for ducks and geese
Nuphar advena (yellow water lily)	Seeds provide food for waterfowl; leaves, stems, and flowers are food for deer; rhizomes are food source for muskrats and beaver; leaves provide shelter and shade for fish and habitat for invertebrates
Nymphaea odorata (white water lily)	Seeds provide food for waterfowl; leaves, stems, and flowers are food for deer; rhizomes are food source for muskrats and beaver; leaves provide shelter and shade for fish and habitat for invertebrates
Potamogeton amplifolius (large-leaf pondweed)	Offers shade, shelter, and foraging for fish; valuable food for waterfowl
Potamogeton crispus (curly-leaf pondweed)	Nonnative
Potamogeton foliosis (leafy pondweed)	Provides food for geese and ducks; food for muskrat, beaver, and deer; good surface area for insects; cover for juvenile fish
Potamogeton gramineus (variable pondweed)	Provides habitat for fish and food for waterfowl, muskrat, beaver, and deer
Potamogeton illinoensis (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl
Potamogeton natans (floating-leaf pondweed)	Provides food for waterfowl, muskrat, beaver, and deer; good fish habitat
Potamogeton nodosus (long-leaf pondweed)	Fruit is food source for waterfowl; habitat and foraging opportunities for fish
Potamogeton pectinatus (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish
Potamogeton pusillus (small pondweed)	Provides food for ducks, geese, muskrat, beaver, and deer; provides food and shelter for fish

Table 10 (continued)

Aquatic Plant Species Present	Ecological Significance
Potamogeton richardsonii (clasping-leaf pondweed)	Provides food, shelter, and shade for some fish; food for some wildfowl; and food for muskrat; provides shelter and support for insects, which are valuable as fish food
Potamogeton zosteriformis (flat-stem pondweed)	Provides some food for ducks
Scirpus acutus (hardstem bulrush)	Provides habitat and shelter for fish; food for waterfowl; nesting materials for marsh birds
Sparganium minima (small bur reed)	Helps anchor bottom sediment; provides nesting sites for waterfowl and birds; food source for muskrat and deer
Utricularia spp. (bladderwort)	Provides cover and foraging for fish
Vallisneria americana (wild celery/eel-grass)	Provides good shade and shelter; supports insects; valuable fish food
Zosterella dubia (water stargrass)	Provides food and shelter for fish; locally important food for waterfowl

NOTE: Information obtained from *A Manual of Aquatic Plants* by Norman C. Fassett, University of Wisconsin Press; *Guide to Wisconsin Aquatic Plants*, Wisconsin Department of Natural Resources; and, *Through the Looking Glass...A Field Guide to Aquatic Plants*, Wisconsin Lakes Partnership, University of Wisconsin-Extension.

Source: SEWRPC.

Table 11

FREQUENCY OF OCCURRENCE[a] OF SUBMERGED AQUATIC PLANT SPECIES OBSERVED IN THE LAUDERDALE LAKES—GREEN LAKE: 1999 AND 2008

Aquatic Plant Species	1999	2008
Ceratophyllum demersum (coontail)	4.2	6.6
Chara vulgaris (muskgrass)	47.4	73.6
Elodea canadensis (waterweed)	4.2	10.4
Myriophyllum sibiricum (northern water milfoil)	1.1	7.5
Myriophyllum spicatum (Eurasian water milfoil)	58.9	34.9
Najas flexilis (bushy pondweed)	41.1	19.8
Najas marina (spiny naiad)	51.6	8.5
Potamogeton crispus (curly-leaf pondweed)	1.1	6.6
Potamogeton foliosis (leafy pondweed)	3.2	2.8
Potamogeton gramineus (variable pondweed)	- -	20.8
Potamogeton illinoensis (Illinois pondweed)	3.2	2.8
Potamogeton natans (floating-leaf pondweed)	- -	2.8
Potamogeton pectinatus (Sago pondweed)	32.6	30.2
Potamogeton pusillus (small pondweed)	- -	0.9
Potamogeton richardsonii (clasping-leaf pondweed)	- -	0.9
Potamogeton spp.	24.2	- -
Potamogeton zosteriformis (flat-stem pondweed)	8.4	4.7
Utricularia spp. (bladderwort)	- -	3.8
Vallisneria americana (wild celery/eel-grass)	51.6	50.0
Zosterella dubia (water stargrass)	7.4	2.8

NOTE: Sampling occurred at 106 sampling sites along 28 transects in 2008 and at 95 sampling sites in 1999.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

Source: SEWRPC.

Table 12

FREQUENCY OF OCCURRENCE[a] OF SUBMERGED AQUATIC PLANT SPECIES OBSERVED IN THE LAUDERDALE LAKES—MIDDLE LAKE: 1999 AND 2008

Aquatic Plant Species	1999	2008
Ceratophyllum demersum (coontail)	1.9	3.6
Chara vulgaris (muskgrass)	61.1	66.3
Elodea canadensis (waterweed)	3.7	9.6
Myriophyllum sibiricum (northern water milfoil)	9.3	15.7
Myriophyllum spicatum (Eurasian water milfoil)	29.6	18.1
Najas flexilis (bushy pondweed)	42.6	19.3
Najas marina (spiny naiad)	55.6	22.9
Potamogeton crispus (curly-leaf pondweed)	5.6	8.4
Potamogeton foliosis (leafy pondweed)	- -	2.4
Potamogeton gramineus (variable pondweed)	- -	13.3
Potamogeton illinoensis (Illinois pondweed)	11.1	3.6
Potamogeton natans (floating-leaf pondweed)	3.7	- -
Potamogeton nodosus (long-leaf pondweed)	- -	1.2
Potamogeton pectinatus (Sago pondweed)	18.5	9.6
Potamogeton spp.	13.0	- -
Potamogeton zosteriformis (flat-stem pondweed)	11.1	6.0
Utricularia spp. (bladderwort)	18.5	15.7
Vallisneria americana (wild celery/eel-grass)	40.7	32.5
Zosterella dubia (water stargrass)	1.9	- -

NOTE: Sampling occurred at 106 sampling sites along 28 transects in 2008 and at 95 sampling sites in 1999.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

Source: SEWRPC.

growth, which can be explosive under suitable conditions. The plant exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed. It frequently has been reported as a colonizing species following dredging, unless its growth is anticipated and controlled. Eurasian water milfoil populations can displace native plant species and interfere with the aesthetic and recreational use of the waterbodies. This plant has been known to cause severe recreational use problems in lakes within the Southeastern Wisconsin Region.

Eurasian water milfoil reproduces by the rooting of plant fragments. Consequently, some recreational uses of lakes can result in the expansion of Eurasian water milfoil communities, especially when boat propellers fragment Eurasian water milfoil plants. These fragments, as well as fragments that occur for other reasons, such as wind-induced turbulence or fragmentation of the plant by fishes, are able to generate new root systems, allowing the plant to colonize new sites. The fragments also can cling to boats, trailers, motors, and/or bait buckets, and can stay alive for weeks contributing to the transfer of milfoil to other lakes. For this reason, it is very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

Curly-leaf pondweed is a plant that thrives in cool water and exhibits a peculiar split-season growth cycle that helps give it a competitive advantage over native plants and makes management of this species difficult. In late summer, the plant produces specialized over-wintering structures, or “turions.” In late summer, the main body of the plant dies off and drops to the bottom where the turions lie dormant until the cooler fall water temperatures trigger the turions to germinate. Over the winter, the turions produce winter foliage that thrives under the ice. In

Table 13

FREQUENCY OF OCCURRENCE[a] OF SUBMERGED AQUATIC PLANT SPECIES OBSERVED IN THE LAUDERDALE LAKES—MILL LAKE: 1999 AND 2008

Aquatic Plant Species	1999	2008
Ceratophyllum demersum (coontail)	35.7	13.9
Chara vulgaris (muskgrass)	70.0	53.5
Elodea canadensis (waterweed)	11.4	23.8
Myriophyllum sibiricum (northern water milfoil)	1.4	14.9
Myriophyllum spicatum (Eurasian water milfoil)	87.1	47.5
Najas flexilis (bushy pondweed)	47.1	3.7
Najas marina (spiny naiad)	32.9	2.0
Nitella spp. (stonewort)	- -	4.0
Potamogeton amplifolius	1.4	1.0
Potamogeton crispus (curly-leaf pondweed)	11.4	4.0
Potamogeton foliosis (leafy pondweed)	4.3	3.0
Potamogeton gramineus (variable pondweed)	- -	8.9
Potamogeton illinoensis (Illinois pondweed)	4.3	- -
Potamogeton natans (floating-leaf pondweed)	5.7	- -
Potamogeton nodosus (long-leaf pondweed)	- -	1.0
Potamogeton pectinatus (Sago pondweed)	38.6	17.8
Potamogeton pusillus (small pondweed)	- -	2.0
Potamogeton spp.	17.1	- -
Potamogeton zosteriformis (flat-stem pondweed)	14.3	5.0
Utricularia spp. (bladderwort)	17.1	13.9
Vallisneria americana (wild celery/eel-grass)	55.7	40.6
Zosterella dubia (water stargrass)	1.4	5.0

NOTE: Sampling occurred at 106 sampling sites along 28 transects in 2008 and at 95 sampling sites in 1999.

[a]*The percent frequency of occurrence is the number of occurrences of a species divided by the number of samplings with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.*

Source: SEWRPC.

spring, when water temperatures begin to rise again, the plant has a head start on the growth of native plants and quickly grows to full size, producing flowers and fruit earlier than its native competitors. Because it can grow in more turbid waters than many native plants, protecting or improving water quality is an effective method of control of this species; clearer waters in a Lake can help native plants compete more effectively with curly-leaf pondweed.

Changes in the Lauderdale Lakes Aquatic Plant Communities

Aquatic plant communities do undergo cyclical and periodic changes, which reflect, in part, changing climatic conditions on an interannual scale, as well as, in part, the evolution of the aquatic plant community in response to changing hydroclimate conditions in the Lakes—these latter factors include changes in long-term nutrient loading, sedimentation rates, and recreational use patterns, for example. Interannual changes occur over a period of three to seven years and may be temporary. Evolutionary changes occur over a decadal period or longer, and are longer-lasting. Also, some species, such as the pondweeds, exhibit distinct seasonality, with individual species having well-defined growing periods that reflect water temperature, insolation, and other factors. It is not unusual to see a succession of pondweeds occurring in a lake during the course of the spring, summer, and autumn.

Changes in the Eurasian water milfoil population of a lake, in contrast, may reflect the results of aquatic management practices and/or be a reflection of the periodicity naturally experienced by this species. This periodicity has been observed throughout southeastern Wisconsin, and potentially reflects the influences of a combination of

stressors. These stressors include biological factors, such as the activities of naturally occurring Eurasian water milfoil weevils, as well as climatic and limnological factors, such as insolation, water temperature, and lake circulation patterns.

Tables 11 through 13 present data comparing the frequencies of occurrence of aquatic plant species in each of the Lauderdale Lakes in 1999 with those from the same lakes reported during 2008. These data represent a 10-year period of record, although the two surveys conducted during this period may be insufficient to distinguish interannual changes from longer-term trends. For this reason, more frequent surveys at approximately three- to five-year intervals, based upon a consistent methodology, are generally suggested to statistically discern interannual variability from longer-term changes in species abundance or community composition. Use of the modified Jesson and Lound transect method, as promulgated by the WDNR, in successive aquatic plant surveys at this interval, would allow the statistical evaluation of changes in the aquatic plant community within the Lakes.[30]

Past and Present Aquatic Plant Management Practices

An aquatic plant management program has been carried out on the Lauderdale Lakes in a documented manner since 1950. Records of aquatic plant management efforts were first maintained by the WDNR beginning in 1950. Prior to 1950, aquatic plant management interventions are likely, but were not recorded. Currently, all forms of aquatic plant management are subject to permitting by the WDNR pursuant to authorities granted the Department under Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*.

Since 1950, and prior to the development of the first aquatic plant management plan for the Lakes,[31] the aquatic plant management activities in the Lauderdale Lakes could be characterized as primarily a chemical control program designed to minimize nuisance growths of aquatic macrophytes and algae. A cumulative summary of the chemical applications to the Lauderdale Lakes for a range of commonly used herbicides is shown in Table 14 for the period between 1950 and 1996. Cumulative totals for each of the major chemical herbicides applied to the individual lakes in the Lauderdale chain for the period from 1950 through 1996 are set forth in Table 15. As shown in Tables 14 and 15, 19,306 pounds of sodium arsenite were applied to the Lauderdale Lakes between 1950 and 1969.

Sodium arsenite was typically sprayed onto the surface of a lake within an area of up to 200 feet from the shoreline. Treatments typically occurred between mid-June and mid-July. The amount of sodium arsenite used was calculated to result in a concentration of about 10 milligrams per liter (mg/l) of sodium arsenite in the treated lake water, or about 5.0 mg/l of elemental arsenic. The sodium arsenite typically remained in the water column for less than 120 days. Although the arsenic residue was naturally converted from a highly toxic form to a less toxic and less biologically active form, much of the arsenic residue was deposited in the lake sediments.

When it became apparent that arsenic was accumulating in the sediments of treated lakes, the use of sodium arsenite was discontinued in the State in 1969. The applications and accumulations of arsenic were found to present potential health hazards to both humans and aquatic life. In drinking water supplies, arsenic was suspected of being carcinogenic and, under certain conditions, arsenic is known to have leached into, and contaminated, the groundwater, especially in sandy soils that serve as a source of drinking water in some communities. The USEPA recommended drinking water standard for arsenic is a maximum level of 0.05 mg/l.

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[30]*Memo from Stan Nichols, to J. Bode, J. Leverence, S. Borman, S. Engel, D., Helsel, entitled "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes example," Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, February 4, 1994.*

[31]*Integrated Lakes Management,* Lauderdale Lakes Aquatic Plant Distribution, *July 1989.*

Table 14

TOTAL CHEMICAL CONTROLS ON THE LAUDERDALE CHAIN OF LAKES: 1950-2008

Year	Total Acres Treated	Algae Control			Macrophyte Control					
		Copper Sulfate (pounds)	Blue Vitriol (pounds)	Cutrine or Cutrine Plus (gallons)	Sodium Arsenite (pounds)	2,4-D (gallons)	2,4,5-TP (gallons)	2,4,5-T (gallons)	Diquat (gallons)	Endothall/ Aquathol (gallons)
1950-1969	- -	15,181.0	- -	- -	20,566	80.0	92.6	52.0	78.0	9.0 + 48.4 lbs.
1970	9.0	- -	- -	- -	- -	- -	- -	- -	15.0	10.0 + 300.0 lbs.
1971	3.4	- -	- -	- -	- -	- -	- -	- -	- -	67.0
1972	- -	- -	- -	- -	- -	- -	- -	- -	6.0	41.0
1973	- -	- -	- -	- -	- -	- -	- -	- -	18.0	8.0
1974	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
1975	- -	- -	- -	- -	- -	4.0	- -	- -	- -	8.0
1976	N/A	- -	- -	- -	- -	- -	- -	- -	- -	- -
1977	- -	- -	- -	- -	- -	- -	- -	- -	- -	22.0
1978	N/A	- -	- -	5.0	- -	- -	- -	- -	- -	- -
1979	- -	- -	- -	5.0	- -	- -	- -	- -	2.0	10.0 + 100.0 lbs.
1980	- -	100.0	- -	- -	- -	48.0	- -	- -	4.0	9.0 + 50.0 lbs.
1981	- -	8.0	- -	- -	- -	- -	- -	- -	5.5	12.0 + 160.0 lbs.
1982	- -	30.0	- -	- -	- -	- -	- -	- -	4.0	28.0
1983	N/A	- -	- -	- -	- -	- -	- -	- -	- -	- -
1984	3.8	36.0	- -	- -	- -	13.5	- -	- -	1.0	10.0
1985	- -	- -	- -	- -	- -	13.0	- -	- -	1.0	14.0
1986	8.2	3.0	- -	- -	- -	41.0	- -	- -	1.5	61.7 lbs.
1987	14.4	0.5	- -	- -	- -	21.0	- -	- -	0.5	3.5
1988	12.3	- -	- -	- -	- -	22.0	- -	- -	- -	1.5
1989	N/A	- -	- -	- -	- -	- -	- -	- -	- -	- -
1990	6.0	- -	- -	- -	- -	14.0	- -	- -	- -	- -
1991	N/A	- -	- -	- -	- -	6.0	- -	- -	- -	- -
1992	0.9	- -	- -	- -	- -	2.5	- -	- -	- -	- -
1993-2001	N/A	- -	- -	- -	- -	- -	- -	- -	- -	- -
2002[a]	1.3	2.7 gal.	- -	- -	- -	- -	- -	- -	2.7	2.7 + 10.0 lbs.
2003	1.0	1.3 gal.	- -	- -	- -	- -	- -	- -	1.3	1.0
2004	3.4	- -	- -	- -	- -	2.5 + 138 lbs.	- -	- -	- -	- -
2005	0.4	- -	- -	- -	- -	- -	- -	- -	0.8	1.0
2006	0.3	1.0 gal.	- -	- -	- -	- -	- -	- -	0.5	1.7
2007	0.9	2.0 gal.	- -	- -	- -	- -	- -	- -	1.5	2.5
2008	0.3	2.0 gal.	- -	- -	- -	- -	- -	- -	0.6	2.5
Total	- -	15,358.5 + 9.0 gal.	- -	10.0	20,566	267.5 + 138 lbs.	92.6	52.0	143.9	264.4 + 730.1 lbs.

NOTE: N/A = Records are not available or no chemical applications were reported as made during this year.

[a]*In 2002, 0.7 gallon of Aquashade was applied.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

In recent years, the aquatic plant management program conducted on the Lauderdale Lakes has been modified to include an emphasis on aquatic plant harvesting as the major element of the aquatic plant management strategy. Applications of aquatic herbicides have been limited to primarily individual applications around piers and docks, and focused on the treatment of nuisance growths of Eurasian water milfoil and curly-leaf pondweed. Contrasting Table 14 with Table 15 shows the magnitude of this shift in emphasis from the use of chemical control measures to harvesting of aquatic plants. During the period since 1996, herbicide use has been greatly reduced, with application of those herbicides—2,4-D, diquat, and endothal—having effectiveness in reducing growths of the nonnative aquatic plant species found within the Lauderdale Lakes, accounting for the majority of the applications of aquatic chemicals, the balance being accounted for through the application of copper compounds to control algal growths in the Lakes. Table 16 illustrates this shift in aquatic plant management practices, and documents the mass of aquatic vegetation removed from the Lakes since 2002 by means of mechanical harvesting.

Table 15

CHEMICAL CONTROL OF AQUATIC PLANTS IN INDIVIDUAL LAUDERDALE LAKES: 1950-1996

Lake	Algae Control			Macrophyte Control				
	Copper Sulfate (pounds)	Blue Vitriol (pounds)	Cutrine or Cutrine Plus (gallons)	Sodium Arsenite (pounds)	2,4-D (gallons)	Diquat (gallons)	Silvex (gallons)	Endothall/ Aquathol (gallons)
Green Lake	2,506	- -	- -	1,260	2.0	6.0	- -	20.0
Middle Lake	2,574	- -	5.0	- -	30.5	9.5	- -	55.0 + 20.0 lbs.
Mill Lake	2,525	- -	- -	- -	4.0	8.0	- -	39.0 + 305.0 lbs.
Lauderdale Lakes (unspecified)	7,754	- -	5.0	19,306	228.5	113.0	92.6	139.0 + 395.1 lbs.
Total	15,359	- -	10.0	20,566	265.0	136.5	92.6	253 + 720.1 lbs.

NOTE: Data for individual annual chemical application amounts, by lake, are presented in Tables 10, 11 and 12 of SEWRPC Memorandum Report No. 143.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table 16

AQUATIC PLANT MATERIAL MECHANICALLY HARVESTED IN LAUDERDALE LAKES

Year	Acres Harvested	Tons of Plant Material Removed	Primary Plant Types Harvested
2002	200	620	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*
2003	200	387	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*
2004	200	401	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*
2005	200	347	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*
2006	200	406	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*
2007	200	362	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*
2008	200	352	Eurasian water milfoil, native milfoil, *vallisneria*, and *chara*

Source: Wisconsin Department of Natural Resources and SEWRPC.

FISHERIES

Fish Community Composition

At the time of the 1969 WDNR report,[32] the Lauderdale Lakes were considered to have one of the best fish populations in Walworth County. Based on a 1966 fisheries survey, panfish were noted to be abundant, with largemouth bass being the principal game species present in the Lakes. Northern pike were considered to be of

[32]*Wisconsin Department of Natural Resources Publication Lake Use Report No. FX-17, 18 and 20,* op. cit.

secondary importance, and walleye, although able to reproduce naturally, were found to be present only as a small population. Spawning areas for largemouth bass were widespread throughout the Lauderdale Lakes system, while walleye spawning areas were assumed to be confined mostly to the gravelly east shores of the deeper basins. Areas suitable for northern pike spawning were found in the large bays on the western end of Middle Lake and the southern end of Mill Lake. Although present, roughfish—such as carp, longnose gar, and dogfish—were not considered to be a problem.

WDNR fish surveys conducted in 1978, 1998 and 1999,[33] summarized in the previous SEWRPC report,[34] noted 19 species of fishes. Bluegill being considered to be very abundant, largemouth bass abundant, and rock bass, pumpkinseed, and black crappie common. Walleye and northern pike were noted to be present within the system.

During the spring of 2008, the WDNR conducted additional fisheries surveys of the Lauderdale Lakes.[35] The surveys incorporated both fyke netting and electrofishing. These surveys indicated that the Lauderdale Lakes support naturally reproducing gamefish populations of largemouth bass and northern pike; populations of smallmouth bass and walleye are maintained primarily through stocking. The Lakes also supported naturally reproducing populations of numerous panfish species, including bluegill, yellow perch, rock bass, pumpkinseed, and black crappie.[36]

The 2008 netting survey documented largemouth bass as the most abundant gamefish, comprising over 69 percent of the sample. Very low numbers of legal-sized largemouth bass were recorded, however, probably due to harvesting pressure from anglers. The second most abundant gamefish was walleye, comprising about 15 percent of the sample and reflecting an excellent size structure with over 82 percent of the walleye being of legal size, compared to only about 3.5 percent of the bass population being of legal size. Northern pike was the next most abundant gamefish, comprising about 15 percent of the sample. Nearly 30 percent of the northern pike population was of legal size and the data seemed to indicate a balanced population.

The 2008 electrofishing survey also was dominated by largemouth bass, although the majority of fish captured during this survey also were less than the legal length.[37] Smallmouth bass of legal size comprised about 10 percent of the smallmouth bass population noted in this survey, and the overall size distribution of smallmouth bass seemed to indicate a population in balance. Panfish surveyed included bluegill, rock bass, yellow perch, pumpkinseed, and black crappie; the dominant panfish were bluegill, with more than half of those sampled being considered quality fish of seven inches or more in length.

The diverse fish population of the Lauderdale Lakes also contains the lake chubsucker (*Erimyzon sucetta*), a State Species of Special Concern. Special Concern species are "those in which reduced abundance or distribution is suspected, but not yet proven." The main purpose of this category is to focus attention on certain species before

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[33]*D.E. Welch and R. Dauffenbach,* Fisheries Survey Report for the Lauderdale Lakes (WBIC 0755500), Walworth County, *Wisconsin Department of Natural Resources, 2000.*

[34]*SEWRPC Memorandum Report No. 143,* op. cit.

[35]*D.E. Welch, personal communication.*

[36]Ibid.

[37]Ibid.

Table 17

FISH STOCKED INTO LAUDERDALE LAKES

Year	Species Stocked	Number	Average Fish Length (inches)
2002	Smallmouth bass	9,674	3.25
2003	Smallmouth bass	4,950	3.30
2004	Smallmouth bass	13,940	4.00

Source: Wisconsin Department of Natural Resources and SEWRPC.

they become threatened or endangered."[38] The lake chubsucker is a preferred food for largemouth bass. Habitat necessary for supporting this fish is found in Middle Lake, Mill Lake, and in the upper reaches of Honey Creek immediately downstream of the Lauderdale Lakes outlet.

Fisheries Management

Stocking of the Lauderdale Lakes with largemouth bass, bluegill, and several other species, was fairly regular during the period from 1937 through 1946. After 1946, annual stocking of walleye and sometimes northern pike was carried out between 1948 and 1965. This became intermittent between 1973 through 1998. Since 2002, smallmouth bass have been stocked into the Lauderdale Lakes, as shown in Table 17.

WILDLIFE

With respect to wildlife, and given the urbanization of land uses present around the shorelands of the Lakes, most of the wildlife remaining are urban-tolerant species. Smaller animals and waterfowl that would be expected to inhabit the lakeshore areas include muskrats, beaver, grey and fox squirrels, and cottontail rabbits, which are likely to be the most abundant and widely distributed fur-bearing mammals in the immediate riparian areas, and larger mammals, such as the whitetail deer, which are likely to be confined to the larger wooded areas and the open meadows found within the tributary area to the Lakes. The remaining undeveloped areas provide the best-quality cover for many wildlife species.

The Lauderdale Lakes tributary area supports a significant population of waterfowl including mallards, wood duck, and blue-winged teal. During the migration seasons a greater variety of waterfowl may be present and in greater numbers.

Amphibians and reptiles are vital components of the Lauderdale Lakes ecosystem, and include frogs, toads, and salamanders, and turtles and snakes, respectively. About 14 species of amphibians and 16 species of reptiles would normally be expected to be present in the Lauderdale Lakes area.

WDNR-DESIGNATED SENSITIVE AREAS

Within or immediately adjacent to bodies of water, the WDNR identifies sites that have special importance biologically, historically, geologically, ecologically, or even archaeologically. Such areas are defined as "areas of aquatic vegetation identified by the Department as offering critical or unique fish and wildlife habitat, including seasonal or life-stage requirements, or offering water quality or erosion control benefits of the body of water" and, after comprehensive examination and study is completed by WDNR staff from many different disciplines and

[38]*Wisconsin Department of Natural Resources*, Lauderdale Lakes (Walworth County, Wisconsin) Integrated Sensitive Area Report; *this report appears as* Appendix B *attached hereto.*

fields of study, are identified as Sensitive Areas pursuant to Chapter NR 107 of the *Wisconsin Administrative Code*. Chapter NR 107 authorizes the Department of Natural Resources to restrict chemical treatment of aquatic plants in Sensitive Areas on lakes and requires that alternatives to chemical treatment of aquatic plants be evaluated.

As reported in the previous SEWRPC plan, the WDNR surveyed the Lauderdale Lakes in 1990 to evaluate potential sensitive areas, identifying and designating five such areas. In 2004, the WDNR surveyed two additional sensitive sites in the Lauderdale Lakes area; the draft 2004 WDNR report and management recommendations for these seven areas in the Lauderdale Lakes basin are appended hereto as Appendix B. It is of note that Eurasian water milfoil was present in all but one of these sensitive areas.

