Nantucket Island Ponds and Their Water Quality

Chapter 5

Maxcy Pond - 2014

5.0 Introduction

This chapter presents a summary and discussion of the physical, chemical and biological data collected from Maxcy Pond by Nantucket Land Council staff during 2014.

5.1 Results

Maxcy Pond was sampled on August 26th and September 15th 2014. The maximum water depth located in the pond was 5.1 feet (61 inches) on August 26th at the sampling location in the approximate center of the pond. The maximum water depth located on September 15th was 4.8 feet (58 inches).

Following the collection of temperature and dissolved oxygen profile data on August 26th, an integrate sample was collected from the surface down to 4 feet of depth for the chemistry and phytoplankton samples. A grab sample was not collected since the pond was so shallow.

The depth of integrate sample collection on September 15th also was from 0-4 feet of depth and there was no grab sample collected on this sampling date either.

5.1.1 Physical characteristics

General. Maxcy Pond has an irregular shape with a bulge along the western shoreline and its axis is oriented in a north-south direction (Figure 3.1). The surface area of the pond is estimated at about 10 acres. There are no permanent streams flowing into the pond, and there is no outlet located along the shoreline.

Figure 5.1 Aerial view of Maxcy Pond (from *Google*™ earth)

Maxcy Pond has a total depth of about 5 feet and is situated in a basin of low elevation which should provide some protection from winds blowing across the Island.

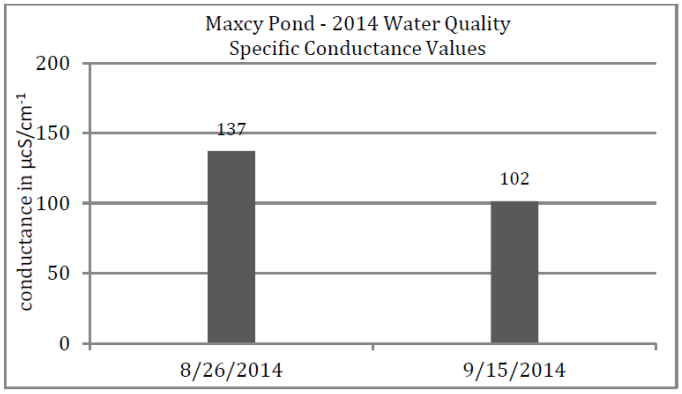
Temperature. Temperature profile data were collected on both 2014 sampling excursions to Maxcy Pond. The temperature collected on both sampling dates essentially was isothermal from the surface to the bottom; the average temperature of the water column was 24.1°C on August 26th and 20.8 °C on September 15th.

Transparency. The Secchi depth transparency measured at Maxcy Pond was 'on the bottom' on both sampling dates which means that the pond had exceptional clarity and was not deep enough to measure the actual Secchi depth transparency. In addition, the water color was noted as 'clear' on both sampling dates by NLC staff sampling the pond.

5.1.2 Chemical characteristics

Specific conductance. Figure 5.2 presents the specific conductance values measured at Maxcy Pond on August 26th and September 15th.

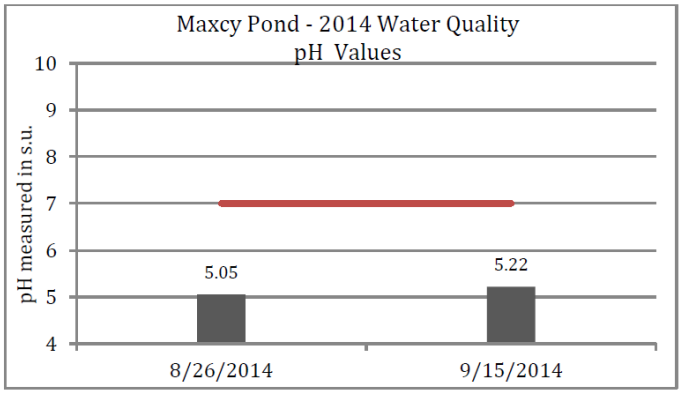
Figure 5.2 Specific conductance measured in Maxcy Pond, August-September 2014.



