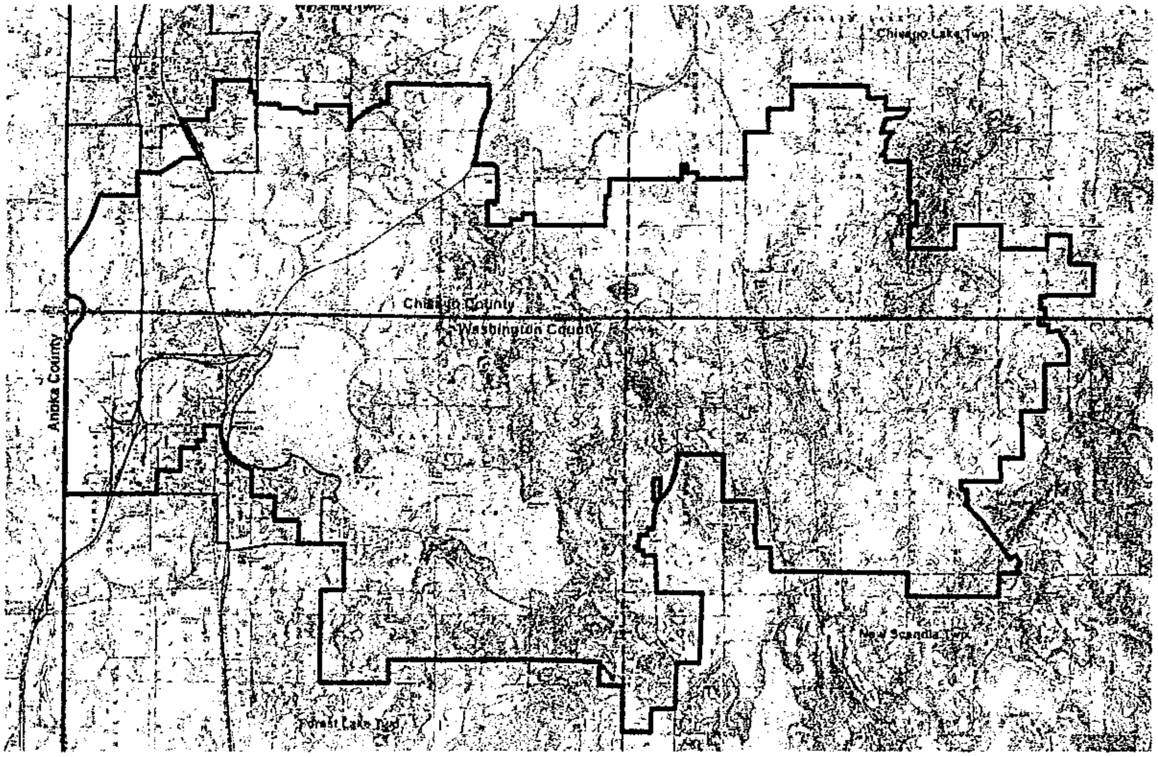


2006 ANNUAL REPORT

Comfort Lake – Forest Lake Watershed District

April 2007

220 North Lake Street
Forest Lake, MN 55025
651.209.9753

COMFORT LAKE - FOREST LAKE WATERSHED DISTRICT

2006 ANNUAL REPORT

INTRODUCTION

Pursuant to Minnesota Statutes Section 103D.351 and Minnesota Rules Section 8410.0150, the Board of Managers of the Comfort Lake - Forest Lake Watershed District (CLFLWD or District) submits its 2006 Annual Report. The District was established in 1999. The report is intended to inform readers of the District's activities, plans, goals and objectives in 2006 as well as projected work plan and budget for 2007. The District invites comments and suggestions on the report.

The District submits its Annual Activity Report to the Board of Water and Soil Resources, the Commissioner of the Department of Natural Resources, and the Director of the Division of Waters. Copies are available from the District Administrator or the watershed Managers.

This report is organized in three sections

Section 1: Introduction and Background: Provides background information on the District.

Section 2: Activity Report: Summarizes the District's programs and activities completed in 2006 and presents a work plan for 2007.

Section 3: Financial Administration: Summarizes fund balances, budgets, levees and the 2006 audit.

BACKGROUND

The Comfort Lake – Forest Lake Watershed District was established in 1999 after citizens petitioned the Board of Water and Soil Resources (BWSR) to replace the existing Forest Lake Watershed Management Organization (FLWMO) in order to address water quality and flooding issues. The petition included the area encompassed by the predecessor organization (FLWMO), plus the drainage area of Comfort Lake in Chisago County (i.e., Joint Ditch No. 1 (JD 1).

The CLFLWD encompasses roughly 47 square miles in northern Washington County and southern Chisago County, including the Cities of Forest Lake, Scandia, and Wyoming, and the Townships of Chisago Lake and Wyoming. The CLFLWD is the only watershed district in the state which transects both metropolitan and outstate counties. Roughly 60 percent of the watershed lies in Washington County and 40 percent lies in Chisago County.

The District is managed by a five member appointed Board, with three members appoint by Washington County and two member appointed by Chisago County. From the five member Board of Managers, the positions of President, Vice President, Treasurer and Secretary are elected annually. The Comfort Lake – Forest Lake Watershed District's first Water Management Plan was approved by the Board of Water and Soil Resources in 2001.

The Board of Managers, with the help of its Citizen Advisory Committee, adopted the following mission statement:

> The mission of the Comfort Lake – Forest Lake Watershed District is to protect and conserve its water resources. The District will use sound scientific water management approaches, technologies, and methods. The District will develop a uniform, integrated approach to water management within a rapidly changing and urbanizing area.

ANNUAL ACTIVITY REPORT

2006 BOARD OF MANAGERS

While the CLFLWD is represented by a five member Board of Managers, one of the Managers, Dennis G. Larson, resigned during the last quarter of 2006. The position is to be filled in January 2007.

Manager	Position	Term Expires	County
John T. Lynch 920 15th Street SE Forest Lake, MN 55025 (651) 464-3022	**President**	**9/22/08**	**Washington**
Richard P. Damchik 9109 North Shore Trail Forest Lake, MN 55025 (651) 464-5890	**Secretary**	**9/22/07**	**Washington**
Jackie A. Anderson 25484 E Comfort Dr Forest Lake, MN 55025 (651)462-3734	**Treasurer**	**9/22/09**	**Chisago**
Jon W. Spence 25582 Comfort Dr Chisago City, MN 55103 (651) 514-6324	**Manager**	**9/22/08**	**Chisago**
Dennis G. Larson 20750 Kirby Avenue N Scandia, MN 55073 (651)779-5054	**Manager**	**9/22/09**	**Washington**

2006 ADVISORY COMMITTEE MEMBERS

Employees and Consultants

In 2006, the District employed independent contractor consultants who provide all of the necessary accounting, legal, public information and other services to fulfill its obligations, goals, and objectives within budget. The following consultants served the District in 2006:

Consultant	Services	Address	Telephone	E-mail
Kathleen Blackford	Accountant	21231 Paso Fino Circle P.O. Box 186 Forest Lake, MN 55025	(651) 748-1889	kmb@kblackford.com
Dan Fabian Emmons and Olivier Resources	Engineer	651 Hale Ave N Oakdale, MN 55128	(651) 203-6029	dfabian@eorinc.com
Mark Gibbs HLB Tautges Redpath, Ltd.	Accounting	4810 White Bear Parkway White Bear Lake, MN 55110	(651) 426-7000	mgibbs@hlbtr.com
Paul R. Haik Krebsbach & Haik, Ltd	Attorney/ Administrator	225 South Sixth Street Suite 4320 Minneapolis, MN 55402	(612) 333-7400	phaik@haik.com
John Hoffman ICS Agency	Insurance	4901 West 7th Street Minneapolis, MN 55435	(612) 835-4848	
Curt Sparks North American Wetland Engineering	Engineer	444 Centerville Road Suite 140 White Bear Lake, MN 55127	(651) 255-5050	csparks@nawe-pa.com
John Thene Wenck & Associates	Engineer	1800 Pioneer Creek Cntr P.O. Box 249 Maple Plain, MN 55359	(763) 479-4234	jthene@wenck.com
Travis Thiel Washington Conservation District	Technical Advisor	1380 W Frontage Road Hwy 36 Stillwater, MN 55082	(651) 275-1136	tthiel@mnwcd.org

Citizen Advisory Committee Members

Name	Address
Bruce Anderson	24484 East Comfort Drive North Forest Lake, MN 55025
Deb Anderson	26885 Forest Blvd. P.O.Box 188 Wyoming, MN 55092
Kathy Blomquist	6044 Cedar Street North Branch, MN 55025
Terry Dreyer	23290 Melanie Trail North Scandia, MN 55073
Vernon Haag	26996 Fenwick Avenue Wyoming, MN 55092
Don Hull	813 8th Avenue SE Forest Lake, MN 55025
Roger Johnson	9095 228th St. N Scandia, MN 55073
Judy and Tim Rahey	20801 Keewahtin Avenue North Forest Lake, MN 55025
Mary Schmitz	313 Main Street North, Ste. 243 Center City, MN 55012
A.J. Schwidder	7980 230th Street North Forest Lake, MN 55025
John Springman	24658 Greenway Avenue North Forest Lake, MN 55025
Don Steinke	8890 220nd Street North Forest Lake, MN 55025
James Thoreen	303 North Main Street Center City, MN 55012

GOALS AND OBJECTIVES OF 2006 WORK PLAN

In 2006 the CLFLWD hired Wenck and Associates to undertake a watershed-wide water quality model and design services project following the completion of the District's watershed-wide hydrologic and hydraulic (floodplain delineation) model (completed by SRF Consulting Group in 2005). While the hydrologic and hydraulic model identified potential flooding issues throughout the watershed, the current water quality modeling project will determine load allocations to our water resources and develop a Capital Improvement Plan (through the evaluation and design of projects) which will determine and prioritize tasks needed to either improve or maintain the quality of our water resources. The water quality modeling effort is designed to meet or exceed the Total Maximum Daily Load (TMDL) requirements for all major lakes in the watershed. Therefore the results of the modeling effort will be three fold:

1) **Determine load allocations throughout the watershed.** The modeling effort is designed to use the District's existing hydrology and hydraulic model as a foundation for the determination of the load allocations (internal and external) to each major waterbody within the watershed.

2) **Develop and prioritize a Capitol Improvement Program (CIP) Schedule.** Following the results of the Wenck & Associates water quality modeling design service project, the CLFLWD, with the assistance of Wenck & Associates, will develop a schedule of, and prioritize potential projects to address water quality and quantity issues determined through the modeling effort.

3) **Preparation of total maximum daily loads (TMDL) studies on impaired water bodies**. There are currently three lakes within CLFLWD which are listed as impaired by the Minnesota Pollution Control Agency (MPCA) due to excessive nutrients [Bone, Comfort, and Shields lakes]. Because of their listing, TMDL studies/plans are to be completed on the lakes. The current Wenck & Associate water quality (load allocation) model will provide the majority the needed information to complete the TMDLs, therefore reducing the effort and monies needed to complete the task. Furthermore, already available data reveal that a few more lakes within the District will be listed as impaired as soon as the data are analyzed by MPCA.

Additionally, the Board of Managers initiated the process of hiring a District Administrator/Staff Engineer in 2006. The driving concept behind the Board starting the process of hiring an administrator was to increase the local visibility of the District and have a local office to work with our member communities and citizens to implement rules and projects, and to provide technical expertise for oversight to the District's consultants and facilitate Board actions and decisions.

The CLFLWD has also been an active member in the local and state organizations in 2006.

a) At a local level, the CLFLWD was an active member of the Washington County Water Consortium. The Water Consortium, which was identified in the County's water governance study, is a group of those responsible for water resource management in Washington County, working toward consistent performance between watershed districts in accounting, rules development, groundwater management, budgetary development and sharing information regarding studies or research.

b) At the state level, the CLFLWD was an active participant in the Minnesota Association of Watershed Districts (MAWD). Two managers and the incoming District Administrator attended the annual meeting as well as a couple of associated meetings during the year.

Since the District's formation, the Washington Conservation District has provided water quality monitoring data and services for CLFLWD. The CLFLWD has also participated in the Metropolitan Council's Citizen-Assisted (lake) Monitoring Program (CAMP). To date, the District has mainly focused on floodplain analysis, and load allocation modeling which will be the foundation for the determination for future watershed rules and the formation of a CIP in order to protect and enhance the District's water resource.

GOALS AND OBJECTIVES OF PROJECTED 2007 WORK PLAN

A copy of the District's proposed budget for 2007 is included below. Additional copies are available by contacting the District Administrator at the District offices.

1) **Lake and Stream Monitoring**. The CLFLWD will continue its baseline monitoring program. The District contracts with Washington County Conservation District (WCD) for technical services associated with the majority of the monitoring program. In 2007, however, the CLFLWD will directly enroll five lakes (Bone, Comfort, Forest, Little Comfort, and Sylvan) into the Metropolitan Council's Citizen-Assisted Monitoring Program (CAMP), which uses volunteers to collect water samples, take Secchi transparencies and surface water temperature, and record basic user perceptions and climate information. The samples are then analyzed for total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a. The use of volunteers will not only result in a savings to the monitoring budget, but will build needed relationships between CLFLWD and local lake associations.

2) **Water Quality (load allocation) Modeling and Design Services**. The water quality modeling and design services effort, which began in 2006, is being carried out by Wenck & Associates. The study is scheduled to be completed during the second half of 2007. A component of the study includes the determination and prioritization of remedial alternatives to address water resource (quality and quantity) issues raised in the modeling effort.

3) **Rules and Regulations**. In order to fulfill requirements mandated by the State, as well a provide guidance to local communities, the CLFLWD will develop and adopt rules and regulations. The developed rules will focus on upholding the integrity of the goals and objectives listed in the CLFLWD Watershed Management Plan.

   The CLFLWD will use the Citizen Advisory Committee and Technical Advisory Committee, to review and comment on the rules. Local community representation will be an important component to the Technical Advisory Committee, in order to get "buy in" and form a strong partnership with our local communities. In an effort to seek involvement from local communities, the Administrator will meet with each communities City Administrator and/or staff to discuss CLFLWD's rule development process, seek information as to their current permitting program, determine potential areas of conflict and needs, and maintain an open conduit for the current review and comment on projects in their communities.

It is this strong partnership which will ultimately provide the best protection for our water resources.

4) **Education/Outreach Program.** As part of the CLFLWD education and outreach program in 2007, the District will develop a website in order to increase their visibility and accountability with local stakeholders, will work with local lake associations to distribute information on an array of water resource management issues (i.e., shoreline stabilization BMP alternatives), and will host workshops in order to provide valuable water resource management educational material and training to local stakeholders.

5) **Total Maximum Daily Loads (TMDLs).** There are currently three lakes within CLFLWD which are listed as impaired by the Minnesota Pollution Control Agency (MPCA) due to excessive nutrients [Bone, Comfort, and Shields lakes]. Because of their listing, TMDL studies/plans are to be completed on the lakes. Furthermore, already available data reveal that a few more lakes within the District will be listed as impaired as soon as the data are analyzed by MPCA. For this reason, the CLFLWD will further look into expanding their proposed TDML to include those lakes which recent data show as impaired. The current Wenck & Associate water quality (load allocation) model will provide the majority the needed information to complete the TMDLs, therefore reducing the effort and monies needed to complete the task. Because CLFLWD will not have all the needed information to complete the Lake TMDLs until the Wenck & Associates water quality (load allocation) modeling effort is complete, CLFLWD will work with WCD in completing a work plan for submittal to MPCA for Clean Water Legacy funds. If unsuccessful in acquiring Clean Water Legacy funds, the CLFLWD will look into alternative methods of funding the TMDLs.

   A side product of the CLFLWD TDMLs and load allocation modeling, will be the completion of a Bone Lake Diagnostic Study. By combining the processes, potential grant dollars will be maximized and the resulting study on the lake will be completed in a timelier manner

WATER QUALITY

Community Concerns

The District is in the process of reconvening the citizen's advisory committee and has received input and requests from area residents regarding assistance in protecting lake water quality. Members of the Bone Lake and Comfort Lake Associations have addressed the Board regarding water quality concerns and have raised issues that may be properly addressed through a basic water management project.

