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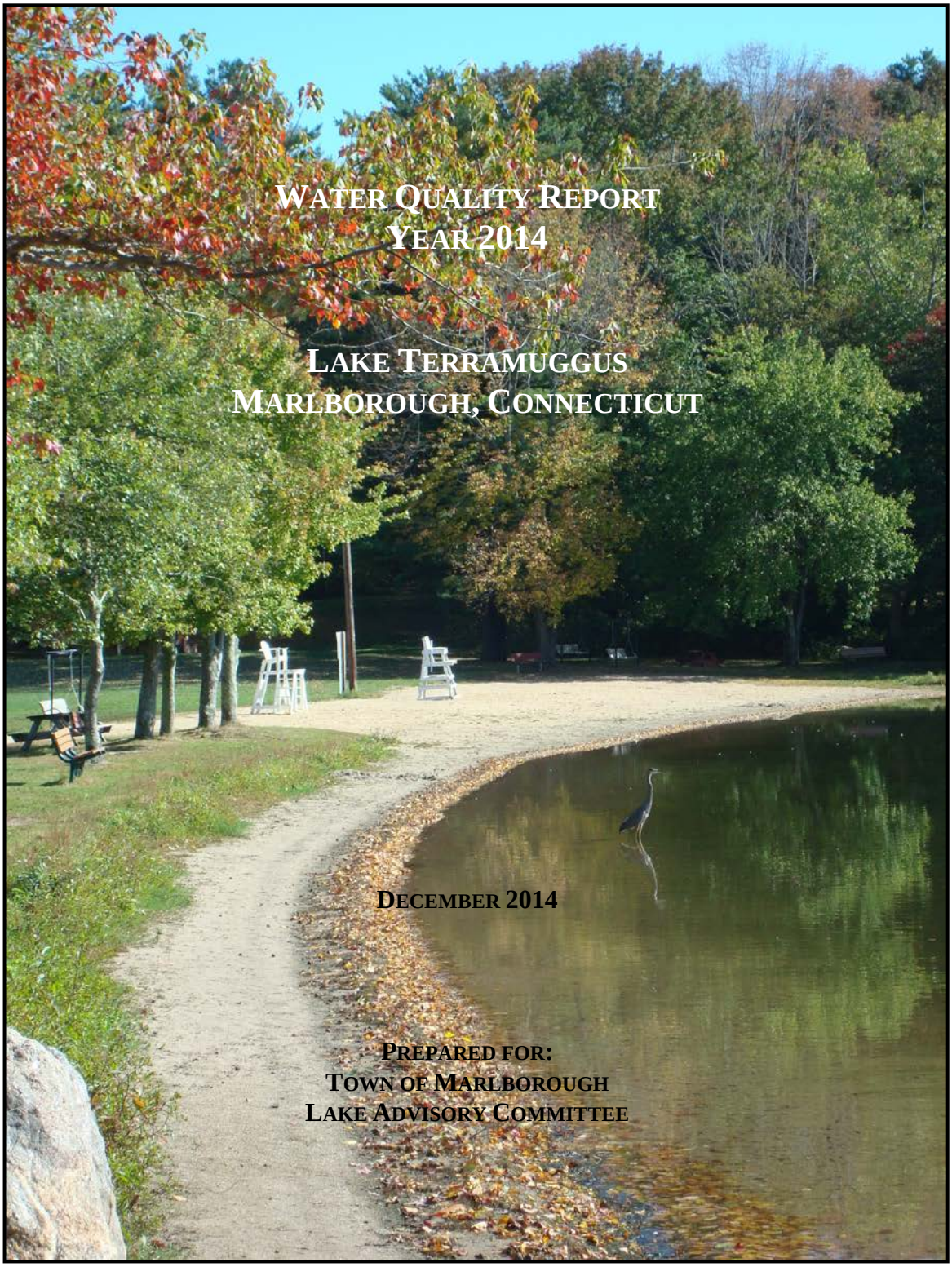

WATER QUALITY REPORT
YEAR 2014

LAKE TERRAMUGGUS
MARLBOROUGH, CONNECTICUT

DECEMBER 2014

PREPARED FOR:
TOWN OF MARLBOROUGH
LAKE ADVISORY COMMITTEE

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Introduction

A program was initiated in the spring of 1994 to monitor the water quality of Lake Terramuggus, on a monthly basis, during the period of May to September. Monitoring has continued over the summers of 1994 through 2014 on a monthly basis over the same five month period. From 2008 to 2011 an additional sampling event was added to the monitoring program in October due to an algal bloom that was experienced in October 2007. October sampling was ceased in 2012. This report summarizes the field and laboratory results for the 2014 sampling season and compares them to results from previous years.

Site Description

Lake Terramuggus is located near the intersection of Routes 2 and 66, northwest of the center of Marlborough, Connecticut (Figure 1).

Table 1. Physical Features of Lake Terramuggus

Parameter	Value
Surface area (acres)	83.0
Volume (acre-feet)	1776.2
Maximum depth (feet)	43.0
Average depth (feet)	21.4
Watershed area (acres)	345.6
Watershed:lake area ratio	4.16
Flushing rate (times/year)	0.31

The lake has multiple uses including swimming, boating, and fishing. The Town Beach is located on the northern end of the lake. Residential development surrounds the lake and many houses have docks for boats and general recreation.

The surface elevation of Lake Terramuggus is 454 feet above mean sea level (MSL). The lake has maximum and mean depths of 43 and 21.4 feet, respectively. It has a volume of about 77.4 million cubic feet.

The lake has a relatively small watershed of approximately 0.54 square miles (345.6 acres), including the lake itself. Because of its small watershed area, it takes about 1,453 days or about 4 years for the lake volume to be completely replaced with water from the watershed.

The watershed boundary is shown on Figure 2. Approximately 58% of the watershed is covered by low density residential housing, 13% is wooded, 5% is industrial or commercial, and the remainder (24%) is water. Except for some stretches of mowed lawn at the southern end, and boat launch areas at different points around the lake, the land directly adjacent to the lake shore is undisturbed and well-vegetated.

Lake Terramuggus is part of the Dickinson Creek drainage basin (DEP #4708). This basin is part of the Salmon Regional Basin and the Connecticut Major Basin. There are two inlet streams and a stormwater drainage system outlet entering the southern end of the lake and one outlet stream that flows to the north and eventually reaches Dickinson Creek. The balance of surface flows reaching the lake is via sheet runoff from the shoreline properties.

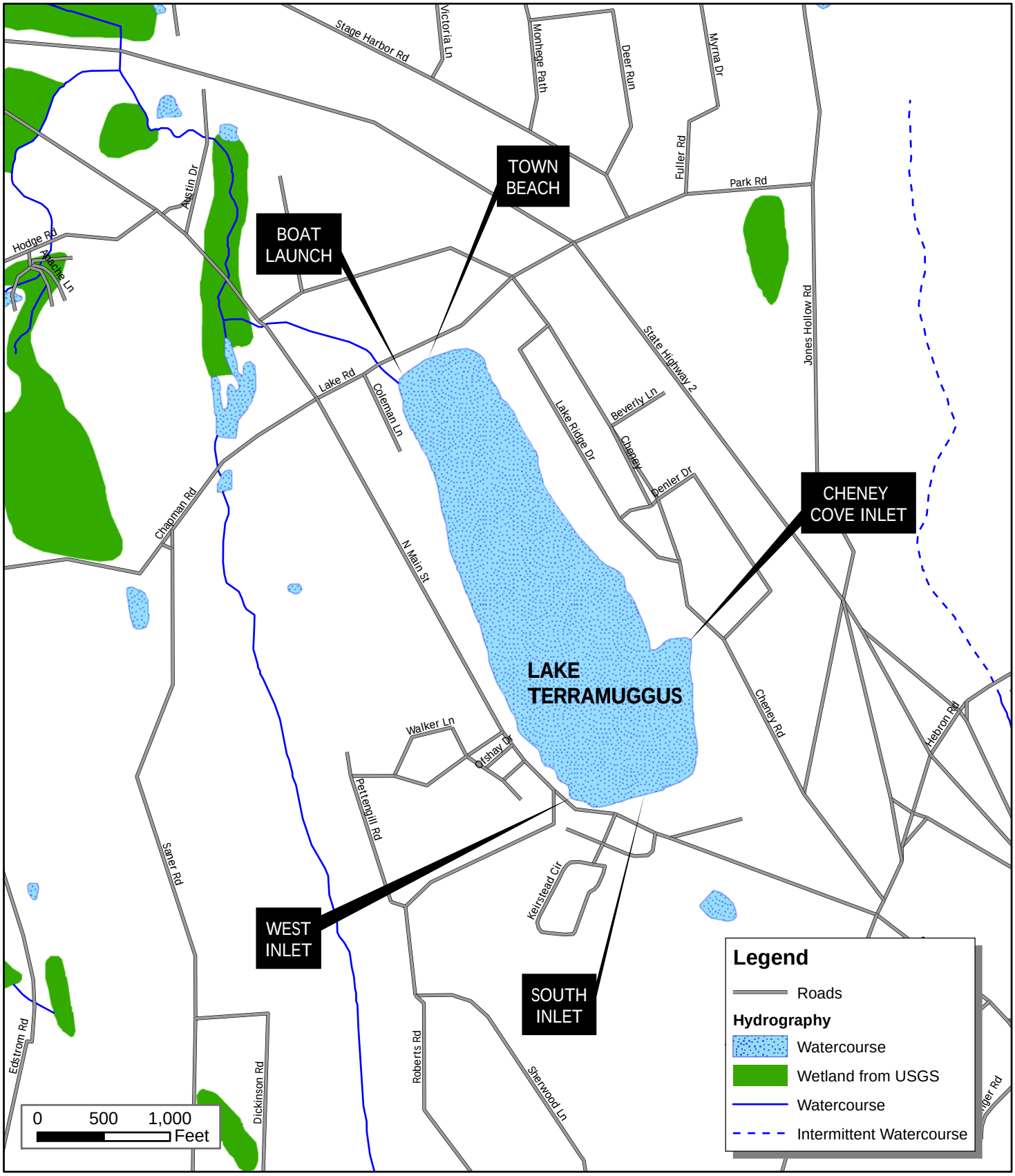

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FIGURE 1
SITE LOCATION MAP

LAKE TERRAMUGGUS
MARLBOROUGH, CT

Map Date: 12.29.2005
Data Source: Connecticut DEP Environmental GIS Data v.2002; NDDB Data v. June 2004
Drawing file: s/gis/lk_terramuggus_marlborough/basemap.mxd