The results for the 2 integrate samples were similar; 137 and 102 $\mu S \cdot cm^{-1}$ on August 26th and September 15th, respectively, and the values measured in Maxcy Pond are low, but are within the range of specific conductance values expected in ponds considered to be fresh water.

pH. As shown in Figure 5.3, Maxcy Pond had an acid pH on both sampling dates, 5.05 s.u. on August 26th and 5.22 s.u. on September 15th.

Figure 5.3 pH measured in Maxcy Pond, August-September 2014.



The horizontal 'red' line show on Figure 5.3 indicates the region along the pH scale that is considered 'neutral'. Low pH such as measured in Maxcy Pond is characteristic of waters with low concentrations of dissolved ions and the acidic nature is due, in large part, to the bog-like nature of the vegetation along the pond shoreline.

Dissolved oxygen concentration-percent saturation. The maximum concentration of dissolved oxygen that can occur in water, in general, is a function of water temperature. Higher concentrations of dissolved oxygen occur in low water temperatures than at high temperature. Dissolved oxygen levels in water often are reported in 'percent saturation' since the calculation corrects for temperature and removes bias from the oxygen concentration readings.

The dissolved oxygen concentration and saturation values in Maxcy Pond during August and September 2014 were essentially the same from the surface of the pond down to the bottom and were not noteworthy for any particular reason.

The data collected on August 26th show average oxygen concentration and saturation values of 8.4 mg/L^{-1} and 100.5 percent, respectively, while the average values measured on September 15th were 8.4 and 94.1 percent, respectively.

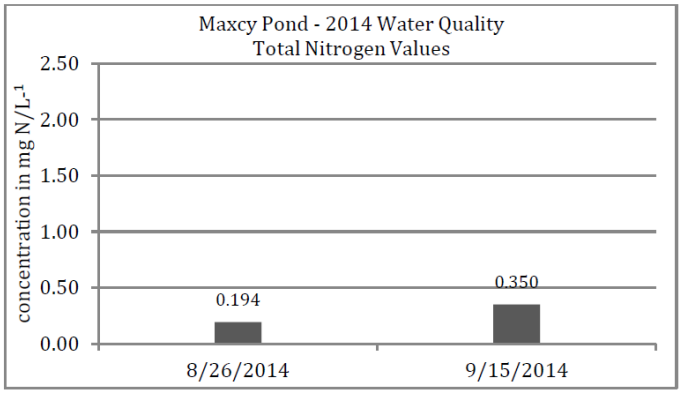
5.1.3 Plant Nutrients

Nitrogen. Nitrate-nitrogen was detectable in Maxcy Pond on August 26th and the concentration was 0.033 mg N·L^{-1}; on September 15th, the concentration was below the limit of detection which is 0.005 N·L^{-1}. Low (undetectable) **nitrate-nitro**gen levels is not an unusual phenomenon in fresh-water systems since this form of nitrogen is readily taken up by phytoplankton for metabolism when it is available in the water column.

Although there were measureable levels of **ammonia-nitrogen** in the water column on both sampling dates, the levels were low, which also is not unusual since this form of nitrogen is available for uptake by phytoplankton. The levels of **ammonia-nitrogen** measured in Maxcy Pond were as follows: 0.010 and 0.004 mg N·L^{-1} on August 26th and September 15th, respectively.

The **total nitrogen** (**TN**) concentrations measured in Maxcy Pond during August and September 2014 are presented in Figure 5.4.

Figure 5.4 Total nitrogen concentrations measured in Maxcy Pond, August-September 2014.