PERMITTING

Permits and Variances

At the present time the District does not have a permit program. In lieu of a permit program, the District reviews and comments on incoming plans and permit applications from federal, state, and local stakeholders in order that they meet the goals and objectives of the Comfort Lake – Forest Lake Watershed Management Plan.

Enforcement Actions

The District did not commence any enforcement actions in 2006.

WATER QUALITY MONITORING DATA

Since forming in 1999, the District has contracted with the Washington County Conservation District, for the collection of water quality and quantity monitoring data. In 2006, the normal lake and stream monitoring program was intensified in order to provide needed data to support the District's load allocation modeling study. The District partnered with WCD and the Metropolitan Council to accomplish the more intensive water quality monitoring program, which not only included additional sites, but an enhanced array of water quality parameters. In addition to the water quality monitoring, the District partnered with WCD and the Metropolitan Council to conducted macrophyte surveys and phytoplankton/zooplankton analysis/enumeration on seven of the District's lakes (Bone, Comfort, Forest, Little Comfort, Moody, Shields, and Sylvan). The resulting data from the District's monitoring program are forwarded to the MPCA for permanently storage in the United States Environmental Protection Agency's national water quality database STORET (STOrage and RETrieval). A summary of the District's 2006 monitoring data is presented in Appendix C.

In 2006, the District contracted with Wenck & Associates to conduct a water quality (load allocation) modeling and design services study. The goals of the study are to determine nutrient load allocation throughout the watershed, and to determine and prioritize potential remedial alternatives (projects) to address water resource issues raised in the model. The load allocation model will also provide needed nutrient load information to develop TMDLs for the District's impaired lakes.

LOCAL PLAN ADOPTION AND IMPLEMENTATION

As the District has adopted its plan, municipalities of the District have separately begun to adopt local water management plans. In late 2006 the City of Forest Lake finished its Stormwater Pollution Prevention Program (SWPPP) in order to fulfill MS4 permit requirements (established by the United States Environmental Protection Agency and are administered by the Minnesota Pollution Control Agency [MPCA]) designed to reduce the amount of sediment and pollution that enters surface and ground water from storm sewer systems. In addition, Chisago County completed its Surface Water Management Plan and its latest revision to their County

Comprehensive Plan in 2006. Additionally, New Scandia Township became the City of Scandia in 2006. The CLFLWD is working with these local units of government in order to jointly address water quality and quantity issues within the watershed.

WRITTEN COMMUNICATION

As the District begins utilizing its load allocation model and floodplain analysis for rules and CIP development (in order to protect and enhance the District's water resources), it will provide communications about its increasing activities.

SOLICITATIONS OF INTEREST

In June of 2006, District solicited administrative, engineering, legal and accounting services. Pursuant to statute, the District's next biennially solicitation will be in 2008.

In addition, the District solicited engineering proposals for the water quality modeling (load allocation) and design services project mentioned earlier in this repot.

WETLAND BANKING PROGRAM

Currently, the District is not the Wetland Conservation Act local government unit, and does not have an adopted wetland-banking program. The District relies upon the state wetland bank administered the Board of Soil and Water Resources.

FINANCIAL ADMINISTRATION

PROJECTED 2007 BUDGET

A copy of the District's proposed budget for 2007 is presented in Appendix A. Additional copies are available by contacting the District Administrator at the District offices.

REPORTING OF REVENUES AND EXPEDITURES

The District's revenue sources are general, survey and data, and insurance levies pursuant to Minnesota Statutes Chapters 103D and 466. In 2006, the District levied $250,000 pursuant its general levy. Funding pursuant to Chapter 103B is not available, as the District is not located completely within the metropolitan area.

The District completed conversion to Washington County's standard chart of accounts, and pursued accounting programs to standardize financial reporting. The Board is looking into adopting the Small City and Town Accounting Software (CTAS) for 2007 and is working with the State Auditors Office to format an accounting package from the CTAS software specifically for Watershed Districts.

ANNUAL AUDIT

The 2006 Audit was completed by HLB Tautges Redpath, Ltd, and includes the District's Annual Financial Report and the Independent Auditor's Report on Compliance with Minnesota Legal Compliance Guide of Local Governments for the year ended December 31, 2006. A complete copy of the 2006 audit is included in Appendix B of this report.

the State Auditors Office to format an accounting package from the CTAS software specifically for Watershed Districts.

ANNUAL AUDIT

The 2006 Audit was completed by HLB Tautges Redpath, Ltd, and includes the District's Annual Financial Report and the Independent Auditor's Report on Compliance with Minnesota Legal Compliance Guide of Local Governments for the year ended December 31, 2006. A complete copy of the 2006 audit is included in Appendix A of this report.

CONCLUSION

In 2006, the CLFLWD initiated a water quality (load allocation) modeling and design services study, which will lead to the determination and prioritization of potential remedial alternatives (projects) to address water resource issues raised in the model, as well as provide needed nutrient load information to develop TMDLs for the District's impaired lakes.

To provide needed support to the water quality (load allocation) modeling effort, lake and stream monitoring activities were intensified in 2006. The expanded monitoring, is meant to provide better representation of watershed and in-lake conditions, including the addition of sites and analytical parameters as well as the addition of biological monitoring of lakes (phytoplankton, zooplankton and macrophyte surveys).

Additionally, in order to increase the local visibility of the District and have a local office to work with our member communities and citizens to implement rules and projects, and to provide technical expertise for oversight to the District's consultants and facilitate Board actions and decisions, the Board of Managers approved the process of hiring a District Administrator/Staff Engineer and the establishment of a local office in 2006.

The results of the load allocation modeling and project design, as well as the hiring of a District Administrator, will provide much needed benefit in considering and responding to lake residents and associations regarding inquiries and requests for assistance in protecting lake water quality. In 2007 and beyond, the District looks forward to establishing projects and implementing rules to protect the District's water resources.

Respectfully submitted,

COMFORT LAKE - FOREST LAKE WATERSHED DISTRICT

By
Jackie A. Anderson
President

APPENDIX A

COMFORT LAKE - FOREST LAKE WATERSHED DISTRICT
PROJECTED 2007 BUDGET

COMFORT LAKE-FOREST LAKE WATERSHED DISTRICT
EXPENSE/ BUDGET WORKSHEET

4/27/2007

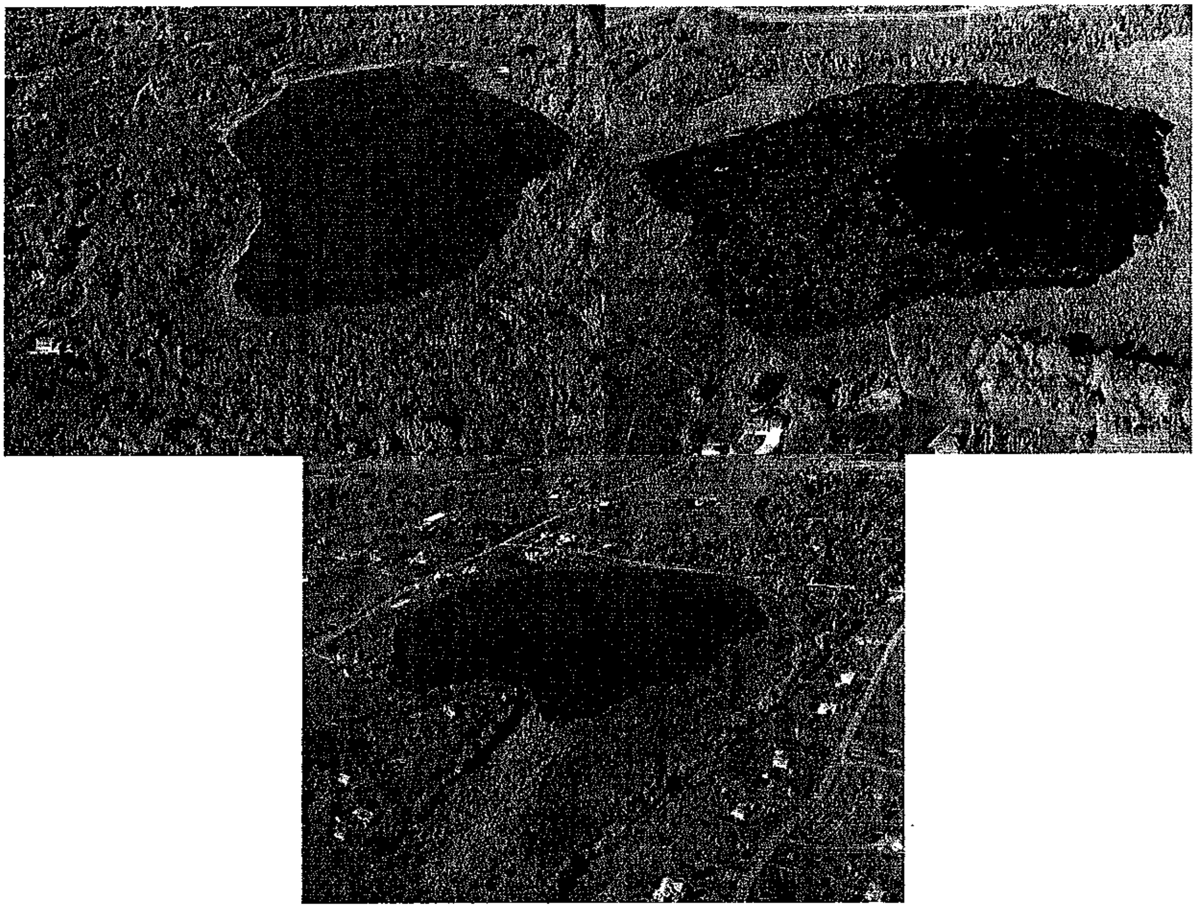
2007	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	BUDGET 2007
BEGINNING FUND BALANCE													
Checking			0	0	0	0	0	0	0	0	0	0	
Savings			0	0	0	0	0	0	0	0	0	0	
TOTAL BEGINNING FUND BALANCE	278020	258687	241355	215271	197938	175605	278271	253438	236105	210021	192688	175355	
REVENUE													
General Levy		0	0	0	0	125000	0	0	0	0	0	125000	250000
Insurance Levy	0	0	0	0	0	3750	0	0	0	0	0	3750	7500
Survey Levy	0	0	0	0	0	0	0	0	0	0	0	0	0
Basic Water Management Levy	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL REVENUE	0	0	0	0	0	128750	0	0	0	0	0	128750	257500
TOTAL GROSS FUND BALANCE	278020	258687	241355	215271	197938	304355	278271	253438	236105	210021	192688	304105	
EXPENSES													
BOARD ADMINISTRATION:													
Advisory Committee	125	125	125	125	125	125	125	125	125	125	125	125	1500
Annual Audit	0	0	0	0	3500	0	0	0	0	0	0	0	3500
Insurance, Bond and Dues	2000	0	0	0	1500	0	7500	0	0	0	0	0	11000
Miscellaneous	100	100	100	100	100	100	100	100	100	100	100	100	1200
Office	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000
Per Diem and Expenses	500	500	500	500	500	500	500	500	500	500	500	500	6000
GENERAL ADMINISTRATOR/STAFF ENGINEER:													
Salary	6667	6667	6667	6667	6667	6667	6667	6667	6667	6667	6667	6667	80000
Payroll Taxes	500	500	500	500	500	500	500	500	500	500	500	500	6000
PERA	433	433	433	433	433	433	433	433	433	433	433	433	5200
Benefits	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000
PROFESSIONAL SERVICES:													
Accounting	400	400	400	400	400	400	400	400	400	400	400	400	4800
Consulting Engineer	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000
Legal	500	500	500	500	500	500	500	500	500	500	500	500	6000
PROJECTS:													
Quality/Stormwater Plan	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	20000
Lake & Stream Monitoring	0	0	8750	0	0	8750	0	0	8750	0	0	8750	35000
Comprehensive Diagnostic Study:													
Bone Lake	2675	2675	2675	2675	2675	2675	2675	2675	2675	2675	2675	2675	32100
Miscellaneous Projects	383	383	383	383	383	383	383	383	383	383	383	383	4600
Education Materials	383	383	383	383	383	383	383	383	383	383	383	383	4600
TOTAL 2007 EXPENSES	19333	17333	26083	17333	22333	26083	24833	17333	26083	17333	17333	26083	257500
TOTAL FUND BALANCE	258687	241355	215271	197938	175605	278271	253438	236105	210021	192688	175355	278021	

APPENDIX B

2006 COMFORT LAKE - FOREST LAKE WATERSHED DISTRICT ANNUAL AUDIT

The Comfort Lake – Forest Lake Watershed District's 2006 Annual Audit has not yet been completed by HLB Tautges Redpath, Inc. for inclusion in the District's Annual Report. The District will forward a copy of the Audit on once the Board of Managers has received the report from HLB Taugtes Redpath, Inc.

APPENDIX C
2006 WATER MONITORING SUMMARY



Pictures (clockwise from top-left): Shields Lake, Birch Lake, and Moody Lake, October 5, 2006

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT 2006 WATER MONITORING REPORT

Prepared for:

Comfort Lake Forest Lake Watershed District

Prepared By:

Washington Conservation District

February 2007

Memorandum

To: Comfort Lake Forest Lake Watershed District Managers
From: Erik Anderson, Jessica Arendt, Wendy Griffin, Tim Sundby, and Travis Thiel --Washington Conservation District
Date: February 22, 2007
Re: CLFLWD 2006 Monitoring: Tributary to Sunrise River at Bone Lake Outlet, Tributary to Sunrise River at Bone Lake North Inlet, Tributary to Sunrise River at Bone Lake South Inlet, Tributary to Sunrise River at Little Comfort Lake Inlet, Tributary to Sunrise River at Shields Outlet/Forest Inlet, Sunrise River at Forest Lake Outlet, Sunrise River at Comfort Lake Inlet, Sunrise River at Comfort Lake Outlet, Forest Lake Subwatershed FL47 Drainage, Forest Lake Subwatershed FL44 Drainage, Forest Lake Subwatershed FL71 Drainage, Bone Lake Subwatershed SBL05 Drainage, Shields Lake Subwatershed FL61 Drainage, Bone Lake Subwatershed NBL23, Bone Lake, Sylvan/Halfbreed Lake, Shields Lake, Forest Lake (1st or West Basin), Forest Lake (2nd or Middle Basin), Forest Lake (3rd or East Basin), Little Comfort Lake, Big Comfort Lake, Moody Lake, School Lake, Birch Lake

---

At the request of the Comfort Lake Forest Lake Watershed District (CLFLWD), the Washington Conservation District (WCD) conducted:

Continuous discharge and stream water quality monitoring at:
- Tributary to Sunrise River at Bone Lake Outlet (Grab Samples only)
- Tributary to Sunrise River at Bone Lake North Inlet (Grab Samples only)
- Tributary to Sunrise River at Bone Lake South Inlet
- Tributary to Sunrise River at Little Comfort Lake Inlet
- Tributary to Sunrise River at Shields Outlet/Forest Inlet
- Sunrise River at Forest Lake Outlet (Grab Samples only)
- Sunrise River at Comfort Lake Inlet
- Sunrise River at Comfort Lake Outlet (Grab Samples only)

Manual flow measurements and grab sampling at:
- Forest Lake Subwatershed FL47 Drainage
- Forest Lake Subwatershed FL44 Drainage
- Forest Lake Subwatershed FL71 Drainage
- Bone Lake Subwatershed SBL05 Drainage
- Shields Lake Subwatershed FL61 Drainage
- Bone Lake Subwatershed NBL23

Water quality and water level monitoring at:

- Shields Lake
- Big Comfort Lake
- Bone Lake
- Sylvan/Halfbreed (level only)
- Forest Lake (1st or West Basin) (water quality only)
- Forest Lake (2nd or Middle Basin) (water quality only)
- Forest Lake (3rd or East Basin) (water quality only)
- Moody Lake
- School Lake (water quality only)
- Birch Lake (water quality only)

Macrophyte surveys at:

- Bone Lake
- Sylvan/Halfbreed Lake
- Shields Lake
- Forest Lake (1st or West Basin)
- Forest Lake (2nd or Middle Basin)
- Forest Lake (3rd or East Basin)
- Little Comfort Lake
- Big Comfort Lake
- Moody Lake

Bathymetry surveys at:

- School Lake
- Birch Lake

A table of the locations and monitoring types can be found in Table 1. The locations of the monitoring sites can be found in Figure 1. The following report briefly summarizes our methods and results for monitoring conducted from January 1 - December 31, 2006. A complete list of detailed Washington Conservation District water monitoring methods and standard operating procedures can be found at http://www.mnwcd.org/id27.html. This report and the accompanying data will also be provided in an electronic format.