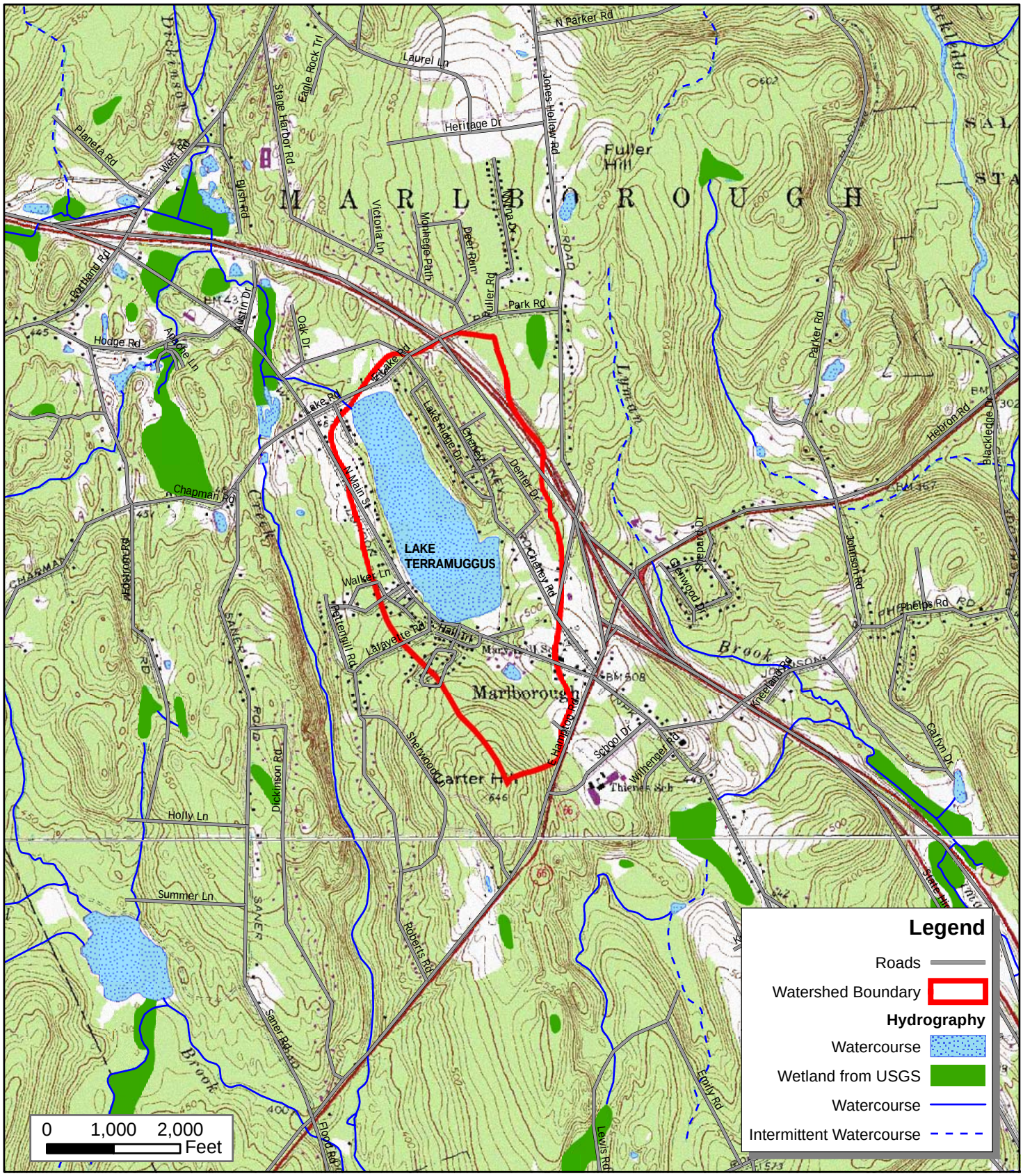

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FIGURE 2
WATERSHED BOUNDARY

LAKE TERRAMUGGUS
MARLBOROUGH, CT

Map Date: 12.29.2005
Data Source: Connecticut DEP Environmental GIS Data v.2002; NDDB Data v. June 2004
Drawing file: s/gis/lk_terramuggus_marlborough/watershed.mxd

Monitoring Program

A water sampling program was established in 1994 to monitor bacteria, physical and chemical water quality within Lake Terramuggus. From 1994 through 2007, water monitoring has been done on a monthly basis from May to September (5 sampling events). From 2008 through 2011, a sixth sampling event was added in October as a result of a late summer/early autumn algal bloom in 2007. October sampling was ceased in 2012.

Samples are obtained from several locations around the Lake to monitor bacteria levels and assess bathing water quality. In the 2014 sampling period, bacteria water samples were obtained by the Chatham Health District and LandTech. Bacteria sampling station locations are as follows:

- **Boat Launch -** at the lake's north end.
- **Town Beach Center -** mid-way between east and west shores
- **Town Beach North -** near the east shore.
- **Cheney Cove, East Side -** the southeastern cove.
- **South End -** near an inlet stream draining to the lake.
- **West Side -** near the stormwater drainage system inlet draining the commercial center.

Physical and chemical water quality is evaluated at a sampling station established near the deepest part of the Lake in the southwest quadrant. Two water samples are collected from this station, one in the top five meters and one in the bottom five meters. These samples are labeled, stored on ice, and for the 2014 sample year, delivered to Columbia Environmental Laboratory for analysis of ortho-phosphate, total phosphorus, total Kjeldahl nitrogen (TKN), ammonia nitrogen, nitrate-nitrite, and specific conductance. Physical parameters, including water temperature, dissolved oxygen, and water clarity are measured in-situ. A composite water sample from the photic zone (top four meters) is collected, stored on ice, and delivered to Hydro-Technologies for chlorophyll-a measurements.

Results for Sampling Season, 2014

Results of the 2014 monitoring for the months of May through September are presented in Tables 2 and 3 on the following pages. Each category is discussed individually in the following sections.

Table 2.
Lake Center Results, 2014

	Upper Depth (0-5m)					Lower Depth (5-10m)				
Parameter	27-May	20-June	29-July	28-Aug	30-Sept	27-May	20-June	29-July	28-Aug	30-Sept
Temperature(°C)*	18	20.5	24	24.4	20.0	12.7	13.9	16.8	17.8	15.8
D.O. (mg/l)*	11.1	9.7	8.5	8.6	9.1	7.2	5.4	4.8	4.3	4.7
Secchi Depth (ft)	13’10”	18’0”	21’0”	19’11”	16’7”	**	**	**	**	**
Ortho Phosphate	2	3	4	3	3	2	3	4	9	2
Total Phosphorus (µg/l)	8	9	7	10	9	11	25	25	16	14
TKN (µg/l)	450	410	465	590	800	700	880	740	1210	1130
Ammonia (µg/l)	18	20	26	25	<10	75	116	151	137	126
Nitrate (µg/l)	<10	<10	<10	<10	<10	25	<10	<10	<10	<10
Turbidity (NTU)	1.5	0.7	1.1	0.7	0.8	1.7	2.4	4.9	4.3	2.5
Sp. Cond. (µmhos/cm)	288	279	285	290	287	288	295	292	290	294
Chlorophyll-a (µg/l)	2.93	4.44	1.89	1.09	10.04	**	**	**	**	**

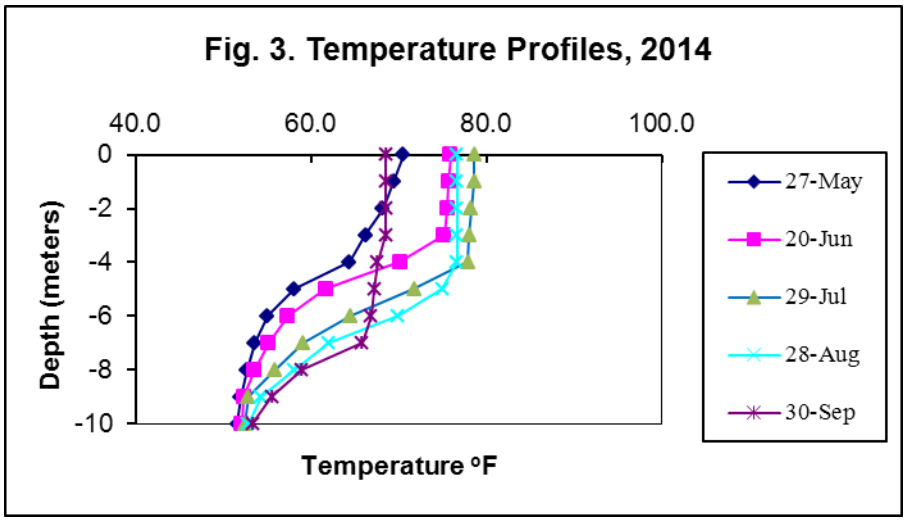
* Value reported is near the mid-point of measurements taken in this depth range.
** Measurement is a single value; reported under Upper Depth category.