SEWRPC-IDENTIFIED CRITICAL SPECIES HABITAT

SEWRPC has identified natural areas and critical species habitat areas within the Southeastern Wisconsin Region.[39] In the tributary area to the Lauderdale Lakes, the lakeshores, located within the environmental corridor network delineated by the Regional Planning Commission as part of its regional land use planning duties, should be candidates for immediate protection through proper zoning or through public ownership. Of the areas not already publicly owned, the remaining areas of natural shoreline (natural shoreline constitutes about 30 percent of the shoreline) and riparian wetland areas are perhaps the most sensitive areas in need of greatest protection. In this regard, two natural areas that contain intact native plant and animal communities of local significance have been identified, and are shown on Map 14. These natural areas, designated as NA-3 areas of local significance, include:

1. Island Woods: A privately owned, 46-acre, good-quality dry-mesic woods on rough terrain located within a primary environmental corridor on the peninsula separating Green and Middle Lakes; and,

2. Baywood Road Sedge Meadow: a privately owned 29-acre, good-quality sedge meadow and shallow marsh complex containing a strong influx of calciphilic species located within the primary environmental corridor in the western near-shore area at the southern end of Mill Lake.

In addition to the abovelisted sites, the tributary area to the Lauderdale Lakes contains several other sites, as well as several species, of special significance. The Lauderdale Lakes Woods contain two plant species of concern: *Aster furcatus*, or the forked aster which produces white blossoms (unusual for asters) and is found in less than 50 known locations across six Midwestern states—about a dozen of which are located in southeastern Wisconsin, and *Eupatorium sessilifolium*, or woodland boneset, an uncommon savannah species more often found in southwestern Wisconsin. Green Lake and Middle Lake both have a rating of AQ-3, designating them as aquatic areas of local significance due to their good water quality, fish diversity and natural habitat. Mill Lake has received a rating of AQ-2 as an aquatic area of countywide or regional significance, due, primarily, to its good overall fishery and habitat supporting "special concern" species lake chubsucker, as described above. Honey Creek, in its upper reaches, is also rated AQ-3 due to its habitat supporting the lake chubsucker.

RECREATIONAL USES AND FACILITIES

As set forth in the regional water quality management plan, the Lauderdale Lakes are multi-purpose waterbodies serving a variety of recreational uses in addition to being a year-round visual amenity.[40] Active recreational uses

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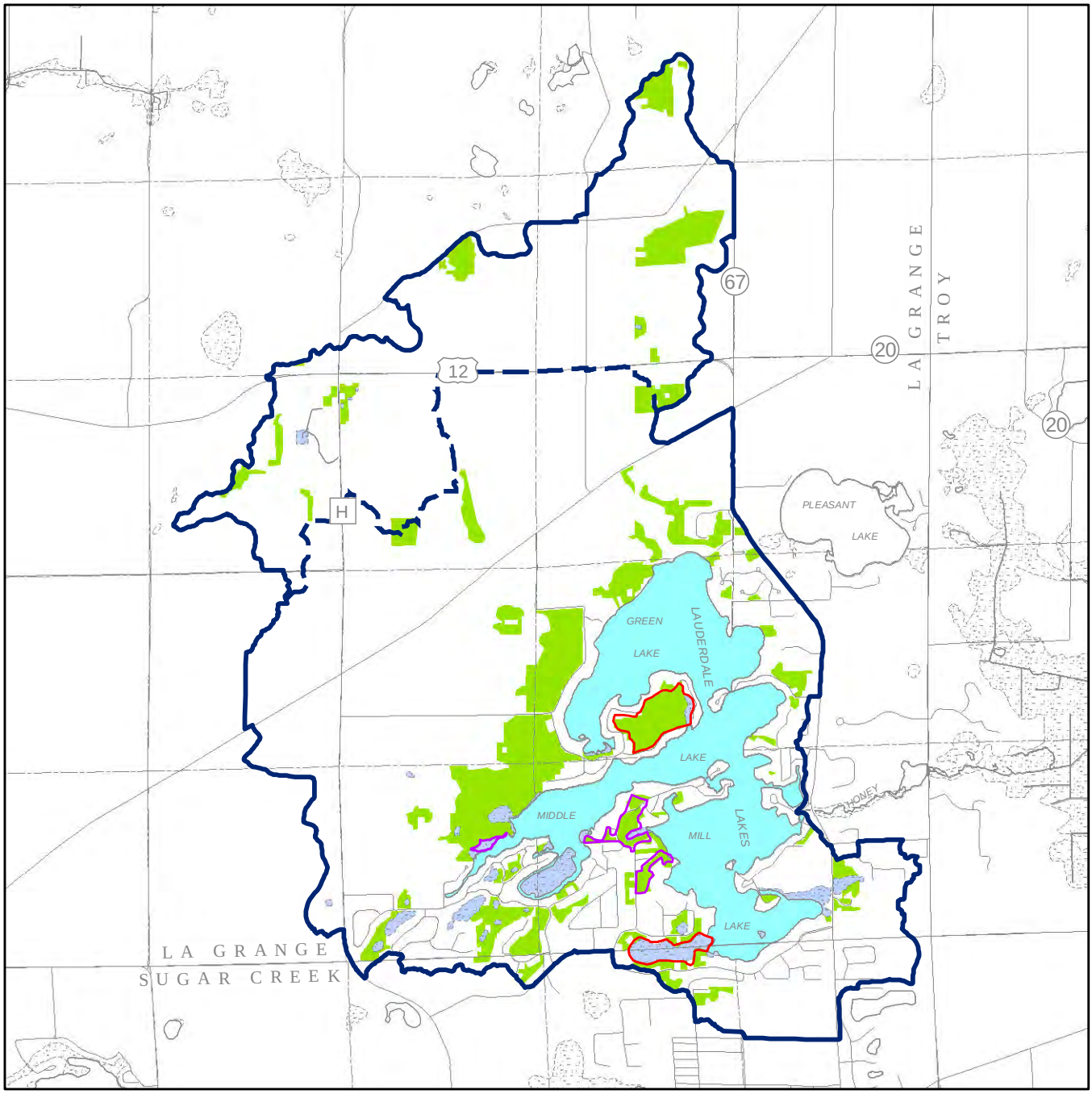
[39]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997.*

[40]*SEWRPC Planning Report No. 30,* op.cit. *See also SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995.*

Map 14

WETLANDS, WOODLANDS, AND NATURAL AREAS WITHIN THE LAUDERDALE LAKES TRIBUTARY AREA



Natural Area

Critical Species Habitat Site

Woodlands

Wetlands

Surface Water

N

0 2,000 4,000 Feet

Source: SEWRPC.

include boating, waterskiing, swimming, and fishing during the summer months; and cross-country skiing, snowmobiling, and ice-fishing during the winter; popular passive recreational uses include walking, bird watching, and picnicking. The Lakes experience intense recreational boating use during open-water periods, especially on weekends. In an intensive statewide survey of boating pressure on Wisconsin's lakes and rivers conducted in 1989 by the WDNR, the Lauderdale Lakes were reported to be eighth most-visited site in the then-WDNR Southeast District.[41] Public access to the Lakes is provided through three sites located on the western shores of Green and Middle Lakes and on the eastern shore of Middle Lake. The Lakes are deemed to have adequate public access as defined in Chapter NR 1 of the *Wisconsin Administrative Code*, which establishes quantitative standards for determining the adequacy of public recreation boating access, setting maximum and minimum standards based upon available parking facilities for car-top and car-trailer units.

Surveys of watercraft docked or moored on the Lauderdale Lakes were conducted by SEWRPC staff in 1999, as part of the initial planning project, and again in 2008 for the current study. The types of watercraft found on the Lakes included fishing boats, pontoon boats, paddleboats, canoes, sailboats, rowboats, and personal watercraft ("jetskis"®).

During the current study, a total of 2,151 watercraft were observed either moored in the water or stored on land in the shoreland areas around the Lakes, as shown in Table 18. Of these watercraft, 635 were observed to be moored or stored around Green Lake, 728 around Middle Lake, and 788 around Mill Lake. This total represents an increase of about 15 percent over the total number of watercraft inventoried during 1999. Comparison of the categories of watercraft observed during the two surveys showed the rankings of the three most numerous types of watercraft—in order: powerboats, pontoon boats, personal watercraft—to be the same in 2008 as it was in 1999, although some differences were observed in the other categories, most notably a decrease in the proportion of fishing boats between 1999 and 2008.

The types of watercraft docked or moored on a lake, as well as the relative proportion of nonmotorized to motorized watercraft, reflect the attitudes of the primary users of the lake, the lake residents. In a similar survey conducted on nearby Lake Wandawega during 2007,[42] only about 15 percent of watercraft were motorized, with pontoon boats comprising the single largest category of motorized watercraft, while the 2008 survey of the Lauderdale Lakes showed motorized watercraft accounted for about 73 percent of all watercraft, with powerboats comprising the single largest category of motorized watercraft. This would indicate that recreational high-speed boating is a major active recreational use of the Lauderdale Lakes. Of the nonmotorized watercraft observed on the Lauderdale Lakes during 2008, paddleboats and kayaks represented the most common types on the Lake, with canoes and rowboats also observed in good numbers. At times, especially on Sunday mornings, sailboats are the principal recreation watercraft to be observed on Green Lake.

To assess the degree of recreational boat use on a lake, it has been estimated that, in southeastern Wisconsin, the number of watercraft operating on a lake at any given time is between 2 percent and 5 percent of the total number of watercraft docked and moored. On the Lauderdale Lakes system as a whole, this would amount to somewhere between 43 and 108 boats of all kinds, about 71 percent of which would be capable of high-speed operation. Individually, on Green Lake, this would amount to between 13 and 32 watercraft of all kinds, 76 percent of which would be capable of high speed; on Middle Lake, between 15 and 36 watercraft, 62 percent capable of high speed; and, on Mill Lake, between 16 and 39 watercraft of all kinds, with 75 percent capable of high speed. Based on the

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[41]*Wisconsin Department of Natural Resources,* http://digital.library.wisc.edu/1711.dl/EcoNatRes.DNRBull174*; the WDNR Southeast District encompassed Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington, and Waukesha Counties. This same region now forms the WDNR Southeast Region.*

[42]*See SEWRPC Memorandum Report No. 175,* An Aquatic Plant Management Plan for Lake Wandawega, Walworth County, Wisconsin*, April 2009.*

Table 18

WATERCRAFT DOCKED OR MOORED ON THE LAUDERDALE LAKES: 2008[a]

Type of Watercraft—Green Lake									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Paddleboat	Rowboat	Total
220	17	144	109	45	24	30	25	21	635

Type of Watercraft—Middle Lake									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Paddleboat	Rowboat	Total
170	33	160	102	44	24	68	80	47	728

Type of Watercraft—Mill Lake									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Paddleboat	Rowboat	Total
245	32	214	117	27	29	28	61	35	788

Type of Watercraft—Total for All Lakes									
Powerboat	Fishing Boat	Pontoon Boat	Personal Watercraft	Canoe	Sailboat	Kayak	Paddleboat	Rowboat	Total
635	82	518	328	116	77	126	166	103	2,151

[a]*Including trailered watercraft and watercraft on land observable during survey.*

Source: SEWRPC.

number of watercraft docked or moored around the Lakes, it would appear that Mill Lake would be likely to have the greatest number of high-speed boats operating at any given time, although with the high degree of mobility exercised by watercraft of all types in navigating from one lake to the next in the Lauderdale Lakes system, it is difficult to predict with any degree of reliability which Lake might have the greatest high-speed boat traffic at any one time. Nevertheless, based upon the observed watercraft usage in the Lauderdale Lakes, as set forth in Table 18, it would appear that the density of usage of watercraft on the Lakes is consistent with the lower numbers of watercraft.

There is a range of opinion on the issue of what constitutes optimal boating density, or number of acres of open water in which to operate a boat on a lake. In this regard, an average area of about 16 acres per powerboat or sailboat was, at one time, considered suitable for the safe and enjoyable use of a boat on a lake. Over time, motorized watercrafts of all kinds have steadily increased in power and speed. For safe waterskiing and fast boating, the regional park and open space plan suggested an area of 40 acres per boat as the minimum area necessary for safe operations.[43] Chapter NR 1 of the *Wisconsin Administrative Code* has established recreational boating standards that suggest densities of between 25 acres and 35 acres per watercraft as being appropriate for lakes with a surface area equal to that of the Lauderdale Lakes. Using these standards, estimates of the densities of

[43]*See SEWRPC Planning Report No. 27,* A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000, *November 1977.*

high-speed boats on the Lauderdale Lakes, based on the percentages of watercraft docked or moored around the Lakes, would produce boating densities ranging between about one-boat-per 13 acres to about one-boat-per 31 acres on Green Lake; one-boat-per 11 acres to one-boat-per 29 acres on Middle Lake; and, one-boat-per nine acres to one-boat-per 23 acres on Mill Lake. When taken as a whole, the Lauderdale Lakes system, based on percentages of watercraft docked or moored, is capable of producing high-speed boating densities that range between 11 acres-per-boat to 28 acres-per-boat.

Another way to assess the degree of recreational boat use on a lake is through direct counts of boats actually in use on a lake at a given time. During 2009, surveys to assess the types of watercraft in use on a typical summer weekday and a typical summer weekend day were conducted by SEWRPC staff. The results of these surveys are shown in Table 19. As shown in the table, powerboats were the most popular watercraft in use on the Lakes during weekdays and weekends. Based on counts of boats observed to be actually in use, the density of high-speed watercraft on Green Lake ranged from a low of about one-boat-per 52 acres on a weekday morning to a high of about one boat-per 13 acres on a weekend afternoon; on Middle Lake, the range was from one-boat-per 52 acres on a weekday morning to one-boat-per 22 acres on a weekend afternoon; and on Mill Lake, the range was from one-boat-per 68 acres on a weekday morning to one-boat-per 14 acres on a weekend afternoon. For the Lauderdale Lakes system as a whole, the values ranged from one high-speed boat per 60 acres on a weekday morning to one-boat-per 15 acres on a weekend afternoon. Such densities reflect the intense weekend recreational use the Lakes experience, a situation not uncommon on many of the lakes in the Region. The densities observed on the Lauderdale Lakes on weekdays and weekend mornings are generally within those considered appropriate for the conduct of safe high-speed boating activities; however, the higher degree of boating activity that often occurs on the Lakes during holidays and weekend afternoons may produce high-speed boating densities that temporarily exceed the standards.

Table 20 shows the numbers of people engaged in the various types of recreational activities on and around the Lauderdale Lakes during a typical summer weekday and a typical summer weekend in 2009. The most popular weekday and weekend recreational activities on the Lakes, both as a whole and individually, were pleasure boating and waterskiing/tubing, swimming, fishing from boats, and operating personal watercraft were also popular activities. Sailing was also a popular activity mostly during those limited predetermined times and events, such as noted above; kayaking was a fairly popular activity, as well.

LOCAL ORDINANCES

As shown in Table 21, the Towns of LaGrange and Sugar Creek have each adopted the Walworth County ordinances in regard to general zoning and subdivision control ordinances, floodland zoning, shoreland or shoreland-wetland zoning; the Town of LaGrange has adopted its own construction site erosion control/storm-water management control ordinances, while the Town of Sugar Creek has adopted the Walworth County ordinances in this regard. Recreational boating activities on the Lauderdale Lakes are currently regulated through Town ordinances as appended hereto in Appendix C.

Table 19

WATERCRAFT IN USE ON THE LAUDERDALE LAKES: SUMMER 2009

Green Lake									
Date and Time	Powerboat	Pontoon Boat	Fishing Boat	Personal Watercraft	Sailboat	Canoe/ Kayak	Wind Surf Board	Paddleboat	Total
Wednesday, July 29									
8:30 a.m. to 9:30 a.m.	3	1	4	0	0	0	0	0	8
2:30 p.m. to 3:30 p.m.	6	6	1	1	0	5	0	1	20
Sunday, August 2									
8:30 a.m. to 9:30 a.m.	2	4	11	1	13	0	0	0	31
12:30 p.m. to 1:30 p.m.	16	4	2	6	3	0	0	0	31

Middle Lake									
Date and Time	Powerboat	Pontoon Boat	Fishing Boat	Personal Watercraft	Sailboat	Canoe/ Kayak	Wind Surf Board	Paddleboat	Total
Wednesday, July 29									
8:30 a.m. to 9:30 a.m.	2	2	1	0	0	0	0	0	5
2:30 p.m. to 3:30 p.m.	3	3	0	1	1	0	0	0	8
Sunday, August 2									
8:30 a.m. to 9:30 a.m.	5	2	3	1	1	4	0	0	16
12:30 p.m. to 1:30 p.m.	6	6	0	0	5	0	0	0	17

Mill Lake									
Date and Time	Powerboat	Pontoon Boat	Fishing Boat	Personal Watercraft	Sailboat	Canoe/ Kayak	Wind Surf Board	Paddleboat	Total
Wednesday, July 29									
8:30 a.m. to 9:30 a.m.	3	0	1	0	0	0	0	0	4
2:30 p.m. to 3:30 p.m.	6	2	1	0	0	0	0	0	9
Sunday, August 2									
8:30 a.m. to 9:30 a.m.	11	3	2	0	1	1	0	0	18
12:30 p.m. to 1:30 p.m.	8	6	1	4	3	1	0	0	23

Total for All Lakes									
Date and Time	Powerboat	Pontoon Boat	Fishing Boat	Personal Watercraft	Sailboat	Canoe/ Kayak	Wind Surf Board	Paddleboat	Total
Wednesday, July 29									
8:30 a.m. to 9:30 a.m.	8	3	6	0	0	0	0	0	17
2:30 p.m. to 3:30 p.m.	15	11	2	2	1	5	0	1	37
Sunday, August 2									
8:30 a.m. to 9:30 a.m.	18	9	16	2	15	5	0	0	65
12:30 p.m. to 1:30 p.m.	30	16	3	10	11	1	0	0	71

Source: SEWRPC.

Table 20

PARTICIPANTS ENGAGED IN WATER-BASED RECREATION IN/ON THE LAUDERDALE LAKES: SUMMER 2009

Green Lake										
Date and Time	Fishing from Shoreline	Pleasure Boating	Skiing/ Tubing	Sailing	Operating Personal Watercraft	Swimming	Fishing from Boats	Canoeing/ Paddle Boating	Park Goers	Total
Wednesday, July 29										
8:30 a.m. to 9:30 a.m.	1	3	5	0	0	0	6	0	0	15
2:30 p.m. to 3:30 p.m.	0	32	11	0	1	21	4	21	0	90
Total for the Day	1	35	16	0	1	21	10	21	0	105
Percent	1	33	15	0	1	20	10	20	0	100
Sunday, August 2										
8:30 a.m. to 9:30 a.m.	1	11	3	13	1	0	25	0	8	62
12:30 p.m. to 1:30 p.m.	0	25	25	3	8	9	8	0	0	78
Total for the Day	1	36	28	16	9	9	33	0	8	140
Percent	1	26	20	11	6	6	24	0	6	100

Middle Lake										
Date and Time	Fishing from Shoreline	Pleasure Boating	Skiing/ Tubing	Sailing	Operating Personal Watercraft	Swimming	Fishing from Boats	Canoeing/ Paddle Boating	Park Goers	Total
Wednesday, July 29										
8:30 a.m. to 9:30 a.m.	1	0	5	0	0	0	6	0	0	12
2:30 p.m. to 3:30 p.m.	1	12	10	1	0	0	0	0	0	24
Total for the Day	2	12	15	1	0	0	6	0	0	36
Percent	5	33	42	2	0	0	18	0	0	100
Sunday, August 2										
8:30 a.m. to 9:30 a.m.	4	21	3	1	1	0	12	4	0	46
12:30 p.m. to 1:30 p.m.	0	20	15	5	0	12	0	0	0	52
Total for the Day	4	41	18	6	1	12	12	4	0	98
Percent	4	42	19	6	1	12	12	4	0	100

Mill Lake										
Date and Time	Fishing from Shoreline	Pleasure Boating	Skiing/ Tubing	Sailing	Operating Personal Watercraft	Swimming	Fishing from Boats	Canoeing/ Paddle Boating	Park Goers	Total
Wednesday, July 29										
8:30 a.m. to 9:30 a.m.	0	3	8	0	0	0	2	0	0	13
2:30 p.m. to 3:30 p.m.	0	0	31	0	0	4	1	0	0	36
Total for the Day	0	3	39	0	0	4	3	0	0	49
Percent	0	6	80	0	0	8	6	0	0	100
Sunday, August 2										
8:30 a.m. to 9:30 a.m.	4	13	28	1	0	0	10	1	0	57
12:30 p.m. to 1:30 p.m.	25	17	13	3	4	12	3	1	0	78
Total for the Day	29	30	41	4	4	12	13	2	0	135
Percent	22	23	30	3	3	9	9	1	0	100

Table 20 (continued)

Total for All Lakes										
Date and Time	Fishing from Shoreline	Pleasure Boating	Skiing/ Tubing	Sailing	Operating Personal Watercraft	Swimming	Fishing from Boats	Canoeing/ Paddle Boating	Park Goers	Total
Wednesday, July 29										
8:30 a.m. to 9:30 a.m.	2	6	18	0	0	0	14	0	0	40
2:30 p.m. to 3:30 p.m.	1	44	52	1	1	25	5	21	0	150
Total for the Day	3	50	70	1	1	25	19	21	0	190
Percent	2	26	36	1	1	13	10	11	0	100
Sunday, August 2										
8:30 a.m. to 9:30 a.m.	9	45	34	15	2	0	47	5	8	165
12:30 p.m. to 1:30 p.m.	25	62	53	11	12	33	11	1	0	208
Total for the Day	34	107	87	26	14	33	58	6	8	373
Percent	9	29	23	7	4	9	16	1	2	100

Source: SEWRPC.

Table 21

LAND USE REGULATIONS WITHIN THE AREA TRIBUTARY TO THE LAUDERDALE LAKES IN WALWORTH COUNTY BY CIVIL DIVISION: 2003

	Type of Ordinance				
Community	General Zoning	Floodland Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Construction Site Erosion Control and Stormwater Management
Walworth County.....	Adopted	Adopted	Adopted and Wisconsin Department of Natural Resources approved	Adopted	Adopted
Town of LaGrange	County ordinance	County	County	County and Town	Adopted
Town of Sugar Creek	County ordinance	County	County	County and Town	County

Source: SEWRPC.

Chapter III

ALTERNATIVE AND RECOMMENDED AQUATIC PLANT MANAGEMENT PRACTICES

INTRODUCTION

The Lauderdale Lakes generally contain a robust and fairly diverse aquatic plant community capable of supporting a warmwater fishery, albeit with some areas that suffer impairment of recreational boating opportunities and other lake-oriented activities due to an overabundance of aquatic macrophytes. For example, in those areas of the Lakes where Eurasian water milfoil (*Myriophyllum spicatum*) is abundant, certain recreational uses are limited, the aesthetic quality of the Lakes is impaired, and in-lake habitat degraded. The plant primarily interferes with recreational boating activities, by encumbering propellers, clogging cooling water intakes, snagging paddles, and slowing sailboats by wrapping around keels and control surfaces. The plant also causes concern among swimmers who can become entangled within the plant stalks. Thus, without control measures, these areas can become problematic to navigation, fishing, and swimming. Native aquatic plants, generally found at slightly deeper depths, pose fewer potential problems for navigation, swimming, and fisheries, and generally have attributes that sustain a healthy fishery. Many native aquatic plants provide fish habitat and food resources, and offer shelter for juvenile fishes and young-of-the-year fish.

In this chapter, alternative and recommended actions for the management of aquatic plants in the Lauderdale Lakes are presented. These measures are focused primarily on those measures which can be implemented by the Lauderdale Lakes Lake Management District (LLLMD), with lesser emphasis given to those measures which are applicable to other agencies having jurisdiction, or other organizations having interests, within the area tributary to the Lakes. To this end, the Lauderdale Lakes Partnership—comprised of the LLLMD, the Lauderdale Lakes Improvement Association (LLIA), and Kettle Moraine Land Trust (KMLT)—should continue to promote collective and cooperative community involvement and action in lake management and monitoring activities.

AQUATIC PLANT MANAGEMENT MEASURES

As stated in Chapter II of this report, recent aquatic plant management activities in the Lauderdale Lakes can be categorized as being primarily based on mechanical harvesting. In addition, individual householders on the Lauderdale Lakes have been known to engage in manual harvesting in the vicinities of their piers and docks. This approach provides for maximum impact of the harvesting operations.

The shoreland and aquatic macrophyte management elements of this plan consider alternative management measures consistent with the provisions of Chapters NR 103, NR 107, and NR 109 of the *Wisconsin Administrative Code*. Further, the alternative aquatic plant management measures are consistent with the requirements of

Chapter NR 7 of the *Wisconsin Administrative Code,* and with the public recreational boating access requirements relating to the eligibility under the State cost-share grant programs, set forth under Chapter NR 1 of the *Wisconsin Administrative Code*.

Array of Management Measures

Aquatic plant management measures can be classed into four groups: ***physical measures***, which include lake bottom coverings and water level management; ***biological measures***, which include the use of various organisms, including herbivorous insects and plantings of aquatic plants; ***manual*** and ***mechanical measures***, which include harvesting and removal of aquatic plants; and, ***chemical measures***, which include the use of aquatic herbicides. All control measures are stringently regulated and require a State of Wisconsin permit; chemical controls are regulated under Chapter NR 107 of the *Wisconsin Administrative Code,* and all other aquatic plant management practices are regulated under Chapter NR 109 of the *Wisconsin Administrative Code*. Placement of bottom covers, a physical measure, also requires a Wisconsin Department of Natural Resources (WDNR) permit under Chapter 30 of the *Wisconsin Statutes*. Costs range from minimal for manual removal of plants using rakes and hand-pulling, to upwards of $75,000 for the purchase of a mechanical plant harvester, for which the operational costs can approach $2,500 to $25,000 per year depending on staffing and operation policies.

Physical Measures

Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. Synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. However, such materials, known as bottom screens or barriers, generally have to be placed and removed annually. Such barriers also are susceptible to disturbance by watercraft propellers or the build-up of gasses from decaying plant biomass trapped under the barriers. In the case of the Lauderdale Lakes, the need to encourage native aquatic plant growth while simultaneously controlling the growth of Eurasian water milfoil, suggests that the placement of lake bottom covers as a method to control aquatic plant growth does not appear to be warranted. Thus, such measures are not considered viable for the Lauderdale Lakes.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance plants, particularly purple loosestrife (*Lythrum salicaria*), an invasive shoreland wetland plant, and Eurasian water milfoil. Classical biological control techniques have been successfully used to control both nuisance plants with herbivorous insects.[1] Recent evidence shows that *Galerucella pucilla* and *Galerucella calmariensis,* both beetle species, and *Hylobius transversovittatus* and *Nanophyes brevis,* both weevil species, have potential as biological control agents for purple loosestrife.[2] Extensive field trials conducted by the WDNR in the Southeastern Wisconsin Region since 1999 have indicated that these insects can provide effective management of large infestations of purple loosestrife. In contrast, the few studies of Eurasian water milfoil control utilizing *Eurhychiopsis lecontei*, an aquatic weevil species, have resulted in variable levels of control, with little control being achieved on those lakes having extensive motorized boating traffic. Thus, while the use of insects as a means of shoreland wetland plant management is considered to be viable, the use of *Eurhychiopsis lecontei* as a means of aquatic plant management control, is not considered a viable option for use on the Lauderdale Lakes at this time.