Continuous Stream Monitoring Sites: Tributary to Sunrise River at Bone Lake Outlet, Tributary to Sunrise River at Bone Lake North Inlet, Tributary to Sunrise River at Bone Lake South Inlet, Tributary to Sunrise River at Little Comfort Lake Inlet, Tributary to Sunrise River at Shields Outlet/Forest Inlet, Sunrise River at Forest Lake Outlet, Sunrise River at Comfort Lake Inlet, and Sunrise River at Comfort Lake Outlet.

Continuous stage, velocity, and discharge measurements were taken every 15 minutes at Tributary to Sunrise River at Bone Lake Outlet from May 1-October 30, 2006, at Tributary to Sunrise River at Bone Lake North Inlet from May 1-October 25, 2006, at Tributary to Sunrise River at Bone Lake South Inlet from May 1-October 30, 2006, at Tributary to Sunrise River at Little Comfort Lake Inlet from May 4-October 30, 2006, at Tributary to Sunrise River at Shields Outlet/Forest Inlet from May 2-October 30, 2006, at Sunrise River at Forest Lake Outlet from May 2-October 25, 2006, at Sunrise River at Comfort Lake Inlet from May 2-October 30, 2006, and at Sunrise River at Comfort Lake Outlet from May 2-October 30, 2006. Precipitation data was also continuously collected at each of these sites except at Sunrise River at Forest Lake Outlet and Tributary to Sunrise River at Bone Lake South Inlet.

Staff gages were installed and read at each site. Field stage measurements were taken in the stream channels. Temperature, dissolved oxygen, and transparency tube measurements were also taken. If feasible, stage-discharge relationships were developed at all stream sites. When the area-velocity probe was covered with debris, erroneous velocity readings were given and the stage to discharge relationships were used to calculate discharge. Flow weighted storm event composite samples and/or storm event grab samples; baseflow composite samples and/or baseflow grab samples were collected at all continuous stream monitoring sites. In addition to these samples, E.coli grab samples were also taken at all eight sites. The samples were analyzed by the Metropolitan Council Environmental Services Lab.

Discontinuous Stream Monitoring Sites: Forest Lake Subwatershed FL47 Drainage, Forest Lake Subwatershed FL44 Drainage, Forest Lake Subwatershed FL71 Drainage, Bone Lake Subwatershed SBL05 Drainage, and Shields Lake Subwatershed FL61 Drainage, and Bone Lake Subwatershed NBL23

Periodic manual discharge measurements were taken or attempted throughout the monitoring season at each site. Grab samples were collected concurrently with the discharge measurements for discharge/nutrient correlations to be established. Bone Lake Subwatershed NBL23 discharge measurements and grab sampling were attempted throughout the monitoring season with no success. No water discharged through this location during the season. Due to lack of attainable data at Bone Lake Subwatershed NBL23, Bone Lake Subwatershed NBL19 discharge measurements and grab sampling were also attempted in order to gather data to enhance the understanding of this particular area of drainage to Bone Lake as well with no success due to lack of discharge.

Lake Water Quality Monitoring Sites: Bone Lake, Sylvan/Halfbreed Lake, Shields Lake, Forest Lake (1st or West Basin), Forest Lake (2nd or Middle Basin), Forest Lake (3rd or East Basin), Little Comfort Lake, Big Comfort Lake, Moody Lake, School Lake, and Birch Lake.

The work plan for 2006 included monitoring of ten lakes (Forest Lake 1st, 2nd, and 3rd Basins and Bone Lake monitored by Randy Anhorn at Metropolitan Council Environmental Services and Sylvan/Halfbreed lake to be monitored by Curt Sparks {lake resident and Minnesota Pollution Control Agency Citizen Lake Monitoring Program volunteer}). All lakes were monitored biweekly from April through October except School and Birch Lake (monitored monthly from April through October), and Sylvan/Halfbreed Lake (monitored for secchi transparency only on an available volunteer basis). All lakes were monitored by collecting Secchi transparencies, temperature, and dissolved oxygen profiles. Secchi transparencies are used for general comparisons of water quality across the watershed and for monitoring general water quality trends in a given lake from year to year. Temperature and dissolved oxygen profiles provide information on the in-lake dynamics and how each lake may be functioning each year. All ten lakes had 2-meter surface composite water quality samples taken for analysis of total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a concentrations. All lakes except for School, Birch, and Sylvan/Halfbreed Lake had subsurface hypolimnion samples collected using a Van Dorn horizontal water quality sampler. The hypolimnion samples were analyzed for total phosphorus, dissolved ortho-phosphate, and total iron. Bone Lake and Forest 1st, 2nd, and 3rd Basins also had 2-meter surface composite water quality samples taken that included the analysis of total chloride ions and dissolved ortho-phosphate, and metalimnion samples of total phosphorus, total Kjeldahl nitrogen,, and dissolved ortho-phosphate. Zooplankton tows were conducted using a Wisconsin style 80-μm plankton net for analysis on Bone Lake, Shields Lake, and Forest 1st, 2nd, and 3rd Basins.

Lake Macrophyte Surveys: Bone Lake, Sylvan/Halfbreed Lake, Shields Lake, Forest Lake (1st or West Basin), Forest Lake (2nd or Middle Basin), Forest Lake (3rd or East Basin), Little Comfort Lake, Big Comfort Lake, and Moody Lake

Spring and Fall macrophyte (aquatic plant) surveys were conducted on the lakes listed above. Survey transects were developed using aerial mapping, GIS (Geographic Information Systems), and GPS (Global Positioning System) technology. Surveys were conducted using a self-designed grappling hook and metal rake along each transect for plant collection. Plants were identified and a general estimate of density was made on each transect.

Lake Bathymetry Surveys: School Lake, Birch Lake

A bathymetric survey was conducted on both School Lake and Birch Lake in the fall of the 2006 monitoring season. Survey points were developed using GIS and aerial photography. To conduct the survey, the team moved to the approximate locations plotted, and then using a GPS, points were marked and depths to the bottom of the lake were measured at each location. Once all points had been located, surveyed, and marked on the GPS, data was brought to the office for analysis. Analysis involved utilizing GIS to plot the GPS points and associated depths at each point. Once in GIS, the software was able to interpolate contour lines between matching depths in order to provide an approximate model of the depth structure of Birch Lake and School Lake (Figure 56 and Figure 62 respectively).

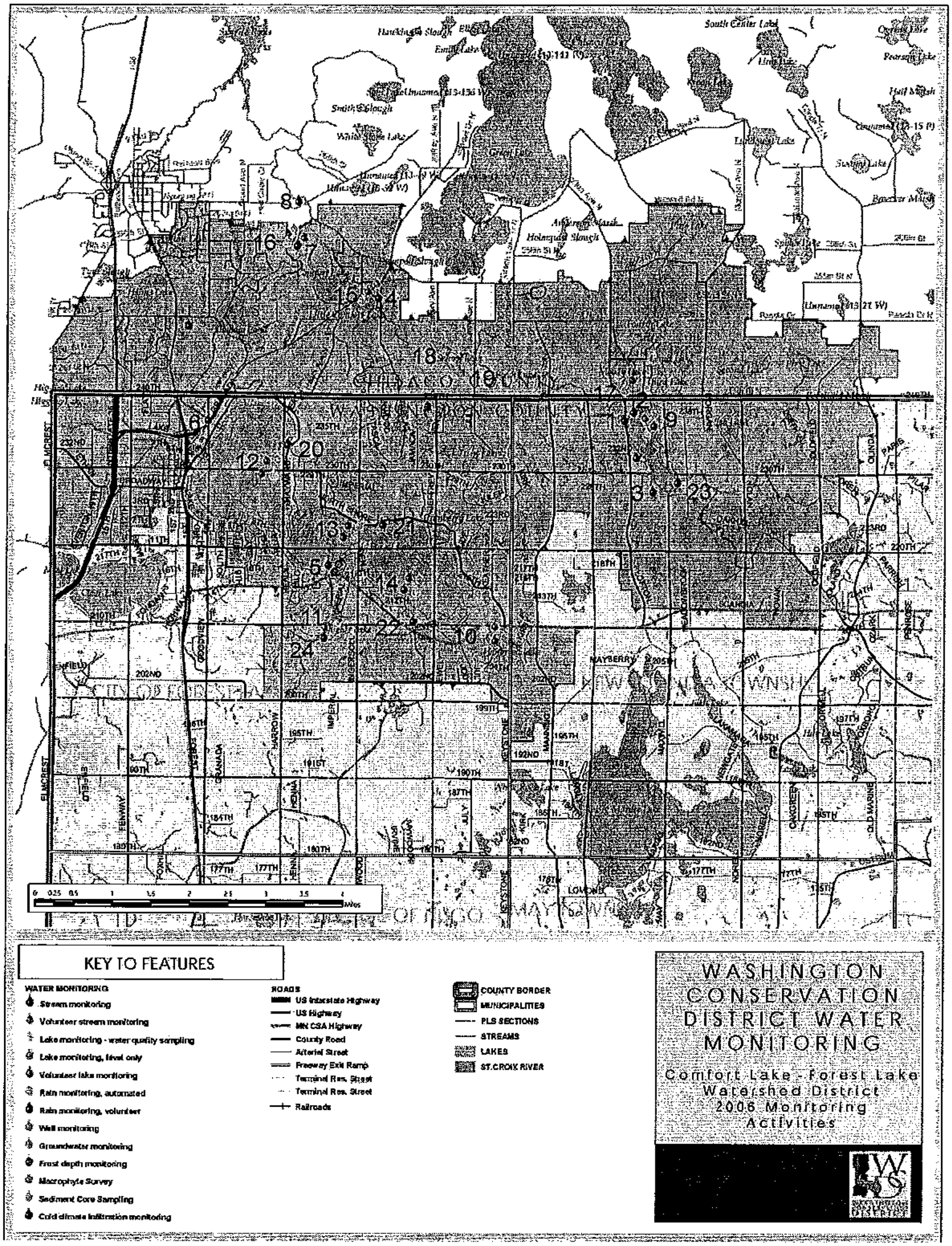


Figure 1. CLFLWD Monitoring Locations

Table 1. Monitoring Site Location and Description Summary

Site Description	Map Site ID#	Full Site Name	Summarized Site Name	General Site Location	Monitoring Site Description	Monitored Parameters*
Stream Monitoring	1	Tributary to Sunrise River at Bone Lake Outlet	Bone Lake Outlet	Lofton Avenue	Flow Monitoring Through Culvert	Discharge and Water Quality Grab Samples
Stream Monitoring	2	Tributary to Sunrise River at Bone Lake North Inlet	Bone Lake Inlet	238th St.	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Grab Samples
Stream Monitoring	3	Tributary to Sunrise River at Bone Lake South Inlet	Bone Lake South Inlet	228th St.	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Composite Samples
Stream Monitoring	4	Tributary to Sunrise River at Little Comfort Lake Inlet	Little Comfort Lake Inlet	Itasca Avenue	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Composite Samples
Stream Monitoring	5	Tributary to Sunrise River at Shields Outlet/Forest Inlet	Shields Lake Outlet	Hwy 97	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Composite Samples
Stream Monitoring	6	Sunrise River at Forest Lake Outlet	Forest Lake Outlet	North Shore Drive	Flow Monitoring in Natural Cross-Section	Discharge and Water Quality Grab Samples
Stream Monitoring	7	Sunrise River at Comfort Lake Inlet	Comfort Lake Inlet	West Comfort Drive	Flow Monitoring Through Culvert	Discharge and Water Quality Composite Samples
Stream Monitoring	8	Sunrise River at Comfort Lake Outlet	Comfort Lake Outlet	Wyoming Trail	Flow Measurements in Natural Cross-Section	Discharge and Water Quality Grab Samples
Stream Monitoring	9**	Forest Lake Subwatershed FL47 Drainage	--	North Shore Drive	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples
Stream Monitoring	10**	Forest Lake Subwatershed FL44 Drainage	--	North Shore Drive	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples
Stream Monitoring	11**	Forest Lake Subwatershed FL71 Drainage	--	Hwy 97	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples
Stream Monitoring	12**	Bone Lake Subwatershed SBL05 Drainage	--	Meadowbrook Ave.	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples
Stream Monitoring	13**	Shields Lake Subwatershed FL61 Drainage	--	209th St.	Flow Measurements in Natural Cross-Section	Manual Discharge Measurements and Water Quality Grab Samples
						Monitored Parameters***
Lake Monitoring	9	Bone Lake	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Zooplankton, Elevation, Sediment Core
Lake Monitoring	10	Sylvan/Halfbreed Lake	--	--	Deepest Point Within the Lake	Elevation, Volunteer Secchi Disk, Macrophytes
Lake Monitoring	11	Shields Lake	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Zooplankton, Elevation, Sediment Core
Lake Monitoring	12	Forest Lake (1st or West Basin)	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Zooplankton, Elevation, Sediment Core
Lake Monitoring	13	Forest Lake (2nd or Middle Basin)	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Zooplankton, Elevation, Sediment Core
Lake Monitoring	14	Forest Lake (3rd or East Basin)	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Zooplankton, Elevation, Sediment Core
Lake Monitoring	15	Little Comfort Lake	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Elevation, Sediment Core
Lake Monitoring	16	Big Comfort Lake	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Elevation, Sediment Core
Lake Monitoring	17	Moody Lake	--	--	Deepest Point Within the Lake	Surface/Hypolimnion Water Quality Samples, Macrophytes, Elevation, Sediment Core
Lake Monitoring	18	School Lake	--	--	Deepest Point Within the Lake	Lake Water Quality Samples, Macrophytes, Zooplankton, Bathymetry
Lake Monitoring	19	Birch Lake	--	--	Deepest Point Within the Lake	Lake Water Quality Samples, Macrophytes, Zooplankton, Bathymetry

*Stream Monitoring Water Quality Sample Parameters Include: Total Phosphorus, Dissolved Phosphorus, Total Kjeldahl Nitrogen, Nitrate, Nitrite, Ammonia Nitrogen, Total Suspended Solids, Volatile Suspended Solids, Total Organic Carbon, E. Coli Bacteria

**Site ID# 9-13 Water Quality Sample Parameters Include: Total Phosphorus, Ortho Phosphorus, and Total Kjeldahl Nitrogen only

***Lake Water Quality Sample Parameters Include: Total Kjeldahl Nitrogen, Total Phosphorus, Ortho Phosphorus (hypolimnion only), Total Iron (hypolimnion only), Chlorophyll-a, Secchi Disk Transparency, Temperature, Dissolved Oxygen

Sections Within Report

1) Summary of 2006 Lake Water Quality

2) Bone Lake Subwatershed

- Stream Monitoring
  a. Bone Lake North Inlet
  b. Bone Lake South Inlet
  c. Bone Lake Outlet
  d. Bone Lake Subwatershed Drainage Monitoring
- Lake Monitoring
  a. Bone Lake
  b. Moody Lake
  c. Bone Lake Macrophyte Survey
  d. Moody Lake Macrophyte Survey

3) Little Comfort Lake Subwatershed

- Stream Monitoring
  a. Little Comfort Lake Inlet
- Lake Monitoring
  a. Little Comfort Lake
  b. Little Comfort Lake Macrophyte Survey
  c. Birch Lake
  d. School Lake

4) Sylvan/Halfbreed Subwatershed

- Lake Monitoring
  a. Sylvan/Halfbreed Lake
  b. Sylvan/Halfbreed Lake Macrophyte Survey

5) Forest Lake Subwatershed

- Stream Monitoring
  a. Shields Lake Outlet
  b. Forest Lake Outlet
  c. Forest Lake/Shields Lake Subwatershed Drainage Monitoring
- Lake Monitoring
  a. Forest Lake (1st Basin)
  b. Forest Lake (2nd Basin)
  c. Forest Lake (3rd Basin)
  d. Shields Lake
  e. Forest Lake (1st or West, 2nd or Mid, and 3rd or East Basin) Macrophyte Surveys
  f. Shields Lake Macrophyte Survey

6) Comfort Lake Subwatershed

- Stream Monitoring
  a. Comfort Lake Inlet
  b. Comfort Lake Outlet
- Lake Monitoring
  a. Big Comfort
  b. Big Comfort Lake Macrophyte Survey

7) Historical Lake Water Quality Trends

8) Historical Stream Loading and Discharge Summary

9) 2003-2006 Growing Season (June-September) and Monitored Season Stream Water Quality Diagrams

10) Appendices and References

1) Summary of 2006 Lake Water Quality

1. TRANSPARENCY (SECCHI DISK)

The measurement of depth of light penetration using a Secchi disk gives a simple measure of water transparency, or clarity. It is a possible indication of turbidity in the water, as well as, an indication of the trophic state of the lake. A reduction in water transparency is usually the result of increased turbidity caused by suspended sediments, organic matter, and/or phytoplankton (algae). 2006 average summer water transparency (June 1* – September 30) was calculated for each lake monitored in CLFLWD, and they ranged from 2.8 feet in Moody Lake to 16.1 feet in Sylvan/Halfbreed Lake. The typical range for this ecoregion, the North Central Hardwood Forests, is 4.9 - 10.5 feet (Figure 2). Of the average Secchi disk transparency values observed in 2006, three were less than (poorer than) the average range for this ecoregion, one was greater than (better than) average, and seven were within the average range. The average transparency for lakes sampled in both 2006 and 2005 was 6.1 feet. Forest Lake (2nd Basin), Forest Lake (3rd Basin), and Little Comfort Lake were sampled for the first time in 2006 and averaged 5.3 feet, which decreased the summer Secchi disk average for all lakes to 5.9 feet. Historical transparency data for selected lakes appears in Appendix A.