Table 3. E.Coli Bacteria, 2014

Sample Date	Boat Launch		Town Beach Center		Town Beach North		Cheney Cove East Side		South End		West Side	
	E.Coli Bacteria #/100ml	Geometric Mean (Y=5)	E.Coli Bacteria #/100ml	Geometric Mean (Y=5)	E.Coli Bacteria #/100ml	Geometric Mean (Y=5)	E.Coli Bacteria #/100ml	Geometric Mean (Y=5)	E.Coli Bacteria #/100ml	Geometric Mean (Y=5)	E.Coli Bacteria #/100ml	Geometric Mean (Y=5)
5/20/2014	10		10		10							
5/27/2014*	10		10		10		10		10		30	
5/27/2014	10		53		10							
6/3/2014	10		10		10							
6/10/2014	10		10	13.96	10	10.00						
6/17/2014	10	10.00	10	13.96	10	10.00						
6/20/2014*	10	10.00	10	13.96	20	11.49	10		10		10	
7/1/2014	10	10.00	53	13.96	20	13.20						
7/8/2014	20	11.49	31	17.50	10	13.20						
7/17/2014	31	14.40	20	20.11	64	19.13						
7/22/2014	10	14.40	10	20.11	10	19.13						
7/29/2014*	10	14.40	10	20.11	20	19.13	10		10		10	
7/29/2014	75	21.55	42	19.19	20	19.13						
8/5/2014	10	18.76	10	15.31	64	27.73						
8/12/2014	20	17.19	53	18.60	87	29.48						
8/19/2014	20	19.74	10	18.60	**290**	57.81						
8/21/2014					99	79.61						
8/26/2014	10	19.74	110	30.05	10	69.30						
8/28/2014*	10	13.20	10	22.55	20	54.92	30		180		20	
9/30/2014*	10	13.20	10	22.55	10	35.63	10	12.46	10	17.83	40	18.88

* indicates samples collected by Land-Tech and analyzed by Columbia Environmental Laboratory
all other samples collected by Chatham Health Dept and analyzed by State Laboratory
Resample when E.Coli exceeds 235/100ml
Geometric mean above 126 indicates unacceptable bathing water quality

Temperature and Dissolved Oxygen



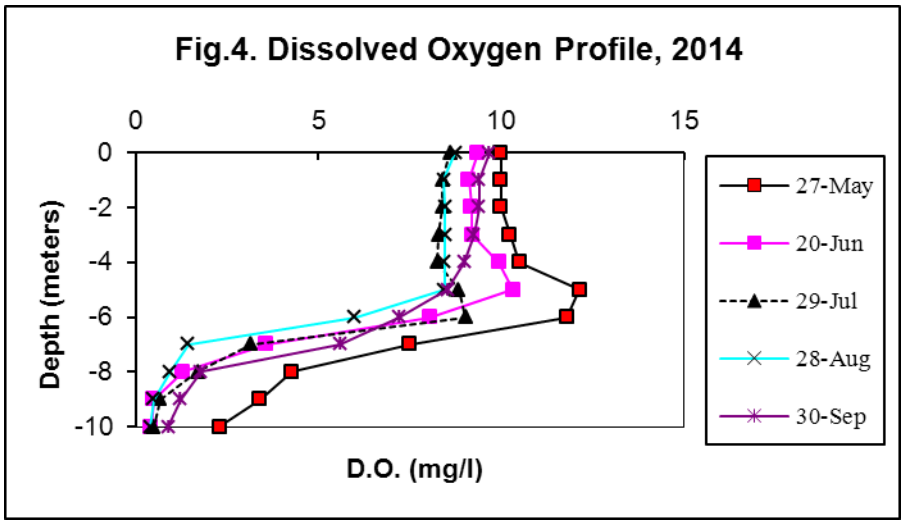
The temperature profile was obtained by measuring the temperature, in one meter increments, from the surface to the bottom of the lake. Lake Terramuggus had begun to stratify by late May. Surface water temperature rose through the end of July with a high temperature of 78.6°F, resulting in strong stratification throughout the summer. Surface water temperatures cooled in August and September. By the end of September the lake had begun to de-stratify.

Table 4. Water Temperature

Depth (m)	Sample Date									
	27-May		20-June		29-July		28-Aug		30-Sept	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
0	21.4	70.5	24.4	75.9	25.9	78.6	24.8	76.6	20.3	68.5
-1	20.8	69.4	24.3	75.7	25.9	78.6	24.8	76.6	20.3	68.5
-2	20.1	68.2	24.2	75.6	25.7	78.3	24.8	76.6	20.3	68.5
-3	19	66.2	24	75.2	25.6	78.1	24.8	76.6	20.3	68.5
-4	18	64.4	21.2	70.2	25.5	77.9	24.8	76.6	19.8	67.6
-5	14.5	58.1	16.5	61.7	22.1	71.8	23.9	75.0	19.6	67.3
-6	12.8	55.0	14.1	57.4	18.1	64.6	21.1	70.0	19.4	66.9
-7	12	53.6	12.9	55.2	15.1	59.2	16.7	62.1	18.8	65.8
-8	11.5	52.7	12	53.6	13.3	55.9	14.5	58.1	15	59.0
-9	11.1	52.0	11.3	52.3	11.6	52.9	12.4	54.3	13.1	55.6
-10	10.9	51.6	11.2	52.2	11.4	52.5	11.6	52.9	11.9	53.4

Table 5. Dissolved Oxygen (mg/l)					
Depth (m)	**Sample Date**				
	27-May	**20-Jun**	**29-Jul**	**28-Aug**	**30-Sep**
0	10	9.36	8.6	8.75	9.67
-1	10	9.12	8.4	8.43	9.4
-2	10	9.18	8.4	8.46	9.4
-3	10.24	9.2	8.3	8.46	9.25
-4	10.5	9.94	8.25	8.45	9
-5	12.15	10.32	8.84	8.45	8.54
-6	11.8	8.05	9.03	6	7.2
-7	7.5	3.58	3.16	1.44	5.6
-8	4.28	1.3	1.7	0.95	1.8
-9	3.4	0.5	0.67	0.49	1.24
-10	2.3	0.42	0.5	0.41	0.9

Dissolved oxygen (D.O.) profiles show strong stratification within the water column for the five sampling dates from May to September (Figure 4). D.O. concentrations in the surface waters remained at high levels to a depth of about 6 meters and showed decreasing levels through the end of August. September levels increased as water temperatures cooled. Low dissolved oxygen concentrations were observed at the lake bottom from May to September.



The State of Connecticut recommends that dissolved oxygen should not be less than 5 mg/l at any time (CT DEP, 1992). Both the temperature and dissolved oxygen profiles were normal over the summer of 2014 and typified a thermally stratified lake. Bottom depths approached anoxic conditions for much of the summer. Importantly, however, upper depths maintained a more than adequate level of dissolved oxygen throughout the summer. Low levels of dissolved oxygen can severely restrict fish habitat and stress vegetation and other aquatic life. No signs of such stress were evident throughout the sampling period.

Lake Clarity

The clarity of a lake has biological and aesthetic importance. Biologically, clear water generally signifies low levels of phytoplankton and suspended sediments (turbidity). Aesthetically, lake users generally prefer clear water for recreational use.

The clarity of Lake Terramuggus was measured using Secchi disk transparency. A Secchi disk is a circular, white, plastic disk that is lowered into the water. The Secchi depth is the greatest depth at which the Secchi disk is still visible from the surface.

Table 6. Secchi Depth-

Sample Date	Depth (feet)
27-May	-13.8
20-Jun	-18
29-Jul	-21
28-Aug	-19.9
30-Sep	-16.6

Table 7. Chlorophyl-a & Turbidity

Sample Date	Chlor. a (µg/ml)	Turb. (NTU)
27-May	2.93	1.5
20-Jun	4.44	0.7
29-Jul	1.89	1.1
28-Aug	1.09	0.7
30-Sep	10.04	0.76

The Secchi depth may serve as a surrogate measurement of biological productivity in lake systems. Secchi depth is influenced by the concentrations of phytoplankton, suspended inorganic material, and dissolved nutrients. The perceived transparency is also influenced by cloud cover, glare and angle of the sun, wave action, rooted aquatic vegetation, and reflection from the lake floor.

Figure 5.a. Secchi Depth and Chlorophyll-a, 2014

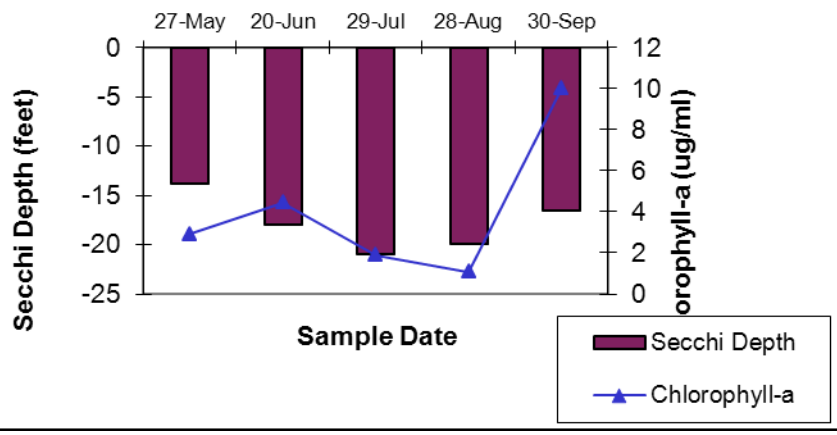
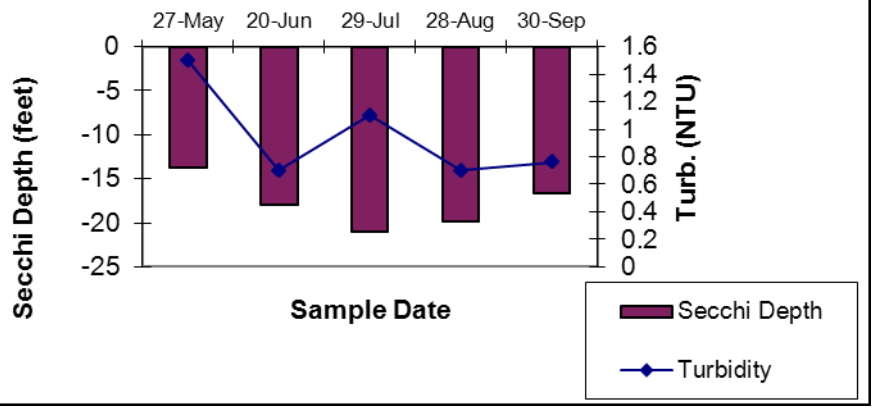


Figure 5.b. Secchi Depth and Turbidity, 2014



Turbidity is a measurement of the suspended particulate matter in a water body which interferes with the passage of a beam of light through the water. Materials that contribute to turbidity are silt, clay, organic material, or micro-organisms. Turbidity values are generally

reported in Nephelometric Turbidity Units (NTU). Pure distilled water would have non-detectable turbidity (0 NTU). Secchi depth is also used in lakes as an alternative means of expressing turbidity.