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[1]*B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control,"* LakeLine, *Vol. 17, No. 3, September 1997, pp. 20-21, 34-3. See also, C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities, *1984, pp. 659-696; and C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology, *John Wiley, New York, New York, USA.*

[2]*Sally P. Sheldon, "The Potential for Biological Control of Eurasian Water Milfoil (*Myriophyllum spicatum*) 1990-1995 Final Report," Department of Biology Middlebury College, February 1995.*

The use of grass carp, *Ctenopharyngodon idella*, an alternative biological control used elsewhere in the United States, is not permitted in Wisconsin. This voracious herbivore has been shown to denude lakes and ponds of aquatic vegetation, exposing lake bottom sediments to wind erosion and increasing turbidity in lakes and ponds, and enhancing the likelihood of occurrence of nuisance algal blooms.[3]

A variation on the theme of biological control is the introduction of aquatic plants into a waterbody as a means of encouraging or stimulating the growth of desirable native aquatic plant species in a lake. While few projects of this nature have been undertaken in the Southeastern Wisconsin Region, the Lac La Belle Management District, in partnership with the WDNR and University of Wisconsin-Milwaukee, did attempt to supplement the aquatic plant community of that lake by selectively planting pondweeds (*Potamogeton* spp.).[4] Several hundred pondweeds were transplanted into Lac La Belle, and, while there is some evidence that a few of these transplants were successful, the net outcome of the project was disappointing. Few of the introduced plants were observed in subsequent years.[5] Given the extensive and diverse aquatic plant community present in the Lauderdale Lakes, supplemental plantings are not considered to be a viable aquatic plant management option.

Manual and Mechanical Measures

The physical removal of specific types of vegetation by selective harvesting of plants provides a highly selective means of controlling the growths of nuisance aquatic plant species, including purple loosestrife and Eurasian water milfoil. Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, manual harvesting of aquatic plants within a 30-foot-wide corridor outside of a WDNR-designated sensitive area along a shoreline would be allowed without a WDNR permit, provided the plant material is removed from the lake. Any other manual harvesting, including manual harvesting within a WDNR-designated sensitive area, would require a State permit, unless employed in the control of designated nonnative invasive species, such as Eurasian water milfoil or curly-leaf pondweed.

Aquatic macrophytes also may be harvested mechanically with specialized equipment consisting of a cutting apparatus, which cuts up to about five feet below the water surface, and a conveyor system that picks up the cut plants. Mechanical harvesting can be a practical and efficient means of controlling plant growth as it removes the plant biomass and nutrients from a lake. Mechanical harvesting is particularly effective as a measure to control large-scale growths of aquatic plants. Narrow channels can be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. The harvesting of water lilies and other emergent native plants should be avoided.

"Clear cutting" aquatic plants and denuding the lake bottom of flora, using either manual or mechanical harvesting, should be avoided. However, top cutting of plants, such as Eurasian water milfoil, using mechanical harvesters, as shown in Figure 2, has proven to be beneficial in some lakes as a means of minimizing the

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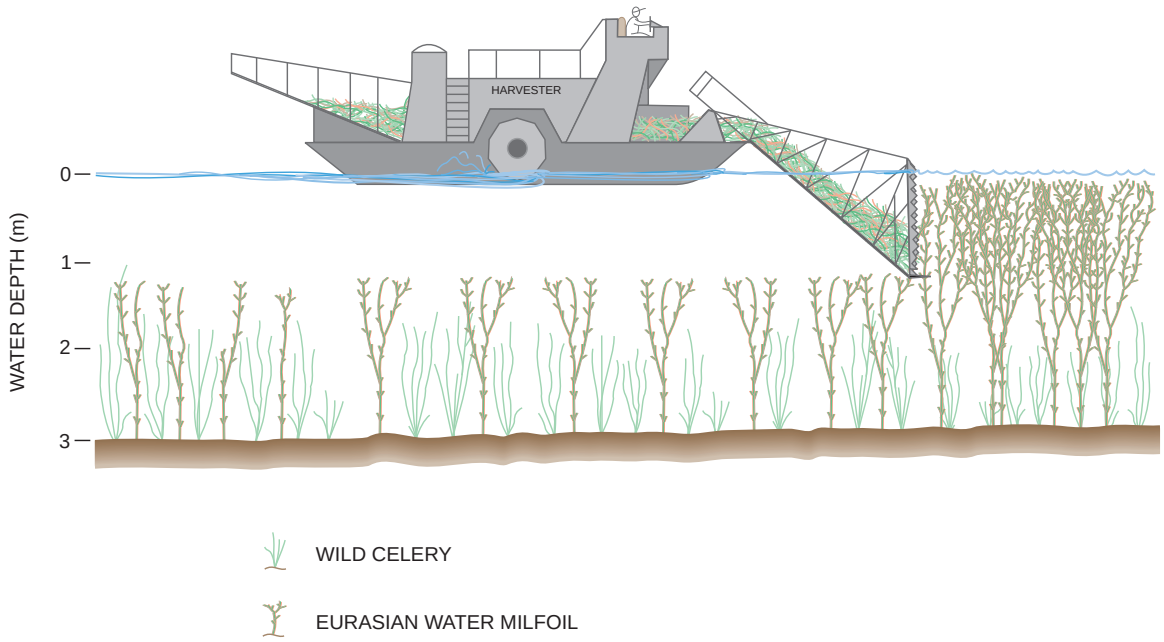
[3]*C. Holdren, W. Jones and J. Taggart*, Managing Lakes and Reservoirs, *Third Edition, North American Lake Management Society, Terrene Institute, and U.S. Environmental Protection Agency, 2001.*

[4]*Donald H. Les and Glenn Guntenpergen, "Laboratory Growth Experiments for Selected Aquatic Plants, Final Report, July 1989-June 1990 (Year 1)," Report to the Wisconsin Department of Natural Resources, June 1990; Wisconsin Department of Natural Resources, "Environmental Assessment: Improvement of the Water Quality and Fisheries Habitat of LacLaBelle [sic] and the Lower Oconomowoc River," s.d.*

[5]*At the 2003 annual meeting of the Lac La Belle Management District, a citizen reported observing a herbicide application in the vicinity of the planted area of the Lake. Such an application might explain the observed lack of success of this management measure. See SEWRPC Community Assistance Planning Report No. 47, 2nd Edition,* A Water Quality Management Plan for Lac La Belle, Waukesha County, Wisconsin, *May 2007.*

Figure 2

PLANT CANOPY REMOVAL WITH AN AQUATIC PLANT HARVESTER



NOTE: Selective cutting or seasonal harvesting can be done by aquatic plant harvesters. Removing the canopy of Eurasian water milfoil may allow native species to reemerge.

Source: Wisconsin Department of Natural Resources and SEWRPC.

competitive advantage of the Eurasian water milfoil plant and encouraging native aquatic plant growths.[6] This "top chopping" of Eurasian water milfoil is particularly recommended in those areas of the Lauderdale Lakes that have been shown to respond well to this method, as reported in an August 2002 Commission memorandum attached to this report as Appendix D.

In the shoreland area, where purple loosestrife may be expected to occur, bagging and cutting loosestrife plants prior to the application of chemical herbicides to the cut ends of the stems, can be an effective control measure for small infestations of this plant. Loosestrife management programs, however, should be followed by an annual monitoring and control program for up to 10 years following the initial control program to manage the regrowth of the plant from seeds. Manual removal of such plants is recommended for isolated stands of purple loosestrife when and where they occur.

In the nearshore area, specially designed rakes are available to assist in the manual removal of nuisance aquatic plants, such as Eurasian water milfoil. The use of such rakes also provides a safe and convenient method of controlling aquatic plants in deeper nearshore waters around piers and docks. The advantage of the rakes is that they are relatively inexpensive, easy and quick to use, and immediately remove the plant material from the lake,

[6]*See SEWRPC Memorandum Report No. 143*, An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, *August 2001*.

without a waiting period. Removal of the plants from the lake avoids the accumulation of organic matter on the lake bottom, which adds to the nutrient pool that favors further plant growth. State permitting requirements for manual aquatic plant harvesting mandate that the harvested material be removed from the lake. Should the LLLMD acquire a number of these specially designed rakes, they could be made available for the riparian owners to use on a trial basis to test their operability before purchasing them.

Hand-pulling of stems, where they occur in isolated stands, provides an alternative means of controlling plants, such as Eurasian water milfoil, in a lake, and purple loosestrife, on the lakeshore. Because this is a more selective measure, the rakes being nonselective in their harvesting, manual removal of Eurasian water milfoil is considered a viable option in the Lauderdale Lakes, where practicable and feasible.

An advantage of mechanical aquatic plant harvesting is that the harvester typically leaves enough plant material in the lake to provide shelter for fish and other aquatic organisms, and to stabilize the lake bottom sediments. Aquatic plant harvesting also has been shown to facilitate the growth of native aquatic plants in harvested areas by allowing light penetration to the lakebed. Many native aquatic plants are low-growing species that are less likely to interfere with human recreational and aesthetic uses of a lake. A disadvantage of mechanical harvesting is that the harvesting operation may cause fragmentation of plants and, thus, unintentionally facilitate the spread of some plants that utilize fragmentation as a means of propagation, namely Eurasian water milfoil. Harvesting may also disturb bottom sediments in shallower areas where such sediments are only loosely consolidated, thereby increasing turbidity and resulting in deleterious effects, including the smothering of fish breeding habitat and nesting sites. Disrupting the bottom sediments also could increase the risk that an exotic species, such as Eurasian water milfoil, may colonize the disturbed area since this is a species that tends to thrive under disturbed bottom conditions. To this end, most WDNR-issued permits do not allow harvesting in areas having a water depth of less than three feet. Nevertheless, if done correctly and carefully, harvesting has been shown to be of benefit in ultimately reducing the regrowth of nuisance plants when used under conditions suitable for this method of control. Both manual and mechanical harvesting techniques are considered to be viable options for control of aquatic plants in the Lauderdale Lakes.

Chemical Measures

Chemical treatment with herbicides is a short-term method of controlling heavy growths of nuisance aquatic plants. Chemicals are generally applied to the growing plants in either a liquid or granular form. The advantages of using chemical herbicides to control aquatic macrophytes growth are the relatively low-cost and the ease, speed, and convenience of application. The disadvantages associated with chemical control include unknown long-term effects on fish, fish food sources, and humans; a risk of increased algal blooms due to the eradication of macrophyte competitors; an increase in organic matter in the sediments, possibly leading to increased plant growth, as well as anoxic conditions which can cause fishkills; adverse effects on desirable aquatic organisms; loss of desirable fish habitat and food sources; and, finally, a need to repeat the treatment the following summer due to existing seed banks and/or plant fragments. Widespread chemical treatments can also provide an advantage to less desirable, invasive, introduced plant species to the extent that such treatments may produce conditions in which nonnative species can outcompete the more beneficial, native aquatic plant species. Hence, this is seldom a feasible management option to be used on a large scale. Widespread chemical treatment, therefore, is not considered a viable option for the Lauderdale Lakes, although limited chemical control is often a viable technique for the control of the relatively small-scale infestations of aquatic plants, such as Eurasian water milfoil, or shoreland plants, such as purple loosestrife.

To minimize the possible impacts of deoxygenation, loss of desirable plant species, and contribution of organic matter to the sediments, early spring or late fall applications should be considered. Such applications also minimize the concentration and amount of chemicals used due to the facts that colder water temperatures enhance the herbicidal effects, while the application of chemical herbicides during periods when most native aquatic plants species are dormant limit the potential for collateral damage. Use of chemical herbicides in aquatic environments is stringently regulated and requires a WDNR permit and WDNR staff oversight during applications.

Use of early spring or late fall chemical controls,[7] especially in those shoreline areas where mechanical harvesting would not be deemed viable, targeting growths of Eurasian water milfoil and purple loosestrife in and around the Lakes, is considered a viable option for the Lauderdale Lakes. It should be noted, however, that the use of chemical herbicides within WDNR-delineated sensitive areas is prohibited by Town of LaGrange ordinance dated June 14, 2010.

Recommended Management Measures

The most-effective plans for managing aquatic plants rely on a combination of methods and techniques, such as those described above. Therefore, to enhance the recreational uses of the Lauderdale Lakes, while maintaining the quality and diversity of the biological communities, the following recommendations are made:

- Manual harvesting around piers and docks is the recommended means of controlling nonnative nuisance species of plants in those areas. In this regard, the LLLMD could consider purchasing several specialty rakes designed for the removal of vegetation from shoreline property and make these available to riparian owners. This would allow the riparian owners to use the rakes on a trial basis before purchasing their own. Although the rakes do not require a permit for use along a 30-foot-wide length of shoreline, State requirements for manual aquatic plant harvesting mandate that the harvested material be removed from the lake. Where feasible and practicable, hand-pulling of stems, where they occur in isolated stands, is also recommended as an alternative means of controlling Eurasian water milfoil and purple loosestrife. Manual control should target nonnative species.

- Mechanical harvesting should be considered as the primary method of aquatic plant management in the Lauderdale Lakes. Due to the nature of the dual approach to aquatic plant control employed on the Lakes, comprised of manual and mechanical harvesting, specific control measures are recommended to be applied in various areas of the Lake, as summarized below.

- Continued use of the District-owned property on Mill Lake, adjacent to the Lauderdale Lakes Country Club golf course, as the primary on-lake harvester mooring and servicing facility is recommended; repair or replacement of the board walk serving this area is recommended to minimize the impacts on the shoreland wetland system that the District has established on the dredge spoil deposited historically in this vicinity. Additional temporary mooring sites adjacent to the public recreational boating access sites on Green Lake and at the western extreme of Middle Lake are recommended for ongoing use during the limited periods, estimated to be 10 percent of the in-water period, that the harvesters are operating on those waterbodies.

- Through informational programming, riparian owners should be encouraged to monitor their shoreline areas, as well as open-water areas of the Lakes, for new growths of nonnative nuisance plants and report such growths immediately to the LLLMD so that a timely and effective response can be executed.

- It also is recommended that the LLLMD consider the conduct of in-lake aquatic plant surveys at about three- to five-year intervals, depending upon the observed degree of change in the aquatic plant communities. In addition, information on the aquatic plant control program should be recorded and should include descriptions of major areas of nuisance plant growth and areas chemically treated.

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[7]*It should be noted that, at the time of writing, late fall herbicide treatments are considered to be experimental in Wisconsin and will not typically be permitted by the WDNR at this time, pending further research into the use of such treatments. It also is noted that many aquatic plants become dormant during the late fall and winter, die back, and do not meet the nuisance standards established pursuant to Chapter NR 107 of the* Wisconsin Administrative Code *as the basis for the application of aquatic herbicides. Consequently, late fall applications of herbicides are not recommended.*

- Additional periodic monitoring of the aquatic plant community is recommended for the early detection and control of future-designated nonnative species that may occur. Such control could be effected with the assistance of funds provided under the Chapter NR 198, aquatic invasive species control grant program, and should be undertaken as soon as possible once the presence of a nonnative, invasive species is observed and confirmed, reducing the risk of spread from waters where they are present and restoring native aquatic communities. Control of currently designated invasive species, designated pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, using appropriate control measures,[8] is recommended throughout the Lake.

- It is recommended that any use of chemical herbicides be limited to controlling nuisance growths of exotic species, particularly Eurasian water milfoil and purple loosestrife. It is recommended that chemical applications, if required, be made by licensed applicators in early spring, subject to State permitting requirements to maximize their effectiveness on nonnative plant species while minimizing impacts on native plant species and acting as a preventative measure to reduce the development of nuisance conditions. Such use should be evaluated annually and the herbicide applied only on an as-needed basis. Only herbicides that selectively control milfoil, such as 2,4-D, [9] should be used; for the control of purple loosestrife, the use of glyphosate[10] could be considered for application to the cut stems of the plants after the seed heads have been bagged and cut. Use of chemical herbicides within WDNR-delineated sensitive areas is prohibited by Town of LaGrange ordinance.

- The use of algicides, such as Cutrine Plus,[11] is not recommended because there are few significant, recurring filamentous algal or planktonic algal problems in the Lauderdale Lakes and valuable macroscopic algae, such as *Chara* and *Nitella*, are killed by this product. Maintenance of shoreland areas around docks and piers remains the responsibility of individual property owners.

ANCILLARY PLAN RECOMMENDATIONS

Shoreline Protection

Shoreline protection measures refer to a group of management measures designed to reduce and minimize shoreline loss due to erosion by waves, ice, or related action of the water. Currently, about 30 percent of the shoreline of the Lauderdale Lakes is in a natural state. To the extent practicable, continued use of vegetative shoreline protection is recommended. Where structural management measures were installed, most of the observed shoreline protection measures were in a good state of repair and no severe erosion-related problems were observed. Monitoring of shoreline vegetation for early detection and control of purple loosestrife, for example, and ongoing maintenance of shoreline protection structures is recommended.

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[8] *Appropriate control measures include, but are not limited to, any permitted aquatic plant management measure, placement of signage, and use of buoys to isolate affected areas of the Lakes. Such measures as may be appropriate should be determined in consultation with WDNR staff and conducted in accordance with required permits under Chapters NR 107, NR 109, and NR 198, among others, of the* Wisconsin Administrative Code.

[9] *See Wisconsin Department of Natural Resources PUBL-WR-236 90,* Chemical Fact Sheet: 2,4-D, *May 1990.*

[10] *See Wisconsin Department of Natural Resources PUBL-WR-239 90,* Chemical Fact Sheet: Glyphosate, *May 1990.*

[11] *See Wisconsin Department of Natural Resources PUBL-WR-238 90,* Chemical Fact Sheet: Copper Compounds, *May 1990.*

Array of Management Measures

Shoreline Erosion Control

Five shoreline erosion control techniques were commonly observed to be used along the shorelines of the Lauderdale Lakes, 1) vegetative buffer strips, 2) riprap, 3) concrete and rock revetments, 4) wooden and concrete bulkheads, and 5) beach. Of these, revetments and bulkheads are strongly discouraged as these types of structures impede the movement of amphibians and inhibit the reproduction of other aquatic creatures that depend on the shore zone for breeding, feeding, and resting. Factors affecting the choice of method include cost; the shoreline bank height, vegetation, stability, and composition; the shoreline geometry and geographic orientation; the lake bottom contour and vegetation immediately adjacent to the stretch of shoreline under consideration; the proximity to boat channels; possible influence of adjacent structures in producing flank erosion; and the amount of open water (or "fetch") over which wind can act to produce wave action directly into the shoreline under consideration. A worksheet is provided as Table 1 of Section NR 328.08 of the *Wisconsin Administrative Code* in order to assist property owners who wish to install or modify existing shoreline protection structures.

Maintenance of vegetated buffer strips immediately adjacent to the Lakes is the simplest, least costly, and most natural method of reducing shoreline erosion. Along developed shorelines, this technique employs natural vegetation, rather than maintained lawns, in the first five to 10 feet landward from the shoreline and the establishment of emergent aquatic vegetation from the waterline out to two to six feet lakeward from the shoreline. The use of such natural shorescaping techniques is generally required pursuant to Chapter NR 328 of the *Wisconsin Administrative Code,* except in moderate- to high-energy shorelines where more-robust structural approaches may be required. Along undeveloped shorelines, the WDNR recommends shoreland buffers extend from the water's edge onto land at least 35 to 50 feet, contain three layers of flora—herbaceous, shrub, and tree—found along natural Wisconsin lakeshores. It also is recommended that these areas not be mowed except for a viewing access corridor.[12]

Desirable plant species that may be expected and encouraged to form an effective buffer strip, or which could be planted, include arrowhead (*Sagittaria latifolia*), cattail (*Typha* spp.), common reed (*Phragmites communis*), water plantain (*Alisma plantago-aquatica*), bur reed (*Sparganium eurycarpum*), and blue flag (*Iris versicolor*) in the wetter areas; and jewelweed (*Impatiens biflora*), elderberry (*Sambucus canadensis*), giant goldenrod (*Solidago gigantea*), marsh aster (*Aster simplex*), red-stem aster (*Aster puniceus*), and white cedar (*Thuja occidentalis*) in the drier areas. In addition, trees and shrubs, such as silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), black willow (*Salix nigra*), and red-osier dogwood (*Cornus stolonifera*) could become established. These plants will develop a more extensive root system than lawn grass and the aboveground portion of the plants will protect the soil against the erosive forces of rainfall and wave action. A narrow path to the Lakes could be maintained as lake access for boating, swimming, fishing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sediments washing into the Lakes via direct overland flow. This alternative would involve only minimal cost.

Rock riprap is a highly effective method of shoreline erosion control applicable to many types of erosion problems found along active shorelines, especially in areas with low banks and shallow water. Riprap is already in place along much of the shoreline of the Lauderdale Lakes. The technique involves the shaping of the shoreline slope, the placement of a porous filter material, such as sand, gravel, or pebbles, on the slope and the placement of rocks on top of the filter material to protect the slope against the actions of waves and ice. The advantages of riprap structures are that they are highly flexible and not readily weakened by movements caused by settling or ice expansion, they can be constructed in stages, and they require little or no maintenance. The disadvantages are that they limit some uses of the immediate shoreline. The rough, irregular rock surfaces are unsuitable for walking;

[12]*Wisconsin Department of Natural Resources,* Delavan Lake (Walworth County, Wisconsin) Integrated Sensitive Area Report, 2007.

require a relatively large amount of filter material and rocks to be transported to the lakeshore; and can cause temporary disruptions and contribute sediment to the lake. If improperly constructed, they may fail because of washout of the filter material.

Vertical bulkheads and sloping revetments, which form barriers to wildlife and amphibians, are not recommended. Beaches, and the use of sand blankets for the control of aquatic plants within the shoreland zone, also are not recommended, although maintenance of existing beach areas is warranted, given the current intensity of use of these areas by the community.

Shoreline Protection in the Vicinity of the Aquatic Plant Harvester and Water Safety Patrol Dock
As noted above, the District's aquatic plant harvesting equipment is customarily moored at a pier on District-owned property on Mill Lake, adjacent to the Lauderdale Lakes Country Club golf course. This pier also is utilized by the LLLMD and Town of LaGrange water safety patrol, both for mooring of the patrol craft and for emergency access should it be necessary for the water safety patrol to render assistance to persons in distress. Access to the pier is across reclaimed land, in part comprised of dredge spoil from Mill Lake deposited historically in this vicinity. Portions of the access route are served by a board walk, ongoing repair or periodic replacement of which is recommended to minimize the impacts on the shoreland wetland system. In addition, connection of the pier area to the board walk to ensure all weather access to the water safety patrol pier and to minimize degradation of the shoreland wetland system established by the District along the portions of the shoreline adjacent to the water safety patrol and aquatic plant harvester docking area would benefit both the shoreland restoration efforts and public safety on the Lakes. A Chapter 30, *Wisconsin Statutes*, permit may be required for such a board walk.

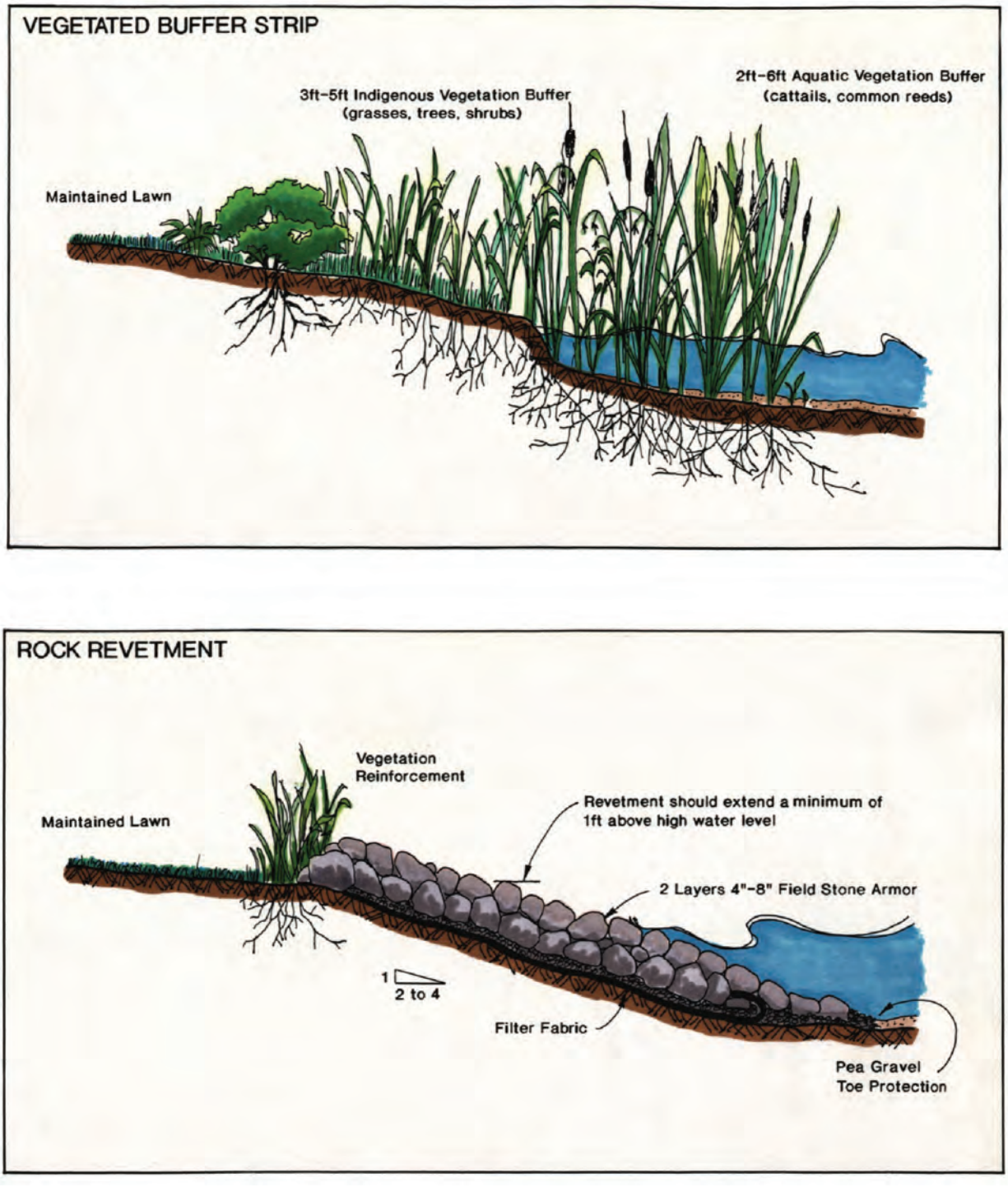
Recommended Management Measures
The use of vegetative buffer strips and riprap, as shown in Figure 3, is recommended. These alternatives were selected because they can be constructed, at least partially, by local residents; because most of the construction materials involved are readily available; because the measures would, in most cases, enable the continued use of the immediate shoreline; and because the measures are visually "natural" or "semi-natural" and should not significantly affect the aesthetic qualities of the lake shoreline. In those portions of the Lakes subject to direct action of wind waves and ice scour, the use of riprap would provide a more-robust means of stabilizing shorelines, while elsewhere along the lakeshores creation of vegetated buffer strips would provide, not only shoreline erosion protection, but also enhanced shoreland habitat for fish and wildlife. This is especially important for WDNR Sensitive Area Number 3, which contains one of the highest-quality shorelines in southeast Wisconsin.[13] It should be noted that the selection of appropriate shoreland protection structures is subject to the provisions of Chapter NR 328 of the *Wisconsin Administrative Code*.