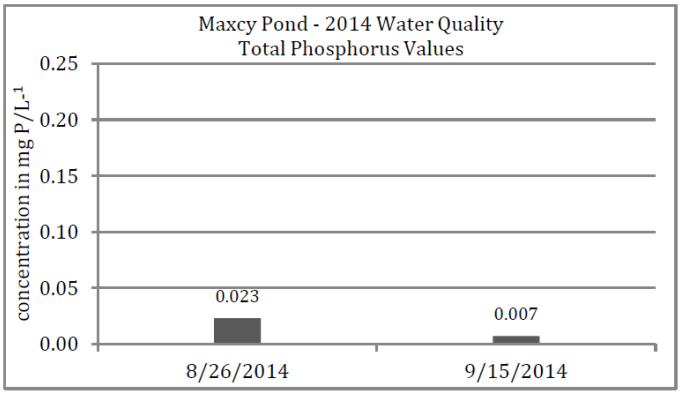


The **TN** concentrations measured in the pond were 0.194 mg N·L^{-1} on August 26th and 0.350 mg N·L^{-1} on September 15th, an average of 0.272 mg N·L^{-1} for both sampling dates, and are low concentrations when compared with other Nantucket Island ponds. Other ponds monitored by NLC staff during 2014 included Washing Pond and Tom Nevers Pond and average **TN** values from these ponds were 0.628 and 1.29 mg N·L^{-1}, respectively.

Phosphorus. The **total phosphorus** (**TP**) concentrations measured in Maxcy Pond during August-September 2014 are shown in Figure 5.5. On August 26th, the **TP** concentration was 0.023 mg P·L^{-1} in the

water column and by September 15th, the TP concentration had dropped to 0.007 mg P·L^{-1}. The average value for the 2014 season was 0.015 mg P·L^{-1}.

Figure 5.5 Total phosphorus concentrations measured in Maxcy Pond, August-September 2014.



The concentrations of TP measured in Maxcy Pond reflect low productivity in the system and this situation is considered normal in dilute systems such as Maxcy Pond. Situations similar to this one occur in the Adirondack Mountain region of New York State where lakes and ponds have been impacted by acid deposition and often reflect low productivity in the water column.

As a comparison to Maxcy Pond, average **TP** levels documented in other Nantucket Island ponds during 2014 were 0.077 mg P·L^{-1} in *Tom Nevers Pond* and 0.043 mg P·L^{-1} in *Washing Pond*.

5.1.4 Phytoplankton

Description of the assemblage. There were 29 taxa identified in the 2014 phytoplankton samples collected from Maxcy Pond and all of the major algal groups were represented in the samples (Table 5.1).

Table 5.1 Major groups and taxa of phytoplankton identified in Maxcy Pond, August-September 2014.

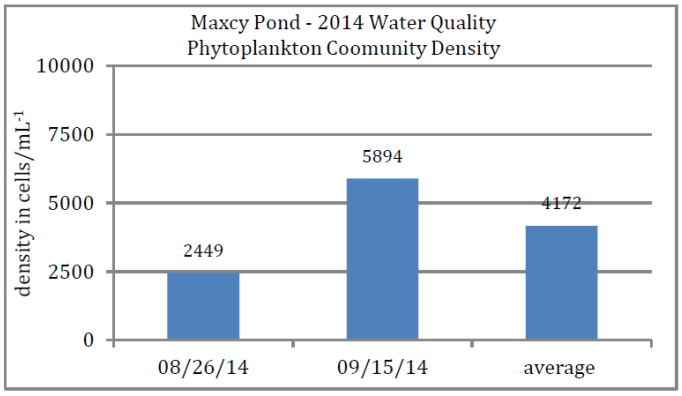
Cyanophytes	**Chlorophytes**	**Chrysophytes (Bacillariophyceae)**
Anabaena flos aquae	*Oocystis solitaria*	*Planothidium* sp.
Anabaenopsis Elenkinii	*Quadrigula lacustris*	**Chrysophytes (Chrysophyceae)**
Aphanizomenon flos aquae	*Scenedesmus bijuga*	*Dinobyron divergens*
Chroococcus dispersus	**Chrysophytes (Bacillariophyceae)**	*Ochromonas* sp.
Microcystis aeruginosa	*Achnanthes* sp.	**Euglenophytes**
Chlorophytes	*Asterionells formosa*	*Peranema* sp.
Ankistrodesmus falcatus	*Cocconeis* sp.	*Trachelomonas* sp.
A. convolutus	*Cyclotella* sp.	**Pyrrhophytes (Cryptophytes)**
Chlamydomonas sp.	*Gomphonema* spp.	*Cryptomonas erosa*
Closterium spp.	*Navicula* spp.	*C. ovata*
Monoraphidium contortum	*Nitzschia* sp.	**Pyrrhophytes (Dinophytes)**
Mougeotia sp.		*Peridinium cinctum*