High levels of turbidity increase the total available surface area of solids in suspension upon which bacteria can grow. High turbidity reduces light penetration; therefore, it impairs photosynthesis of submerged vegetation and algae. In turn, the reduced plant growth may suppress fish productivity. Turbidity is also aesthetically unpleasant.

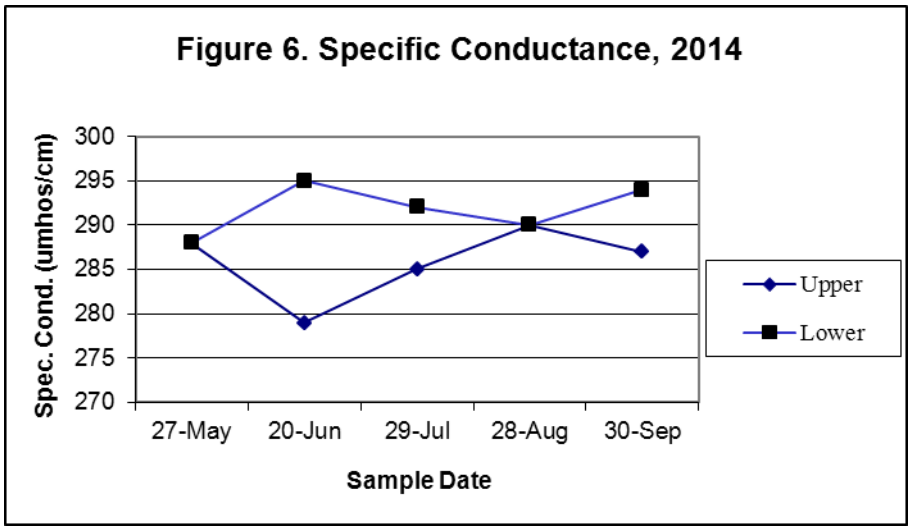
The Secchi depth readings over the sampling period are shown in Figure 5. Secchi depth was shallowest in May and deepest in July. Turbidity values were relatively low throughout the summer and the range between maximum and minimum levels was narrow. Chlorophyll-a concentrations were also low from May through August, with an atypically high value in September that was not reflected in the Secchi depth or turbidity values.

Specific Conductance

Table 8. Specific Conductance

Sample Date	Upper (µmhos/cm)	Lower (µmhos/cm)
27-May	288	288
20-Jun	279	295
29-Jul	285	292
28-Aug	290	290
30-Sep	287	294

All lakes and other inland waters contain small quantities or "background levels" of mineral salts in solution. These salt levels are influenced by many factors, including evaporation rates, precipitation patterns, and the bedrock geology within the region. Specific conductance, referred to as *conductivity* when standardized to 25° C., is a measure of the concentrations of all dissolved ions, or salts, in a lake. Conductivity is a useful means of assessing changes in water quality, and increases in this parameter often precede increases in the trophic status of a lake. Increased imperviousness within the watershed, use of de-icing salts, and erosion of exposed soils can all contribute to increased conductivity levels.



Most species can tolerate small changes in the relative amounts of salts. However, wide variations in the salinity or in the concentrations of individual salts can have significant effects upon aquatic life. When the osmotic pressure is sufficiently high, owing to salts in solution, water may be drawn from gills and other delicate external organs, with considerable damage to cells, or even death.

Generally, the specific conductance of water bodies containing a good mix of fish should range between 150 and 500 µmhos/cm. The conductivity should remain fairly constant throughout the year. Any significant changes over a short period of time may indicate the introduction of pollutants in runoff from the contributing watershed.

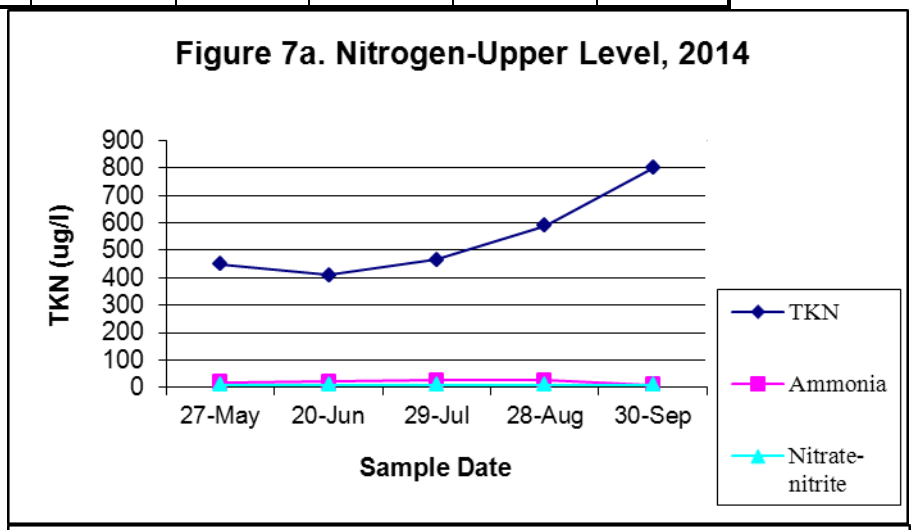
Specific conductance remained fairly constant throughout the summer. It remained in the low range and is consistent with past years.

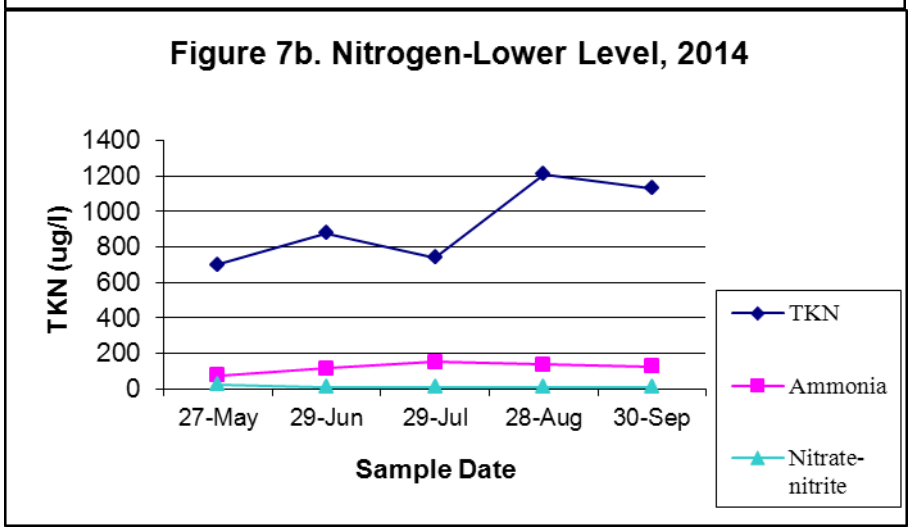
Lake Nutrients

Table 9. Nitrogen

	TKN (µg/l)		Ammonia (µg/l)		Nitrate-nitrite (µg/l)	
Sample Date	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
27-May	450	700	18	75	<10	25
20-Jun	410	880	20	116	<10	<10
29-Jul	465	740	26	151	<10	<10
28-Aug	590	1210	25	137	<10	<10
30-Sep	800	1130	10	126	<10	<10

Nitrogen and phosphorus were monitored over the summer because these are typically the two nutrients that can be limiting for aquatic plant growth. If either nitrogen or phosphorus becomes depleted, plant growth slows despite the fact that other nutrients might still be available. However, if both nitrogen and phosphorus are over-abundant, nuisance plant growth (e.g.





algae blooms) can occur. In most Connecticut ponds and lakes, phosphorus is the nutrient that limits plant growth.

Table 10. Phosphorus

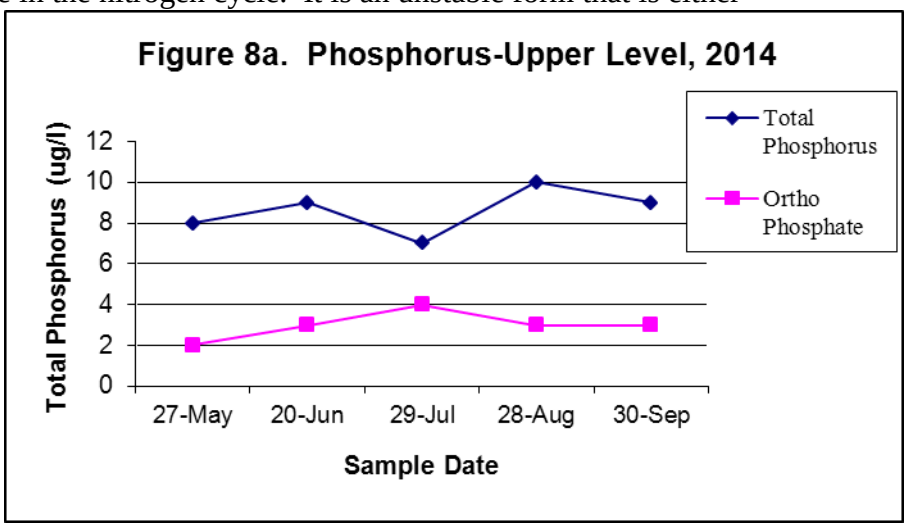
	Total Phosphorus		Ortho Phosphate	
Sample Date	**Upper (µg/l)**	**Lower (µg/l)**	**Upper (µg/l)**	**Lower (µg/l)**
27-May	8	11	2	2
20-Jun	9	25	3	3
29-Jul	7	25	4	4
28-Aug	10	16	3	9
30-Sep	9	14	3	2

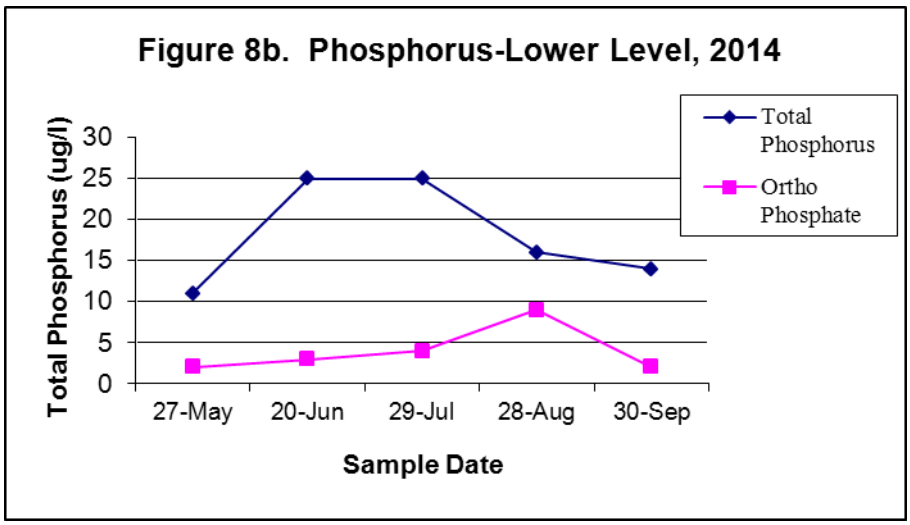
Total Kjehdahl Nitrogen (TKN) is a measure of both the ammonia and organic forms of nitrogen. Organic nitrogen is bound and is therefore not immediately available for biological activity. Ammonia, nitrate and nitrite are considered inorganic forms of nitrogen.

