Friends of the Bay
Volunteer Water Quality Monitoring Program
2002 Annual Report

Working to keep the oyster in Oyster Bay

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Acknowledgments

Friends of the Bay would like to thank the individuals and organizations that make our water quality monitoring program possible.

The McAllister Family - Donald Jr., Maureen and Liane McAllister, residents of Center Island for their financial donation provided the following needed items: "How's the Water? Educational Display boards, Depth Finder, YSI repairs, and Drink holders.

Carolina Skiff - In 2000**,** Carolina Skiff provided a brand new 19' Carolina Skiff Semi-V Hull boat at a 50% discount. The "semi-v" hull provides a stable work platform for volunteers to conduct water quality monitoring, education programs, harbor clean-ups, and for members of the press to photograph events.

Evinrude -Evinrude through its government sales office enabled Friends of the Bay to purchase the 70 horsepower 4-stroke engine for 40% off the regular price. The more environmentally friendly 4-stroke engine, which burns 31% less fuel than a 2-stroke engine, does not discharge oil into the bay and meets the EPA 2006 emissions regulations.

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Water Quality Monitoring Work Group - As a participant in the Water Quality Monitoring Work Group,
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Tow/Boat US and North Shore Diving Services – Mitch Kramer has graciously agreed to support "Baywatch II" in "any way he can."

Polly Weingard

Volunteers -

★Paul Amundson* ★Penn Berens* ★O. J. Donovan* ★David Gaspar★Scott Gurney*
★Alena Hornakova ★Chip Maran,★Catherine McConnell* ★Jim Monk ★Scott Nazarewicz
★Audie O'Connor* ★Charlie Parente,★Jeremiah Relyea* ★Margaret Rendich* ★Ailene Rogers
★Sean Santos, ★Billy Trauernecht,★Sandy Walczyk**.** ** Have volunteered for two or more years*

Executive Summary

Friends of the Bay's Volunteer Water Quality Monitoring Program is an important component of our efforts to preserve the Oyster Bay – Cold Spring Harbor ecosystem while serving to increase public awareness of local threats to water quality. This program was developed in cooperation with the United States Environmental Protection Agency, New York State Department of Environmental Conservation, local governments, and other volunteer monitoring groups around Long Island Sound.

The year 2002 was marked by significant expansion of the program; the number of stations doubled, we added a new water quality monitoring parameter and started to monitor the wildlife in the area. FOB went out on the water 27 times between April 8th and October 28th, and collected over 1,500 samples of water that were analyzed for coliform bacteria (1062) and nitrogen pollution (508) and took over 2,000 readings of both dissolved oxygen and temperature around the bay. Friends of the Bay monitored nineteen locations throughout Oyster Bay and Cold Spring Harbor. Fifteen sites were monitored for dissolved oxygen depletion, coliform bacteria pollution, salinity, temperature, water clarity and enrichment by nitrogen. An additional four sites were tested for coliform bacteria counts only. Each of the sites were tested one day every week in the morning hours.

In the spring of 2002, Friends of the Bay initiated a Bilge Sock Education program by distributing bilge socks and educational pamphlets to inboard motorboat owners in the hope of preventing oil pollution in Oyster Bay and Cold Spring Harbor. Additionally, FOB installed three monitoring boards that inform the public about weekly changes in the water quality in their area. Further public outreach was achieved also through a regular weekly column in the Enterprise Pilot titled “How’s the Water”.

Three major water quality parameters were monitored in 2002: coliform bacteria levels, dissolved oxygen levels and enrichment of the water by nitrogen. Analysis of this season’s data provided many interesting insights into water quality in Oyster Bay Estuary.

The first nitrogen monitoring season provided an initial glance at nutrient enrichment problems in the Oyster Bay estuary. The total nitrogen levels revealed yet another area of concern at stations in CSH and MNC. Yet, the total nitrogen levels in the whole estuary suggest that more attention should be paid to nitrogen loadings that enter the bay.

Dissolved oxygen data shows that every site failed to meet the New York State Dissolved Oxygen Standard of 5.0 mg/L at least five times during the monitoring season and eight of the fifteen stations were hypoxic (dissolved oxygen levels less than 3.0 mg/L) at least once.

While coliform bacteria levels still present a challenge in regard to NYS standard for shell fishing, one positive development was observed. The data indicated that MNC waters marked the first significant decrease of both total and fecal coliform levels in three years. These changes seem to be promising since this season had its highest precipitation in the past three years. On the other hand, the data gathered at two new stations in inner CSH indicate that this area is suffering from a multitude of pollution problems: high levels of coliform bacteria, severe hypoxia and enrichment by nutrients.