There were 21 taxa identified in the pond's phytoplankton community on August 26th and 16 taxa on September 15th; community richness was calculated for the 2 sampling periods and was 18.5 (±3.5) taxa.

Density. The phytoplankton community density in Maxcy Pond was 2,449 cells·mL^{-1} on August 26th and 5,894 cells·mL^{-1} on September 15th, and the average density was 4,172 cells·mL^{-1} for both sampling dates (Figure 5.6). The phytoplankton densities measured in Macy Pond during 2014 are low when compared with other Island ponds that have been monitored by the report author during recent years. As mentioned

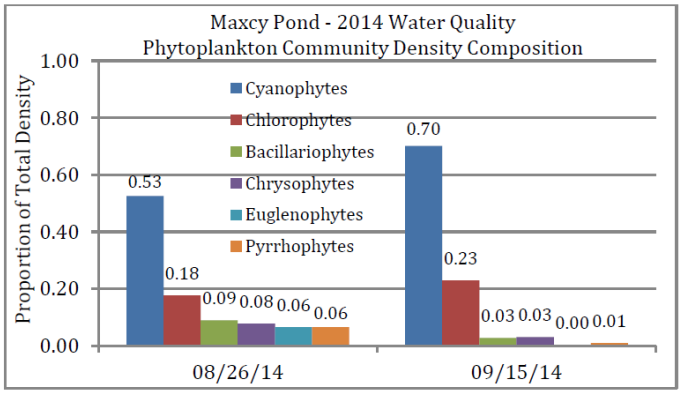
previously, Maxcy Pond appears to be a low productivity system that results from acidic conditions and this condition affects the physical, chemical and biological components of the pond.

Figure 5.6 Phytoplankton community density in Maxcy Pond, August-September 2014.



The August 26th phytoplankton assemblage in Maxcy Pond was comprised primarily of Cyanophytes (Blue-green algae) with 53 percent of the community density and Chlorophytes (green algae) with 18 percent of the community density (Figure 5.7).

Figure 5.7 Density composition of the phytoplankton community in Maxcy Pond, August-September 2014.



The other major phytoplankton groups, the Bacillariophytes (diatoms), the Chrysophytes, the Euglenophytes and the Pyrrhophytes, made up the remaining 29 percent of the community density on August 26th.

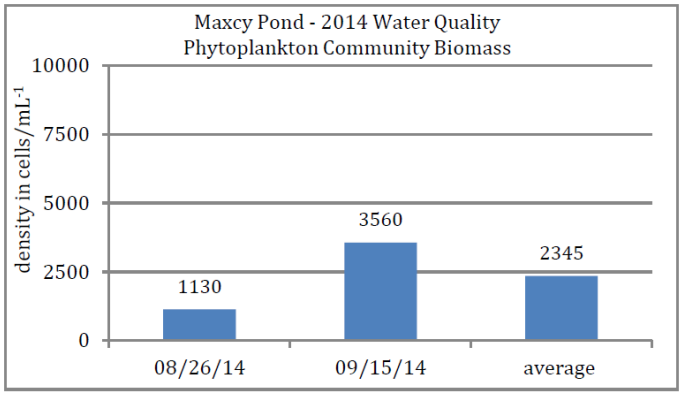
The relative importance of the Cyanophytes and the Chlorophytes increased on September 15th to 70 and 23 percent, respectively, while the other major groups of phytoplankton exhibited decreases in their relative proportion of the total density, comprising less than 10 percent of the community total on that sampling date.