Ammonia is a measure of the most reduced form of nitrogen in water; it is readily available to plants and can contribute to the eutrophication of water bodies. Nitrite occurs as an intermediate in the nitrogen cycle. It is an unstable form that is either rapidly oxidized to nitrate (nitrification) or reduced to nitrogen gas (denitrification). It can also be a source of nutrients for plants. Nitrate is the most oxidized and stable form of nitrogen in water. It is the principal form of nitrogen found in natural waters, is the principal form of nitrogen used by plants and contributes to lake eutrophication.

TKN values were highest in late September in the epilimnion and in late August and September in the hypolimnion.

Total Phosphorus is a measure of both inorganic and organic forms of phosphorus. Phosphorus can be present as dissolved or particulate matter. It is an essential plant nutrient and is often the most limiting nutrient to plant growth in fresh water.





Orhtophosphate is a measure of the inorganic oxidized form of soluble phosphorus. This form of phosphorus is the most readily available for uptake during photosynthesis.

Total Phosphorus levels in the epilimnion were within the oligotrophic range (0-10 μg/l) for the sampling period.

Chlorophyll-a and Phytoplankton

Table 11. Chlorophyll-a

Sample Date	(μg/l)
27-May	2.93
20-Jun	4.44
29-Jul	1.89
28-Aug	1.09
30-Sep	10.04

Chlorophyll-*a* concentrations were determined by Hydro-Technologies laboratory.

Chlorophyll-*a* is the major photosynthetic pigment of most phytoplankton (algae), and levels of chlorophyll-*a* in surface waters are a common measure of phytoplankton productivity. Increases in chlorophyll-*a* are typically correlated with phytoplankton productivity. Chlorophyll-*a* concentrations were in the oligotrophic (0-2 μg/l) and lower mesotrophic range (3-15 μg/l) for the sampling period.

Indicator Bacteria

Coliform bacteria serve as indicator organisms. While they normally do not pose any health threat themselves, they may indicate the presence of other pathogenic (disease-causing) organisms. When large numbers of coliform are present in natural waters, it is a good biological indicator for pathogenic bacteria and may be an indication of sewage contamination.

The Revised Bathing Water Standards (May 7, 2002) issued by the Connecticut Department of Public Health mandates the use of E. Coli as an indicator bacteria for evaluating bathing water quality of freshwaters. According to the standards, a single sample with a concentration of E. Coli greater than 235 per 100 ml is in excess of that which is normally considered acceptable for bathing. A resample is required and a sanitary survey of the surrounding watershed is recommended. A running geometric mean is used to evaluate the long-term suitability of bathing waters. An acceptable geometric mean is less than or equal to 126.

A tabulation of E. Coli levels and their geometric means for samples collected by LandTech and the Chatham Health Department throughout the summer are included in Table 3 (page 6). Only one sample from the Town Beach North sampling station exceeded the Public Health standard on one date in August. Re-sampling on the following day indicate E.Coli levels returned to below the Public Health Standard. All other sample dates were below the standard. No exceedences of the geometric mean occurred throughout the sample period.

Inlet Samples

The Lake's three surface water inlets are sampled at their point of discharge into the lake on two dates. Once in the spring when surface water flows are generally high and once in late summer when flows are generally low. The sampling results are tabulated in Table 13.

Table 13. Inlet Stream Results

	May 27, 2014			August 28, 2014		
Parameter	**Cheney Rd**	**South Inlet**	**West Inlet**	**Cheney Rd**	**South Inlet**	**West Inlet**
E. Coli (#/100ml)	<10	10	30	30	180	20
Sp. Cond. (μmhos/cm)	290	288	283	290	293	291
Turbidity (NTU)	8.9	1.9	0.2	0.6	0.9	0.9
TKN (μg/l)	780	620	184	540	470	505
Nitrate (μg/l)	<10	16	540	<10	<10	<10
Ammonia (μg/l)	16	18	50	<10	11	14
Total Phosphorus (μg/l)	16	9	6	6	7	7
Ortho Phosphate (μg/l)	4	4	7	1	1	1

Both inlet sample dates showed good water quality at all three inlets with most parameters showing levels similar to in-lake sample results.

Trophic State

Eutrophication is the term given to an increase in lake biological productivity, which is often part of the natural aging process of a lake. This aging typically involves the accumulation of nutrients and sediments in the lake basin and concurrent changes in the lake's water chemistry. Eutrophication is the process of change from a nutrient poor condition (referred to as oligotrophic productivity), to intermediate productivity (mesotrophic), to a nutrient rich condition (eutrophic). The current state of eutrophication is referred to as a lake's trophic state or trophic status. Oligotrophic lakes are typically fairly deep, have high water clarity, and limited plant growth. Eutrophic lakes, conversely, are generally characterized by shallow water, high nutrient levels, excessive plant growth and algae blooms.

The Trophic State Index (TSI) is based on the assumption that changes in nutrient levels (measured as total phosphorus) result in changes in levels of algae (measured as chlorophyll-a) and other plants and animals, causing changes in lake clarity (measured as Secchi disk transparency). The Trophic State Index (Carlson, 1977) is a means of quantifying the trophic state of a lake and is computed as follows:

$$TSI_{SD} = 60 - 14.41(\ln (SD))$$
$$TSI_{Chl} = 9.81(\ln (Chl)) + 30.6$$
$$TSI_{TP} = 14.42(\ln (TP)) + 4.15$$

where Chl = chlorophyll-a (ug/l)
TP = total phosphorus (ug/l)

SD = Secchi disk transparency (m)

The results of the TSI calculations for Secchi disk, chlorophyll-*a*, and total phosphorous are presented in Table 4. The TSI scores are often categorized into ranges that typify the trophic state classification (NY DEC, 1990). These ranges are found in the second block of Table 4.

Table 14. Trophic State Index (TSI)

Parameter	30-May	27-Jun	29-July	5-Sept	30-Sep	Average
Secchi Depth	39.30	35.47	33.25	34.02	36.64	35.74
Chlorophyll-a	41.15	45.22	36.84	31.45	53.23	41.58
Total phosphorus-upper	34.14	35.83	32.21	37.35	35.83	35.07
Monthly Avg.	38.19	38.84	34.10	34.27	41.90	

Trophic Status	TSI Score	Lake Productivity
Oligotrophic	< 37	Low
Mesotrophic	37-51	Moderate
Eutrophic	> 51	High

The average TSI scores in the 2014 sampling season for Secchi Depth and Total Phosphorus fall within the oligotrophic range. The average TSI score for Chlorophyll-a falls within the mesotrophic range.

The Connecticut DEEP also groups lakes into different trophic classifications based on total phosphorus, total nitrogen, Chlorophyll-a and Secchi Disk Transparency. The Connecticut DEEP ranking of trophic categories is presented in Table 15.

Table 15. CT DEEP Lake Trophic Categories

Category	Total Phosphorus µg/l	Total Nitrogen (µg/l)	Chorophyll-a (µg/l)	Secchi Depth (m)
Oligotrophic	0-10	0-200	0-2	6+
Mesotrophic	10-30	200-600	2-15	2-6
Eutrophic	30-50	600-1000	15-30	1-2
Highly Eutrophic	50+	1000+	30+	0-1

The limits of the CT DEEP lake trophic categories are depicted on the following long-term trend graphs, where appropriate.

Trends over Time

Where available, data for the parameter discussed below is shown for the twenty year period from 1994 to 2014.

Temperature and Dissolved Oxygen

Summer water temperatures were generally in line with previous years' data. Surface water temperatures as well as all bottom temperatures show little annual variation.

The 2014 dissolved oxygen (D.O.) level in the lake's surface water was relatively similar to previous years. A trend of low D.O. levels in the lake's deeper waters is observed in June, July and August with a rebound in September and October.