*For all water quality parameters, samples collected May 30th are included in calculating summer averages.

2. PHOSPHORUS

Phosphorus is a major nutrient involved in eutrophication and is generally associated with the growth of aquatic weeds and algae blooms. Common sources of phosphorus include runoff from agricultural fields, livestock areas, urban areas, lakeshore lawns, and improperly operating septic systems. In most lakes in the Northern Hardwood ecoregion, phosphorous is the least available nutrient; therefore, the concentration of phosphorous controls the extent of algal growth. Algal growth in turn affects the clarity of the water and light penetration. The typical range for surface total phosphorous concentrations in the ecoregion is 0.023 - 0.050 mg/L (Figure 3). Surface total phosphorous concentrations in sampled lakes in CLFLWD range from 0.038 mg/L in Forest Lake (1st and 2nd Basins) to 0.234 mg/L in Shields Lake with a watershed average of 0.087 mg/L. In 2006, no lakes sampled had an average summer surface total phosphorous value less than (better than average) the range for this ecoregion, six lakes had an average summer total phosphorous value greater than (poorer than average) the ecoregion range, and four lakes were within the ecoregion range for average surface total phosphorous. Comparing results from lakes monitored both in 2005 and 2006, average surface summer phosphorous concentrations in 2005 ranged from 0.029 mg/L in Big Comfort Lake to 0.201 mg/L in Shields Lake with a watershed average of 0.104 mg/L; for the same lakes in 2006 the average for the watershed was 0.103 mg/L. In 2005, Sylvan/Halfbreed Lake had the lowest average concentration of 0.019 mg/L, however, water quality samples were not collected in the 2006 monitoring season. Three new lakes were sampled in 2006 (Forest Lake 2nd Basin, Forest Lake 3rd Basin, and Little Comfort Lake) by the CLFLWD and had an average of 0.050 mg/L, which improved the watershed average. High concentrations of surface phosphorus were seen again in 2006 as well as historically in Shields and Moody Lakes, when compared to the rest of the watershed. Projects that would address the sources of phosphorus either in or entering Shields or Moody should be implemented by the CLFLWD in order to better manage the internal and external loads within those subwatersheds. Hypolimnion samples of total phosphorus and ortho-phosphate were also collected and analyzed on eight lakes in 2006, while metalimnion samples were collected on four.

Throughout this report, lake graphs containing surface total phosphorus include a nutrient impairment threshold of 0.040 mg/L for this ecoregion. The Minnesota Pollution Control Agency uses this threshold as a determination of lake impairment for TP, where a minimum of four summertime measurements are collected and twelve total samples is considered ideal for impairment determination. Listing a lake as impaired, in turn, can lead to Total Maximum Daily Loads and nutrient reducing actions and projects.

3. CHLOROPHYLL-*a*

Chlorophyll-*a* is a photosynthetic component found in algae and aquatic plants. It is also an indicator of algal productivity. The 2006 average summer chlorophyll-*a* concentrations ranged from 12.13 µg/L in Big Comfort Lake to 59.39 µg/L in Shields Lake, with a watershed average of 25.95 µg/L. Comparing results from lakes monitored both in 2005 and 2006, average summer chlorophyll-*a* concentrations in 2005 ranged from 15.68 µg/L in Big Comfort to 60.78 µg/L in Shields Lake with a watershed average of 39.50 µg/L; for the same lakes in 2006 the average was 28.15 µg/L. Sylvan/Halfbreed Lake had the lowest average concentration of 3.48 µg/L in 2005, however, water quality samples were not collected on this lake in 2006. Forest Lake (2nd Basin), Forest Lake (3rd Basin), and Little Comfort Lake had an average of 20.83 µg/L in 2006, improving the watershed average. The ecoregion range for chlorophyll-*a* concentration is 5.0-22.0 µg/l (Figure 4). Of the lakes sampled in 2006, four exceeded (poorer than) the ecoregion range for chlorophyll-*a*, six lakes were within the ecoregion values, and no lakes were less than (better than) the ecoregion range.

4. NITROGEN

Nitrogen, much like phosphorus, is a nutrient found naturally in lakes and streams. Several forms of nitrogen are responsible for health problems in young children and pregnant women and increase the rate of lake eutrophication. The concentration of nitrogen (along with phosphorus) can control primary production (the rate of algal growth) and subsequently water quality. Phosphorus is usually thought to become limiting where the total nitrogen to total phosphorus (TN/TP) ratio is 10:1 (Carlson 1992). Therefore, the nutrient controlling water quality in the lakes of the CLFLWD is phosphorous and not nitrogen. In 2006, average summer surface total Kjeldahl nitrogen (TKN) concentrations ranged from 0.88 mg/L in Forest Lake (3rd Basin) to 3.17 mg/L in Shields Lake, with a watershed average of 1.47 mg/L. The ecoregion range for surface TKN is 0.60 – 1.20 mg/L (Figure 5). Of the lakes sampled in 2006, six exceeded (poorer than) the ecoregion range, four lakes were within the ecoregion range, and no lakes were below (better than) the ecoregion range. When comparing lakes monitored in both 2005 and 2006, average summer surface TKN concentrations in 2005 ranged from 0.97 mg/L in Forest (1st Basin) to 2.27 mg/L in Shields, with a watershed average of 1.51 mg/L. The 2006 watershed average was 1.63 mg/L. The three lakes that were sampled for the first time in 2006 had an average of 1.08 mg/L, which helped to decrease the watershed average surface TKN concentration. Hypolimnion samples of TKN were also sampled and analyzed on eight lakes in 2006, while metalimnion samples were collected on four lakes.

5. TEMPERATURE AND DISSOLVED OXYGEN

Temperature and dissolved oxygen profiles were measured when samples were taken. In addition to surface water measurements, temperature and dissolved oxygen was measured at one-meter intervals from the surface to the lake bottom. This data is contained in Appendix C. The data collected enables temperature and dissolved oxygen profiles to be developed. These profiles show the extent of summer stratification and are useful in identifying the thermocline (the layer of water in which the temperature rapidly declines). The thermocline is an important thermal barrier for chemical and biological activity. In lakes with no thermocline present or little stratification, the lake may mix throughout the summer making bottom nutrients available throughout the water column for use by organisms like algae.

6. TOTAL CHLORIDE ION

Chloride ions are naturally present in very small amounts in surface water. The presence of larger amounts of chloride ions in surface water could indicate a point-source location where the chloride is originating. These point sources could include road runoff from spring snowmelts where salts were used to keep roads clear of ice or from septic systems where a water softener has been used. It is important to note that the presence of chloride does not indicate malfunctioning septic systems, as septic systems are not intended to remove chlorides. It can, however, indicate where possible human impact is contributing to higher chloride levels and may need further study to understand the sources completely. Chloride was collected on the three basins of Forest Lake and Bone Lake in 2006. Summer averages ranged from 14.3 mg/L in Bone Lake to 23.2 in Forest (1st Basin) with a watershed average of 20.9 mg/L. The three Forest Lake basin averages were very similar and all lakes sampled had average concentrations higher than the ecoregion range of 4.0-10.0 mg/L for 2006 (Figure 6). Only Bone Lake has total chloride data previous to 2006, and the 2005 average was 8.0 mg/L, lower than the summer average in 2006. Hypolimnion samples of total chloride ion were also collected and analyzed on four lakes in 2006.

7. MACROPHYTES

Macrophytes are aquatic plants, growing in or near water that are emergent, submergent, or floating. Macrophytes are beneficial to lakes because they provide cover for fish and substrate for aquatic invertebrates. They also produce oxygen and recycle nutrients, which assists with overall lake functioning, and provide food for some fish and other wildlife. In addition, the absence of macrophyte may indicate water quality problems as a result of excessive turbidity, herbicides, or salinization. However, an overabundance of macrophytes can result from high nutrient levels and may interfere with lake processes, recreational activities (e.g., swimming, fishing, and boating), and detract from the aesthetic appeal of the lake ecosystem. The presence of exotic species can have the potential for many negative impacts. Invasive species tend to establish themselves earlier than other macrophytes, many times growing substantially in the winter and early spring. Early establishment and growth allows for exotic species to out-compete other native species and establish populations that become too dense for recreational activities and harms general aesthetics. These unwanted plants usually die early in the season and their decay releases large amounts of nutrients, providing for optimum algae growth and possibly algae blooms. Many lakes in the Twin Cities Metro Area have the potential for problems with regards to their macrophyte population: 1) loss of the vegetation as a result of development, 2) transport and invasion of exotic species such as Eurasian water milfoil and Curly-leaf pondweed by anthropogenic sources, 3) decline in water clarity and quality, and 4) switch from a plant dominated system to an algal dominated lake. Having a lake with a relatively undisturbed native plant community can help buffer against these potential problems. It also shows that abundant native aquatic plants serve a valuable role in a healthy lake system. A list of macrophytes and their scientific names present during the spring and fall of 2006 surveys is listed in Table 3. The surveys conducted in 2006 show a direct impact to many of the macrophyte population based on the number of lakes where invasive species were present. Curly-leaf pondweed (an invasive species) was found during the spring survey on all lakes surveyed in CLFLWD and Eurasian water milfoil (an invasive species) was found in high density in Bone Lake. Sylvan/Halfbreed and Forest Lake (3rd Basin) were the only lakes that no invasive species of macrophytes were found in the fall survey. The absence of invasive species in Sylvan/Halfbreed in the fall survey most likely indicates that the lake's large native plant population and diversity assists in controlling the infestation of invasive species. Because Forest Lake (3rd basin) is harvested regularly during the year, it is hard to say whether or not invasive plants would be present during the fall survey period. In general, the lakes surveyed with moderate to high plant diversity, low densities of invasive species, (Table 4 and Table 5), and a population showing a high frequency of submergent plants as well as having both emergent and floating plants present, show the highest water quality in the watershed.

8. PHYTOPLANKTON (ALGAE) AND ZOOPLANKTON

Plankton are often used as indicators of environmental and aquatic health because of their high sensitivity to environmental change and short life span. Phytoplankton are useful indicators of high nutrient conditions due to their tendency to multiply rapidly in favorable conditions. The major environmental factors influencing phytoplankton growth are temperature, light, and nutrient availability. Zooplankton are useful indicators for determining water quality and fisheries health because they are sensitive to changes in their environment, are dependent on phytoplankton populations, and are a source of food for organisms at higher trophic levels. Zooplankton are planktonic animals that range in size from microscopic rotifers to macroscopic jellyfish. The smallest zooplankton can be characterized as recyclers of water-column nutrients and often are closely tied to measures of nutrient enrichment. Larger zooplankton are important food for forage fish species and larval stages of all fish. Zooplankton also link the primary producers (phytoplankton) with larger or higher trophic level organisms. The zooplankton community is composed of both primary consumers, which eat phytoplankton, and secondary consumers, which feed on other zooplankton. In many of the lakes in this region, zooplankton species are grouped by size and feeding habits. Within the zooplankton community, rotifers, copepods, and cladocerans are typically smallest to largest and prey to predator respectively. Large cladocerans may be preyed upon by planktivorous fish and will in turn shift the balance of zooplankton to a dominant population of smaller species. A lake with high populations of rotifers and copepods are an indicator of poor water quality and/or excessive numbers of planktivorous small fish. Of the lakes where zooplankton tows were conducted, zooplankton population data from Shields Lake indicates that planktivorous fish may be controlling the population of the larger zooplankton (Figure 14). From the spring survey to the fall survey, the size of zooplankton changes little, and the population remains small in size. The other lakes in the watershed show less of this top-down control. Larger species of zooplankton are present more often in the remaining lakes and the population is controlled less by the predator and more by resource limitation.