It is recommended that the LLLMD and Town of LaGrange consider placement of a board walk or elevated accessway to provide all-weather access to the water safety patrol pier and aquatic plant harvester dock on the District-owned property on Mill Lake, adjacent to the Lauderdale Lakes Country Club golf course, utilized for mooring of the aquatic plant harvesting equipment and for docking of the water safety patrol craft. Provision of such all weather access would contribute to public safety by minimizing the risk of emergency vehicles becoming mired in the wetland areas leading to the pier, and protect the shoreland wetland habitat that has been recreated by the LLLMD in this vicinity from unnecessary disturbance. To this end, it is recommended that any such accessway be sized to accommodate a light-duty vehicle, such as a golf cart, and provide for adequate area to allow this vehicle to turn around at the lakeward extent of the accessway. In addition, as it is likely that any such accessway would inevitably form part of a lakeshore trail system, also allowing pedestrians access to the shoreland area and connect to the lake access linking the shoreland (Walworth County Tax Key Parcel H LG 3600009) to USH 12

[13]*Wisconsin Department of Natural Resources*, Lauderdale Lakes (Walworth County, Wisconsin) Integrated Sensitive Area Report.

Figure 3

RECOMMENDED ALTERNATIVES FOR SHORELINE EROSION CONTROL



NOTE: Design specifications shown herein are for typical structures. The detailed design of shoreline protection structures must be based upon analysis of local conditions.

Source: SEWRPC.

along the northern perimeter of the subdivision identified as Strawberry Banke Plantation (specifically along the northern property line of Walworth County Tax Key Parcel H LG 3600009C), the provision of turn outs at intervals is recommended to allow emergency vehicles to pass pedestrians without fear of contact. Such turn outs could also form areas for placement of informational signage, in accordance with the public informational program recommended below.

Water Quality Management

Water quality is one of the key parameters used to determine the overall health of a waterbody. The importance of good water quality can hardly be underestimated, as it impacts nearly every facet of the natural balance and relationships that exist in a lake between the myriad of abiotic and biotic elements present. Because of the important role that water quality plays in the functioning of a lake ecosystem, careful monitoring of key water quality indicators represents a fundamental lake management tool.

Array of Management Measures

The University of Wisconsin-Extension (UWEX) operates the Citizen Lake Monitoring Network (CLMN), formerly the WDNR Self-Help Monitoring Program. Volunteers enrolled in this program gather data at regular intervals on water clarity using a Secchi disk. Because pollution tends to reduce water clarity, either by spurring algal growth or by introducing inorganic turbidity into a lake, Secchi-disk measurements are generally considered one of the key parameters in determining the overall quality of a lake's water, as well as a lake's trophic status. Secchi-disk measurement data are included in the WDNR lake data base. This lake water quality information is accessible on-line through the WDNR website for many lakes in Wisconsin. The UWEX also offers an Expanded Monitoring Program that involves the collection of data on several other key physical and chemical parameters in addition to the Secchi-disk measurements. Under this program, samples of lake water are collected by volunteers at regular intervals and analyzed by the State Laboratory of Hygiene. Data collection is more extensive and, consequently, places more of a burden on volunteers.

The basic UWEX CLMN program is available at no charge, but does require volunteers to be committed to taking Secchi-disk measurements at regular intervals throughout the spring, summer, and fall. The Expanded Self-Help Program requires additional commitment by volunteers to take a more-extensive array of measurements and samples for analysis, also on a regular basis. As with any volunteer-collected data, despite the implementation of standardized field protocols, individual variations in levels of expertise due to background and experiential differences, can lead to variations in data and measurements from lake-to-lake and from year-to-year for the same lake, especially when volunteer participation changes.

In addition to the UWEX volunteer-based CLMN program, the University of Wisconsin-Stevens Point (UWSP) Water and Environmental Analysis Laboratory (WEAL) offers several other water quality packages that can supplement the water clarity monitoring program. Under these programs, volunteers collect water samples and send them to the UWSP WEAL for analysis. The basic program includes the analysis of a spring overturn sample (once per year), while additional packages include the submission of multiple samples taken during the open water season. The UWSP turnover sampling program requires only a once-a-year sampling, thereby requiring a smaller time commitment by the volunteers, but there is a modest charge for the laboratory analysis, and because sampling is performed by volunteers, is subject to those variations identified above. Additionally, since samples need to be taken as closely as possible to the actual turnover period, which occurs only during a relatively short window of time, volunteers need to monitor lake conditions as closely as possible to be able to determine when the turnover period is occurring.

The U.S. Geological Survey (USGS) offers a more extensive water quality monitoring program under their Trophic State Index monitoring program. USGS field personnel conduct a series of approximately five monthly samplings beginning with the spring turnover. Samples are analyzed by the State Laboratory of Hygiene for an extensive array of physical and chemical parameters. The USGS program does not require volunteer sampling. All sampling and analysis is provided by USGS personnel using standardized field techniques and protocols. As a result, a more standardized set of data and measurements may be expected. However, the cost of the USGS program is significantly higher than the UWSP program, even with State cost-share availability.

The LLLMD has participated in all of these programs on an intermittent basis.

Recommended Management Measures

The WDNR offers Small Grant cost-share funding within the Chapter NR 190 Lake Management Planning Grant Program that can be applied for to defray the costs of laboratory analysis and sampling equipment. It is recommended that the LLLMD resume regular participation in the CLMN program sponsored by the UWEX. Data gathered as part of this program should be presented annually by the volunteers at meetings of the LLIA, where the citizen monitors could be given some recognition for their work. The Lake Coordinator of the WDNR, Southeast Region, could assist in enlisting more volunteers in this program. The information gained at first-hand by the public from participation in this program can increase the credibility of the proposed changes in the nature and intensity of use to which the Lakes are subjected.

It is further recommended that the LLLMD consider participating in one of the other more comprehensive water quality programs: the UWEX Expanded Self-Help Program on an annual basis, or either the UWSP WEAL lake sampling program or USGS program on a periodic basis at three- to five-year intervals. The use of either the UWSP or USGS programs would be especially valuable as a means to attain a comprehensive water quality determination on a periodic basis while maintaining yearly CLMN data.

Recreational Use Management

Current public recreational boating standards as set forth in Sections NR 1.91(4) and NR 1.91(5) of the *Wisconsin Administrative Code*, establish minimum and maximum standards for public boating access development, respectively, to qualify waters for resource enhancement services provided by the WDNR. As noted in Chapter II of this report, the Lakes are deemed to have adequate public access as defined in Chapter NR 1 of the *Wisconsin Administrative Code*, which establishes quantitative standards for determining the adequacy of public recreation boating access, setting maximum and minimum standards based upon available parking facilities for car-top and car-trailer units.

These sites should continue to be periodically monitored to ensure consistency with public recreational boating access standards.

Recommended Management Measures

In addition to the existing public recreational boating access, it is recommended that appropriate signage at the public recreational boating access site be provided to alert users of Eurasian water milfoil, zebra mussels, and other nonnative invasive species. Such information should also be included in the District's informational programming, consistent with the aquatic plant management measures set forth in this plan. The District should also consider participating in the UWEX Clean Boats-Clean Waters Program.

Continued operation of the joint water safety patrol, operated by the LLLMD and the Town of LaGrange, also is recommended.

Public Informational and Educational Programming

As part of the overall citizen informational and educational programming to be conducted in the Lauderdale Lakes community, residents and visitors in the vicinity of the Lakes should be made aware of the value of the ecologically significant areas in the overall structure and functioning of the ecosystems of the Lakes. Specifically, informational programming related to the protection of ecologically valuable areas in and around the Lakes should focus on the need to minimize the spread of nuisance aquatic invasive species, such as purple loosestrife and Eurasian water milfoil. To this end, the Lauderdale Lakes Partnership can play a major role in outreach to the Lakes community and beyond.

Recommended Management Measures

With respect to aquatic plants, distribution of posters and pamphlets, available from the UWEX and the WDNR, that provide information and illustrations of aquatic plants, their importance in providing habitat and food

resources in aquatic environments, and the need to control the spread of undesirable and nuisance plant species is recommended. Currently, many lake residents seem to view all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impact. Inclusion of specific public informational and educational programming within the lake-related activities of the Towns of LaGrange and Sugar Creek and the LLLMD is recommended. These programs should focus on the value and impacts of these plants on water quality, fish, and wildlife; and on alternative methods for controlling existing nuisance plants, including the positive and negative aspects of each method. These programs can be incorporated into the comprehensive informational and educational programs that also would include information on related topics, such as water quality, recreational use, fisheries, and onsite sewage disposal systems.

Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the lake management program, are available from UWEX, WDNR, Walworth County, and many Federal governmental agencies. These brochures could be provided to homeowners through local media, direct distribution, or targeted library/civic center displays. Alternately, they could be incorporated into the newsletters produced and distributed by the LLLMD and the Lauderdale Lakes Partnership. Many of the ideas contained in these publications can be integrated into ongoing, larger-scale activities, such as anti-littering campaigns, recycling drives, and similar pro-environment activities undertaken by the Partnership and other community organizations.

Other informational programming offered by the WDNR, Walworth County, and the UWEX Lakes Program, such as the Adopt-A-Lake program and Project WET (Water Education Training) curriculum, can contribute to an informed public, actively involved in the protection of ecologically valuable areas within the area tributary to the Lauderdale Lakes. Citizen monitoring and awareness of the positive value of native aquatic plant communities are important opportunities for public informational programming and participation that are recommended for the Lakes.

Continuing Education

As part of their commitment to the effective managing of the Lauderdale Lakes, the LLLMD commissioners, LLIA board members, and KMLT trustees should continue to avail themselves of opportunities to learn about current developments and issues involving lake management. There are numerous publications, writings, newsletters, seminars, and conventions available through governmental, educational and other organizations and agencies dealing with the subject of lake management. Walworth County, UWEX, the Wisconsin Association of Lakes (WAL), the North American Lake Management Society (NALMS), and WDNR, all produce written materials and conduct meetings and seminars dealing with lake management issues. Publications, such as *Lake Tides*, published by the Wisconsin Lakes Partnership, comprised of WDNR, UWEX, and WAL, and available from UWEX, are also readily available and deal with a wide range of lake-related topics. Additionally, the statewide Lakes Convention, held annually in Green Bay, Wisconsin, provides valuable opportunities to learn about important and timely developments in lake management and learn about lake issues from experts in their fields. Participation in such activities that will further understanding of lake management issues is deemed an important part of the lake management experience. In this regard, the participation of the LLLMD, LLIA, and KMLT officers as lecturers in sharing their collective expertise with other lake organizations from around Wisconsin is noted.

SUMMARY

This plan documents the findings and recommendations of a study of the aquatic plant community of the Lauderdale Lakes, requested by the LLLMD, and examines existing and anticipated conditions, potential aquatic plant management problems, and recreational use problems on the Lauderdale Lakes. The plan sets forth recommended actions and management measures for the resolution of those problems. The recommended plan is summarized in Table 22 and shown on Maps 15 through 17.

Table 22

RECOMMENDED MANAGEMENT PLAN ELEMENTS FOR THE LAUDERDALE LAKES

Plan Element	Subelement	Management Measures	Management Responsibility
Aquatic Plant Management Measures	Proactive measures	Conduct periodic in-lake reconnaissance surveys of aquatic plant communities and update aquatic plant management plan every three to five years	LLLMD
		Conduct additional periodic monitoring of the aquatic plant community for the early detection and control of future-designated nonnative species that may occur	WDNR, LLLMD, and private landowners
		Monitor invasive species populations; where they occur, remove isolated stands of purple loosestrife through bagging, cutting, and herbicide application onto cut stems	WDNR, LLLMD, KMLT, and private landowners
	Management actions	Mechanically harvest nuisance plants to maintain boating access, promote public safety, enhance angling opportunities, and encourage growth of native plants; consider "top chopping" of Eurasian water milfoil in areas designated by SEWRPC memorandum of 2002 to encourage native plant growth and biodiversity	WDNR and LLLMD
		Limited use of aquatic herbicides for control of nuisance nonnative aquatic plant growth where necessary; specifically target Eurasian water milfoil[a]	WDNR and private landowners
		Encourage growth of native plants in the Lauderdale Lakes through use of vegetated buffer strips and control of Eurasian water milfoil	Walworth County, UWEX, KMLT, and private landowners
		Manually harvest around piers and docks as necessary[b]	Private landowners
		Collect floating plant fragments from shoreland areas to minimize rooting of Eurasian water milfoil and deposition of organic materials in Lakes	Private landowners
Ancillary Management Measures	Shoreline Protection Management	Maintain existing shoreline structures and repair as necessary using vegetative means insofar as practicable; reconstruction may require WDNR Chapter 30 permits	Walworth County, Towns of LaGrange and Sugar Creek, WDNR, and private landowners
	Water Quality Management	Continue participation in WDNR CLMN program; consider participation in WDNR Expanded Self-Help program; periodic participation in USGS TSI or similar programs	WDNR, CLMN/USGS, and LLLMD/LLIA
	Recreational Use Management	Maintain recreational boating access from the public access site pursuant to Chapter NR 7 guidelines	WDNR, Towns of LaGrange and Sugar Creek, and LLLMD
		Maintain signage at public access sites regarding invasive species and WDNR Clean Boats-Clean Waters Program; provide disposal containers for disposal of plant material removed from watercraft	WDNR, Towns of LaGrange and Sugar Creek, and LLLMD
	Public informational and educational programming	Continue to provide informational material and pamphlets on lake-related topics, especially the importance of aquatic plants and the protection of ecologically significant areas; consider offering public informational programming on topics of lake-oriented interest and education	Towns of LaGrange and Sugar Creek, WDNR, UWEX, LLLMD, LLIA, and KMLT
		Encourage inclusion of lake studies in environmental curricula (e.g., Pontoon Classroom, Project WET, Adopt-A-Lake)	Area school districts, UWEX, WDNR, LLIA, KMLT, and LLLMD
		Encourage riparian owners to monitor their shoreline areas, as well as open-water areas of the Lakes, for new growths of nonnative plants and report same immediately to LLLMD	LLLMD and LLIA

Table 22 (continued)

Plan Element	Subelement	Management Measures	Management Responsibility
Ancillary Management Measures (continued)	Lake district board continuing education	Maintain awareness of current developments in the area of lake management through informative publications such as "Lake Tides" (available free through the Wisconsin Lakes Partnership) and attendance at lake education conventions, workshops, and seminars	LLLMD and LLIA

NOTE: The following abbreviations have been used:

CLMN = University of Wisconsin-Extension Citizen Lake Monitoring Network
KMLT = Kettle Moraine Land Trust
LLIA = Lauderdale Lakes Improvement Association
LLLMD = Lauderdale Lakes Lake Management District
TSI = Trophic State Index monitoring program
USGS = U.S. Geological Survey
UWEX = University of Wisconsin-Extension
WDNR = Wisconsin Department of Natural Resources

[a]*Use of aquatic herbicides requires a WDNR permit pursuant to Chapter NR 107 of the* Wisconsin Administrative Code*. Use of chemical herbicides within WDNR-delineated sensitive areas is prohibited by Town of LaGrange ordinance.*

[b]*Manual harvesting beyond a 30-linear-foot width of shoreline is subject to WDNR individual permitting pursuant to Chapter NR 109 of the* Wisconsin Administrative Code*.*

Source: SEWRPC.

The Lauderdale Lakes were found to be mesotrophic lakes of average to slightly above average water quality. Preservation of environmental corridor lands, especially within the shoreland areas situated immediately adjacent to the Lakes, is recommended. Walworth County and the Towns of LaGrange and Sugar Creek, together with the LLLMD and its partner organizations in the Lauderdale Lakes Partnership, the Lauderdale Lakes Improvement Association and the Kettle Moraine Land Trust, should support appropriate land management practices designed to reduce nonpoint source pollutant discharges in stormwater runoff into the Lakes. Further, the Towns and LLLMD should promote appropriate shoreline management practices, including the use of riprap and vegetative buffer strips, where applicable.

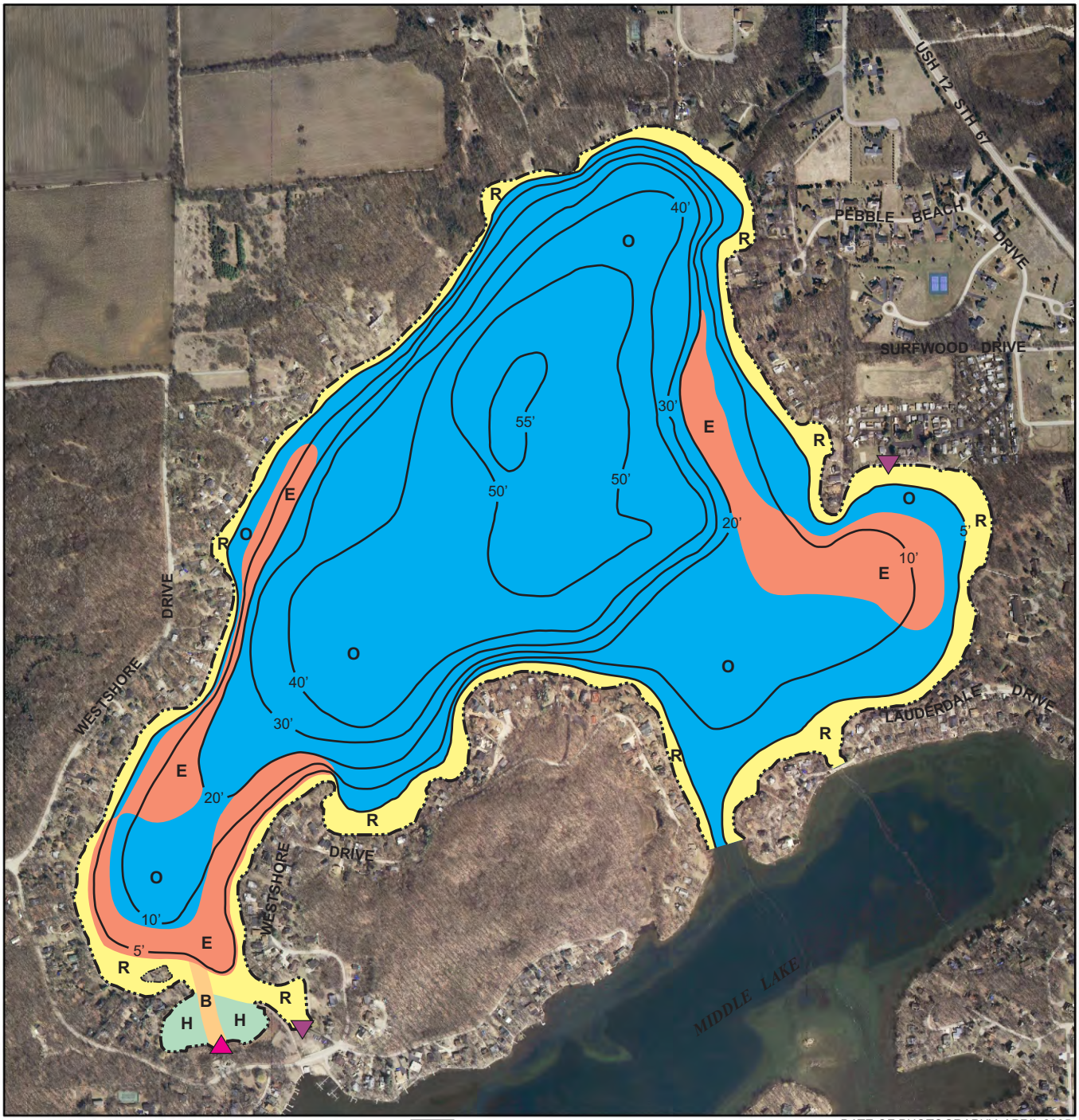
The shoreland protection and aquatic plant management elements of this plan recommend actions be taken that would reduce human impacts on ecologically valuable areas in and adjacent to the Lakes, encourage a biologically diverse community of native aquatic plants, and limit the spread of nonnative invasive plant species. The plan recommends the use of mechanical harvesting of nuisance plants in those areas where depth of water and bottom substrate are sufficient to support such activity, manual harvesting aquatic plants around piers and docks with subsequent removal of cut material from the Lakes, and monitoring of invasive species populations. The plan further recommends periodic in-lake aquatic plant surveys every three to five years to monitor changes in the aquatic plant community and assess effectiveness of aquatic plant management techniques.

The plan recommends regular participation in the UWEX CLMN volunteer water quality monitoring program with consideration of participation in the Expanded Self-Help Program, and periodic conduct of USGS, or equivalent, comprehensive water quality surveys. With regard to recreational uses of the Lauderdale Lakes, the plan recommends maintaining the public access sites in a manner consistent with Chapter NR 1 standards and Chapter NR 7 guidelines, as well as maintaining signage regarding aquatic and other invasive species.

Finally, the recommended plan includes continuation of an ongoing program of public information and education, focusing on providing riparian residents and lake users with an improved understanding of the lake ecosystem. For example, additional options regarding household chemical use, lawn and garden care, onsite sewage disposal

Map 15

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR GREEN LAKE



—20'— WATER DEPTH CONTOUR IN FEET

PUBLIC ACCESS SITE AND HARVESTER OFF-LOAD AREA

PRIVATE ACCESS SITE

H WISCONSIN DEPARTMENT OF NATURAL RESOURCES DESIGNATED CHAPTER NR 107 ENVIRONMENTALLY SENSITIVE AREA
HARVESTING: ACCESS LANE ONLY
CHEMICALS: NONE

O OPEN WATER AREA: NO CONTROL REQUIRED

B BOATING ACCESS LANE: 15 FEET WIDE TO FIVE FOOT CONTOUR
HARVESTING: HIGH PRIORITY
CHEMICALS: NONE

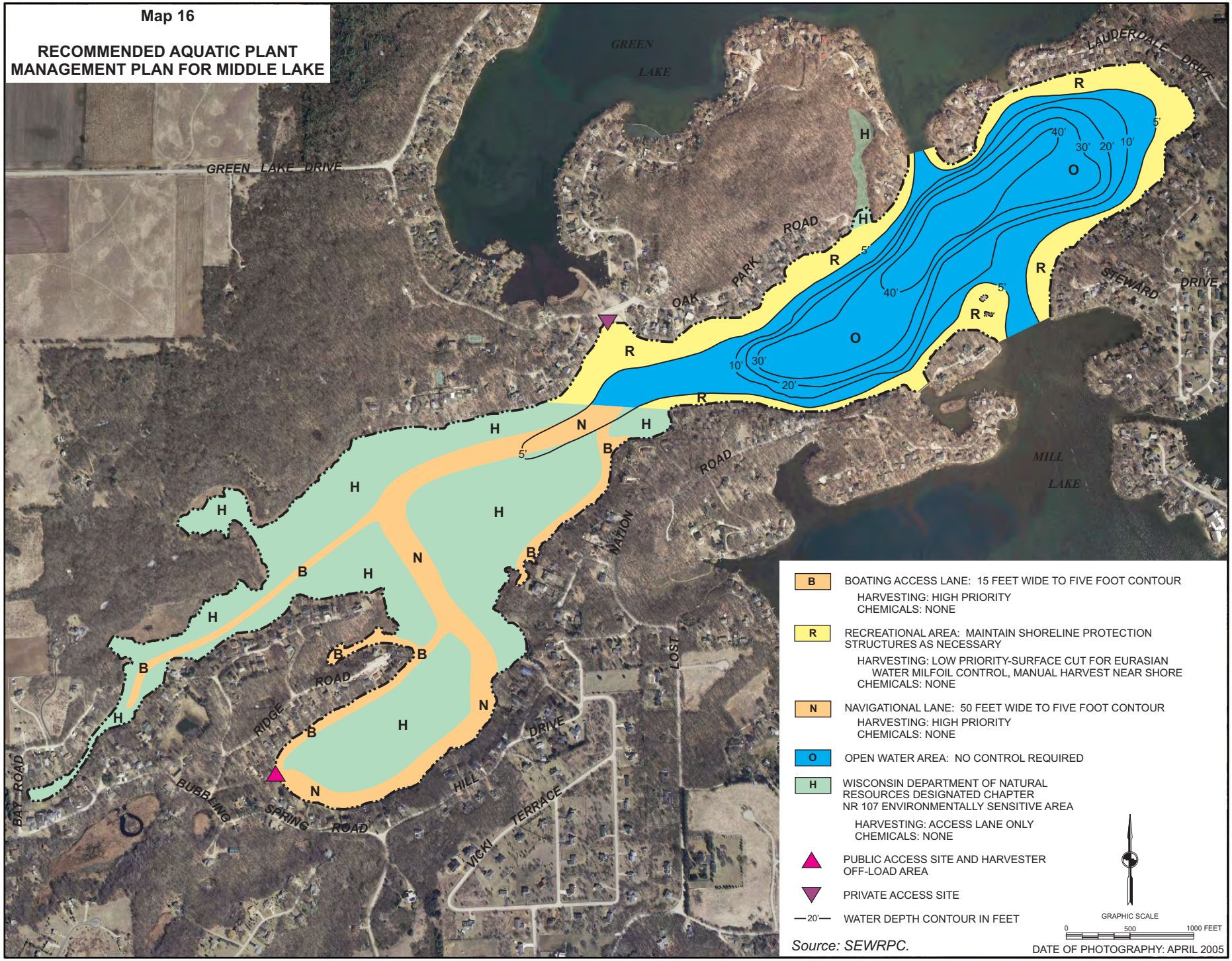
R RECREATIONAL AREA: MAINTAIN SHORELINE PROTECTION STRUCTURES AS NECESSARY
HARVESTING: LOW PRIORITY-SURFACE CUT FOR EURASIAN WATER MILFOIL CONTROL, MANUAL HARVEST NEAR SHORE
CHEMICALS: NONE

E EURASIAN WATER MILFOIL MANAGEMENT AREA:
HARVESTING: MODERATE PRIORITY
CHEMICALS: NONE

DATE OF PHOTOGRAPHY: APRIL 2005

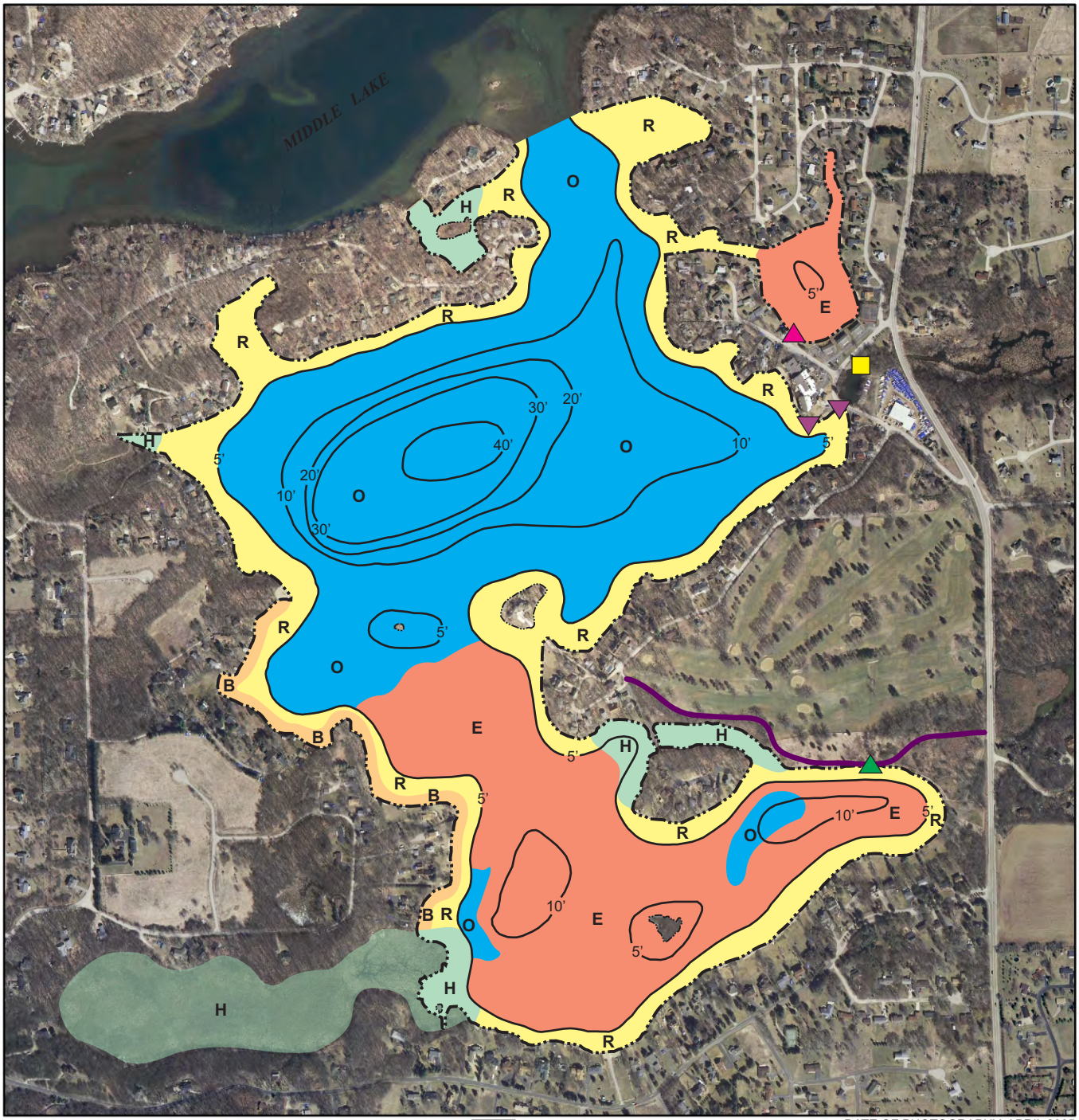
GRAPHIC SCALE
0 450 900 FEET

Source: SEWRPC.