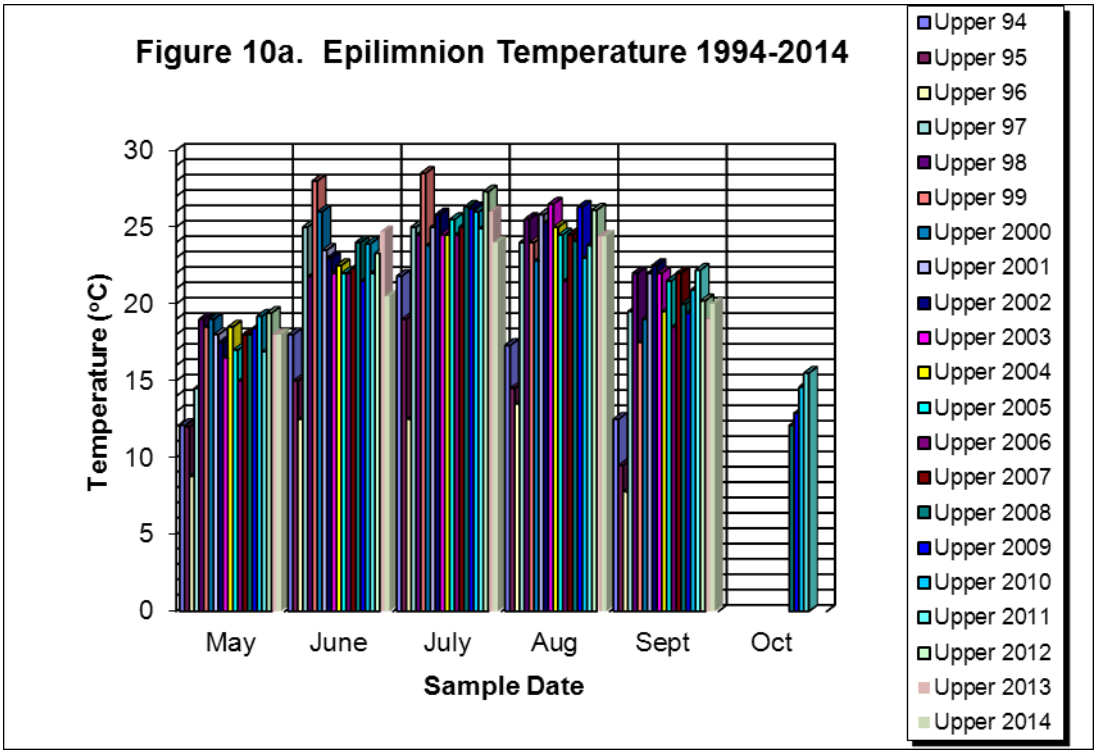


Figure 10a. Epilimnion Temperature 1994-2014
Temperature (°C)
30
25
20
15
10
5
0
May
June
July
Aug
Sept
Oct
Sample Date
Upper 94
Upper 95
Upper 96
Upper 97
Upper 98
Upper 99
Upper 2000
Upper 2001
Upper 2002
Upper 2003
Upper 2004
Upper 2005
Upper 2006
Upper 2007
Upper 2008
Upper 2009
Upper 2010
Upper 2011
Upper 2012
Upper 2013
Upper 2014

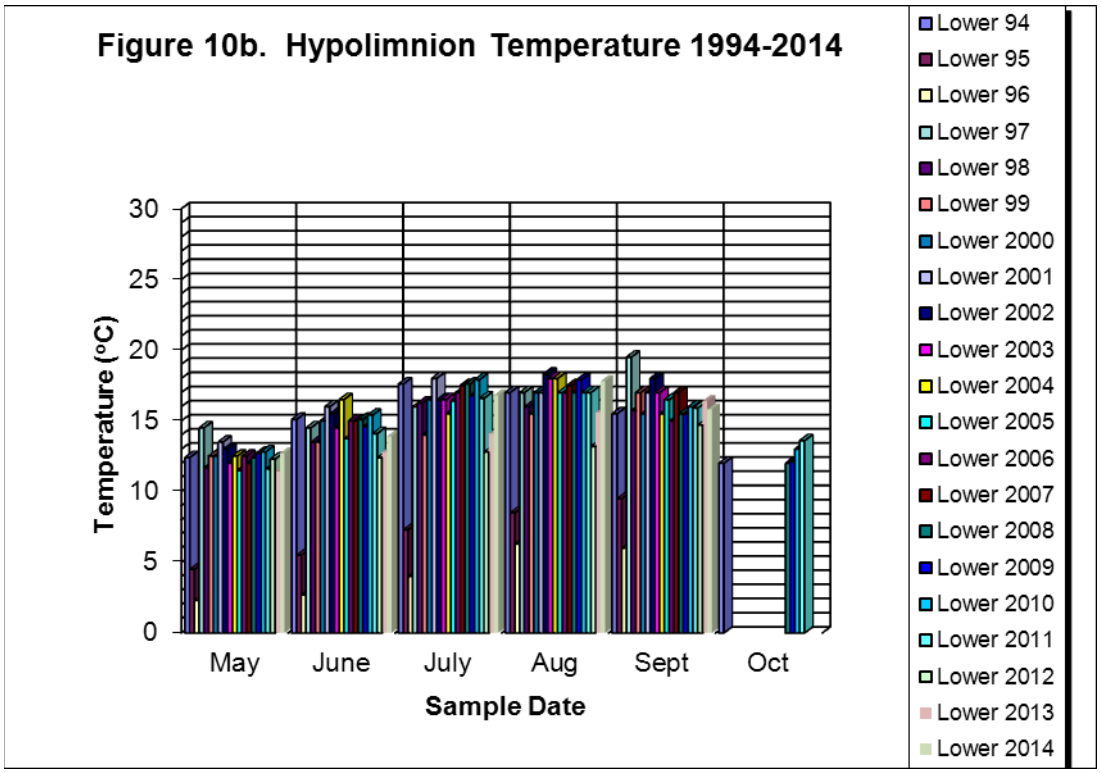


Figure 10b. Hypolimnion Temperature 1994-2014
Temperature (°C)
30
25
20
15
10
5
0
May
June
July
Aug
Sept
Oct
Sample Date
Lower 94
Lower 95
Lower 96
Lower 97
Lower 98
Lower 99
Lower 2000
Lower 2001
Lower 2002
Lower 2003
Lower 2004
Lower 2005
Lower 2006
Lower 2007
Lower 2008
Lower 2009
Lower 2010
Lower 2011
Lower 2012
Lower 2013
Lower 2014

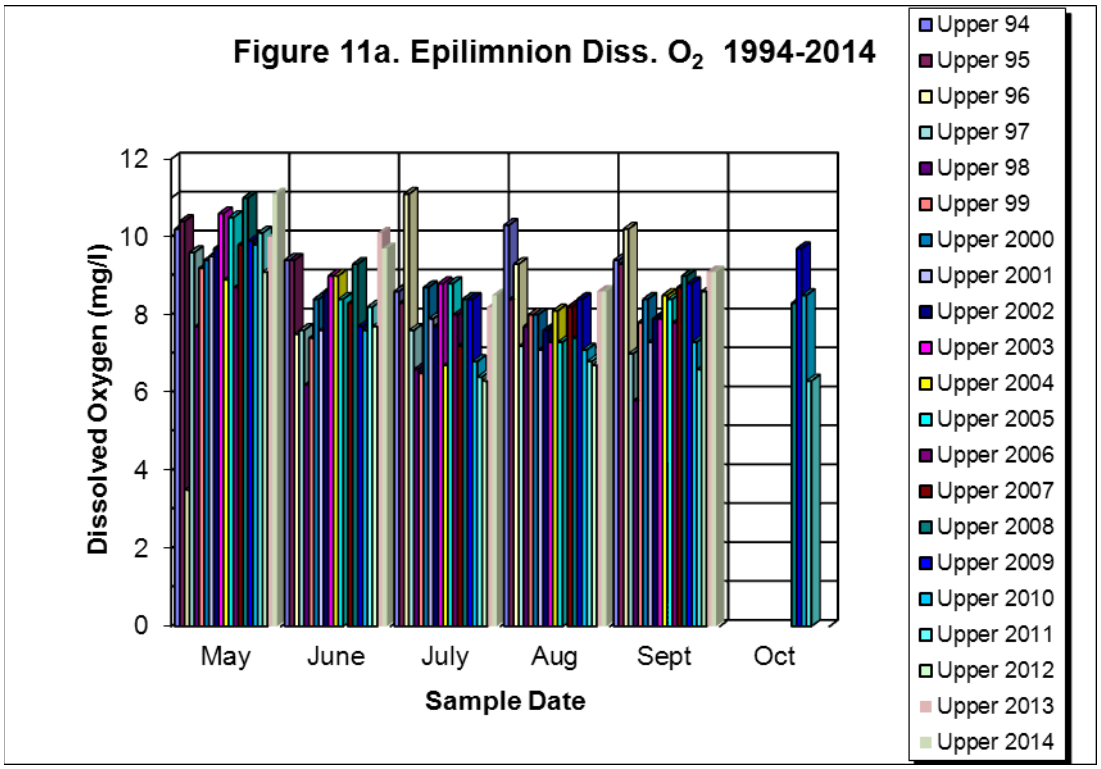


Figure 11a. Epilimnion Diss. O_2 1994-2014
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
May
June
July
Aug
Sept
Oct
Sample Date
Upper 94
Upper 95
Upper 96
Upper 97
Upper 98
Upper 99
Upper 2000
Upper 2001
Upper 2002
Upper 2003
Upper 2004
Upper 2005
Upper 2006
Upper 2007
Upper 2008
Upper 2009
Upper 2010
Upper 2011
Upper 2012
Upper 2013
Upper 2014