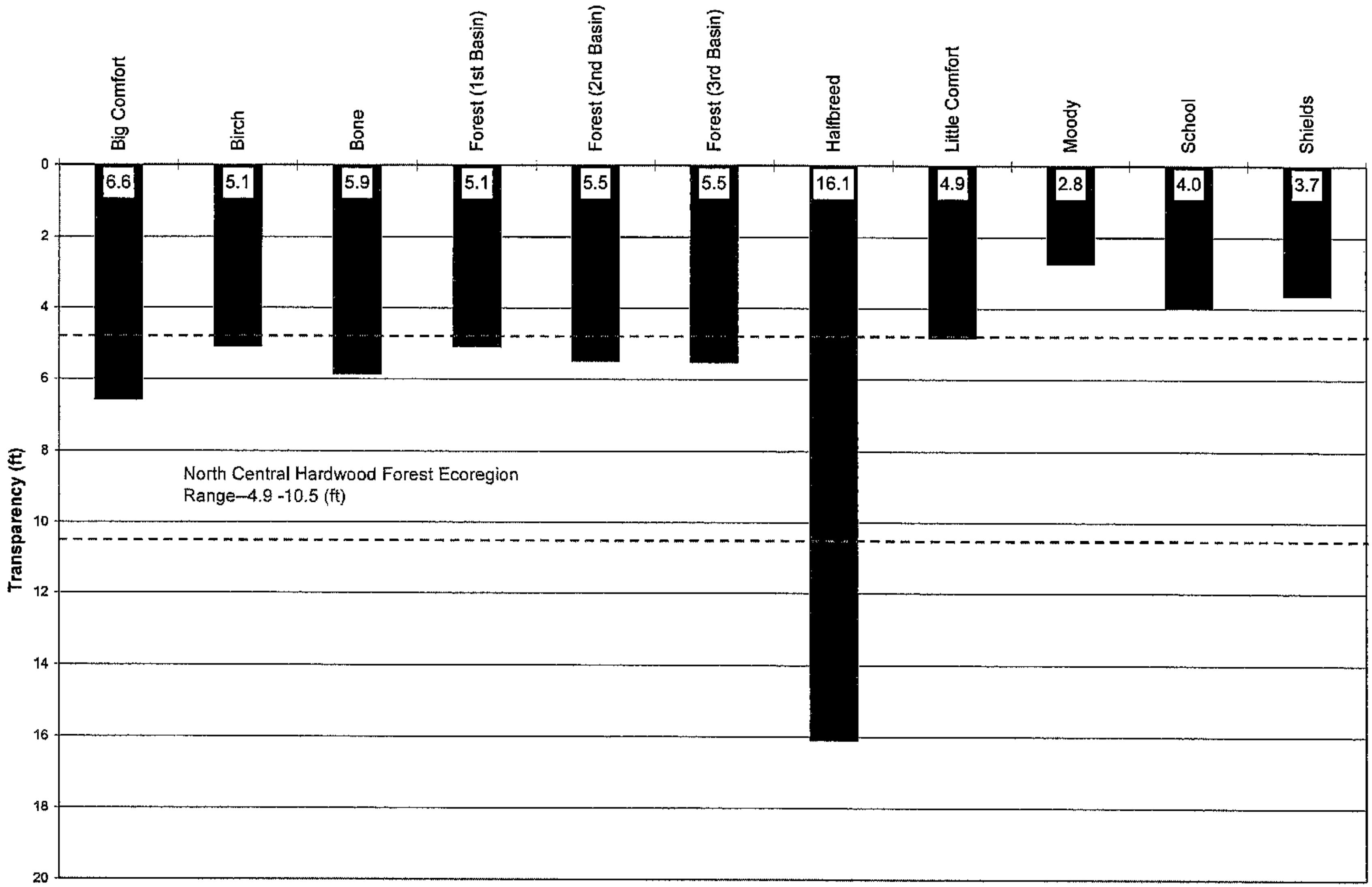


Figure 2. 2006 Average Secchi Transparencies and Ecoregion Range

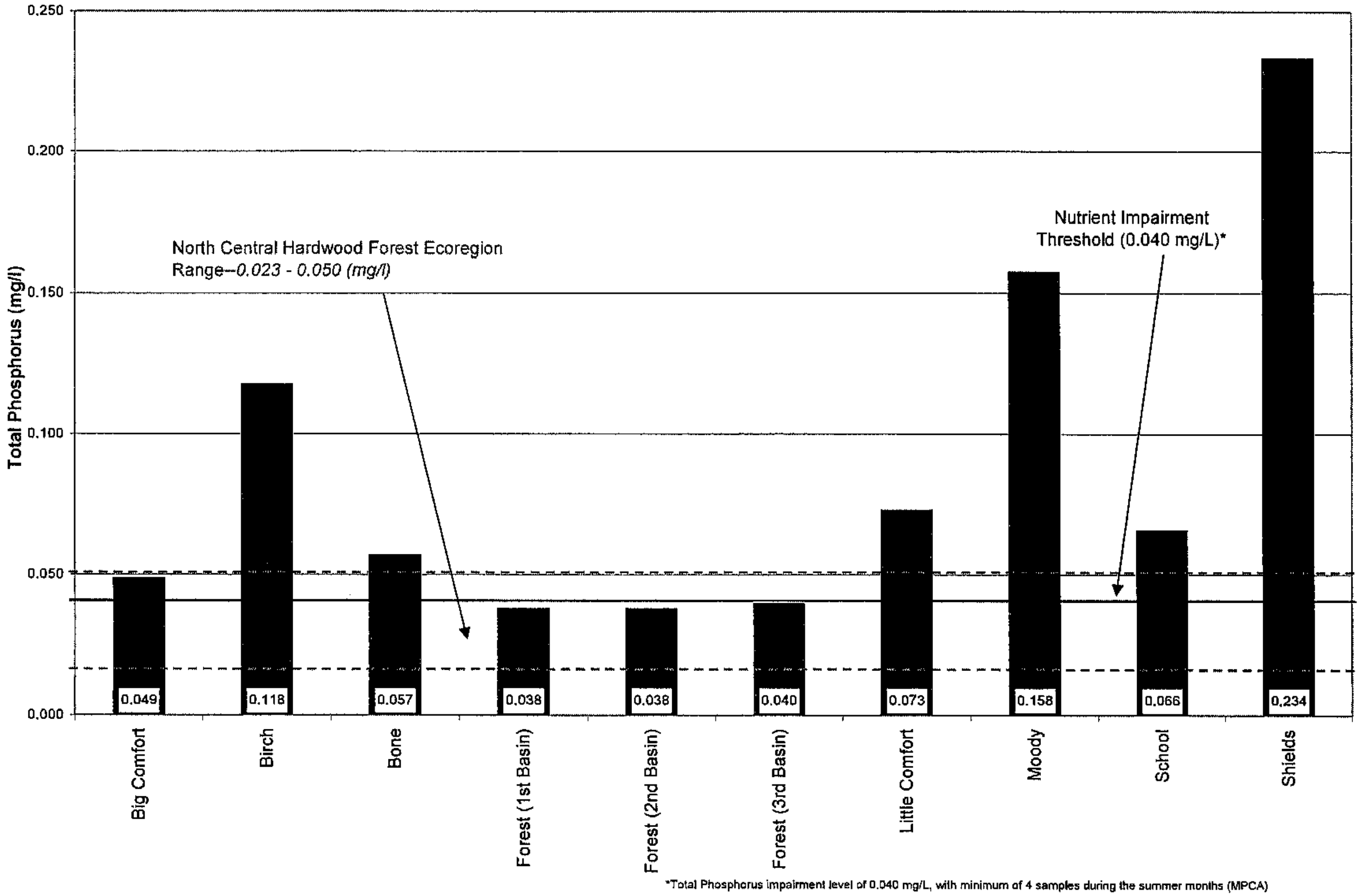


Figure 3. 2006 Average Surface Total Phosphorus, Ecoregion Range, and MPCA Nutrient Impairment Threshold