Map 16
RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR MIDDLE LAKE
GREEN LAKE
LAUDERDALE DRIVE
GREEN LAKE DRIVE
OAK PARK ROAD
STEWARD DRIVE
MILL LAKE
ROAD
NATION
LOST
RIDGE
DRIVE
BAY ROAD
BUBBLING SPRING ROAD
HILL TERRACE
VICKI
B BOATING ACCESS LANE: 15 FEET WIDE TO FIVE FOOT CONTOUR
HARVESTING: HIGH PRIORITY
CHEMICALS: NONE
R RECREATIONAL AREA: MAINTAIN SHORELINE PROTECTION STRUCTURES AS NECESSARY
HARVESTING: LOW PRIORITY-SURFACE CUT FOR EURASIAN WATER MILFOIL CONTROL, MANUAL HARVEST NEAR SHORE
CHEMICALS: NONE
N NAVIGATIONAL LANE: 50 FEET WIDE TO FIVE FOOT CONTOUR
HARVESTING: HIGH PRIORITY
CHEMICALS: NONE
O OPEN WATER AREA: NO CONTROL REQUIRED
H WISCONSIN DEPARTMENT OF NATURAL RESOURCES DESIGNATED CHAPTER NR 107 ENVIRONMENTALLY SENSITIVE AREA
HARVESTING: ACCESS LANE ONLY
CHEMICALS: NONE
PUBLIC ACCESS SITE AND HARVESTER OFF-LOAD AREA
PRIVATE ACCESS SITE
20' WATER DEPTH CONTOUR IN FEET
GRAPHIC SCALE
0 500 1000 FEET
Source: SEWRPC.
DATE OF PHOTOGRAPHY: APRIL 2005

Map 17

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR MILL LAKE



—20'— WATER DEPTH CONTOUR IN FEET

PUBLIC ACCESS SITE AND HARVESTER OFF-LOAD AREA

PRIVATE ACCESS SITE

PUBLIC SAFETY ACCESS AND HARVESTER DOCKING SITE

WATER LEVEL CONTROL STRUCTURE

PROPOSED RECREATIONAL TRAIL AND BOARDWALK

H — WISCONSIN DEPARTMENT OF NATURAL RESOURCES DESIGNATED CHAPTER NR 107 ENVIRONMENTALLY SENSITIVE AREA
HARVESTING: ACCESS LANE ONLY
CHEMICALS: NONE

B — BOATING ACCESS LANE: 15 FEET WIDE TO FIVE FOOT CONTOUR
HARVESTING: HIGH PRIORITY
CHEMICALS: NONE

R — RECREATIONAL AREA: MAINTAIN SHORELINE PROTECTION STRUCTURES AS NECESSARY
HARVESTING: LOW PRIORITY-SURFACE CUT FOR EURASIAN WATER MILFOIL CONTROL, MANUAL HARVEST NEAR SHORE
CHEMICALS: NONE

E — EURASIAN WATER MILFOIL MANAGEMENT AREA:
HARVESTING: MODERATE PRIORITY
CHEMICALS: NONE

O — OPEN WATER AREA: NO CONTROL REQUIRED

DATE OF PHOTOGRAPHY: APRIL 2005

GRAPHIC SCALE
0 450 900 FEET

Source: SEWRPC.

system operation and maintenance, shoreland protection and maintenance, and recreational use of the Lakes should be made available to riparian property owners, thereby providing riparian residents with alternatives to traditional activities. Additionally, LLLMD Commissioners, LLIA board members, and KMLT trustees are encouraged to maintain, broaden, and share their awareness of current developments in the area of lake management through participation in meetings, seminars, conventions, and other lake management-related events, and educational opportunities.

Adherence to the recommendations contained in this plan should provide the basis for a set of management actions that are aligned with the goals and objectives set forth in Chapter I of this report; reflective of the ongoing commitment by the Lauderdale Lakes community, through the LLLMD, the Lauderdale Lakes Partnership, and the Towns of LaGrange and Sugar Creek, to sound planning with respect to the Lakes; and, sensitive to current needs, as well as those in the immediate future.

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APPENDICES

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Appendix A

REPRESENTATIVE ILLUSTRATIONS OF AQUATIC PLANTS FOUND IN THE LAUDERDALE LAKES

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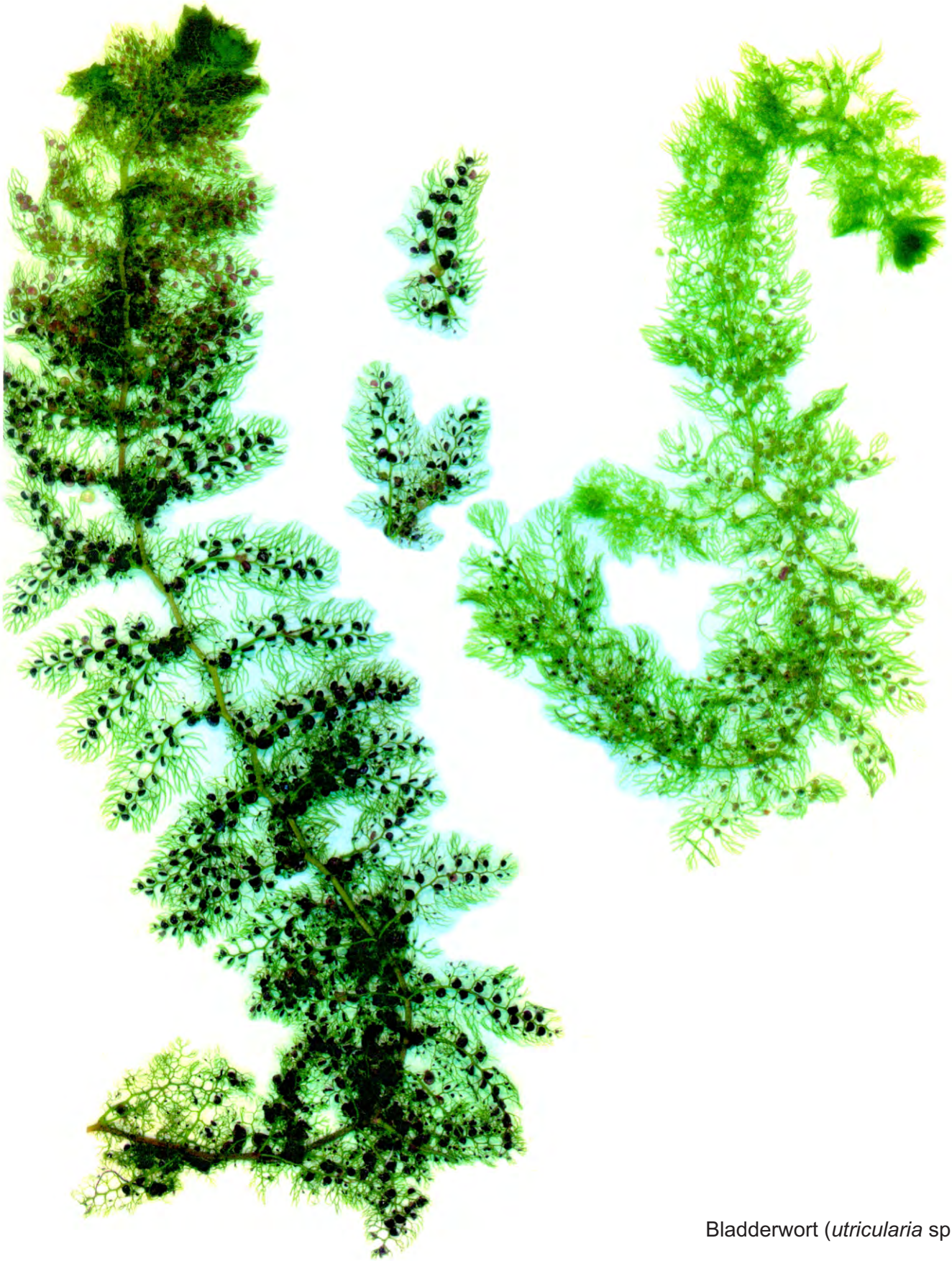


Bladderwort (*utricularia* sp.)

Bushy Pondweed (*najas flexilis*)

Clasping-Leaf Pondweed
(*potamogeton richardsonii*)

Coontail (*ceratophyllum demersum*)

Curly-Leaf Pondweed (*potamogeton crispus*)
Exotic Species (nonnative)

Eurasian Water Milfoil (*myriophyllum spicatum*)
Exotic Species (nonnative)

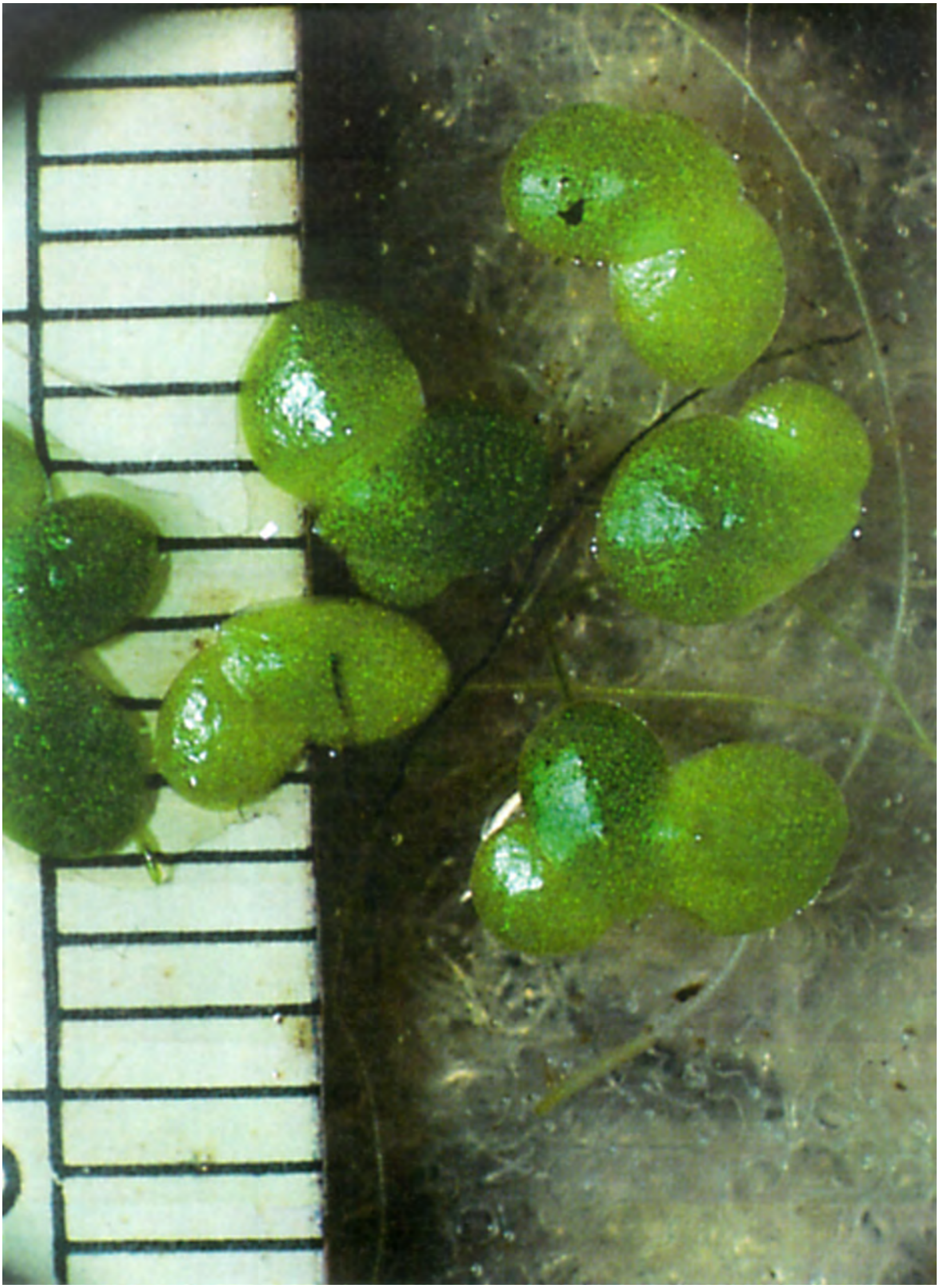
Flat-Stem Pondweed (*potamogeton zosteriformis*)

Floating-Leaf Pondweed (*potamogeton natans*)

Illinois Pondweed (*potamogeton illinoensis*)

Large-Leaf Pondweed (*potamogeton amplifolius*)

Leafy Pondweed (*potamofeton foliosus*)



Lesser Duckweed (*lemna minor*)

NOTE: Plant species in photograph are not shown proportionate to actual size

Source: Steve D. Eggers and Donald M. Reed, Wetland Plants and Plant Communities of Minnesota & Wisconsin*, 2nd Edition, 1997*

Long Leaved Pondweed
(*potamogeton nodosus*)

Muskgrass (*chara vulgaris*)

Native Water Milfoil (*myriophyllum* sp.)

Nitella (*nitella* spp.)

Sago Pondweed (*potamogeton pectinatus*)

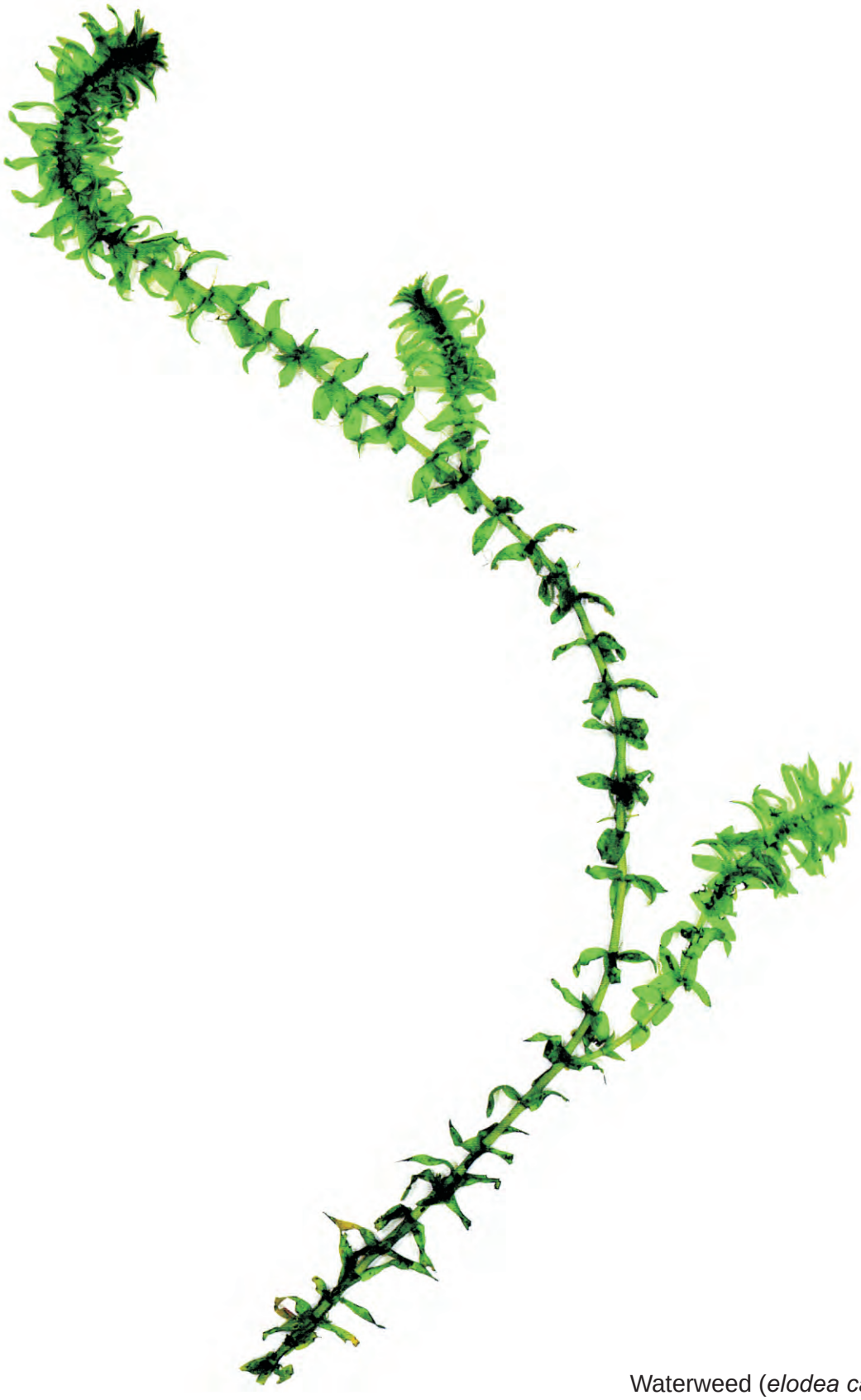
Small Bur Reed (*sparganium minimum*)

Small Pondweed (*potamogeton pusillus*)

Spiny Naiad (*najas marina*)

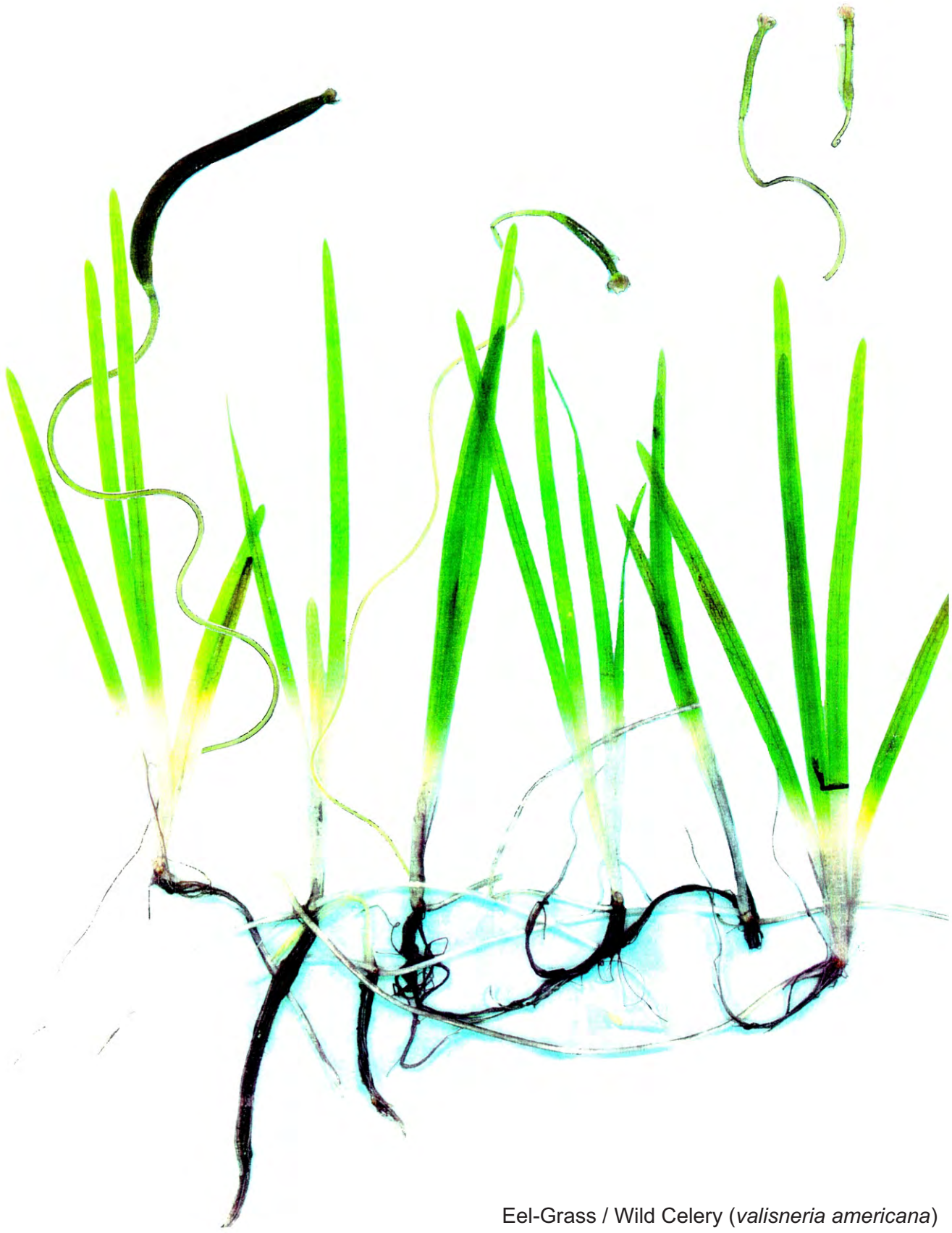
Variable Pondweed (*potamogeton gramineus*)

Water Stargrass (*zosterella dubia*)



Waterweed (*elodea canadensis*)

White Water Lily (*nymphaea odorata*)



Eel-Grass / Wild Celery (*valisneria americana*)

Yellow Water Lily (*nuphar variegatum*)

Appendix B

WISCONSIN DEPARTMENT OF NATURAL RESOURCES CHAPTER NR 107 SENSITIVE AREA REPORTS FOR THE LAUDERDALE LAKES

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Lauderdale Lakes (Walworth County, Wisconsin)
Integrated Sensitive Area Report

Assessment Dates:	June 14, 1990 - Areas 1-5 July 7 and September 2, 2004 - Areas 6-7
Number of Sensitive Areas Surveyed:	7
Site Evaluators:	1990: Jerry Collins, Water Resources Specialist Doug Welch, Fisheries Biologist Bob Wakeman, Water Resource Manager Mark Anderson, Wildlife Biologist 2004: Pam Schense, Water Resources Specialist Doug Welch, Fisheries Biologist Heidi Bunk, Lakes Biologist Jim Jackley, Wildlife Biologist Dave Heilmeier, Town of LaGrange Scott Mason, Lauderdale Lakes Management District Rick Callaway, Town of LaGrange
Authors:	Pat Campfield, Water Resources Specialist Gabe Powers, Water Resources Specialist Heidi Bunk, Lakes Biologist

General Lake Information

The Lauderdale Lakes consist of a chain of three lakes - Green, Middle, and Mill Lakes - located in north-central Walworth County (Township 4 North, Range 16 East, Sections 25-26, 34-36 and Township 3 North, Range 16 East, Sections 1-2). The Lakes have a total surface area of 807 acres with maximum depths ranging from 42-55 feet. Middle and Mill Lakes are characterized as drainage lakes, fed primarily by groundwater, precipitation, and runoff. They have no major surface inlets. Green Lake is spring fed. Lake level of the Lauderdale Lakes is controlled by a dam and weir at a single surface-water outlet, Honey Creek.

The Lauderdale Lakes serve as “all sports” lakes, withstanding intense anthropogenic pressure. The shoreline is approximately 70 percent developed, including 1,010 houses. Three public boating access sites are located on the western shores of Green and Middle Lakes and the eastern shore of Mill Lake, meeting the requirement of “adequate public access” defined by NR 1.91(11), Wis. Adm. Code. There are five

private recreational facilities offering boating access to the general public (SEWRPC 2001).