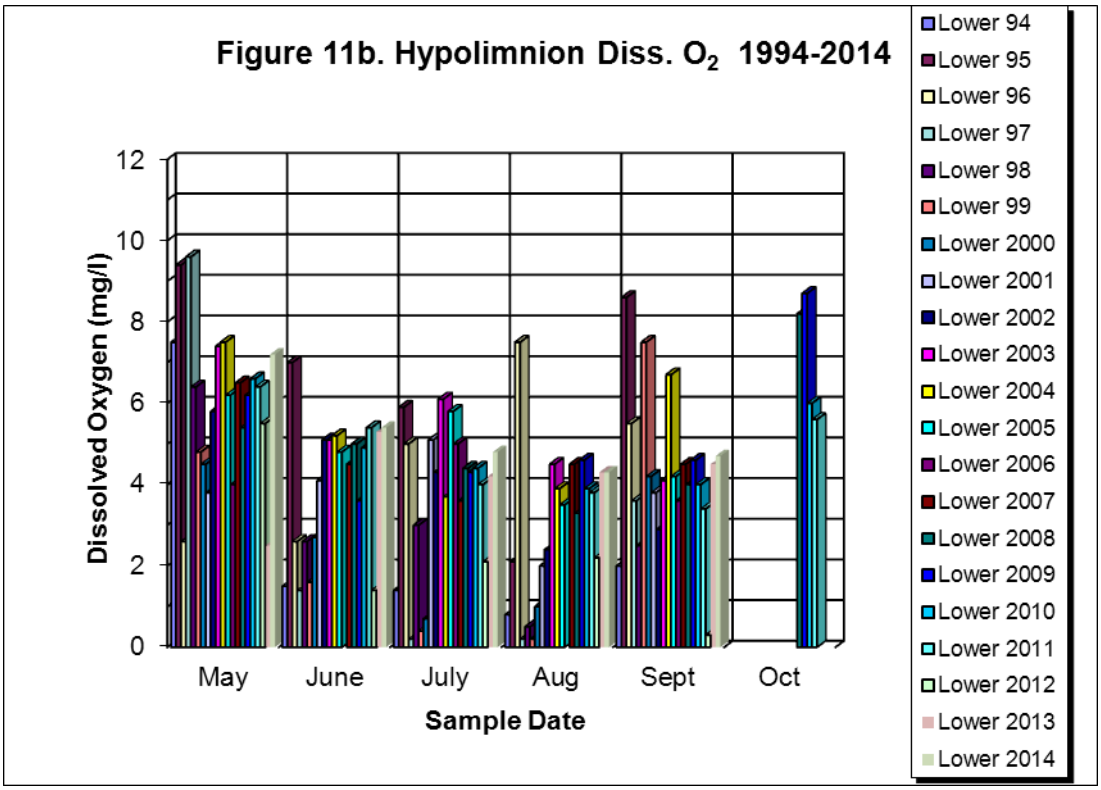
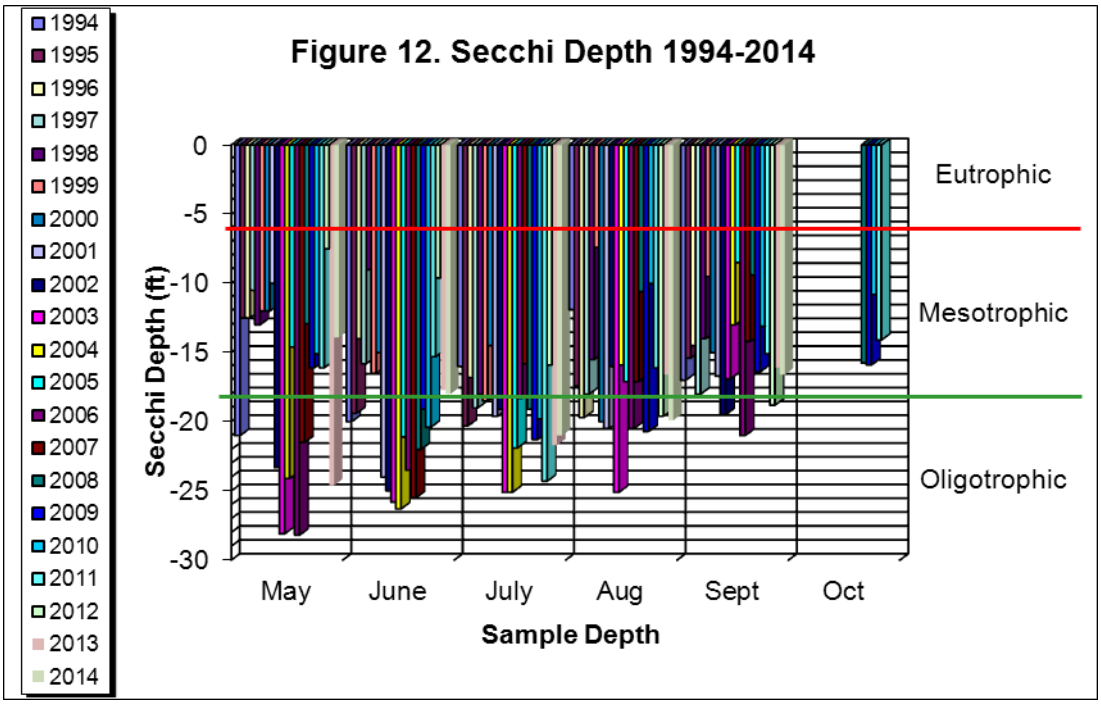


Figure 11b. Hypolimnion Diss. O_2 1994-2014
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
May
June
July
Aug
Sept
Oct
Sample Date
Lower 94
Lower 95
Lower 96
Lower 97
Lower 98
Lower 99
Lower 2000
Lower 2001
Lower 2002
Lower 2003
Lower 2004
Lower 2005
Lower 2006
Lower 2007
Lower 2008
Lower 2009
Lower 2010
Lower 2011
Lower 2012
Lower 2013
Lower 2014

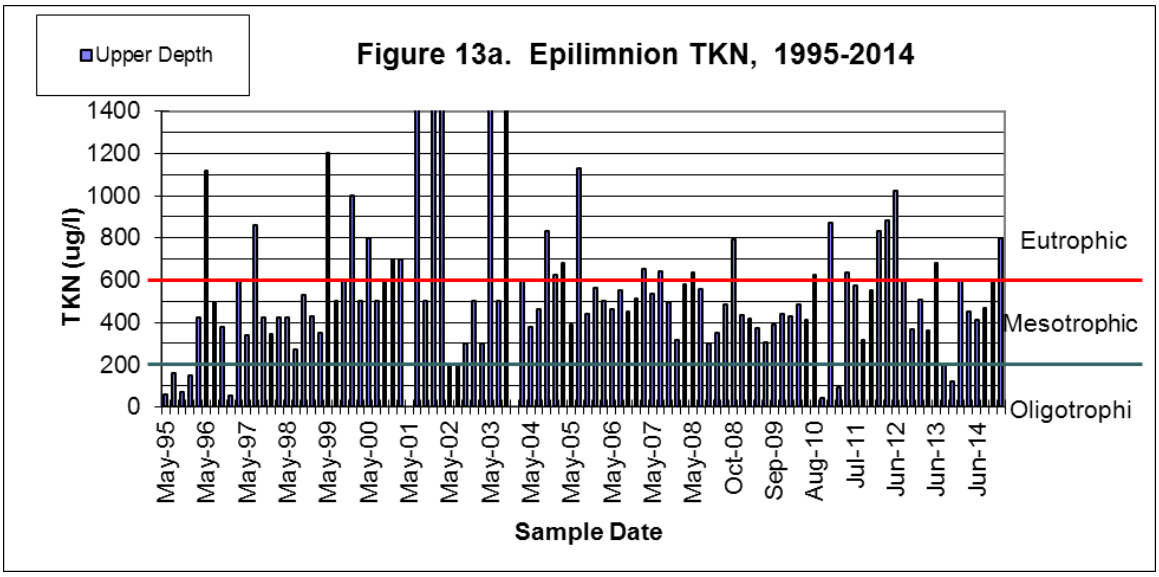
Secchi Depth

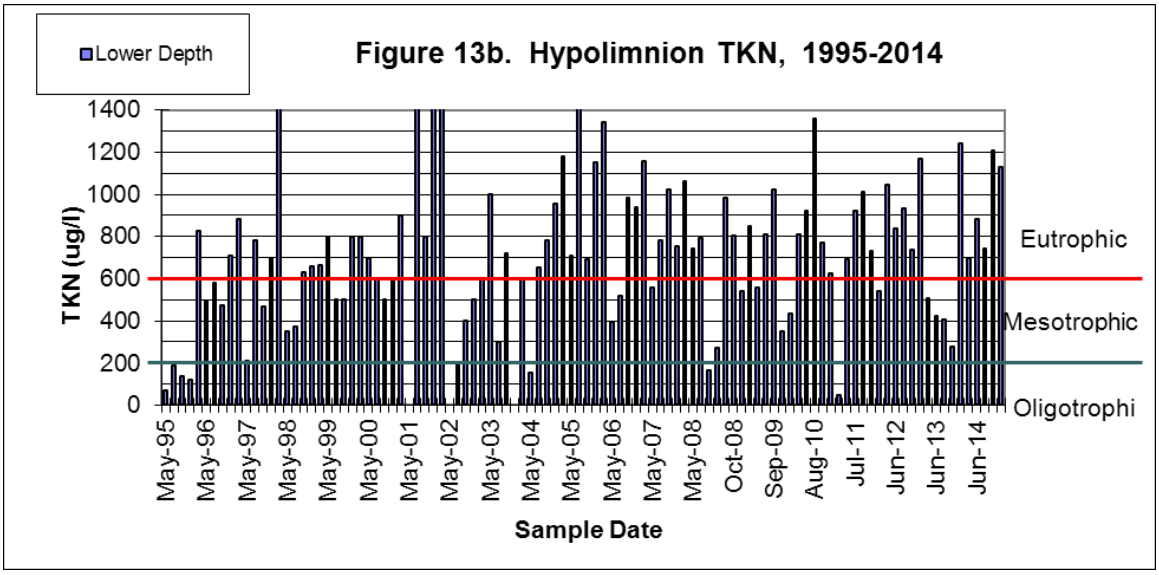
Secchi depth readings were generally good throughout 2014, with results in the oligotrophic to lower mesotrophic range similar to past years.



TKN

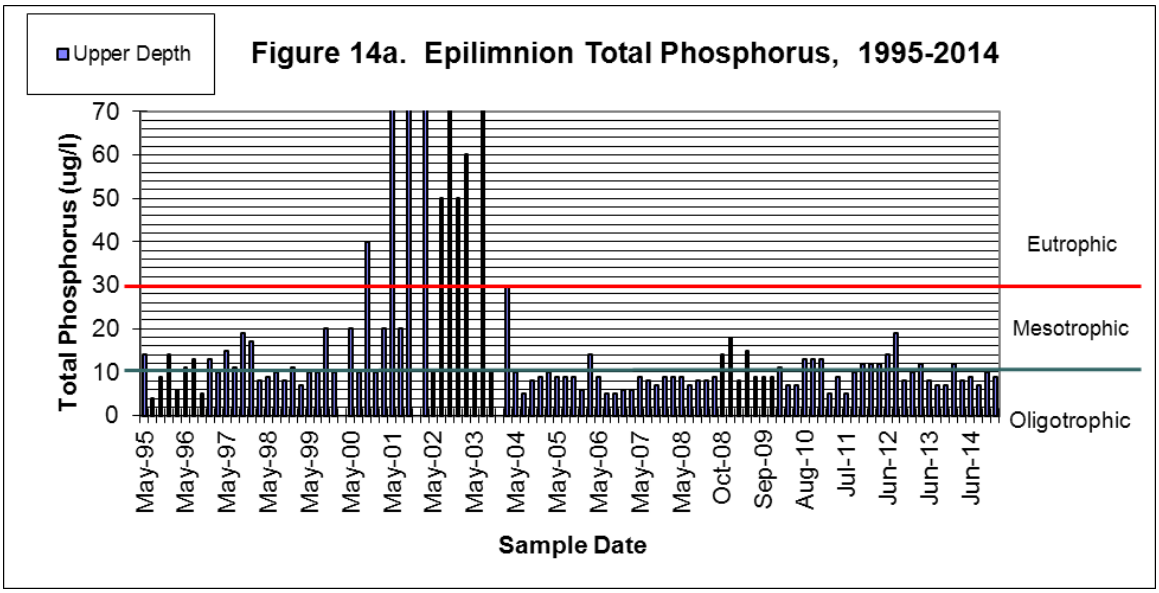
TKN levels in Lake Terramuggus between 1995 and 2014 are shown in Figure 13. Abnormally high concentrations were observed sporadically in 2001 through 2003. TKN levels in 2014 are more in-line those levels observed previous to 2001 and after 2003. It is expected that the 2001-2003 spikes were due to laboratory or reporting errors. TKN levels in the deeper waters show seasonal increase from May to September likely related to release from anoxic deep water sediments.