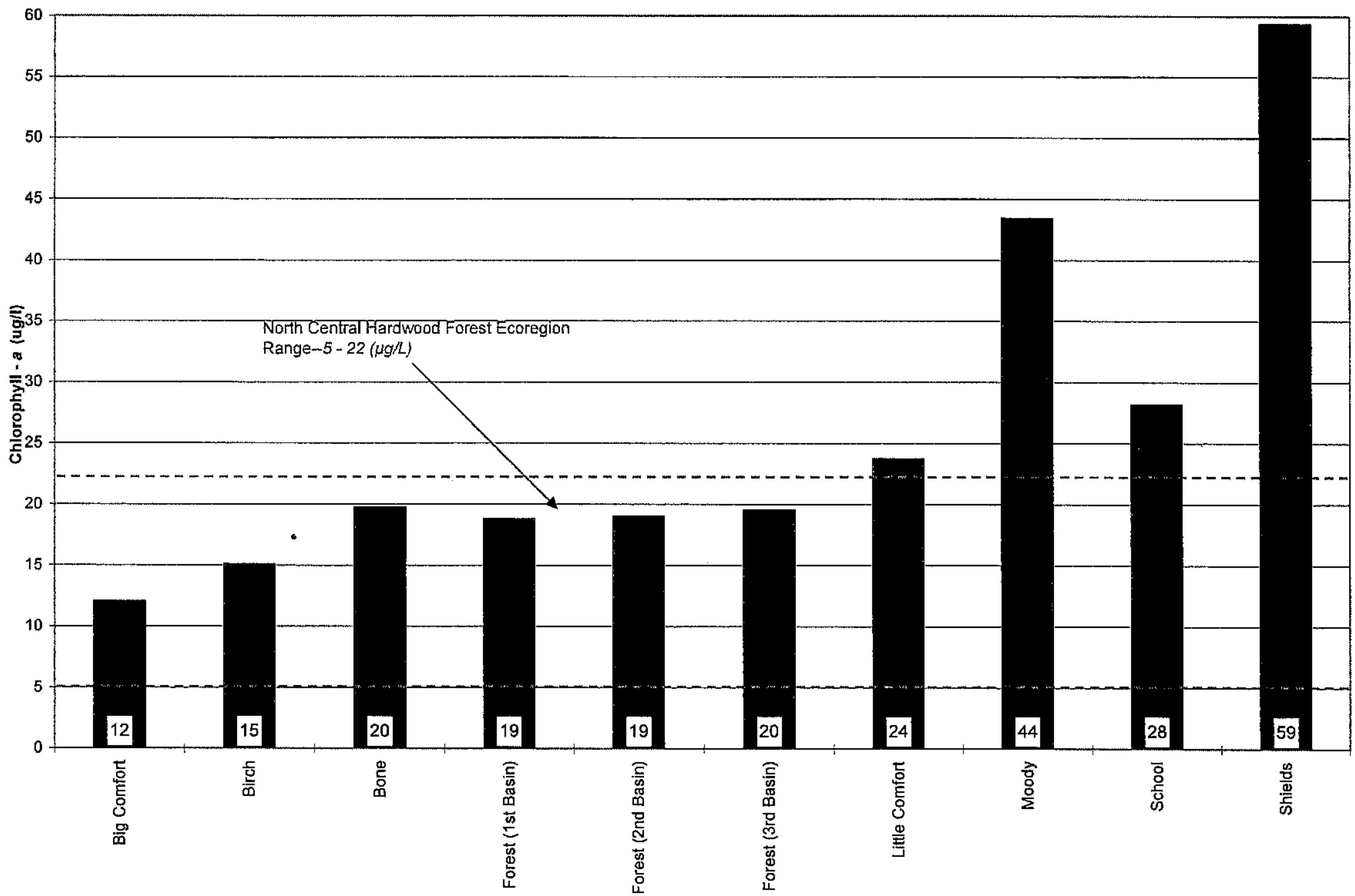


Figure 4. 2006 Average Surface Chlorophyll-*a* and Ecoregion Range

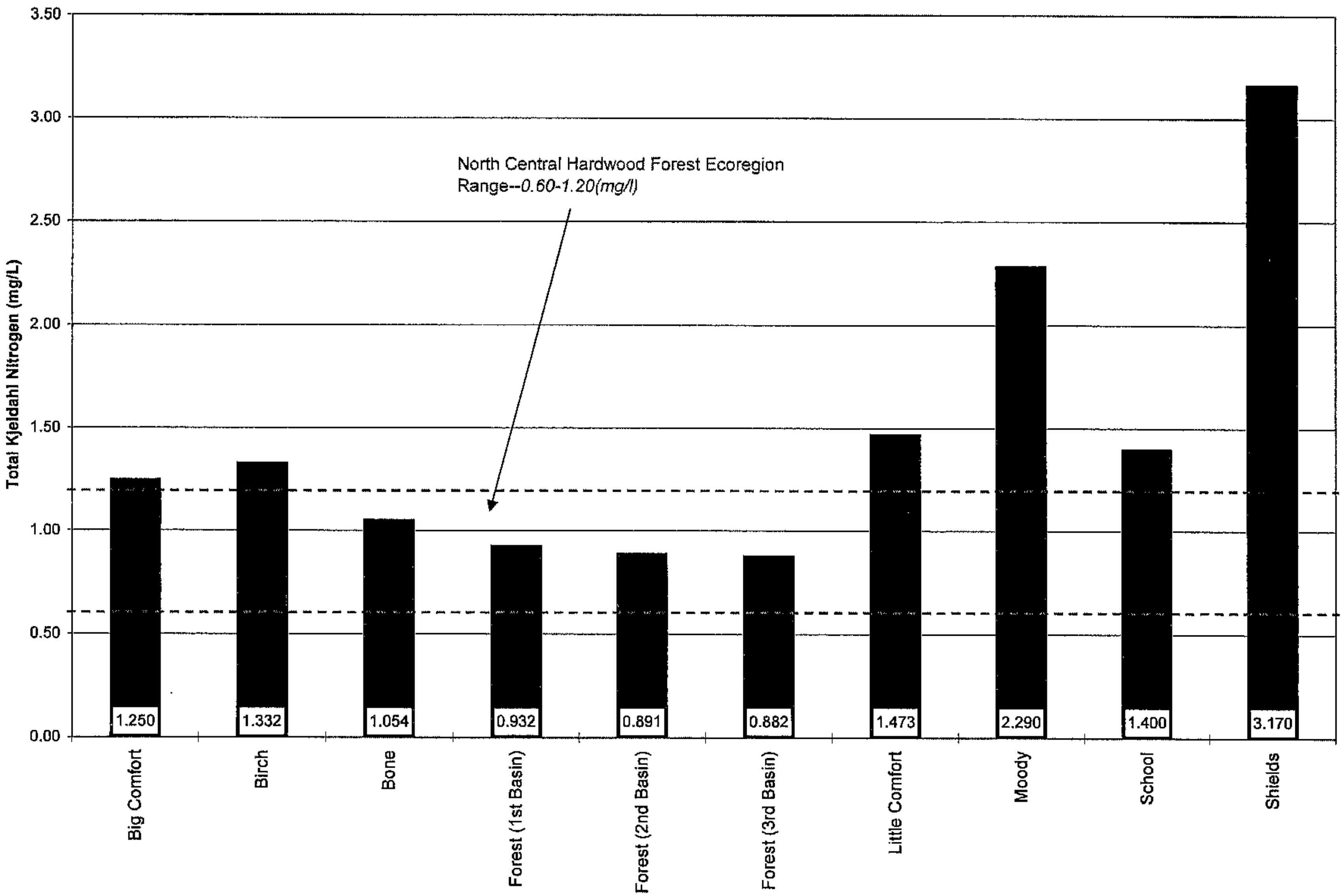


Figure 5. 2006 Average Surface Total Kjeldahl Nitrogen and Ecoregion Range

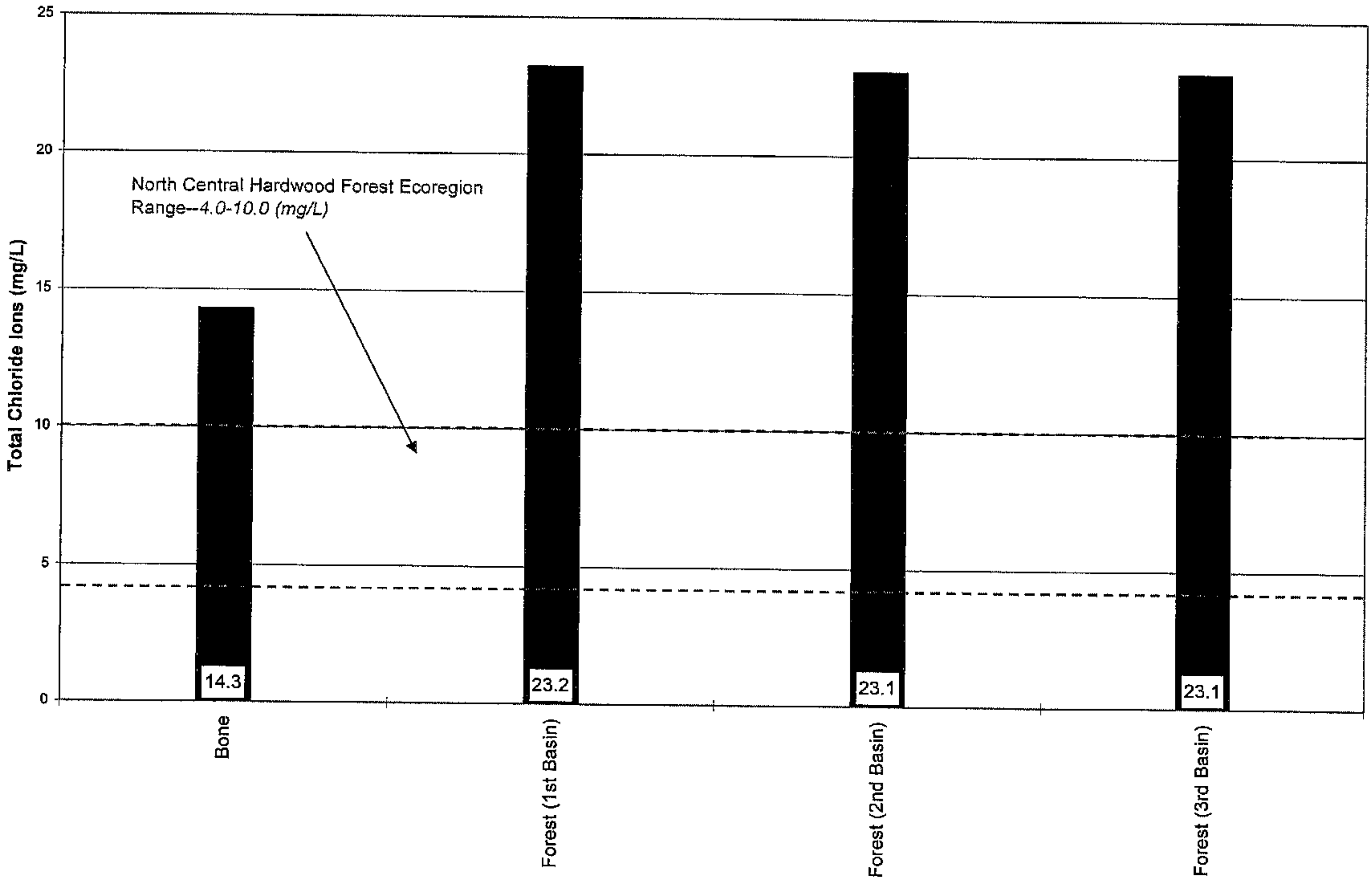


Figure 6. 2006 Average Surface Total Chloride Ions and Ecoregion Range

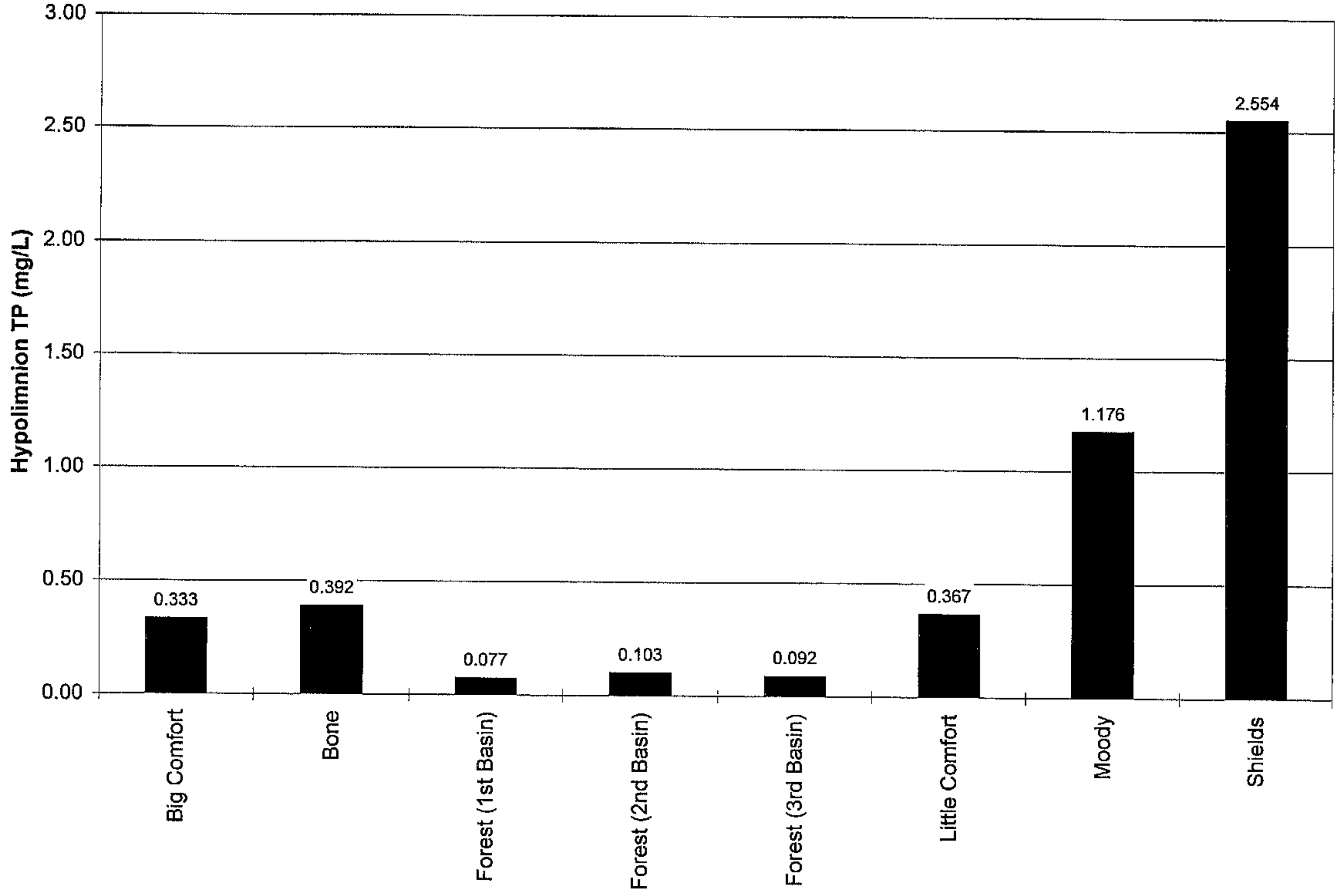


Figure 7. 2006 Average Hypolimnion Total Phosphorus

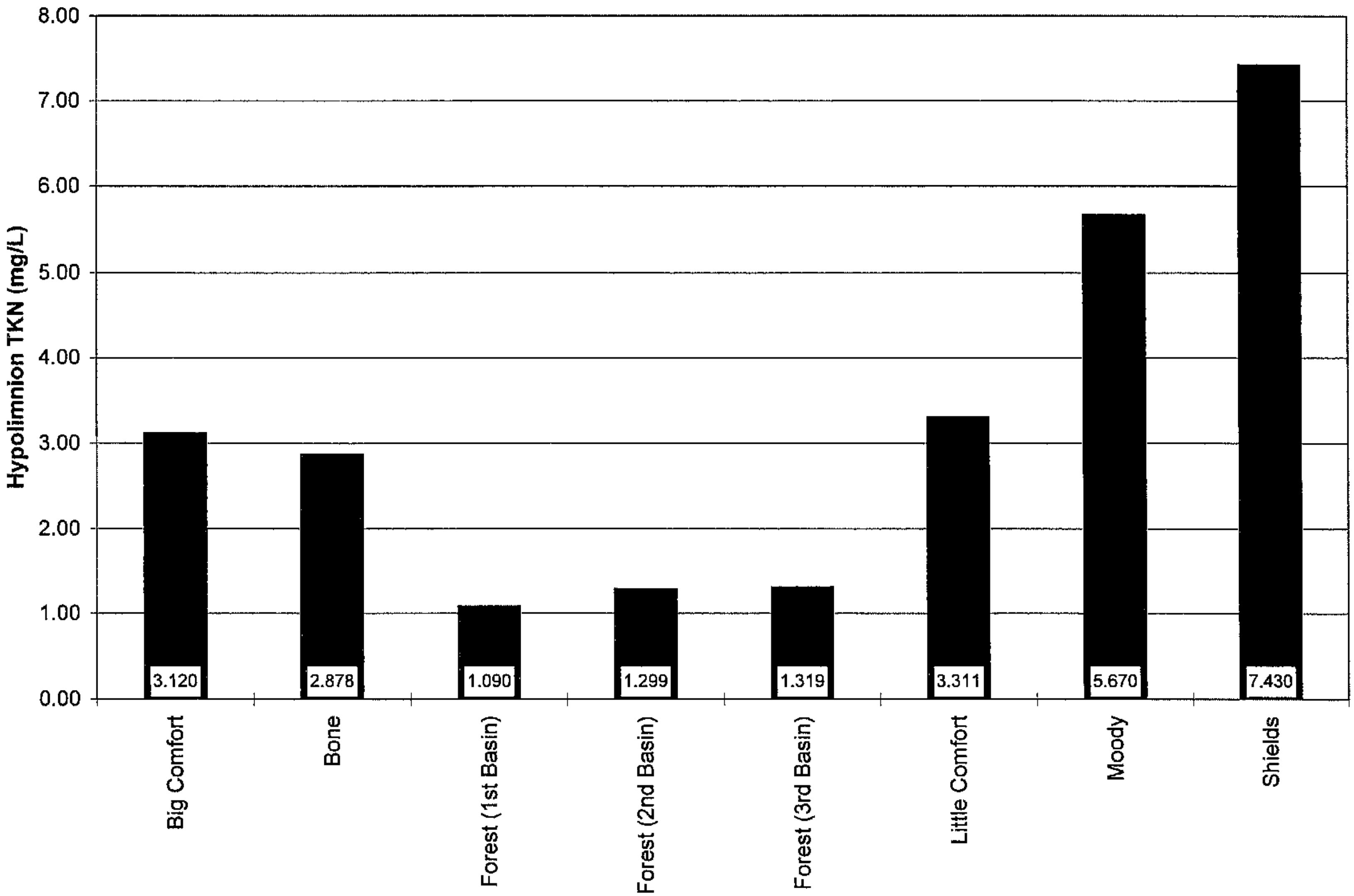


Figure 8. 2006 Average Hypolimnion Total Kjeldahl Nitrogen

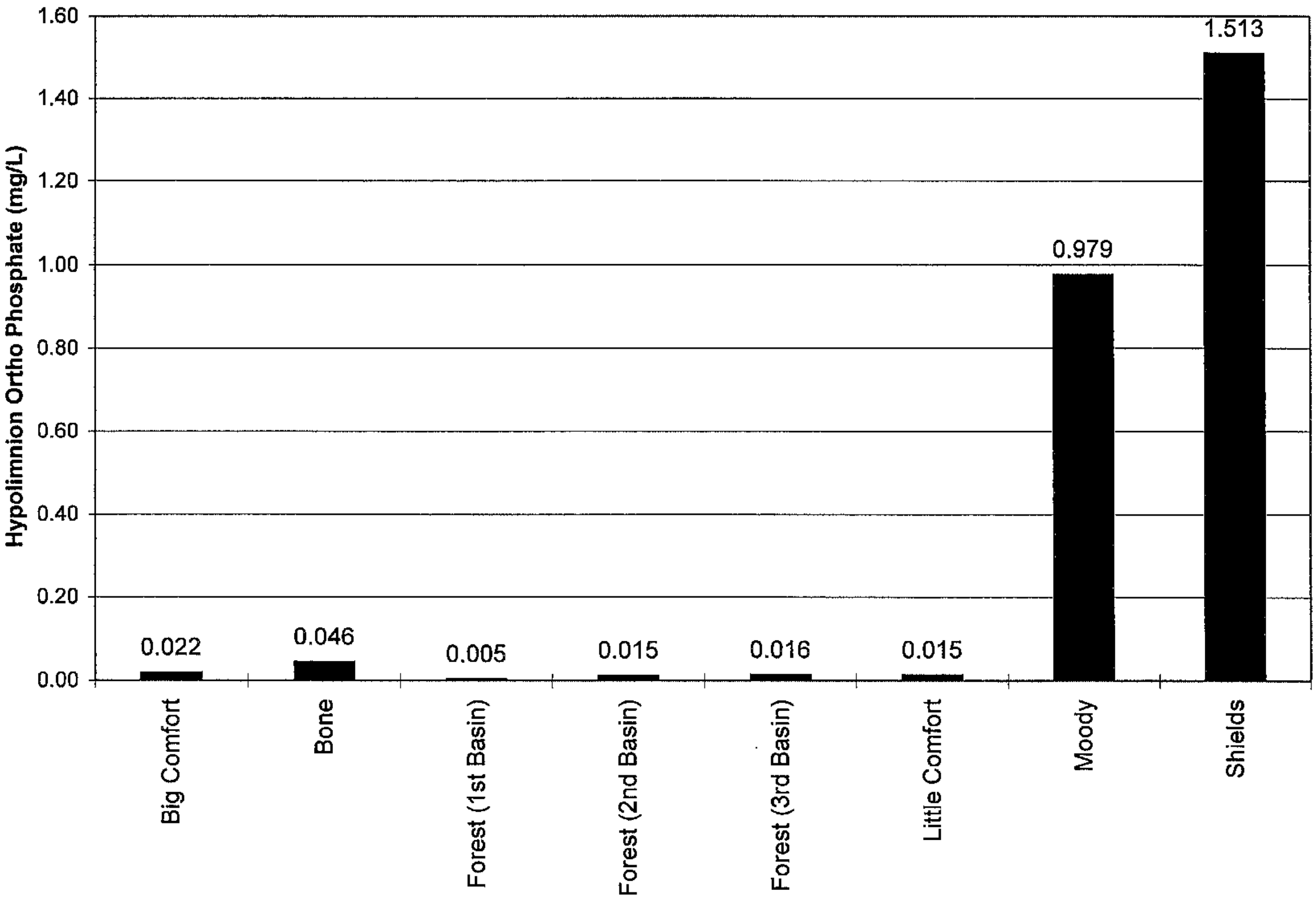


Figure 9. 2006 Average Hypolimnion Ortho-Phosphate

Table 2. 2006 Average Water Quality Results and Ecoregion Ranges

Lake	Surface TP (mg/l)	Chlorophyll-a (ug/l)	Surface TKN (mg/l)	Surface Total Chloride Ions (mg/L)	Hypolimnion TP (mg/L)	Hypolimnion TKN (mg/L)	Hypolimnion Ortho Phosphate (mg/L)	Secchi Disk (feet)	Secchi Disk (meters)
Eco-Region Value	*0.023-0.050*	*5-22*	*0.600-1.200*	*4.0-10.0*	--	--	--	*4.9-10.5*	*1.50-3.20*
Big Comfort	0.049	12	1.250		0.333	3.120	0.022	6.6	2.01
Birch	0.118	15	1.332					5.1	1.55
Bone	0.057	20	1.054	14.3	0.392	2.878	0.046	5.9	1.79
Forest (1st Basin)	0.038	19	0.932	23.2	0.077	1.090	0.005	5.1	1.56
Forest (2nd Basin)	0.038	19	0.891	23.1	0.103	1.299	0.015	5.5	1.68
Forest (3rd Basin)	0.040	20	0.882	23.1	0.092	1.319	0.016	5.5	1.69
Halfbreed								16.1	4.91
Little Comfort	0.073	24	1.473		0.367	3.311	0.015	4.9	1.48
Moody	0.158	44	2.290		1.176	5.670	0.979	2.8	0.84
School	0.066	28	1.400					4.0	1.22
Shields	0.234	59	3.170		2.554	7.430	1.513	3.7	1.11

Table 3. Common Names and Associated Scientific Names for Macrophytes Present in CLFLWD Lakes

Observed Aquatic Plant Common Names	Scientific Name	Emergent, Floating, Submergent	Native/Invasive
Sedge	Carex sp.	Emergent	Native
Creeping Spikerush	Eleocharis palustris	Emergent	Native
Northern Blue Flag	Iris versicolor	Emergent	Native
Softstem Bulrush	Scirpus validus	Emergent	Native
Hardstem Bulrush	Scirpus acutus	Emergent	Native
Three-Square Bulrush	Scirpus americanus	Emergent	Native
River Bulrush	Scirpus fluviatilis	Emergent	Native
Cattail	Typha sp.	Emergent	Native
Stiff Arrowhead	Sagittaria rigida	Emergent	Native
Reed Canary Grass	Phalaris arundinacea	Emergent	Invasive
Marsh Milkweed	Asclepias incarnata	Emergent	Native
Duckweed	Lemna sp., Spirodela sp.	Floating	Native
Forked Duckweed	Lemna trisulca	Floating	Native
Watershield	Brasenia schreberi	Floating	Native
Yellow Pond Lily	Nuphar advena	Floating	Native
Spatterdock	Nuphar variegata	Floating	Native
White Water Lily	Nymphaea odorata	Floating	Native
Water Smartweed	Polygonum amphibium	Floating	Native
Chara	Chara sp.	Submersed	Native
Common Waterweed	Elodea canadensis	Submersed	Native
Bushy Pondweed	Najas flexilis	Submersed	Native
Large Leaf Pondweed	Potamogeton amplifolius	Submersed	Native
Curlyleaf Pondweed	Potamogeton crispus	Submersed	Invasive
Leafy Pondweed	Potamogeton foliosus	Submersed	Native
Variable Pondweed	Potamogeton gramineus	Submersed	Native
Illinois Pondweed	Potamogeton illinoensis	Submersed	Native
Floating Leaf Pondweed	Potamogeton natans	Submersed	Native
Sago Pondweed	Potamogeton pectinatus	Submersed	Native
White Stem Pondweed	Potamogeton praelongus	Submersed	Native
Clasping Leaf Pondweed	Potamogeton richardsonii	Submersed	Native
Flatstem Pondweed	Potamogeton zosteriformis	Submersed	Native
Wild Celery	Vallisneria americana	Submersed	Native
Water Stargrass	Zosterella dubia	Submersed	Native
Water Marigold	Bidens beckii	Submersed	Native
Coontail	Ceratophyllum demersum	Submersed	Native
Northern Water milfoil	Myriophyllum sibiricum	Submersed	Native
Eurasian Water milfoil	Myriophyllum spicatum	Submersed	Invasive
Stiff Water Crowfoot	Ranunculus longirostris	Submersed	Native
Creeping Bladderwort	Utricularia gibba	Submersed	Native
Common Bladderwort	Utricularia vulgaris	Submersed	Native