Biomass. Cell biovolume also was used to evaluate phytoplankton taxon biomass, or productivity, since cell counts and conversion into density does not account for the significant size difference among the various phytoplankton taxa that occur in the pond. It is quite common for size differences among different types of phytoplankton of several orders of magnitude.

The 2014 phytoplankton community biomass documented in Maxcy Pond on August 26th and September 15th is presented in Figure 5.8. Biomass was low on both dates, 1,130 mg·m^{-3} on August 26th and 3,560 mg·m^{-3} on September 15th; the average biomass on the 2 sampling dates was 2,345 mg·m^{-3} (Figure 5.8). The low

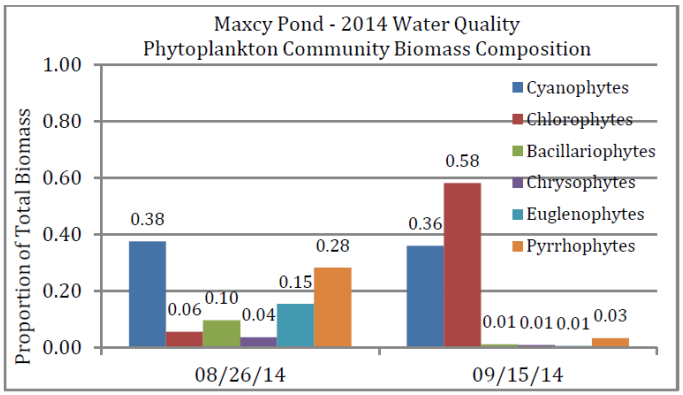
biomass documented on both 2014 sampling dates would explain the excellent water transparency recorded on that date since there was relatively little organic matter suspended in the water column to interfere with visual observations in the pond.

Figure 5.8 Phytoplankton community biomass in Maxcy Pond, August-September 2014.



The August 26th assemblage included primarily the Cyanophytes with 38 percent of the community density and the Pyrrhophytes (red-brown flagellated algae) with 28 percent of the community density (Figure 5.9). The other groups of phytoplankton in the assemblage were ranked as follows: Euglenophytes (15 percent), Bacillariophytes (10 percent), Chlorophytes (6 percent), and Chrysophytes (4 percent).

Figure 5.9 Biomass composition of the phytoplankton community in Maxcy Pond, August-September 2014.



By September 15th, the Cyanophytes comprised 36 percent of the community biomass and the Chlorophytes (green algae) had increased to 58 percent. The remaining groups of phytoplankton were distributed as follows: Pyrrhophytes (3 percent), Bacillariophytes, Chrysophytes and Euglenophytes (all with 1 percent).

Dominance. A ranking of phytoplankton taxa dominance in Maxcy Pond on the 2014 sampling dates is summarized in Table 5.2. Taxa are considered dominant in the community if they comprise at least 5 percent of the total community biomass.

There were 4 dominant taxa in the phytoplankton community on August 26th and 3 dominant taxa in the community on September 15th (Table 3.2). As discussed above, the Blue-green algae and red-brown flagellated algae comprised a major portion of the community in August, and in September, the greens, and Blue-greens were the major components of the community.