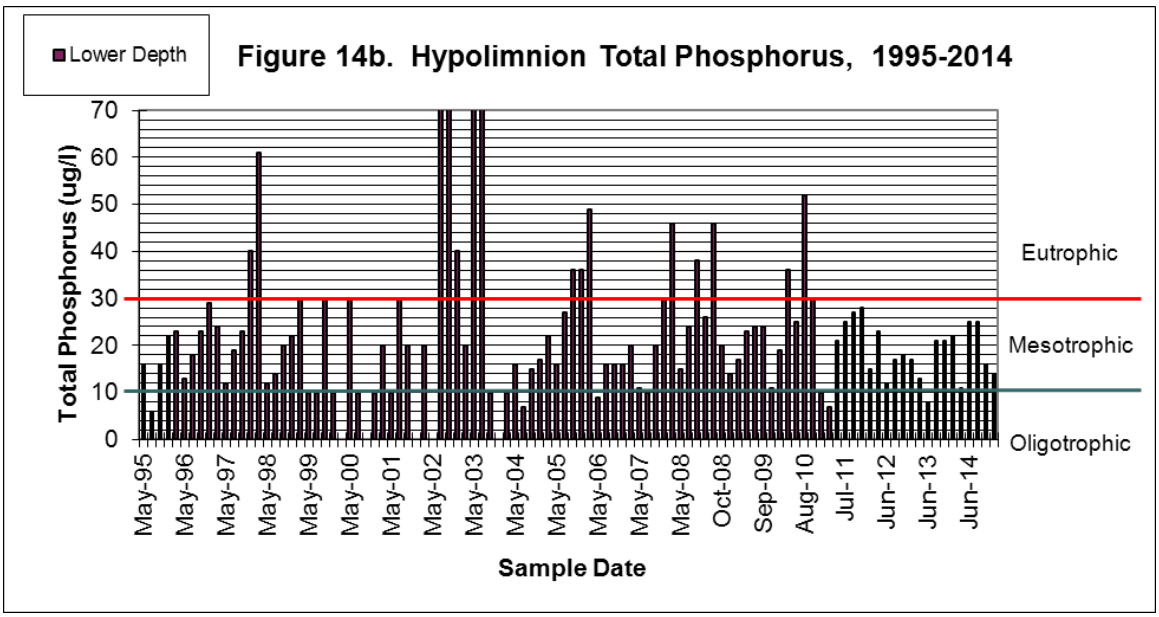




Total Phosphorus

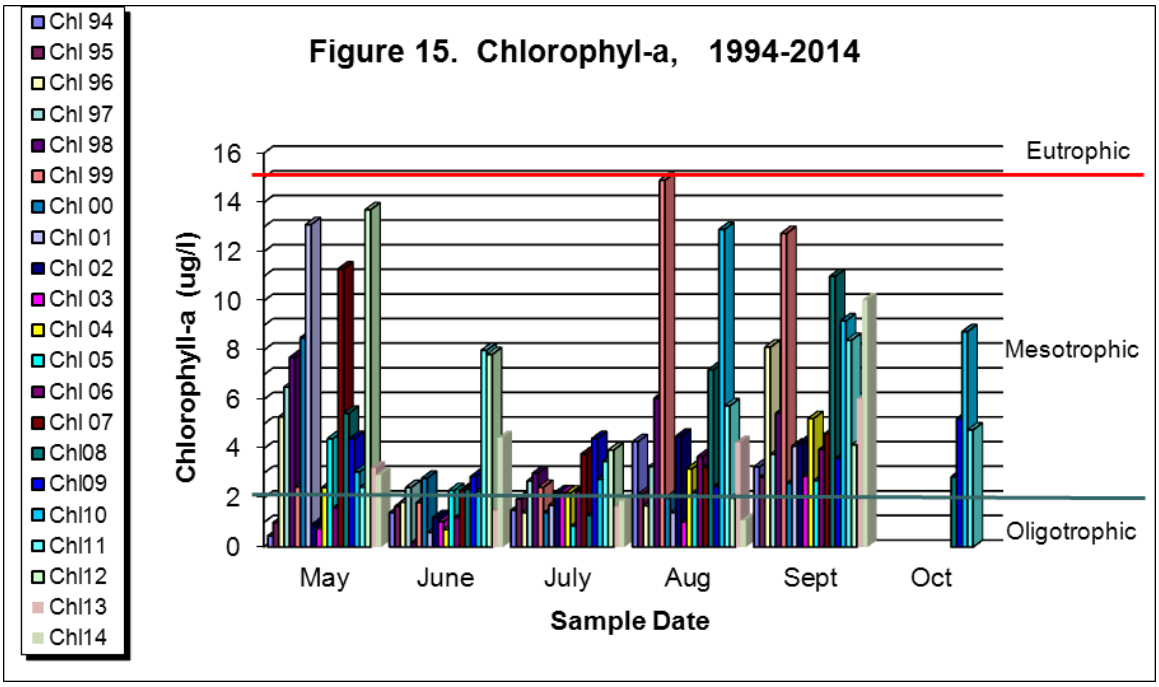
Total phosphorus concentrations for 1995 through 2014 are shown in Figure 14. Prior to 2000, total phosphorus concentrations in the surface water never exceeded 20 µg/l. The observed spikes in Total Phosphorus from 2001 to 2003 correlate well with the use of a different laboratory for analytical evaluation. In 2004 through 2014, phosphorus levels are similar to historic levels observed in the lake prior to 2000. The change in laboratories in 2004 appears to confirm our suspicions that the elevated spikes in phosphorus reported from 2000 to 2003 were not indicative of true phosphorus levels in the lake. Similar to TKN, a seasonal increase in deep water phosphorus is observed corresponding with the development of low oxygen concentrations below the thermocline. There is no apparent long-term trend in phosphorus concentrations.

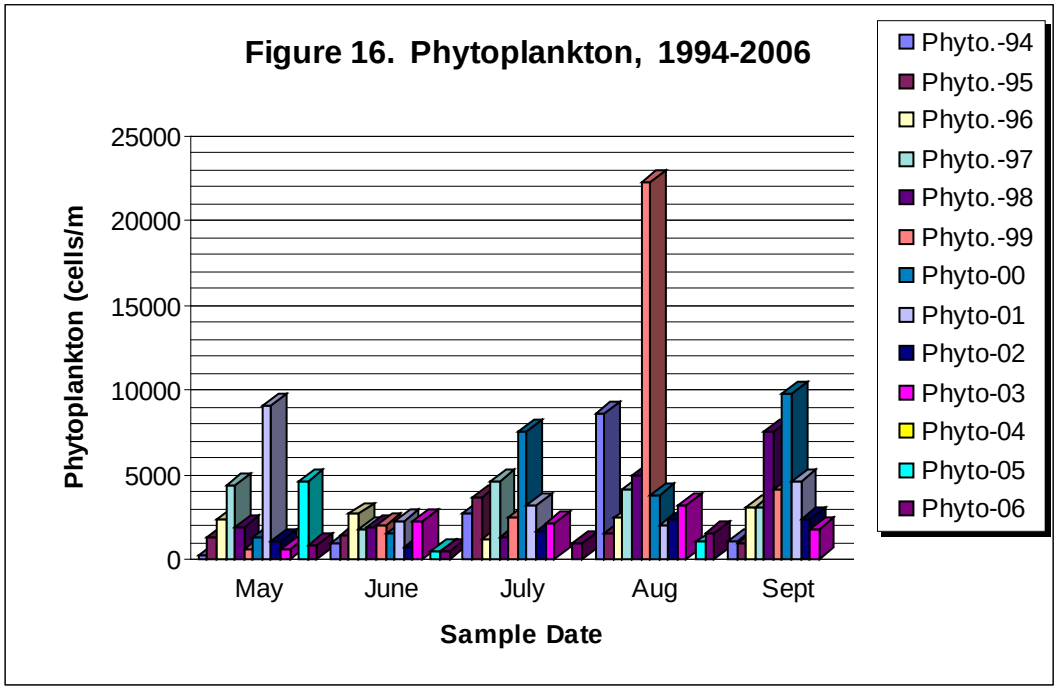




Chlorophyll-a and Phytoplankton

Figures 15 and 16 depict chlorophyll-*a* from 1994 through 2014 and phytoplankton levels from 1994 through 2006. The data show low concentrations in June and July within the oligotrophic range with increased concentrations in May, August and September within the mesotrophic range.





Conclusions

The overall water quality of Lake Terramuggus in 2014 remained good. Sample results are indicative of oligotrophic to mesotrophic conditions. No significant changes in water quality were observed in 2014 in comparison to previous years. Overall trends indicate continued anoxia in the lower levels of the lake below the thermocline in the summer.

E. Coli sample results indicated good bathing water quality throughout the summer season with just one sample date exceeding the State bathing water guidelines. Follow-up sampling on the day after showed E.Coli results below the bathing water standard.

Inlet samples in May and September showed water quality results similar to in-lake water quality conditions, indicating the lack of significant inputs of pollutants from the lake watershed.

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