Table 4. Spring and Fall Macrophyte Survey Transect Plant Presence and Plant Diversity Observations at Lakes within CLFLWD

	Spring Survey Transect Aquatic Plant Presence					Percent Aquatic Plant Presence per Lake				
	Emergent	Floating	Submersed	Invasive	Total Transects	% Emergent	% Floating	% Submersed	% Invasive	General Aquatic Plant Diversity Observation*
Bone Lake	0	12	24	20	24	0%	50%	100%	83%	Moderate
Shields Lake	0	1	6	6	6	0%	17%	100%	100%	Low
Forest (1st Basin) Lake	4	7	13	9	13	31%	54%	100%	69%	Moderate
Forest (2nd Basin) Lake	1	4	11	9	11	9%	36%	100%	82%	High
Forest (3rd Basin) Lake	4	7	22	15	22	18%	32%	100%	68%	High
Big Comfort Lake	13	17	18	15	18	72%	94%	100%	83%	Moderate
Little Comfort Lake	9	11	12	12	12	75%	92%	100%	100%	Moderate
Moody Lake	9	7	9	4	9	100%	78%	100%	44%	Low
Halfbreed Lake	5	10	10	4	11	45%	91%	91%	36%	High
	Fall Survey Transect Aquatic Plant Presence					Percent Aquatic Plant Presence per Lake				
	Emergent	Floating	Submersed	Invasive	Total Transects	% Emergent	% Floating	% Submersed	% Invasive	General Aquatic Plant Diversity Observation*
Bone Lake	0	20	24	24	24	0%	83%	100%	100%	Moderate
Shields Lake	6	6	4	2	6	100%	100%	67%	33%	Low
Forest (1st Basin) Lake	6	6	13	1	13	46%	46%	100%	8%	Moderate
Forest (2nd Basin) Lake	3	2	11	1	11	27%	18%	100%	9%	High
Forest (3rd Basin) Lake	5	2	19	0	22	23%	9%	86%	0%	High
Big Comfort Lake	14	17	13	4	18	78%	94%	72%	22%	Moderate
Little Comfort Lake	10	12	12	1	12	83%	100%	100%	8%	Low
Moody Lake	9	0	7	6	9	100%	0%	78%	67%	Low
Halfbreed Lake	7	11	11	0	11	64%	100%	100%	0%	High

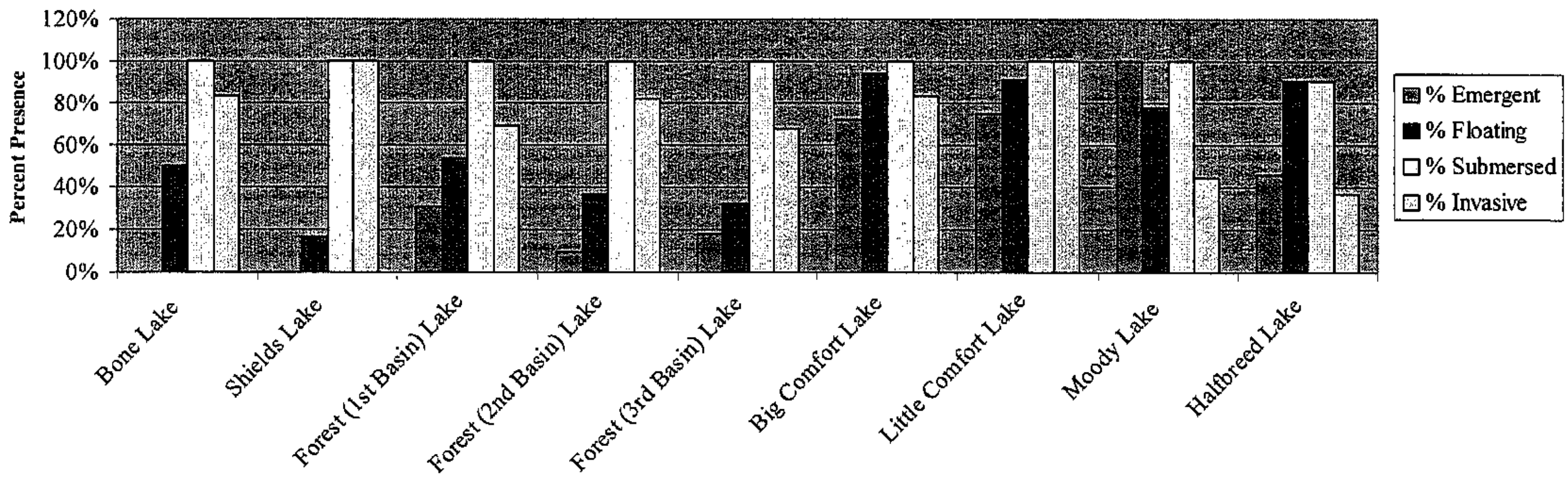
*This general observation categorizes plant diversity into 3 diversity groups: Low (1-4 Species), Moderate (5-8 species), and High (9+ species)

Table 5. Spring and Fall Macrophyte Survey Plant Diversity and Invasive Species Observations

	Spring Survey		
	General Aquatic Plant Diversity Observation*	Number of Invasive Aquatic Species Present	Invasive Aquatic Species Present
Bone Lake	Moderate	2	Eurasian Water Milfoil, Curlyleaf Pondweed
Shields Lake	Low	1	Curlyleaf Pondweed
Forest (1st Basin) Lake	Moderate	1	Curlyleaf Pondweed
Forest (2nd Basin) Lake	High	1	Curlyleaf Pondweed
Forest (3rd Basin) Lake	High	1	Curlyleaf Pondweed
Big Comfort Lake	Moderate	1	Curlyleaf Pondweed
Little Comfort Lake	Moderate	1	Curlyleaf Pondweed
Moody Lake	Low	1	Curlyleaf Pondweed
Halfbreed Lake	High	1	Curlyleaf Pondweed
	Fall Survey		
	General Aquatic Plant Diversity Observation*	Number of Invasive Species Present	Invasive Species Present
Bone Lake	Moderate	2	Eurasian Water Milfoil, Curlyleaf Pondweed
Shields Lake	Low	1	Curlyleaf Pondweed
Forest (1st Basin) Lake	Moderate	1	Curlyleaf Pondweed
Forest (2nd Basin) Lake	High	1	Curlyleaf Pondweed
Forest (3rd Basin) Lake	High	0	NA
Big Comfort Lake	Moderate	1	Curlyleaf Pondweed
Little Comfort Lake	Low	1	Curlyleaf Pondweed
Moody Lake	Low	2	Curlyleaf Pondweed, Reed Canary Grass**
Halfbreed Lake	High	0	NA

*This general observation categorizes plant diversity into 3 diversity groups: Low (1-4 Species), Moderate (5-8 species), and High (9+ species)
**It is likely that reed canary grass was present during spring survey, but was not recorded

Spring Survey Percent Aquatic Plant Presence at All Transects per Lake



Fall Survey Percent Aquatic Plant Presence at All Transects per Lake

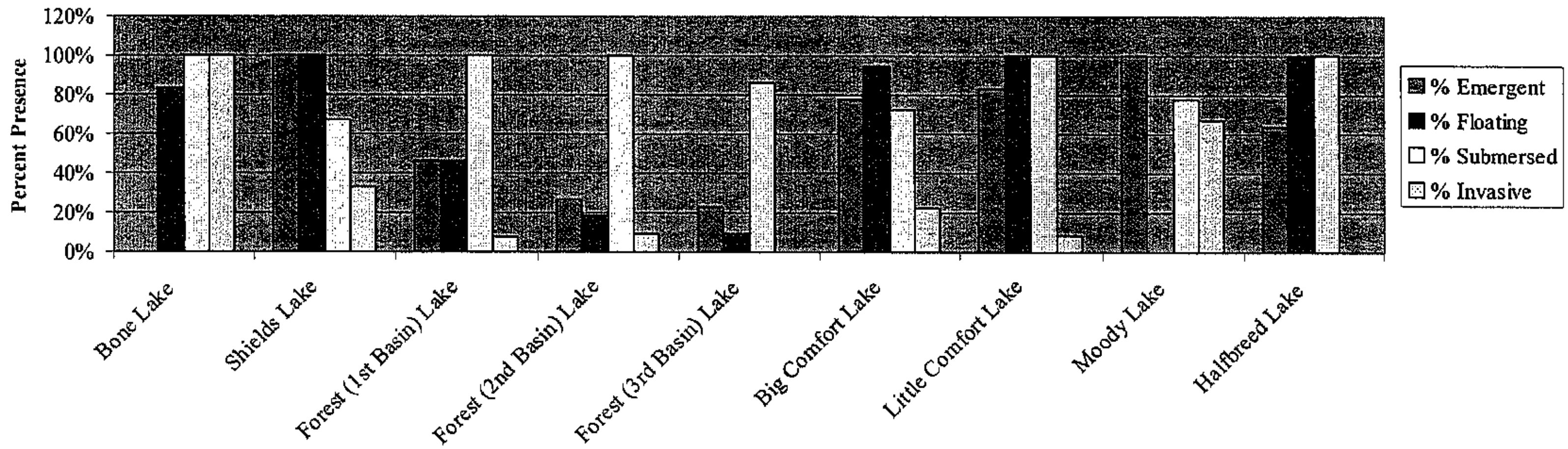


Figure 10. Spring and Fall Macrophyte Survey Transect Plant Presence at Lakes within CLFLWD