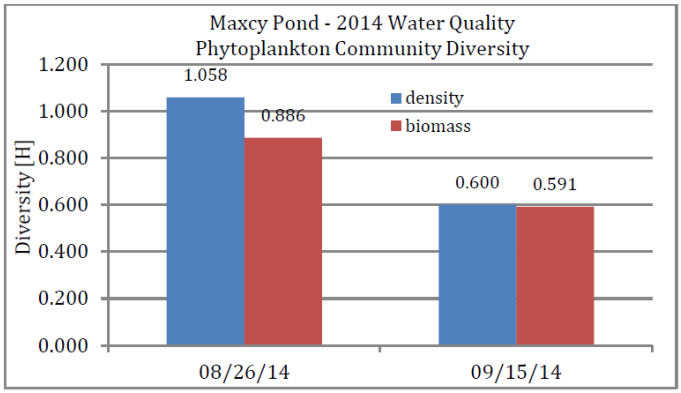
Table 5.2 Rank of phytoplankton taxa dominance, using biomass, in Maxcy Pond, August-September 2014.

Sampling Date	Taxon (Major Group)	Biomass Rank	% of Total Biomass
8/26/14	*Anabaena flos aquae* (Cyanophyte)	1	35
	Trachelomonas sp. (Euglenophyte)	2	15
	Peridinium cinctum (Pyrrhophyte)	3	15
	Cryptomonas erosa (Pyhhhophyte)	4	13
	Asterionella Formosa (Bacillariophyte)	1	6
9/15/14	*Mougeotia* sp. (Chlorophyte)	1	47
	Aphanizomenon flos aquae (Cyanophye)	2	35
	Cosmarium spp. (Chlorophyte)	3	8

Diversity. Phytoplankton diversity in Maxcy Pond was measured using the Shannon-Wiener function[1] which calculates diversity, **[H]**, using number of taxa and the portion of individuals among the taxa on each sampling date. An increase in either factor will increase the value of the diversity index. Calculated values that approach 1.0 indicate conditions of maximum diversity in the distribution of the population.

Diversity in Maxcy Pond was calculated using both density and biomass in the equation. The results of the diversity calculations are presented in Figure 5-10.

Figure 5-10. Phytoplankton community diversity in Maxcy Pond, August-September 2014.



The diversity calculations were very similar on each sampling date, regardless of whether density or biomass was used to evaluate this community characteristic (Figure 5-10). The important information in Figure 5-10 is the significant decline in diversity from August 26th to September 15th as a result of a greater proportion of the community residing within fewer individuals instead of more individuals. Cyanophytes and Chlorophytes comprised 94 percent of the total community on the September 15th sampling date.

Cyanophytes. As a major phytoplankton group of aquatic ecosystem importance, the Cyanophytes were identified in both the August and September samples collected in Maxcy Pond. A total of 5 taxa were identified including *Anabaena flos aquae*, *Anabaenopsis Elenkinii*, *Aphanizomenon flos aquae*, *Chroococcus dispersus*, and *Microcystis aeruginosa*. Three of these genera, *Anabaena, Aphanizomenon*, and *Microcystis* are known to produce algal toxins with a range of effects including liver, nerve, skin and gastrointestinal disorders. While there is no evidence that the phytoplankton genera documented in Maxcy Pond produce any algal toxins, recreational users of the pond should be aware that Cyanophytes (Blue-greens) are possible components of the mid-summer phytoplankton community.

[1] $H = -\sum_{i=1}^{s} (p_i)\,(log_2)(p_i)$, in units of information per individual per unit volume or area, where p_i is the proportion of the total samples belonging to the *i*th species and S is the number of species.

Chlorophyll *a*. The chlorophyll ***a*** concentrations measured in Maxcy Pond were 2.39 µg·L^{-1} on August 26th and 3.11 µg·L^{-1} on September 15th, indicating a low level of algal productivity in the pond on both occasions. The average chlorophyll ***a*** concentration for both 2014 sampling dates was 2.75 µg·L^{-1}.

In comparison to Maxcy Pond, chlorophyll ***a*** levels measured in Nantucket Island ponds during 2014 include an average of 4.18 µg·L^{-1} in *Tom Nevers Pond* during September and an average of 7.94 µg·L^{-1} in *Washing Pond* during August-September. (this report).