All waters in the Oyster Bay estuary need protection. However, the management efforts should be more focused on the areas of concern such as CSH Inner Harbor and MNC Beaver Lake and Oak Neck Creek area.

Friends of the Bay looks forward to a successful 2003 season by continuing to work with volunteers, government agencies, and fellow not-for-profit organizations. Together we will continue to improve and expand our monitoring program while providing a link to show how investment in water quality protection is improving Oyster Bay and Cold Spring Harbor.

1. Introduction

Noticeable changes and exciting prospects are occurring around Oyster Bay and Cold Spring Harbor. In 2002, Friends of the Bay doubled our Volunteer Water Quality Monitoring Program adding new stations, parameters and a public education component to the program. We also implemented a Bilge Sock Education Campaign to educate motorboat owners on oil pollution prevention measures which we hope will reduce oil pollution in Oyster Bay, Cold Spring Harbor, and the Long Island Sound. Additionally, we assisted in the completion of a wetland restoration project in Center Island through the installation of a self regulating tide gate; the first to be installed in New York State.

In conjunction with the NYS Department of Environmental Conservation and the Nassau County Soil and Water Conservation District, Friends of the Bay also applied for funding to install a fish ladder to enable fish migration from Mill Neck Creek to Beaver Lake.

Similarly, the Town of Oyster Bay applied for funding to help install the needed package sewage treatment plant in Mill Neck Creek using funding from the New York State Clean Water/Clean Air Bond Act. The Oyster Bay Sewage Treatment Plant has already received Clean Water/Clean Air Bond Act funding which they will be using to upgrade its facility in order to remove nitrogen from the water they treat.

At the Western Waterfront, the grading and planting of grass on the Jakobson shipyard, the completion of the pier and remodeling of the tin buildings continues to beautify the area while increasing public use of the area. It is through the dedication and organized effort between Senator Marcellino, NYS DEC, the Town of Oyster Bay, the Waterfront Center, Nassau County Soil and Water Conservation District and Friends of the Bay that these improvements are occurring.

So how will all these changes affect Oyster Bay and Cold Spring Harbor's water quality? Friends of the Bay will continue to conduct and expand the volunteer water quality program, once a week, from April through October to determine just that!

Started in 1987 as a small group of citizens concerned about the impact of a proposed massive development on Oyster Bay's waterfront, Friends of the Bay has grown into a powerful voice representing over 2,000 area residents and businesses. We are committed to the preservation of Oyster Bay, Cold Spring Harbor and our surrounding upland communities.

Specifically, our mission is to promote community awareness of the need to preserve water quality and marine life in the estuary. We are also dedicated to assuring the aesthetic, economic and recreational value of Oyster Bay and Cold Spring Harbor and to ensuring that development in the watershed is compatible with the needs of a healthy ecosystem. As a representative of the local citizenry, we have developed a wide range of programs that expand public knowledge concerning issues in the bay. One of our most important programs is the volunteer water quality monitoring program.

Friends of the Bay has initiated a Volunteer Water Quality Monitoring Program to fill the void left by county cutbacks. This program was developed in cooperation with the United States Environmental Protection Agency, New York State Department of Environmental Conservation, local governments and other volunteer monitoring groups around the Long Island Sound. Friends of the Bay considers this program a necessary component in the effort to preserve the Oyster Bay – Cold Spring Harbor ecosystem and hopes to increase public awareness of local threats to water quality. The water quality program of Friends of the Bay is being conducted to:

1. Provide high quality data to continue the dissolved oxygen-testing baseline established by the Nassau County Department of Health in 1972
2. Screen for water quality impairments
3. Determine long-term water quality trends
4. Educate and involve citizens in surface water quality protection
5. Document effects of water quality improvements
6. Act as a watchdog for harbor activities
7. Assist local, state, and federal agencies in harbor management

This program enables trained volunteers working along side environmental scientists to monitor various components of the marine ecosystem. Volunteers track a number of elements in the bay including water temperature, clarity, salinity, dissolved oxygen, nitrogen and coliform bacteria. Measuring these parameters enables Friends of the Bay to better understand changes within the local marine ecosystem.

September 21, FOB annual beach clean up – FOB and volunteers collected over 500 lb of garbage at Beakman and Center Island Beach.