The Lakes have multiple recreational uses. These include fishing, water skiing, swimming, and small craft sailing in summer months and ice fishing, cross-country skiing, ice-skating, and hunting during winter. Throughout the year, the Lakes provide natural scenic beauty and opportunities for walking and jogging, bird watching, and picnicking.

Overall, the Lauderdale Lakes have a diverse fish population, including multiple "forage" and "non-game" fish species, and several "game" species. In a 1999 survey, the Wisconsin Department of Natural Resources observed 19 fish species: northern pike, grass pickerel, longnose gar, walleyed pike, largemouth bass, yellow perch, warmouth, bluegill, pumpkinseed, green sunfish, black crappie, rock bass, golden shiner, yellow bullhead, brown bullhead, bowfin, brook silverside, white sucker, and lake chubsucker (Welch 2000).

The lake chubsucker (*Erimyzon sucetta*) is listed as a State **species of special concern** (Lyons et al. 2000). Special Concern species are those in which reduced abundance or distribution is suspected but not yet proven. The main purpose of this category is to focus attention on certain species before they become threatened or endangered. *E. sucetta* relies on dense vegetation for cover throughout its life history. Large and small beds of aquatic moss and filamentous algae are preferred for spawning between late March and early July. Young lake chubsuckers feed on copepods, cladocerans (e.g., *Daphnia*), and midge larvae. Adult lake chubsuckers prey upon these same items, as well as algae, molluscs, and both larval and adult insects. It is a valuable forage fish and fry are a preferred food of largemouth bass (Becker, 1983). In areas where lake chubsucker habitat exists, preservation is highly recommended.

Fish habitat in the Lauderdale Lakes consists mostly of aquatic vegetation. Minimal woody debris, overhanging vegetation, and fallen timber exist along the lakeshore. The lack of natural fish habitat is due to the largely developed shoreline and associated "urbanized lakefront landscapes". Remaining undeveloped shoreline provides critical habitat for fish, reptiles, amphibians, waterfowl, and small and large mammals.

Prime wildlife habitat exists on the Lauderdale Lakes where shoreline and waterfront areas remain natural or in areas where waterfront owners kept "natural corridors" in place. During urbanization of the Lakes, most developed properties retained some large trees, conserving the canopy. However, these owners also eliminated the sub-canopy and associated shrubbery. The sub-canopy provides important nesting, feeding, and cover habitat for multiple species. Consequently, most wildlife remaining in and around the Lauderdale Lakes are urban-tolerant species. The resident mammal population includes white-tailed deer, muskrats, cottontail rabbits, and some squirrels. Songbirds, wood ducks, mallards, and Canada geese are representative avian species. The remaining undeveloped areas associated with the Lakes provide the only balanced cover for a number of wildlife species.

The Lauderdale Lakes Lake Management District is the primary sponsor for aquatic plant management goals/plans on the lakes, currently controlling nuisance plants by harvesting and chemical treatment. In past aquatic plant studies of the entire Lauderdale Lakes chain, approximately 25 plant species were observed (SEWRPC 2001). In 1990, Department surveyors observed 10 native aquatic plant species in sensitive area 1, 8 native plant species in sensitive area 2, 18 native species in sensitive area 3, 13 native species in sensitive area 4, and 10 native species in sensitive area 5. In the 2004 survey, 10 native species occurred in sensitive area 6 and 12 native species in sensitive area 7. Three exotic species were observed in these sensitive areas. Eurasian watermilfoil (*Myriophyllum spicatum*) was observed in areas 1-6. Curly-leaf pondweed (*Potamogeton crispus*) was observed in sensitive areas 2-6, and purple loosestrife (*Lythrum salicaria*) was observed in sensitive areas 6-7.

Exotic Species

Southeastern Wisconsin lakes have been invaded by aquatic exotic species, most notably zebra mussels, Eurasian watermilfoil, and purple loosestrife. Most exotic species are introduced to a waterbody anthropogenically (e.g., transient boaters). The disturbance of lake substrate from human activity (boating, plant harvesting, chemical treatments, etc.) plays a significant role in the colonization and/or expansion of exotic species, particularly exotic plants.

Eurasian watermilfoil has established itself as one of the most common and abundant plants in the Lauderdale Lakes. It occurred in all but one of the sensitive areas. Eurasian watermilfoil is one of eight milfoil species currently found in Wisconsin. It is often misidentified as one of its seven native cousins, and vice versa. In many areas within the Lakes, this non-native milfoil has established large monocultures and out competed many native plants. These dense beds of milfoil not only impede the growth of native plant species but also inhibit fish movement and create navigational problems for boaters.

The regenerative ability of Eurasian milfoil is yet another obstacle when attempting to control this species. Fragments of Eurasian watermilfoil detached by harvesting, boating, and other recreational activities can float to non-colonized areas of the lake or downstream to additional lakes in the drainage system and create new colonies. Therefore, when controlling Eurasian watermilfoil, selective chemicals and harvesting, coupled with skimming, often produces the best results. In some lakes, biological agents such as the milfoil weevil have helped suppress milfoil populations. However, the most effective "treatment" of exotic milfoil is <u>prevention</u> through public education.

Curly-leaf pondweed is another submerged, exotic species found in the Lauderdale Lakes. Like Eurasian watermilfoil, curly-leaf grows into large, homogenous stands. It also crowds out native vegetation, creates navigational problems, and limits fish movement. Also, a unique life history characteristic of curly-leaf pondweed is that the

plant dies off in mid-summer, increasing nutrient availability in the water column. This often contributes to summer algal blooms and decreasing water quality.

The unusual life cycle of curly-leaf pondweed makes management difficult. The plant germinates as temperatures decrease in Fall. Curly-leaf is highly tolerant of cold temperatures and reduced sunlight, continuing to grow under lake ice and snow cover. With ice-off and increasing water temperatures in the spring, the plant produces fruit, flowers, and buds (turions). Turions are the main reproductive mechanism of curly-leaf. To control the species in lakes, the plant must be combated before turions become viable. Most plant harvesters have not started cutting when curly-leaf is most susceptible and a small window of opportunity exists for chemical treatment. Therefore, prevention through public education is once again very important.

Purple loosestrife, a hardy perennial native to Europe, was desirable primarily as an ornamental plant but also marketed for bee keeping. It was transported in soil used as ballast during shipping. Since its introduction to North America in the early 1800s, purple loosestrife has become common in gardens and wetlands, and around lakes, rivers, and roadways. The species is highly invasive and thrives in disturbed areas. Monotypic stands of purple loosestrife out compete native plants, resulting in the destruction of food, cover, and nesting sites for wildlife and fish.

Purple loosestrife most often spreads when seeds adhere to animals. Humans should be aware of picking up seeds on clothing and equipment when in the vicinity of the plant. Loosestrife can be controlled manually, biologically, or with a broad-leaf herbicide. Young plants can be pulled, but adult plants have large root structures and must be excavated with a garden fork. Biological control is most effective on large stands of purple loosestrife. Five different insects are known to feed on this plant. Four of those have been used as control agents in the United States. Of the five species, *Galerucella pusilla* and *G. calmariensis* are leaf-eating beetles; *Nanophyes brevis* and *N. marmoratus* are flower-eating beetles; and *Hylobius trasversovittatus* is a root-boring weevil. Only *N. brevis* has not been released in the United States (WDNR 2003). Lastly and most importantly, prevention through public education plays an important role in the management of this species.

Shoreland Management

Wisconsin's Shoreland Management Program, a partnership between state and local governments, works 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 1000 feet of lakes, 300 feet of rivers, and floodplains. Current research shows that present standards are probably inadequate for the protection of water resources (Woodford and Meyer 2003, Garn 2002). Therefore, many communities have chosen to go beyond minimum standards to ensure protection of our natural resources. This report provides management guidelines for activities within the lake and in the immediate shoreland areas. Before any recommendations in this

report are completed, please check with the Department of Natural Resources and local units of government for required approvals.

A vital step in protecting our water resources is to maintain effective vegetative buffers. 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 are not effective in reducing nutrient loading. Wider buffers of 50 feet or more can help provide important wildlife habitat for songbirds, turtles, frogs, and other animals, as well as filter pollutants from runoff. In general, no mowing should occur in the buffer area, except perhaps in a viewing access corridor. The plant composition of a buffer should match the flora found in natural Wisconsin lakeshores. A buffer should include three layers - herbaceous, shrub, and tree.

In addition, the reader also should investigate other innovative ways to reduce the impacts of runoff flowing into the lake while improving critical shoreline habitat (see A. Greene 2003). This may include the use of phosphorus-free fertilizers, installing rain gardens, setting the lawnmower at a higher mower height, decreasing the area of impervious surfaces, or restoring aquatic plant communities.

Introduction

Department personnel conducted Lauderdale Lakes sensitive area designation surveys on June 14, 1990 and July 7 and September 2, 2004, following the Wisconsin Department of Natural Resources' sensitive area survey protocol. This study utilized an integrated team of DNR resource managers with input from multiple disciplines: water regulation, water chemistry, fisheries, lake biology, and wildlife.

Sensitive areas are defined in Wisconsin Administrative Code NR 107.05 (3)(i)(1) as *areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water*. Department resource managers determined that five areas met this definition in 1990. Two additional areas were added in 2004 (Fig. 1). Their recommendations on future management of these areas are included below.

The companion document, *Guidelines for Protecting, Maintaining, and Understanding Lake Sensitive Areas,* provides additional information to help interpret lake sensitive area reports. This document is designed to help people understand the important factors that determine the health of a lake's ecosystem. It discusses aquatic plant sensitive areas, shoreland use and lakeshore buffers, gravel and coarse rock rubble habitat, large woody cover, and various water regulation and zoning issues.

Overview of Sensitive Area Designations

Sensitive areas often have aquatic or wetland vegetation, terrestrial vegetation, gravel or rubble lake substrate, or areas that contain large woody cover (fallen trees or

logs). These areas provide water quality benefits to the lake, reduce shoreline erosion, and provide habitat necessary for seasonal and/or life stage requirements of fish, invertebrates, and wildlife. A designated sensitive area alerts interested parties (i.e., DNR personnel, county zoning personnel, lake associations, etc.) that the area contains critical habitat vital to sustaining a healthy lake ecosystem or may feature an endangered plant or animal. Information presented in a sensitive area report may discourage certain permits from being approved within these sites.

Whole Lake Recommendations:

Several recommendations from Department staff pertain to the Lauderdale Lakes chain as a whole rather than to individual sensitive areas:

1. The aquatic plant community in the Lauderdale Lakes is not highly diverse outside of the sensitive areas. Native aquatic plant beds should be protected and maintained.
2. Prevent the spread of exotic species through sign postings, education, etc. and control exotic species where established.
3. Comply with State and Local Shoreland Zoning standards by maintaining no-cut buffers and setbacks, removing non-conforming structures, and limiting impervious surfaces.
4. Create shoreland buffers and maintain existing buffers, especially in areas not currently developed.
5. Monitor water quality for early detection of changes and possible degradation.

Resource Value of Sensitive Area Site 1 – Lauderdale Lakes

Sensitive area 1 is located on the southwest end of Green Lake and is unique to the Lauderdale Lakes (Fig. 2). Water lilies in the bay may shade out Eurasian watermilfoil. Eurasian watermilfoil only is present on the outer edge of the bay. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of the Lauderdale Lakes. The substrate in the bay is muck. This area has not been the target of plant control activities.

The bay acts as a sediment and nutrient trap for the lake, enhancing water quality. Aquatic vegetation (Table 1) helps control shoreline erosion. It also provides northern pike, largemouth bass, bluegill, and forage fish (suckers and minnows) with spawning, nursery, and foraging habitat (Table 2).

The extensive development of the Lauderdale Lakes area has reduced available wildlife habitat. However, ducks, herons, bittern, songbirds, muskrat, and opossum inhabit this portion of the lake the majority of the year.

Table 1. Plants observed in sensitive area 1.

	Emergent	**Submergent**	**Free-floating**	**Exotic**
PRESENT (0-25% Cover)	*Typha* (cattail) *Scirpus* (bulrush) *Carex* (sedges)	*Utricularia* (bladderwort) *Ceratophyllum* (coontail) *Stuckenia pectinata* (sago pondweed) *P. praelongus* (white-stemmed pondweed)	*Nymphaea odorata* (white water lily) *Nuphar advena* (yellow water lily) *Lemna* (duckweed)	*Myriophyllum spicatum* (Eurasian watermilfoil)
COMMON (26-50% Cover)				
ABUNDANT (51-75% Cover)				
DOMINANT (76-100% Cover)				

Table 2. Sensitive area 1 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	**Spawning**	**Nursery**	**Feeding**	**Protective Cover**
Northern Pike	cattail	cattail, water lily, coontail, milfoil, sago	water lily, coontail, milfoil, sago	water lily, coontail, milfoil, sago
Largemouth Bass	coontail, milfoil	cattail, water lily, coontail, milfoil, sago	water lily, coontail, milfoil, sago	water lily, coontail, milfoil, sago
Rock Bass	coarse sand or gravel	cattail, water lily, coontail, milfoil, sago	sago, milfoil	sago, milfoil
Bluegill and Pumpkinseed	sand/gravel	cattail, water lily, coontail, milfoil, sago, clasping leaf	water lily, coontail, milfoil, sago, clasping leaf	water lily, coontail, milfoil, sago, clasping leaf
Black Crappie	fine gravel and sand	water lily, coontail, milfoil, sago	sago, milfoil	sago, milfoil
Yellow Perch	cattail, coontail, milfoil, sago	water lily, coontail, milfoil, sago	sago, milfoil	sago, milfoil

* Shaded rows identify fish species found in the Lauderdale Lakes but not specifically observed in this SA.

Management Recommendations for Sensitive Area #1

1. No chemical treatment will be permitted.

2. Mechanical control allowed with the following condition:
   Restrict harvesting to a 25-foot wide navigational channel from the boat launch to open water.

3. None of the following in-lake activities allowed:
   Filling
   Aquatic plant screens
   Wetland alterations
   Boardwalks
   Pea gravel/sand blankets

4. The following in-lake activities may allowed with conditions:
   Dredging only in navigational channel from boat launch.

5. Strictly enforce shoreland and wetland ordinances.

6. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion. A "No-Wake Zone" should be implemented.

Resource Value of Sensitive Area Site 2 – Lauderdale Lakes

Sensitive area 2 consists of a small bay on the north shore of Middle Lake that is dominated by *Decodon* (water willow) (Fig. 3). Its quiet water and proximity to upland areas are important to the Lakes. *Decodon* acts as a buffer for runoff entering the bay. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of the Lauderdale Lakes.

The bay acts as a sediment and nutrient trap for the lake, enhancing water quality. The substrate is primarily silt and muck in open water areas. Aquatic vegetation helps control shoreline erosion (Table 3). It also provides northern pike, largemouth bass, and bluegill with spawning, nursery, and foraging habitat (Table 4). The bay is often not navigable by boat.

This area is not critical to fisheries in the Lakes. It is extremely important to wildlife. The extensive development of the Lauderdale Lakes has reduced available wildlife habitat. However, herons, bittern, songbirds, muskrat, and opossum inhabit this portion of the lake during the majority of the year. The upland woods located west of the bay are valuable to migratory songbirds.

Table 3. Plants observed in sensitive area 2.

PRESENT (0-25% Cover)	**Emergent**	**Submergent** *Vallisneria* (wild celery) *P. praelongus* (white-stemmed pondweed) *P. zosteriformis* (flat-stemmed pondweed) *Elodea* (waterweed)	**Exotic** *Myriophyllum spicatum* (Eurasian watermilfoil) *P. crispus* (curly-leaf pondweed)	**Algae** filamentous algae
COMMON (26-50% Cover)		**Submergents** *Chara* (muskgrass)	**Free-floating** *Nuphar* (yellow water lily)	
ABUNDANT (51-75% Cover)				
DOMINANT (76-100% Cover)	*Decodon* (water willow)			

Table 4. Sensitive area 2 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Northern Pike	*Chara*	water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	milfoil	water lily, *Chara*, wild celery, milfoil	water lily, wild celery, milfoil	water lily, wild celery, milfoil
Rock Bass		water lily, *Chara*, wild celery, milfoil	milfoil	milfoil
Bluegill and Pumpkinseed		water lily, *Chara*, wild celery, milfoil	water lily, wild celery, milfoil	water lily, wild celery, milfoil
Black Crappie	*Chara*	water lily, *Chara*, wild celery, milfoil	milfoil	milfoil
Yellow Perch	milfoil	water lily, *Chara*, wild celery, milfoil	milfoil	milfoil

Management Recommendations for Sensitive Area # 2

1. No chemical treatment will be permitted.

2. No mechanical harvesting will be permitted.

3. None of the following in-lake activities allowed:

Filling	Pea Gravel/Sand Blankets
Aquatic plant screens	Dredging
Wetland alterations	Boardwalks

4. Strictly enforce shoreland and wetland ordinances.

5. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

Resource Value of Sensitive Area Site 3 – Lauderdale Lakes

This is the largest of the sensitive areas on the Lakes, consisting of the western third of Middle Lake (Fig. 4). The area contains the greatest diversity of emergent, submergent, and floating plants within the Lakes, including wild rice. Water lilies, logs, stumps, and vegetation provide cover for fish. The abundance and diversity of native pondweed species (*Potamogeton* spp.) provide essential cover for a variety of fish species. This is excellent spawning and nursery habitat for largemouth bass, bluegill, and pumpkinseed. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of the Lauderdale Lakes.

The area acts as a sediment and nutrient trap for the lake, enhancing water quality. The substrate is sand, silt, and muck. The area is unique because it contains valuable spawning habitat for sunfish. Aquatic vegetation (Table 5) also provides northern pike, largemouth bass, bluegill, and forage fish with spawning, nursery, and foraging habitat (Table 6).

The extensive development of the Lauderdale Lakes has reduced available wildlife habitat. However, ducks, geese, herons, bittern, songbirds, muskrat, and opossum inhabit this portion of the lake during certain periods of the year. The boundaries of this sensitive area expanded between the study conducted in 1990 and the study conducted in 2004. The wild rice bed expanded to the north and the east. This change will affect 13 riparian landowners.

Table 5. Plants observed in sensitive area 3.

	Emergents	**Submergents**	**Free-floating**	**Algae**
PRESENT (0-25% Cover)	*Decodon* (water-willow) *Typha* (cattail) *Scirpus* (bulrush) *Carex* (sedges)	*Myriophyllum sibiricum* (northern watermilfoil) *Elodea* (waterweed), *Najas flexilis* (slender naiad) *Chara* (muskgrass) *Vallisneria* (wild celery) *Utricularia* (bladderwort)	*P. natans* (floating-leaf pondweed) *Nuphar advena* (yellow water lily) *Nymphaea* (white water lily) **Exotics** *Myriophyllum spicatum* (Eurasian watermilfoil) *P. crispus* (curly-leaf pondweed)	filamentous algae
COMMON (26-50% Cover)		*P. zosteriformis* (flat-stemmed pondweed) *Stuckenia pectinata* (sago pondweed) *P. illinoensis* (Illinois pondweed)		
ABUNDANT (51-75% Cover)	*Zizania* (wild rice)			
DOMINANT (76-100% Cover)				

Table 6: Sensitive area 3 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Northern Pike	*Chara*	*Chara*, water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	milfoil sand	water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds, woody debris	water lily, wild celery, milfoil, pondweeds, woody debris
Rock Bass		water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Bluegill and Pumpkinseed	sand	water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Black Crappie	*Chara* sand	water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil, woody debris	pondweeds, milfoil, woody debris
Yellow Perch	woody debris, milfoil, pondweeds	water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil

Management Recommendations for Sensitive Area # 3

1. Chemical treatment is not permitted except to target an infestation of an exotic species such as purple loosestrife, Eurasian water milfoil or curly leaf pondweed.

2. Restrict mechanical harvesting to a navigational channel along the developed shoreline but only after spawning activities have finished.

3. A DNR permit should not be issued for any of the following:
   Filling
   Aquatic plant screens
   Dredging along the undeveloped area
   Wetland dredging, filling or cutting
   Boardwalks

4. The following in-lake activities may be allowed with conditions:
   Dredging a navigational channel along the currently developed shoreline
   Pea gravel/sand blankets along the currently developed shoreline

5. Maintain the “No-Wake Zone”.

6. Recommendations regarding **local zoning** along the currently undeveloped shoreline:
    - Strictly enforce shoreland and wetland ordinances
    - Restrict/limit subdivision of existing undeveloped parcels
    - Require a buffer/"no touch" zone for grading projects. This buffer/"no touch" zone should be at least 200 feet from the edge of the wetland back into the (landward) upland portion of parcels.
    - Require a buffer/"no touch" zone for grading projects located along steep slopes. The zone should extend at least 200 feet from the edge of a steep slope towards the landward side of the parcel.
    - Grading proposals should be strictly examined for superior erosion control and nutrient management plans.

Resource Value of Sensitive Area Site 4 – Lauderdale Lakes

This is a shallow (<5 feet) area adjacent to a wetland on the southwestern shore of Mill Lake (Fig. 5). Large-leaf pondweed is abundant here. The aquatic plant community is not unusually valuable, except for the large-leaf pondweed (Table. 7). However, the proximity of aquatic plants to the wetland improves the overall value of this area. See Appendix 1 for a complete list of aquatic plants found in the sensitive areas of the Lauderdale Lakes.

Northern pike use the area for spawning, while the large amount of cover provides shelter for waterfowl. Aquatic vegetation provides northern pike, largemouth bass, bluegill, and forage fish with spawning, nursery, and foraging habitat (Table 8).

The wetland provides a buffer for runoff entering the lake. It traps sediment and nutrients, enhancing water quality. Aquatic vegetation helps control shoreline erosion.

The extensive development of the Lauderdale Lakes has reduced available wildlife habitat. However, this area is locally important as fish and wildlife habitat. Herons, bittern, songbirds, muskrat, and opossum inhabit this portion Mill Lake during the majority of the year.

Table 7. Plants observed in sensitive area 4.

	Emergents	**Submergents**	**Free-floating**
PRESENT (0-25% Cover)	*Decodon* (water-willow) *Typha* (cattail) *Scirpus* (bulrush) *Carex* (sedges)	*Elodea* (waterweed), *Najas flexilis* (slender naiad) *Chara* (muskgrass) *Vallisneria* (wild celery) *P. zosteriformis* (flat-stemmed pondweed) *P. illinoensis* (Illinois pondweed)	*Nuphar advena* (yellow water lily) *Nymphaea* (white water lily) **Exotics** *Myriophyllum spicatum* (Eurasian watermilfoil) *P. crispus* (curly-leaf pondweed)
COMMON (26-50% Cover)			
ABUNDANT (51-75% Cover)		*P. amplifolius* (large-leaf pondweed)	
DOMINANT (76-100% Cover)			

Table 8: Sensitive area 4 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Northern Pike	*Chara*	*Chara*, water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	milfoil	water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Rock Bass		water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Bluegill and Pumpkinseed		water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Black Crappie	*Chara*	water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil, woody debris
Yellow Perch	milfoil, pondweeds	water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil

Management Recommendations for Sensitive Area # 4

1. No chemical treatment permitted.

2. Restrict mechanical harvesting to a navigational channel extending from piers.

3. None of the following in-lake activities allowed:
   Filling
   Aquatic plant screens
   Wetland alterations
   Boardwalks
   Dredging
   Pea gravel/sand blankets

4. Strictly enforce shoreland and wetland ordinances.

5. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion. A “No-Wake Zone” should be implemented.

Resource Value of Sensitive Area Site 5 – Lauderdale Lakes

This area of the Lauderdale Lakes is located between Treasure Island and the Lauderdale Country Club Golf Course (Fig. 6), in Don Jean Bay. The area has large beds of large-leaf pondweed. The pondweed bed on the extreme western shore of the island should be protected from any removal activities. There is good shoreline cover consisting of woody growth and the north side of the island is excellent for wildlife.

There is little water flow through the area and the substrate is soft muck/silt. The area acts as a sediment and nutrient trap for the lake, enhancing water quality.

Aquatic vegetation (Table 9) controls shoreline erosion and provides northern pike, largemouth bass, bluegill, and forage fish with spawning, nursery, and foraging habitat (Table 10). See Appendix 1 for a complete list of aquatic plants found in sensitive areas of the Lauderdale Lakes.

The extensive development of the Lauderdale Lakes has reduced available wildlife habitat. Ducks, geese, herons, bittern, songbirds, muskrat, and opossum inhabit this portion of Mill Lake during the majority of the year.

Table 9. Plants observed in sensitive area 5.

PRESENT (0-25% Cover)	**Emergents** *Typha* (cattail)	**Submergents** *Elodea* (waterweed) *Najas flexilis* (slender naiad) *Chara* (muskgrass) *Vallisneria* (wild celery) *P. zosteriformis* (flat-stemmed pondweed)	**Free-floating** *P. natans* (floating-leaf pondweed) *Nuphar advena* (yellow water lily) **Exotics** *Myriophyllum spicatum* (Eurasian watermilfoil) *P. crispus* (curly-leaf pondweed)	**Algae** filamentous algae
COMMON (26-50% Cover)				
ABUNDANT (51-75% Cover)				
DOMINANT (76-100% Cover)		*P. amplifolius* (large-leaf pondweed)		

Table 10: Sensitive area 5 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Northern Pike	*Chara*	*Chara*, water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	milfoil	water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Rock Bass		water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Bluegill and Pumpkinseed		water lily, *Chara*, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Black Crappie	*Chara*	water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Yellow Perch	milfoil, pondweeds	water lily, *Chara*, wild celery, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil

Management Recommendations for Sensitive Area # 5

1. No chemical treatment permitted.

2. Restrict mechanical harvesting to a navigational channel extending from piers and only after spawning has ended. No large-leaf or floating-leaf pondweed may be harvested.

3. None of the following in-lake activities allowed:
   Filling/dredging
   Aquatic plant screens
   Wetland alterations
   Boardwalks
   Pea gravel/sand blankets

4. Strictly enforce shoreland and wetland ordinances.

5. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion. A “No-Wake Zone” should be implemented.

Resource Value of Sensitive Area Site 6 – Lauderdale Lakes

Sensitive area 6 is located on the northwest corner of Mill Lake and is unique to the Lauderdale Lakes (Figure 7). The area consists of a shallow bay with abundant *Sagittaria* (arrowhead), an emergent plant providing cover for young fish and valuable food for migratory waterfowl. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of the Lauderdale Lakes.

The substrate is primarily silt and muck in open water areas with more detritus along the shoreline. The bay acts as a sediment and nutrient trap for the lake, enhancing water quality. Aquatic vegetation helps control shoreline erosion (Table 11). It also provides northern pike, largemouth bass, bluegill, yellow perch, and forage fish with spawning, nursery, and foraging habitat (Table 12). The area is not favorable to bluegill spawning due to the silt present. However, submergent vegetation provides excellent sites for northern pike and yellow perch to deposit eggs.