5.1.5 Trophic Status

'Trophic' means nutrition or growth. The trophic state of ponds refers to biological production, plant and animal, that occurs in the pond and the level of production is determined by several factors but primarily phosphorus supply to the pond and by the volume and residence time of water in the pond. Many different indicators are used to describe trophic state such as phosphorus, water clarity, chlorophyll, rooted plant growth and dissolved oxygen.

The reader is referred to Chapter 1 for a more thorough explanation of trophic status and the process of calculating this important indicator of lake and pond productivity.

Except for the absence of a valid Secchi depth on either sampling date, there were sufficient TP and chlorophyll ***a*** data from Maxcy Pond during 2014 to calculate the Carlson Trophic State Index (TSI) using those 2 variables. Average values were calculated for chlorophyll ***a*** and total phosphorus for the Ag=ugust and September sampling dates. The average values then were substituted into equations to calculate the TSI values for each variables. The stepwise calculation and results of the analysis are as follows:

Chlorophyll *a*
Average mid-summer chlorophyll *a* = 2.75 µg/L^{-1}
Chlorophyll *a* TSI = 9.81*[ln (2.75)] + 30.6
TSI = (9.81)(1.01) + 30.6
TSI = 40.5

Total phosphorus
Average mid-summer total phosphorus = 15.07 µg/L^{-1}
Total phosphorus TSI = 14.42*[ln (15.07)] + 4.15
TSI = (14.42)(2.71) + 4.15
TSI = 43.3

Table 5.3 summarizes Carlson's Trophic State Index in relation to the 3 independent water quality variables used as predictors and the trophic classification of lakes and ponds.

Table 5.3 Relationships among Trophic Index, chlorophyll *a*, phosphorus, Secchi depth and Trophic Class.

Trophic State Index	Chlorophyll (µg L^{-1})	TP (µg L^{-1})	Secchi Depth	Trophic Class
< 30 - 40	0.0 – 2.6	0.0 - 12	> 8 - 4	Oligotrophic
40 - 50	2.6 – 7.3	12 - 24	4 - 2	Mesotrophic
50 - 70	7.3 - 56	24 - 96	2 – 0.5	Eutrophic
70 – 100+	56 – 155+	96 – 384+	0.5 - <0.25	Hyper-eutrophic

Based upon the TSI values calculated using the 2014 data, Maxcy Pond was just within the mesotrophic region of productivity and close enough to the oligotrophic-mesotrophic boundary that even a slight change in pond conditions (significant input of rainfall, extended period of evapotranspiration) could cause the pond to shift in either direction. The TSI of 40.5 calculated for chlorophyll ***a*** was on the boundary of the

oligotrophic-mesotrophic scheme, while the TSI calculated for total phosphorus (43.3) was just within the mesotrophic zone.in the middle of the eutrophic region. The average 2014 Secchi depth (1.68 meters) resulted in a calculated TSI value of 52.5 which was just above the mesotrophic-eutrophic threshold of 50. The TSI values calculated from the TP and chlorophyll a variables for Maxcy Pond during 2014 accurately portray the low productivity water quality that was observed on the pond during the August-September sampling excursions.

5.2 Summary

Nantucket has a large number of ponds as compared with the relatively small surface area of the island. And while many of these ponds are used and enjoyed recreationally by Island residents and visitors to the Island, very few of the ponds have any information available concerning water quality. During 2014, the Nantucket Land Council embarked on an effort to monitor different Island ponds and collect data so that some base-line record of water quality could be established and used as a reference by subsequent generations of individuals who inherit the Island and its water resources. Evaluating the water quality of Island ponds and becoming proactive to protect some of these threatened resources is a display of good stewardship and the NLC is to be applauded for its effort in this regard.

5.3 Literature Cited

Carlson, R. E. and J. Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.

Carlson, R. E. 1977. A trophic state index for lakes. Limnol. Oceanogr. 22(2): 361-369.