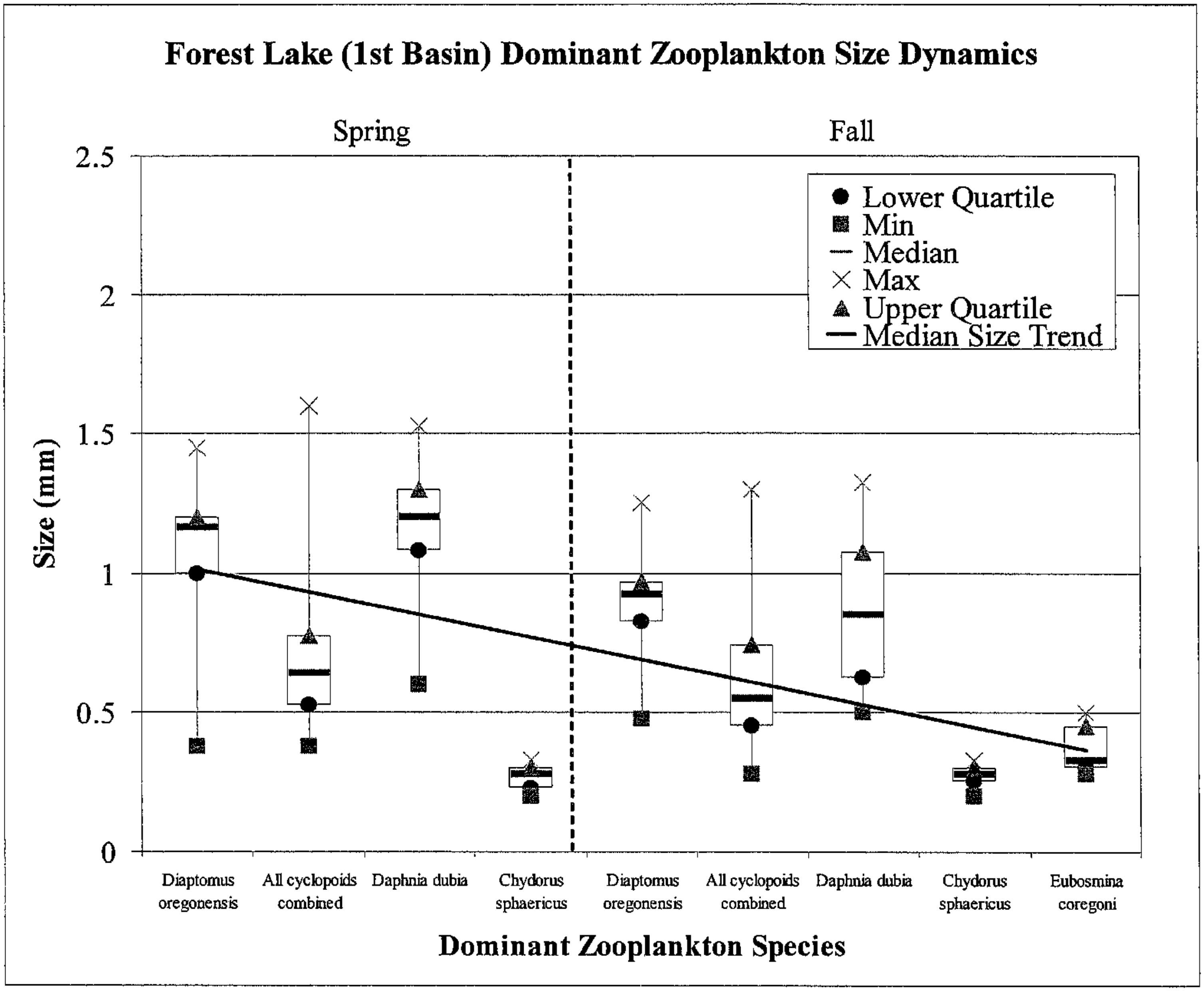


Figure 11. Forest Lake (1st Basin) Dominant Zooplankton Species Size Dynamics

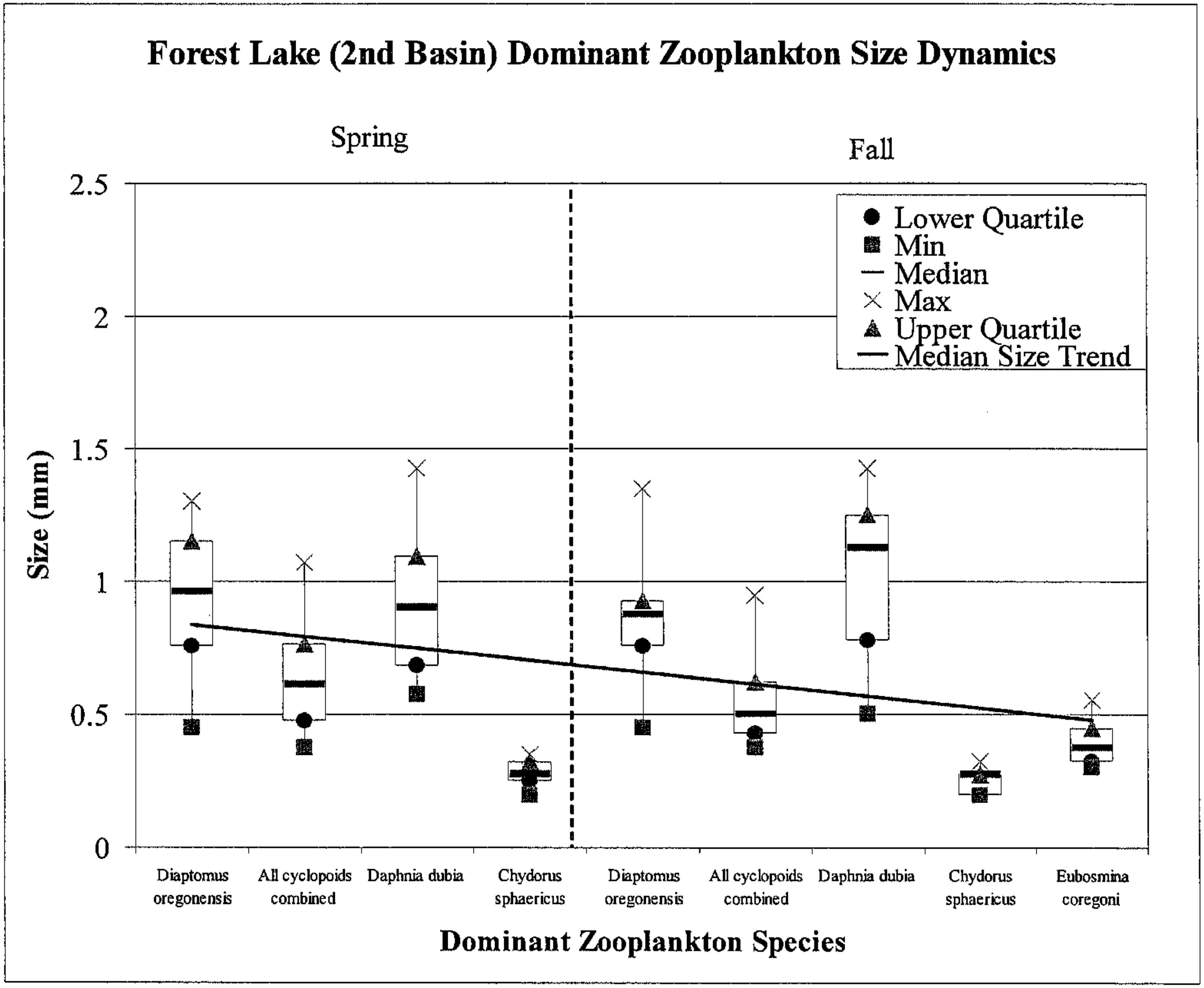


Figure 12. Forest Lake (2nd Basin) Dominant Zooplankton Species Size Dynamics

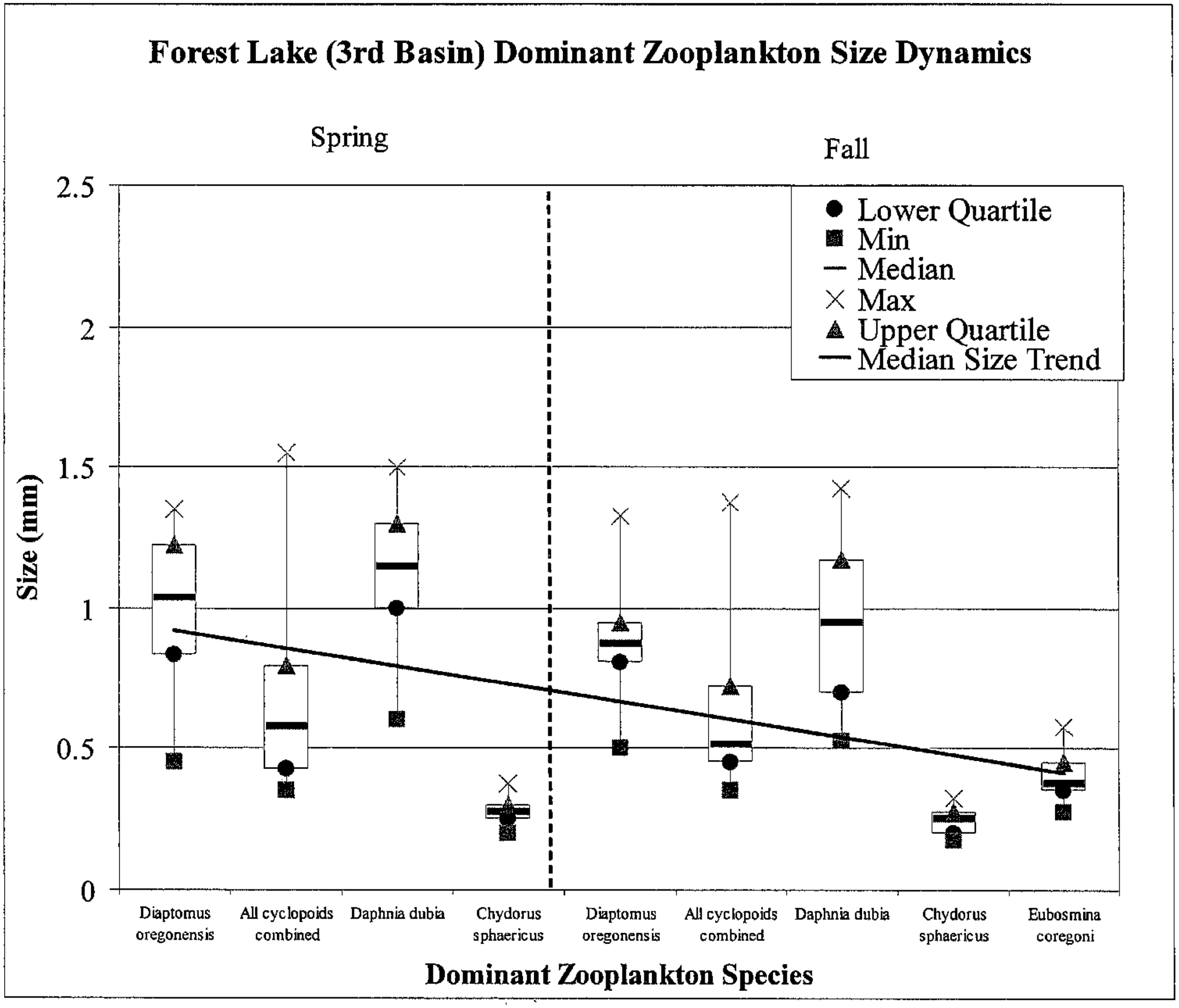


Figure 13. Forest Lake (3rd Basin) Dominant Zooplankton Species Size Dynamics

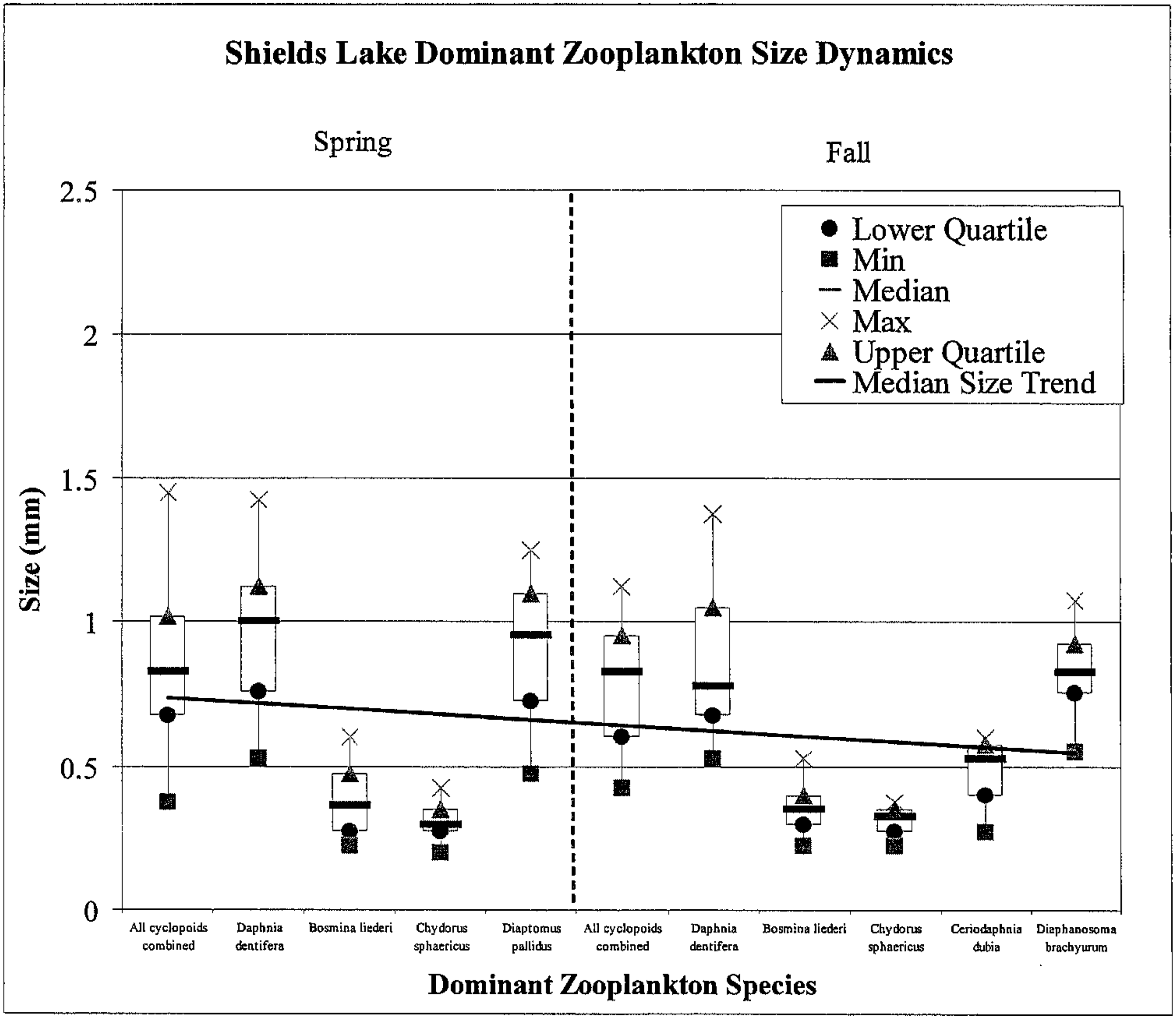


Figure 14. Shields Lake Dominant Zooplankton Species Size Dynamics

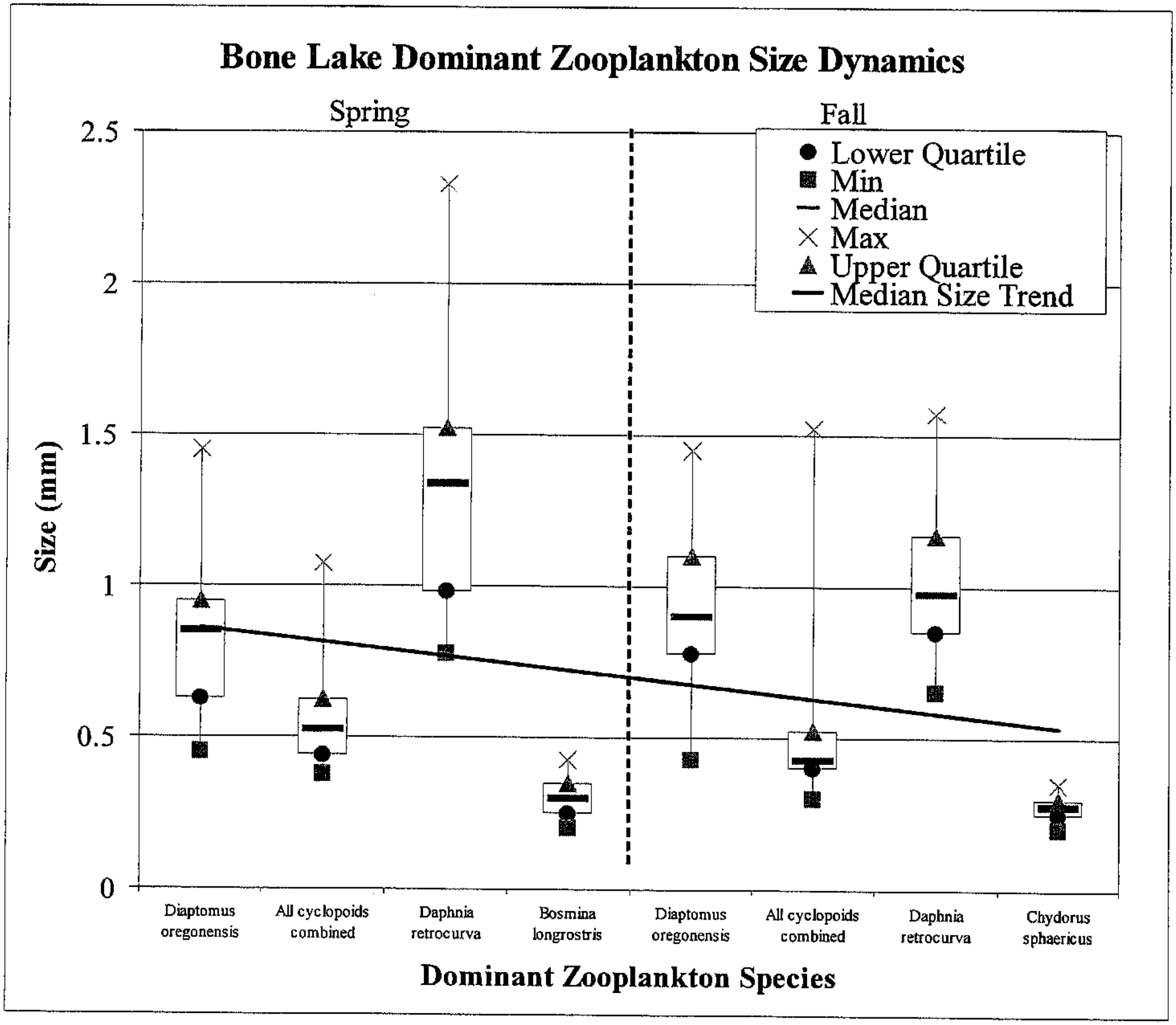


Figure 15. Bone Lake Dominant Zooplankton Species Size Dynamics

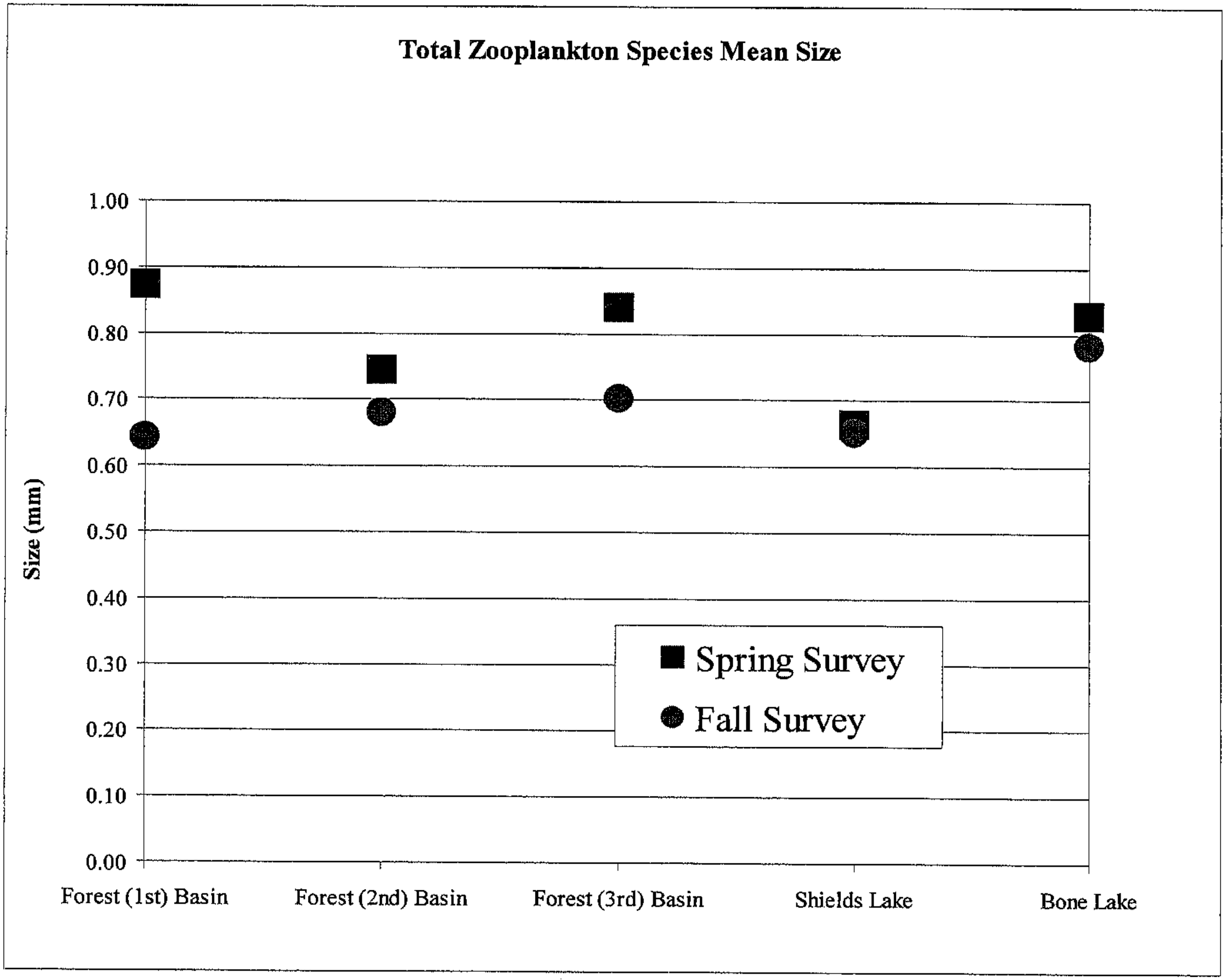


Figure 16. CLFLWD Total Dominant Zooplankton Species Mean Size Per Lake