The extensive development of the Lauderdale Lakes has reduced available wildlife habitat. However, this sensitive area is extremely important for wildlife. Ducks, herons, bittern, songbirds, reptiles, frogs, muskrat, mink, shrews, and voles inhabit this portion of the lake during the majority of the year. The wetland is quite diverse, containing jewelweed, boneset, sedges, sweet flag iris, mannagrass, canada bluejoint grass, marsh fern, bulrushes, bidens, great blue lobelia, blue flag iris, marsh dock, willow, dogwood, cattails, mint, marsh milkweed, arrowhead and coreopsis.

Table 11. Plants observed in the open water area of sensitive area 6.

PRESENT (0-25% Cover)	**Emergents** *Alisma* (water plantain) *Scirpus* (bulrush) *Decodon* (water-willow)	**Submergents** *Ceratophyllum* (coontail) *P. richardsonii* (clasping-leaf pondweed)	**Free-floating** *Lemna* (duckweed) *Nuphar advena* (yellow water lily) *Nymphaea odorata* (white water lily)	**Exotics** *Myriophyllum spicatum* (Eurasian watermilfoil) *P. crispus* (curly-leaf pondweed) *Lythrum* (purple loosestrife)
COMMON (26-50% Cover)	*Carex* (sedges) *Typha* (cattail) *Sagittaria* (arrowhead)	*Najas flexilis* (slender naiad) *Utricularia* (bladderwort) *Vallisneria* (wild celery)		**Algae** filamentous algae
ABUNDANT (51-75% Cover)		*Chara* (muskgrass)	*Spirodela* (large duckweed)	
DOMINANT (76-100% Cover)				

Table 12. Sensitive area 6 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Northern Pike	cattail	cattail, water lily, *Chara*, wild celery, coontail, milfoil, pondweeds	water lily, wild celery, coontail, milfoil, pondweeds	water lily, wild celery, coontail, milfoil, pondweeds
Largemouth Bass	coontail, milfoil	cattail, water lily, *Chara*, wild celery, coontail, milfoil, pondweeds	water lily, wild celery, coontail, milfoil, pondweeds	water lily, wild celery, coontail, milfoil, pondweeds
Rock Bass		cattail, water lily, *Chara*, wild celery, coontail, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Bluegill and Pumpkinseed		cattail, water lily, *Chara*, wild celery, coontail, milfoil, pondweeds	water lily, wild celery, coontail, milfoil, pondweeds	water lily, wild celery, coontail, milfoil, pondweeds
Black Crappie		water lily, *Chara*, wild celery, coontail, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil
Yellow Perch	cattail, coontail, milfoil, pondweeds	water lily, *Chara*, wild celery, coontail, milfoil, pondweeds	pondweeds, milfoil	pondweeds, milfoil

Management Recommendations for Sensitive Area #6

1. No chemical treatment, mechanical harvesting, mowing, or clear-cutting permitted in the wetland. Submergent vegetation within the existing channel (open water area only) may be harvested.

2. A DNR permit should not be issued for any of the following:
   - Filling
   - Dredging
   - Aquatic plant screens
   - Pea gravel/sand blankets
   - Wetland alterations

3. No alteration of littoral zone unless the activity improves spawning habitat.

4. Boardwalks will be permitted on a case by case basis to provide open water access only for a riparian landowner.

5. Chemical treatment is not permitted except to target an infestation of an exotic species such as purple loosestrife, Eurasian water milfoil or curly leaf pondweed.

6. Efforts should be undertaken to create and enforce shoreland and wetland ordinances, as well as educate developers on preventing erosion during construction. A "No-Wake Zone" should be implemented.

Resource Value of Sensitive Area Site 7 – Lauderdale Lakes

Sensitive area 7 consists of a shallow, sinuous waterway surrounding an island located between Middle and Mill Lakes (Figure 8). The area has a diverse plant community, including several emergent wetland species (sedges, rushes, and asters). It is unique in that it lacks Eurasian watermilfoil, an exotic species common elsewhere in the Lakes. See Appendix 1 for a complete list of aquatic plants found in sensitive areas of the Lauderdale Lakes.

The bottom is composed of a few inches of silt with firm substrate underneath. Aquatic vegetation helps control shoreline erosion (Table 13). It also provides northern pike, largemouth bass, bluegill, yellow perch, and forage fish with spawning, nursery, and foraging habitat (Table 14). Submergent vegetation provides excellent sites for northern pike and yellow perch to deposit eggs. Limited but valuable spawning habitat is available for bass, bluegill, and pumpkinseed in substrate uncovered by the thin layer of silt.

The extensive development of the Lauderdale Lakes has reduced available wildlife habitat. However, this sensitive area is extremely important for wildlife. Ducks, herons, bittern, songbirds, reptiles, frogs, muskrat, mink, shrews, voles, and beaver inhabit this portion of the lake during the majority of the year. The island contains a high diversity of wetland plants. Plants observed include marsh fern, mannagrass, canada bluejoint, cattail, bulrush, sedges, spike rush, sweet flag, arrowhead, bidens, great blue lobelia, blue flag iris, blue vervain, marsh milkweed, water willow, goldenrod, boneset, coreopsis, willow, dogwood, and white aster.

Table 13. Plants observed in the open water area of sensitive area 7.

PRESENT (0-25% Cover)	**Emergents**	**Submergents** *Chara* (muskgrass)	**Free-floating**	**Exotics** *P. crispus* (curly-leaf pondweed)
COMMON (26-50% Cover)	*Scirpus* (bulrush) *Eleocharis* (spike-rush) *Aster* (aster) *Acorus* (sweet flag) *Sagittaria* (arrowhead) *Typha* (cattail)			
ABUNDANT (51-75% Cover)		*Vallisneria* (wild celery) *Najas flexilis* (slender naiad) *P. zosteriformis* (flat-stemmed pondweed)	*Nymphaea odorata* (white water lily)	
DOMINANT (76-100% Cover)	*Carex* (sedges)			

Table 14: Sensitive area 7 habitat (plants and substrates) utilized by resident fish species of the Lauderdale Lakes (1999 survey).

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Northern Pike	*Chara*	*Chara*, water lily, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Largemouth Bass	hard substrate	water lily, *Chara*, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Rock Bass		water lily, *Chara*, wild celery, pondweeds	pondweeds	pondweeds
Bluegill and Pumpkinseed		water lily, *Chara*, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Black Crappie	*Chara*	water lily, *Chara*, wild celery, pondweeds	pondweeds	pondweeds, woody debris
Yellow Perch	pondweeds	water lily, *Chara*, wild celery, pondweeds	pondweeds	pondweeds

Management Recommendations for Sensitive Area #7

1. No mechanical harvesting, mowing, or clear-cutting permitted.

2. Chemical treatment is not permitted except to target an infestation of an exotic species such as purple loosestrife, Eurasian water milfoil or curly leaf pondweed.

3. A DNR permit should not be issued for any of the following:

Filling	Boardwalks
Aquatic plant screens	Dredging
Wetland alterations	Pea gravel/sand blankets

4. No alteration of littoral zone unless the activity improves spawning habitat.

5. Maintain the “No-Wake” boating zone.

6. Efforts should be undertaken to create and enforce shoreland and wetland ordinances, as well as educate developers on preventing erosion during construction.

Conclusion

Seven sensitive areas have been designated. Sensitive area number 3 contains one of the highest quality shorelines in southeast Wisconsin. Development along the shoreline of each of the seven sensitive areas sensitive should be carefully studied to prevent the further loss of habitat in the Lauderdale Lakes chain. This sensitive area report identifies characteristics and management recommendations for each of the seven areas.

In Wisconsin, lakes attract many users and water quality in these lakes affects many more. The Lauderdale Lakes attract a diversity of user groups, inevitably creating conflict. An integrated approach that includes the public and all of the Lakes' governing units is essential. The objective is to create and maintain a balance between recreational use and preservation of habitat, which is essential to the Lakes' health. Improving or at least maintaining water quality in Wisconsin lakes is critical. By protecting and restoring habitat these resources will continue to provide ecosystem functions and responsible recreational opportunities for years to come.

Works Cited

Becker, G.C., 1983. Fishes of Wisconsin, *The University of Wisconsin Press*.

Borman, S., R. Korth, and J. Temte, 1997. Through the Looking Glass: A Field Guide to Aquatic Plants, *Wisconsin Lakes Partnership*.

Chapter 30, Wisconsin State Statute.

Garn, H. S. Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin. USGS Water-Resources Investigations Report 02-4130, July 2002.

Greene, A. 2003. A Homeowners Guide to Native Shoreline Buffers, *Walworth County Publication.*

Lyons, J., P.A. Cochran, and D. Fago, 2000. Wisconsin Fishes 2000: Status and Distribution, *University of Wisconsin Sea Grant Institute*.

NR 1, 107, 109, Wisconsin Administrative Code.

Purple Loosestrife: What You Should Know, What You Can Do, *WDNR*, PUB-WT-276 2003.

Southeast Wisconsin Regional Planning Commission, 2001. An Aquatic Plant Management Plan for the Lauderdale Lakes.

Welch, D.E. and R. Dauffenbach, 2000. Fisheries Survey Report for the Lauderdale Lakes (WBIC 0755500), Walworth County, *WDNR*.

Woodford, J. E. and Meyer, M. W. Impact of Lakeshore Development on Green Frog Abundance. Biological Conservation 110 (2003), pp. 277-284

APPENDIX 1 - Aquatic plants within sensitive areas of the Lauderdale Lakes

Emergent	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Zizania (wild rice)			X				
Typha (cattail)	X		X	X	X	X	X
Scirpus (bulrush)	X		X	X		X	X
Eleocharis (spike-rush)							X
Carex (sedges)	X		X	X		X	X
Decodon (water-willow)		X	X	X		X	X
Alisma (water plantain)						X	
Sagittaria (arrowhead)						X	X
Acorus (sweet flag)						X	X
Aster (aster)						X	X
Thelypteris (marsh fern)						X	X
Glyceria (mannagrass)						X	X
Calamagrostis (Can. BG)						X	X
Bidens (Beggar Tick)						X	X
Lobelia (great blue)						X	X
Iris (Blue Flag)						X	X
Eupatorium (Boneset)						X	X
Mentha (mint)						X	
Asclepias (marsh milkweed)						X	X
Verbena (blue vervain)						X	X
Coreopsis						X	X
Impatiens (jewelweed)						X	
Rumex (marsh dock)						X	
Cornus (dogwood)						X	X
Solidago (goldenrod)							X

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Submergent	**Area 1**	**Area 2**	**Area 3**	**Area 4**	**Area 5**	**Area 6**	**Area 7**
Myriophyllum sibiricum (northern watermilfoil)			X				
Chara (muskgrass)		X	X	X	X	X	X
Potamogeton amplifolius (large-leaf pondweed)				X	X		
Elodea (waterweed)		X	X	X	X		
Utricularia (bladderwort)	X		X			X	
Ceratophyllum (coontail)	X					X	
Stuckenia pectinata (sago pondweed)	X		X				
Vallisneria (wild celery)		X	X	X	X	X	X
P. zosteriformis (flat-stemmed pondweed)		X	X	X	X		X
P. illinoensis (Illinois pondweed)			X	X			
Najas flexilis (slender naiad)			X	X	X	X	X
P. praelongus (white-stemmed pondweed)	X	X					
P. richardsonii (clasping-leaf pondweed)						X	

Free-floating							
Nuphar advena (yellow water lily)		X	X	X	X	X	
Nymphaea odorata (white water lily)		X	X	X		X	X
P. natans (floating-leaf pondweed)			X		X		
Lemna (duckweed)						X	
Spirodela (large duckweed)						X	

Exotic							
Myriophyllum spicatum (Eurasian watermilfoil)	X	X	X	X	X	X	
P. crispus (curly-leaf pondweed)		X	X	X	X	X	X
Lythrum (purple loosestrife)						X	

Algae							
filamentous		X	X		X	X	

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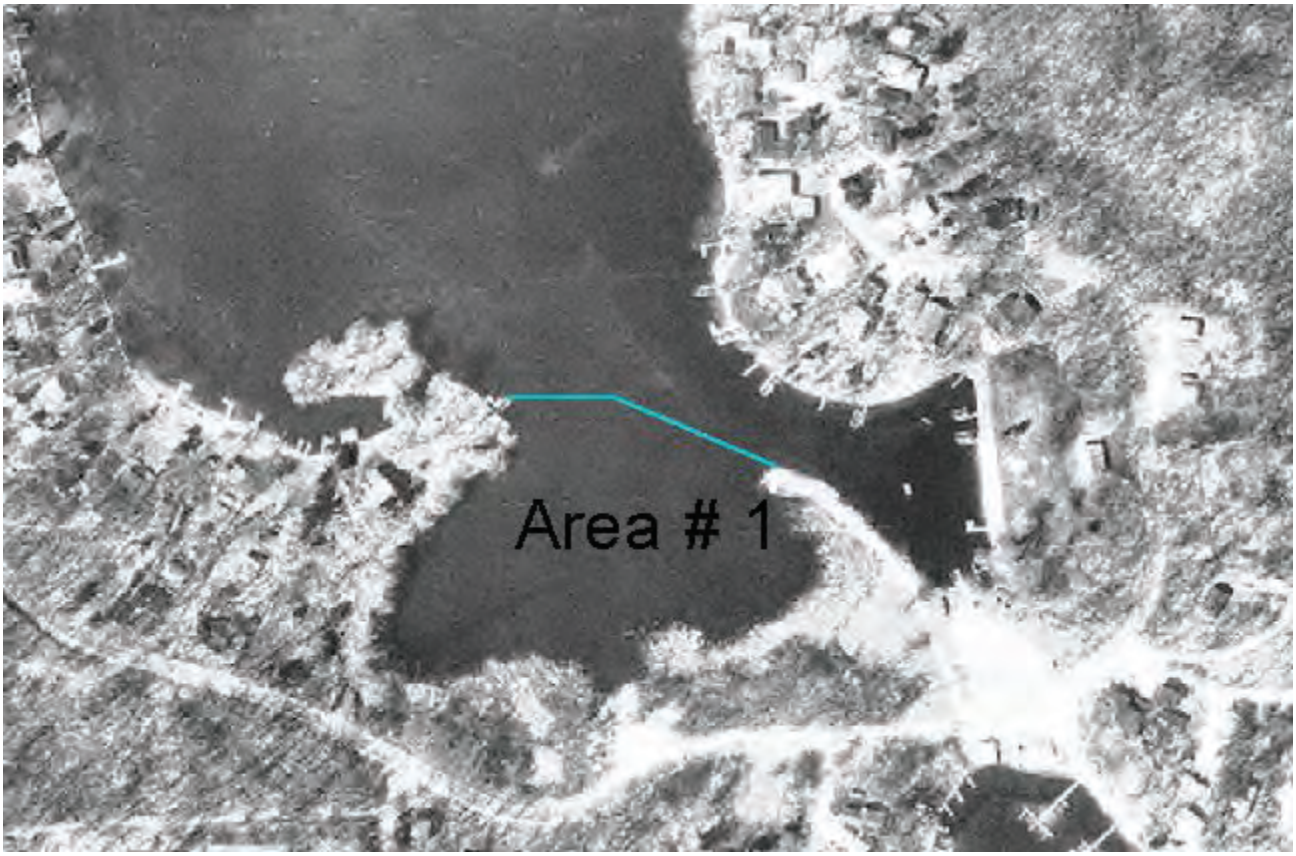
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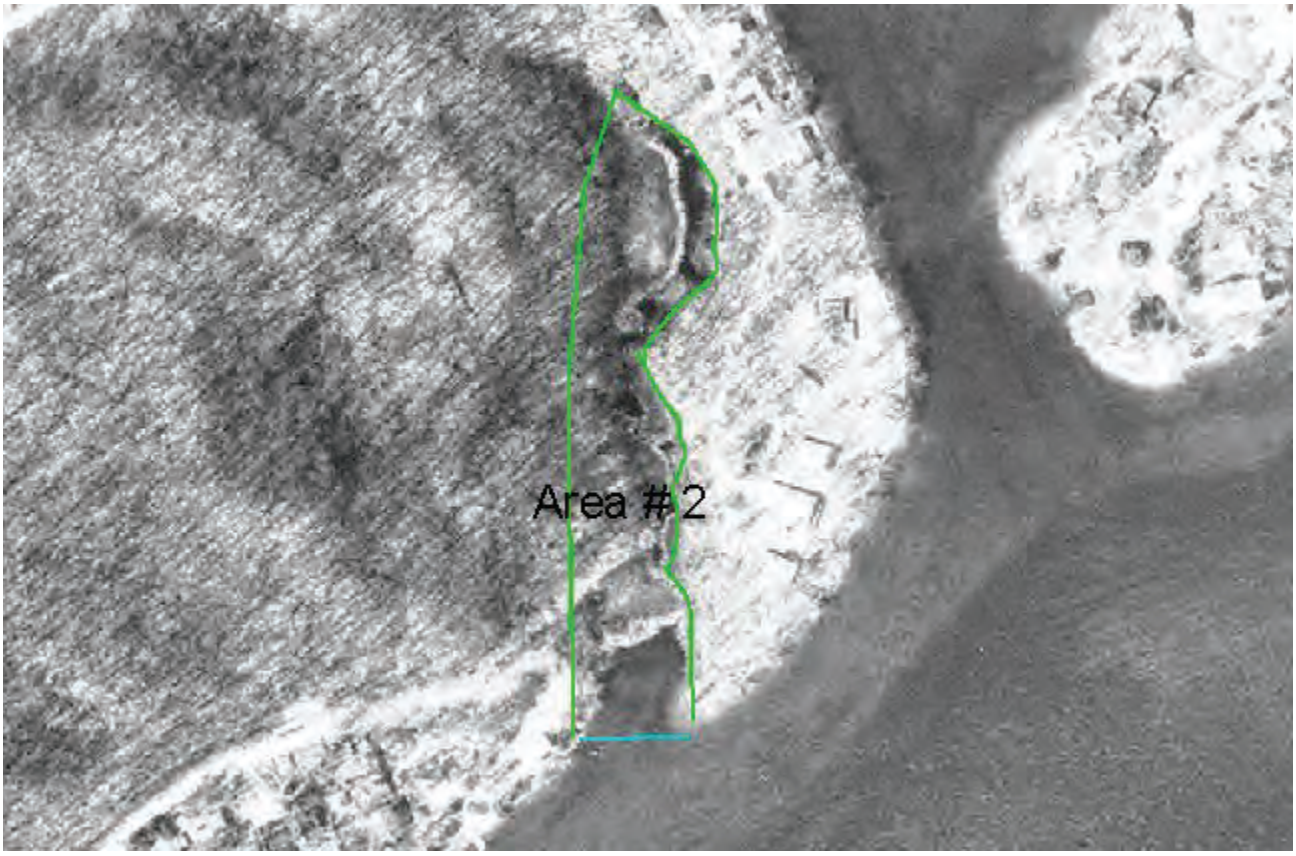
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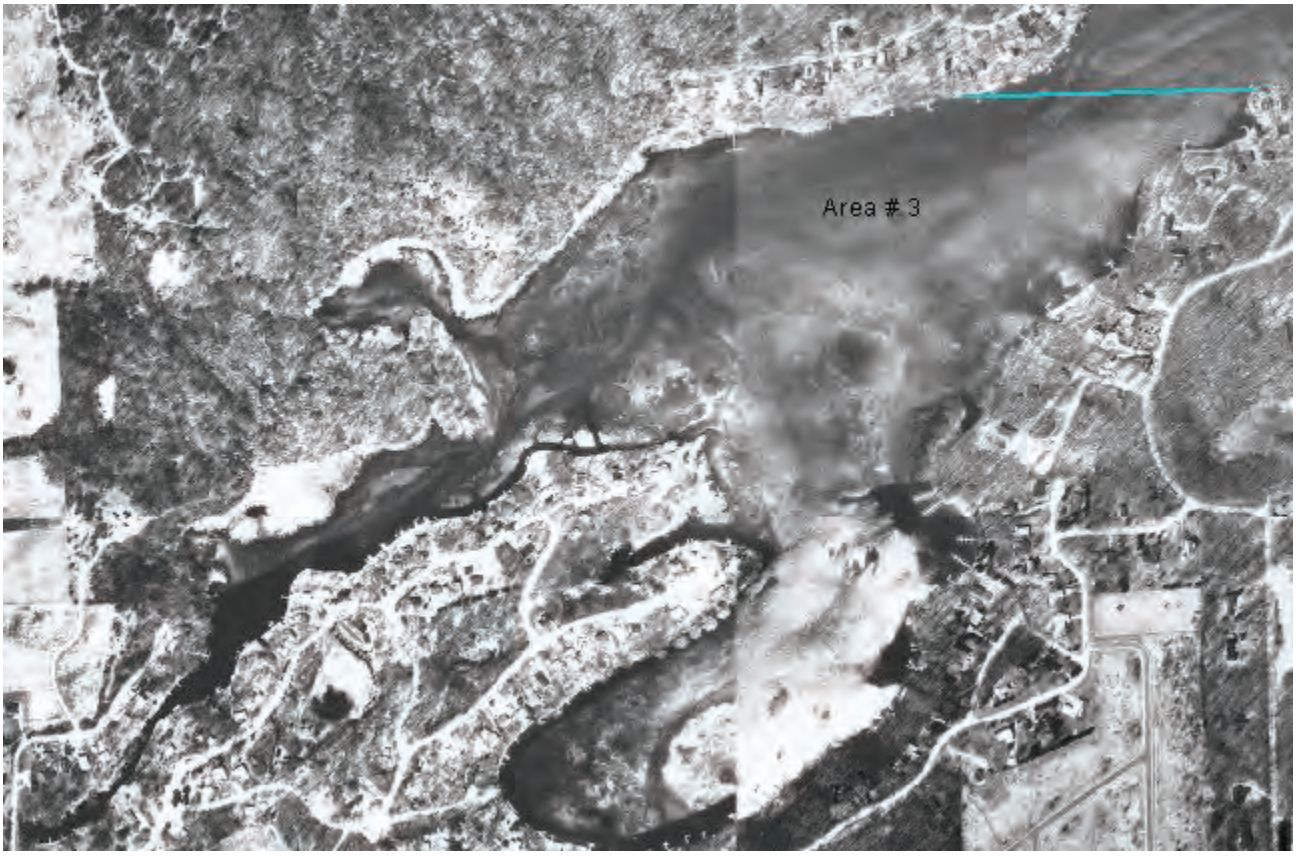
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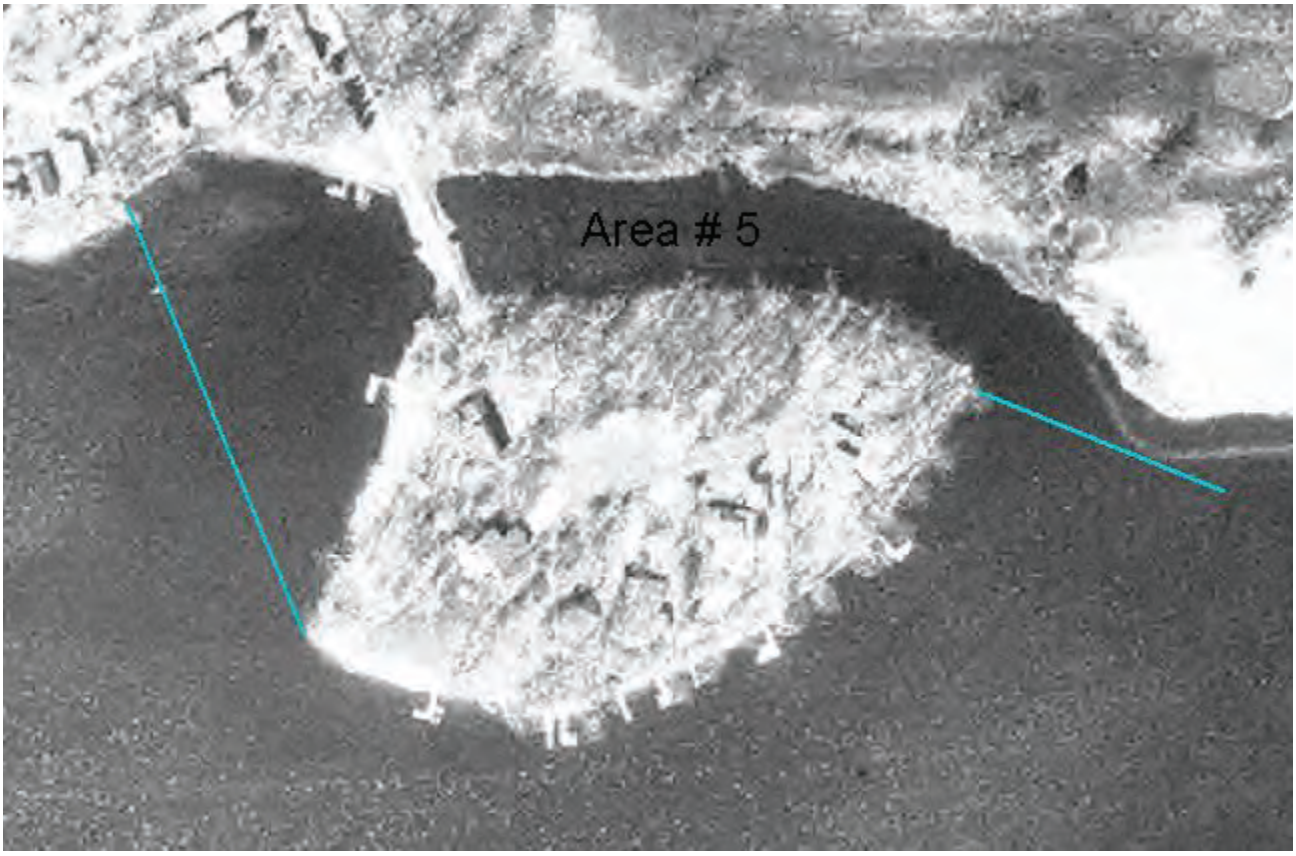
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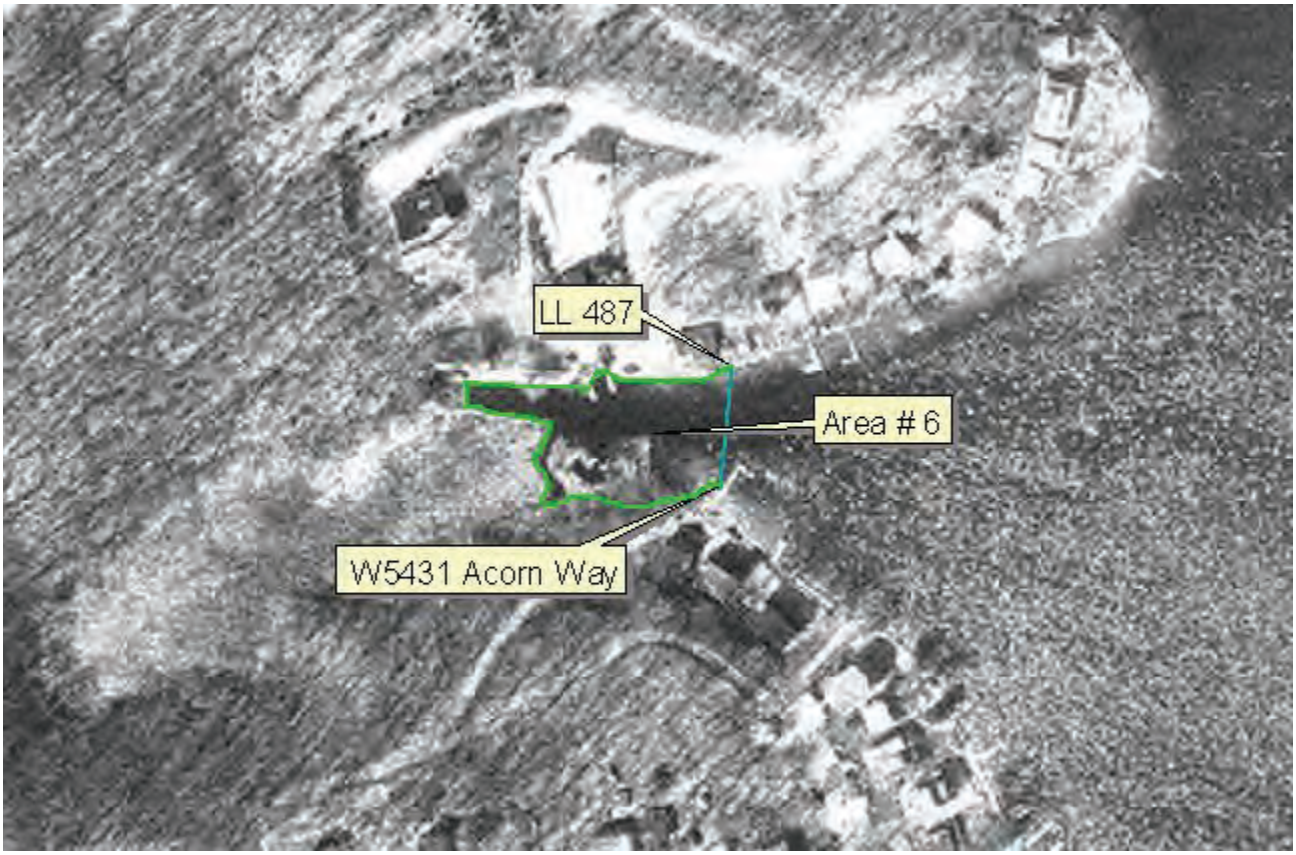
LL 487
Area # 6
W5431 Acorn Way


LL 535D (Brown House)
Area # 7
LL 528 (Green House)

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Appendix C

TOWNS OF LA GRANGE AND SUGAR CREEK BOATING AND PIER ORDINANCES APPLICABLE TO THE LAUDERDALE LAKES

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STATE OF WISCONSIN
TOWNS OF LAGRANGE & SUGAR CREEK
WALWORTH COUNTY

ORDINANCE NO. 2008-03
AN ORDINANCE TO REGULATE WHARFS, PIERS AND MOORING FACILITIES AND. ESTABLISH A PIERHEAD LINE FOR LAUDERDALE LAKES

WHEREAS, the placement of structures in and on Lauderdale Lakes may materially impact the health, safety and welfare of the public, environmental concerns relating to clean water, and aquatic habitat for fish and plant life, and recreational opportunities for all;

NOW, THEREFORE, the Town Boards of LaGrange and Sugar Creek enact this ordinance.

SECTION 1. DEFINITIONS
A. The definitions set forth in Section 30.01, Wis. Stats., as amended from time to time, are adopted by reference.

B. Mooring facility - means any allotted space, place or contrivance to which a single water craft is attached, secured or berthed, including, but not limited to, a mooring buoy, pier slip or shore station. By way of example, a pier of sufficient size to moor two (2) boats counts as two (2) mooring facilities.

C. Pier head line - means the distance into the water from the ordinary high water mark, as defined in NR 320.03(4), Wisconsin Administrative Code, in which area piers maybe allowed.

D.Raft - is any structure which floats on the water by means of inflation, barrels, logs, or similar means, and is not used for transportation.

SECTION II. PERMIT REQUIRED
No property owner, tenant, agent, business or person may do any of the following:0 construct;
• place;
• extend;
• enlarge;
• replace, except seasonal replacement; or
• repair an existing pier greater than 10% of its surface square feet in one year or more than 50% of the posts of a permanent pier in one year, a wharf, pier, or mooring facility in Lauderdale Lakes without obtaining a permit from the Town of LaGrange for the portion of the lakes in the Town of LaGrange and from the Town of Sugar Creek for the portion of the lakes in the Town of Sugar Creek.

• SECTION III. APPLICATION FOR PERMIT

Any person, firm, corporation or association desiring to erect, construct, place, extend or replace or repair to an extent defined in Section II any wharf, pier or mooring facility on or about the bed of Lauderdale Lakes along or beyond the shoreline as it exists or as it may have been determined and established by ordinance shall be required, regardless of other permits obtained, make and file a written application in the office of the Building Inspector of the Town of LaGrange or Town of Sugar Creek. The application shall contain the following information:

A. Describe the real estate, existing mooring facilities, and wharf, pier, mooring facility or extension thereof in detail;

B. The structures location in regard to the shoreline and pier head line;

C. Distances to all property lines of the abutting riparian lands;

D. Details of the dimensions and kinds of materials, together with drawings;

E. Any additional details and specifications that the Town Board may request;

F. The name, addresses of legal residence of riparian property, and signature of the riparian proprietor of the shoreline or easement holder who otherwise meets the criteria in Sec. 30.131, Stats., on whose behalf the application is made, and the name and post office address of the applicant, if different;

G. A fee in the amount established from time to time by the respective Town Board; and

H. In the case of repair or replacement of a legally nonconforming pier, the year the pier, wharf or mooring facility was originally placed in the water and the number of mooring facilities in existence as of May 16, 1981.

SECTION IV STANDARDS AND PROCEDURE FOR GRANTING PERMITS
There shall be two (2) procedures for obtaining a permit. All applicants shall submit an application to the Building Inspector which shall include photographs of the current shoreline showing all mooring facilities and drawings of the proposed construction and or modification of the all mooring facilities.

Procedure 1:
The Building Inspector is authorized to issue permits to riparian owners or easement holders which meet the following standards:

1. Meets the criteria in Sec. 30.131, Stats., for piers, wharfs, mooring facilities and shore stations.
2. Not longer than the established pier head line, (35ft);
3. No pier wider than 5 feet measured at its point of greatest width, except the pier or wharf may exceed 5 feet width for a triangle at an angle of an L or T shaped pier or wharf, no greater than 3 feet on any side of the triangle attached to the pier or wharf;
4. Constructed so as to allow the free movement of water underneath all parts of the structure extending beyond the natural shore;
5. Constructed in such manner as will not cause the formation of land on the lake bed;
6. No more than one mooring facility for each twenty-two (22) feet, or fraction thereof, of shoreline owned by the riparian owner;
7. No more than five (5) mooring facilities per lot regardless of the size of the riparian owner’s shoreline;
8. Placed in a location not inconsistent with the pier planner used by the Department of Natural Resources, as amended from time to time;
9. No mooring facility shall be located closer than eight (8) feet to a lot line; and
10. Not in an environmentally sensitive: area delineated by the Department of Natural Resources.

The Building Inspector shall review the application and forward the application, together with an investigation and report, to the Town Board of LaGrange or Sugar Creek for all applications for piers, wharfs, mooring facilities, moorings, mooring buoys and mooring anchors which do not meet the standards established in Procedure 1 of this ordinance. Any application which does not meet the standards shall be forwarded to the Town Board which may grant or deny the permit pursuant to Procedure 2.

Procedure 2:
At a Town Board meeting, the Town Board may, after considering the application and all evidence presented, and hearing all parties desiring to be heard, grant a permit to riparian owners for piers, wharfs, mooring facilities, moorings, mooring buoys and mooring anchors meeting the following standards and considering the following factors:
1. The location, design and construction will not detrimentally impact the health, safety and welfare of the public which consideration shall include water quality, aquatic habitat and other environmental concerns, including factors considered by the DNR, and of the owners of the abutting riparian property. No new nor enhancement of

established piers, wharfs, mooring facilities, moorings, mooring buoys and mooring anchors shall be permitted in DNR defined environmentally sensitive areas.
2. The location, design and construction will not interfere with public rights in the waters or with the rights of neighboring riparian proprietors or occupants;
3. Constructed so as to allow the free movement of water underneath all parts of the structure extending beyond the natural shore;
4. Constructed in such manner as will not cause the formation of land on the lake bed;
5. No more than one mooring facility for each twenty-two (22) feet, or fraction thereof, of shoreline owned by the riparian owner; however, this is not a guarantee that a permit will be granted;
6. Placed in a location not inconsistent with the pier planner used by the Department of Natural Resources, as amended from time to time;
7. No mooring facility shall be located closer than eight (8) feet to the lot line; and
8. Additional Requirements for Mooring Buoys and Anchors:
a. No permit for placement of a mooring buoy or anchor shall be granted by the Town Board beyond 60 feet from the ordinary high water mark;
b. Mooring buoys shall extend eighteen (18) inches above the waterline, be white in color with a blue band clearly visible above the waterline, and be spherical or ovate in shape;
c. The painter or line between a mooring buoy and any watercraft attached to it shall not exceed ten (10) feet in length; and
d. Section 30.722(d) 1 through 4, Stats., are adopted by reference as though fully set forth herein and as amended from time to time.
9. For replacement or repair for which a permit is required for legally nonconforming piers, wharfs or mooring facilities, the Town Board shall grant permits authorizing structures for the number of mooring facilities in existence as of May, 1981 or grant permits to the extent reasonably possible, or grant permits consistent with the other standards in this ordinance.
D. All permits granted shall state the location and size of the allowed mooring facility, as well as the number of permitted watercraft.
E. The Town Board of the town in which the pier is located may grant variances from the terms of Section C. of this Ordinance for extraordinary circumstances when the riparian owner will suffer a hardship by literal application of the standards established in this ordinance when the hardship is not of the riparian owner's own making.

SECTION V. MAINTENANCE

All wharfs, piers, and mooring facilities extending beyond the natural shore shall be so maintained as to prevent any part or parts thereof from floating or sinking into and obstructing the waters or impeding free navigation of Lauderdale Lakes.

SECTION VI. PREEXISTING PIERS, WHARFS AND MOORING FACILITIES
A. Any wharf, pier or mooring facility legally existing in place as of the date of adoption of this ordinance may be repaired during one year up to 10% of the square feet of the surface of the structure and, if permanent, up to 50% of the posts, so long as the size of the structure is not expanded.
B. In order to protect the legitimate rights of persons with preexisting piers, wharfs and mooring facilities, all persons with a wharf, pier or mooring facility legally in place as of July 10, 2006 shall provide the following information to the LaGrange Town Building inspector by September 1, 2007: Name of riparian owner, address of owner, address where pier is located, year pier first placed in Lauderdale Lakes, length of pier, width of pier and number of mooring facilities. All persons failing to file this information with the Town Building Inspector shall be deemed not to own a pier, wharf or mooring facility with rights as a preexisting pier, wharf or mooring facility and such structures shall conform to the standards established in this ordinance.

SECTION VII. PIERHEAD LINE REGULATED
A. Policy. The Towns of LaGrange and Sugar Creek, pursuant to Chapter 30 of the Wisconsin Statutes, are empowered to regulate wharfs and piers and to establish a pier head line. It is in the interest of the Towns of

LaGrange and Sugar Creek to preserve and protect the property within the Town of LaGrange and Sugar Creek at the same time as preserving and protecting public rights in navigable waters and non-uniformity with respect to wharfs and piers in Lauderdale Lakes can be detrimental to these interests. It is in the interest of the Towns of LaGrange and Sugar Creek and the public to establish uniform requirements for the establishment of piers and wharfs on Lauderdale Lakes, Walworth County, Wisconsin. To that end, a pier head line should be established.
B. Establishment of Pier head Line. There is established, in the Towns of LaGrange and Sugar Creek on Lauderdale Lakes, a pier head line. Such pier head line is established at a distance of thirty-five (35) feet channel ward from the ordinary high water mark of the shore. No pier or wharf shall be so placed or so constructed such that it extends a distance greater than the established pier head line channel ward from the ordinary high water mark of the shore from which such pier or. Wharf is constructed, unless the permit from the Town Board as required by Section IV.C. has been obtained. No pier or wharf may exist more than thirty- five (35) feet from the ordinary high water mark of the shore, except as hereinafter set forth. “Ordinary high water mark" is defined by NR 320.03(4), Wisconsin Administrative Code. Where the bank or shore, at any particular place, is of such a character that it is impossible or difficult to ascertain where the point of ordinary high water mark is, recourse may be had to other places on the shore of the lake to determine whether a given stage of water is above or below the ordinary high water mark. ' C. Prohibition and Exceptions. Any wharf or pier extending into navigable water beyond the limit set forth herein constitutes an unlawful obstruction of navigable water unless a permit for such wharf or pier has been obtained by the Town Board and pursuant to Section 30.12(2) of the Wisconsin Statutes, or is otherwise accepted.

SECTION VIIL RAFTS REQUIRED
A. Size Limitation. No person may use a raft greater than 200 square feet in surface area on Lauderdale Lakes unless that person proves that he/she owned the raft prior to September 30, 2000.
B. B. Reflectors. All rafts floating on Lauderdale Lakes shall have reflectors affixed to the outside perimeter.

SECTION IX. REMEDIES AND PENALTIES
A. All actions to recover forfeitures and penalty assessments under this ordinance are civil actions in the name of the Town of LaGrange or Town of Sugar Creek and shall be heard in Circuit Court for Walworth County.
B. Any person (riparian owner and / or contractor) violating any provisions of this ordinance relating to mooring facilities shall forfeit not less than $10 nor more than $200 for each day that a violation takes place or continues, plus costs and assessments. The cash deposit amount shall be $100 plus costs and assessments per day for each day that a violation takes place or continues.
C. Any permit issued which is contrary to any law or ordinance or rule, or regulation of. the Department of Natural Resources, or with which the applicant has not complied, shall be void and of no effect.
D. In the event a mooring facility for which a permit has been granted shall not be erected, constructed, placed, extended or maintained in accordance with the plans, specifications, details and drawings submitted, or not maintained in a safe condition, or in the event such mooring facility shall not be constructed within one (1) year from date permit was granted, or that it be used in a manner detrimental to the general public, or interfere with the rights of the neighboring riparian owners, then, in such event, the board may cancel and revoke the permit provided it shall first hold a meeting after fixing a time and place of hearing and shall cause a written notice thereof to be issued and delivered or mailed to the holder of such permit, and also to the owners of the neighboring abutting riparian lands, not less than five (5) days before the time fixed for hearing.
E. Every pier, wharf or mooring facility constructed, placed or extended, enlarged or replaced in violation of this ordinance is declared to be a public nuisance, and the construction thereof may be enjoined and the maintenance thereof may be abated by action at the suit of the Town.
F. The Building Inspector(s) of the Towns of LaGrange and Sugar Creek are authorized to issue citations for violations of this ordinance.

SECTION X. SEVERABILITY
The provisions of this ordinance shall be deemed severable and it is expressly declared that the Town Boards would have passed the other provisions of this ordinance irrespective as to whether or not one or more provisions may be declared invalid and any provision of this ordinance or the application thereof to any person or

circumstance is held invalid, the remainder of the ordinance and the application of such provisions, other persons or circumstances shall not be affected thereby.

SECTION XI. REPEAL OF CONFLICTING ORDINANCE
All ordinances and parts of ordinances in conflict with this ordinance heretofore enacted by the Towns of LaGrange and Sugar Creek, Walworth County, Wisconsin, are hereby repealed.

XII. EFFECTIVE DATE AND CLERK'S DUTY

A. This ordinance shall take effect and be in force from and after its passage and publication as provided by law and after review by the Department of Natural Resources.

B. The LaGrange Clerk is directed to file a signed copy of this ordinance with the Department of Natural Resources in Madison, Wisconsin.

Enacted by the Town Board of LaGrange this 9TH day of June, 2008.
Approved:
Frank Taylor
Mark Bromley
Donald Sukala
Richard Callaway
Jeff Schramm

ATTEST: Crystal Hoffinann, Town Clerk, LaGrange

Enacted by the Town Board of Sugar Creek this 18th day of August, 2008.
Approved:
Gary Wallem
Carl Rieken

ATTEST: Diane Boyd, Town Clerk, Sugar Creek

STATE OF WISCONSIN
TOWN OF LAGRANGE
WALWORTH COUNTY

ORDINANCE NO. 2007-003

AN ORDINANCE TO REGULATE USE OF THE TOWN'S PUBLIC BOAT LAUNCHES

The Town Board hereby enacts this Ordinance as follows:
SECTION 1. FEES FOR USE OF PUBLIC BOAT LAUNCH.
A. No person shall use or otherwise launch a watercraft at or on the public boat launches owned by the Town of LaGrange without prepayment of the following fees: Per day watercraft launch fee (entitling the holder to launch watercraft for one day); Per season fee (entitling unlimited launches from January 1 to December 31);

B. The amount of fees shall be established by the Town Board from time to time by motion.

SECTION 2. PAYMENT OF FEES AND DISPLAY OF PERMIT.

A. Fees shall be paid in advance. Upon payment the person shall receive a permit.

B. Fees may be paid as follows:
At the launch ramp; or
At the Town Hall either in person or by mail by sending a check or money order to the Town Clerk at P.O. Box 359, Whitewater WI 53190.
C. Every person or vehicle using the launch ramp shall either carry with them or display on the vehicle dashboard the permit that they receive when paying the fee.

SECTION 3. NO OVERNIGHT TIE UP. No person, firm or association shall tie a watercraft to a launch ramp owned by the Town of LaGrange at any time from 11 PM to 5AM the following day. This prohibition shall not apply to watercraft owned or operated by the Town of LaGrange, the Fire Department or the Lauderdale Lakes Lake Association.

SECTION 4. ITEMS ALLOWED ON RAMP. No person, firm or association shall place any thing on the launch ramp except watercrafts, motor vehicles and trailers.

SECTION 5. ENFORCEMENT. This ordinance may be enforced by the Walworth County Sheriff's Department and the Lake Patrol by issuing citations. Violations shall be punishable by a forfeiture in the amount of a minimum of $25 up to a maximum of $100. Each day of a violation takes place shall be a separate violation. Failure to pay the forfeiture may result in a jail term.

SECTION 6. SEVERABILITY AND REPEAL.
A. The provisions of this ordinance shall be deemed severable and it is expressly declared that the Town Board would have passed the other provisions of this ordinance irrespective as to whether or not one or more provisions may be declared invalid and any provision of this ordinance or the application thereof to any person or circumstance is held invalid, the remainder of the ordinance and the application of such provisions, other persons or circumstances shall not be affected thereby.

B. All ordinances and parts of ordinances in conflict with this ordinance heretofore enacted by the Town of LaGrange are hereby repealed.
Adopted on motion of Supervisor Bromley, seconded by Supervisor Schramm on the 9th day of April, 2007.

Approved:
Frank Taylor,Chairman
Mark Bromley, Supervisor
Don Sukala, Supervisor
Rick Callaway, Supervisor
Jeff Schramm, Supervisor

Attest:
Crystal Hoffmann, Clerk

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Appendix D

EURASIAN WATER MILFOIL MANAGEMENT IN MILL LAKE: 2002

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MEMORANDUM

TO: Peter M. van Kampen, Commissioner
Lauderdale Lakes Lake Management District

FROM: Jeffrey A. Thornton, Principal Planner (Environment)
Southeastern Wisconsin Regional Planning Commission

DATE: August 22, 2002

SUBJECT: EURASIAN WATER MILFOIL MANAGEMENT IN MILL LAKE: 2002

Background

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) prepared an aquatic plant management plan for the Lauderdale Lakes, published as SEWRPC Memorandum Plan No. 143, *An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin*, which was published by the Commission during August 2001. One recommendation of this plan related to the management of Eurasian water milfoil populations in the areas of Mill Lake known as Sterlingworth Bay and Don Jean Bay.

Eurasian water milfoil is a non-native, invasive plant that forms dense, single species stands in many inland lakes in Wisconsin. Since it was originally introduced into the state during the 1960s, the plant has spread rapidly to the point where it has been declared to be a nuisance species. Efforts are underway statewide to control the spread of this plant through informational signage, adoption of Chapter NR 109 of the Wisconsin Administrative Code which prohibits transference of the plant between lakes, and the application of aquatic plant management measures using a variety of techniques.

Strategy

One of the techniques proposed in the management plan to control Eurasian water milfoil was designed to remove the competitive advantage of the milfoil

plant: its competitive advantage is to begin its active growth cycle at water temperatures of about 48 to 54°F—about 5°F cooler than most native plants begin growing—and then shoot straight to the lake surface, where it spreads out and captures the sunlight. This then limits the ability of the lower-growing, native aquatic plants to compete—which start to grow at about 56 to 58°F—given the limited availability of sunlight. To combat this advantage, modification of the harvesting program to cut the tops of the milfoil was recommended.

The Lauderdale Lakes Lake Management District implemented the "top-chopping" strategy during 2002. SEWRPC was asked to monitor the performance the technique in encouraging the growth of native plant populations, and discouraging the growth of Eurasian water milfoil. This assessment was made by comparing aquatic plant communities observed during 2002 to those recorded during the initial survey conducted in August 1999.

Results

Sterlingworth Bay

At the time of the initial survey, Sterlingworth Bay was dominated by Eurasian water milfoil. At the 5-feet depth, the only plants observed were Eurasian water milfoil and Chara or muskgrass, a macro-alga. Sparse growths of Robbins pondweed were also recorded. At the 1.5-feet depth, milfoil was also dominant, or most abundant, with coontail, eel grass and some few pondweeds also present.

During 2002, the aquatic plant community in the Bay remained diverse throughout the summer. The initial sampling was conducted at the end of Mar 2002, and sampling continued at approximately monthly intervals—immediately prior to harvesting—throughout the summer (one additional sampling in planned for mid-September 2002). Eurasian water milfoil remained abundant in the Bay, and, with the exception of late July, did not "top out" as harvesting was undertaken at approximately monthly intervals. (In late July, the harvester was delayed in cutting Sterlingworth Bay, with the result that the Eurasian water milfoil did reach the surface of the Bay—during 2003, it is recommended that harvesting be scheduled at no more than monthly intervals to limit the possibility of "topping out" occurring.)

Notwithstanding, during 2002, a diverse community of aquatic plants was also recorded from within the Bay. This result was quite different from that observed during the initial aquatic plant survey, when the Bay was close to being a mono-culture of milfoil. While some seasonality was observed in the plant community—certain species preferring cooler or warmer water temperatures, and so being reported

during only parts of the summer, substantial numbers of pondweeds, Chara, eel grass, Elodea, and coontail were also observed consistently through the summer period. Muskgrass, eel grass, and Elodea were especially abundant, and these relatively low-growing, native plants generally cause few problems for recreational water users. Some patchiness was noted around the Bay, with this phenomenon seemingly related to the composition of the lake bottom sediments—the peaty soils of the southwestern portion of the Bay forming relatively poor rooting substrate for the aquatic plants, while the more mucky soils of the northeastern portion of the Bay supported the greatest diversity (and abundance) or aquatic plants.

Don Jean Bay

During the August 1999 survey, Don Jean Bay was also dominated by Eurasian water milfoil. Along the three sampling transects established on the western shoreline of the Bay, adjacent to the extensive wetland area, Eurasian water milfoil dominated the aquatic plant flora between the 1.5-feet depth and the 11-feet depth, decreasing in abundance from the shoreline to the deeper water area. Coontail was moderately abundant in these same area, with a few pondweeds were recorded, although these did not constitute a significant part of the aquatic plant community. The most diverse flora, or plant community, was observed along the southwestern shore of Don Jean Bay, where Eurasian water milfoil, eel grass, muskgrass, and a number of pondweeds were more equally distributed—Eurasian water milfoil, however, remained the most abundant plant.

During the 2002 surveys, Eurasian water milfoil remained abundant along this shoreline, although there was a consistent decline in Eurasian water milfoil abundance in later summer as the plant appeared to be dying back with the onset of autumn. The greatest diversity throughout the summer continued to be observed along the southwestern shoreline. Chara or muskgrass, Elodea, eel grass, coontail, and a variety of pondweeds were present throughout this portion of the Bay. Bushy pondweed was exceptionally abundant, increasing in abundance throughout the summer and competing during the later summer with Eurasian water milfoil for dominance.

Evaluation

Based on the four surveys already completed during the 2002 summer season, the adoption of the recommended “top chopping” strategy to combat the dominance and abundance of Eurasian water milfoil in portions of the Lauderdale Lakes appeared to be successful in maintain an increasingly diverse aquatic plant community within the areas where this strategy was applied. In Sterlingworth Bay, especially, the strategy appears to have enhanced the aquatic habitat available for fishes without seriously impairing

recreational uses. That said, the “topping out” of the milfoil plants during late July was noted to have caused some concern, as reported to the field crews by local homeowners. For this reason, a more regular schedule of harvesting is recommended, as noted above.

It should also be noted that 2002 was a year in which Eurasian water milfoil growth was exceptionally abundant. The combination of a mild winter and long cool spring season proved to be an ideal combination that ensured continued, over-winter growth of Eurasian water milfoil in many of the Region’s lakes, while the absence of a spring “cold snap” allowed the plant to secure a dominant position within the aquatic plant community. In many of the Region’s lakes, the growths of aquatic plants were reported to have reached their highest levels in the last 25-years. With this in mind, the continued presence and abundance of native aquatic plants in Sterlingworth and Don Jean Bays demonstrates the effectivity of "top-chopping" as a Eurasian water milfoil control strategy.

Continued Vigilance Required

While the harvesting strategy adopted by the Lauderdale Lakes Lake Management District has proven effective during the 2002 summer season, the role of individuals remains an important part of the overall aquatic plant management strategy for the Lauderdale Lakes:

- help to prevent the spread of the plant by ensuring that boats, trailers, and other aquatic equipment are “weed-free” when removing these items from the Lake and when transporting such equipment between Lakes or locations on the Lake.
- help to limit the spread of the plant by removing plant fragments from along their shorelines—harvested plants make an excellent mulch.
- help to prevent the growth of the plant by limiting the application of garden chemicals and fertilizers to those needed for terrestrial plant growth—remember, what turns your lawn green, will also turn your lake green.
- help to prevent the fertilization of the Lake by having a soil test done to ensure that the nutrients applied to lawns and gardens are those required by the plants, and that these are applied in the quantities necessary for growth—over enthusiastic application of fertilizers means that the excess will simply run off into the lake.
- help to limit the run off of excess fertilizer and other household chemicals to the Lake by installing a buffer strip along the shoreline using native plants—these will add beauty to your property, reduce your maintenance time, and help to stabilize the shoreland area.

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