2. Methods

Every Monday morning from April through October 2002, Friends of the Bay staff and dedicated volunteers monitored the quality of the water at nineteen sites within Oyster Bay and Cold Spring Harbor. The parameters measured by Friends of the Bay included dissolved oxygen, salinity, water temperature, water clarity, coliform bacteria, and nitrogen species. Dissolved oxygen, salinity, and water temperature were measured using a Yellow Springs Instruments (YSI) Model 85 and 58. Water clarity was measured using a Secchi Disk. Coliform bacteria and nitrogen species samples were also collected by Friends of the Bay and analyzed by the Nassau County Department of Health (NCDH) and South Mall Analytical laboratories respectively.

The following is a summary of the water quality testing methods. A more complete description can be found in our Standard Operating Procedures and Draft Quality Assurance Project Plan.

Monitoring Locations – Friends of the Bay monitored a total of nineteen sites throughout Cold Spring Harbor and Oyster Bay. For details see the map in Figure 1. GPS coordinates for each station are listed in Appendix 1.

The following 15 sites were monitored for dissolved oxygen, temperature, salinity, water clarity, nitrogen species, and bacteria: Cold Spring Harbor Cove, as far south as tide permits (FB-10), northeast side of Cold Spring Harbor sand bar (FB-11), mid-channel CSH by Mobil oil terminal (FB-1), mid -channel CSH north of Charles Wang's dock (FB-2).

Sites in Oyster Bay include: Buoy “4” near Plum Point at the entrance to Oyster Bay and Cold Spring Harbor (FB-3), Seawanhaka Yacht Club Cove (FB-12), Oyster Bay Cove/Tiffany's Creek (FB-13), Oyster Bay STP/Whites Creek (by Commander Oil) (FB-14), Roosevelt Beach two hundred yards north off of the flag pole in Roosevelt Park (FB-4), Beekman Beach/Mill Creek (FB-15), West Harbor midway between the east and west shores (FB-5), and Turtle Cove (FB-16), the main channel of Mill Neck Creek (FB-6), and at the warning buoy of the FM Flower and Son's Oyster Company Hatchery (FB-19).

Due to fluctuating tide levels, the following four sites are monitored for coliform bacteria levels only: the confluence of the two branches of Mill Neck and Oak Neck Creek (FB-7), as close to Beaver Dam (south) as the tide permits (FB-8), as far north in Oak Neck Creek as the tide permits (FB-9), by the USFWS Wildlife Refuge sign at the Birches Housing development (FB-18).

Dissolved Oxygen and Water Temperature - Friends of the Bay monitored dissolved oxygen (DO) and water temperature at fifteen monitoring sites using YSI 85. At each station, dissolved oxygen readings were taken at one half-meter above the bay bottom, at one-half meter below the water's surface and at one-meter intervals between the top and bottom. DO is measured in milligrams per liter (mg/L) which is equivalent to parts per million (ppm).

Salinity - Salinity is the measurement of the concentration of dissolved salts in the water. Friends of the Bay used a hydrometer to measure the specific gravity of the water. Salinity is then calculated using specific gravity-temperature conversion tables published in the US EPA Volunteer Estuary Monitoring Program (1993). Salinity is expressed in parts per thousand (ppt).

Water Clarity - Friends of the Bay measured water clarity with a Secchi disk. The disk is 8-inches in diameter and is divided into four alternating black and white quadrants. The disk is lowered into the water on the shaded side of the boat. The point at which the disk becomes completely obscured is noted. The disk is then raised and the point at which the disk becomes visible again is noted. The average of these two numbers is the Secchi Depth - recorded to the nearest tenth of a meter (decimeter).

Coliform Bacteria - Water samples are collected by Friends of the Bay in plastic *Whirl-Packs about* one foot below the water surface which is then stored in a cooler with ice and transported immediately to the Nassau County Department of Health's (NCDH) laboratory in Hempstead for analysis. The NCDH uses the Multiple-Tube Fermentation Technique - Method No.9221 (Standard Methods for the Examination of Water and Wastewater, 1995). The laboratory uses a 5-tube decimal dilution test. The level of total and fecal coliform bacteria in a water sample is expressed as the most probable number per 100ml (MPN/100ml). To ensure that proper temperature standards are met an additional water sample is collected at the first station and designated as the temperature control (TC). It is placed in the cooler with the ice and upon arrival at the NCDH laboratory the TC temperature is immediately recorded. If the TC temperature exceeds 10°C the datasheet is marked as an indication that the data may have been compromised.

Nutrients - Nitrogen species water samples are collected from the water surface in plastic quart containers containing sulfuric acid and placed into a cooler with ice packs. They are then transported to South Mall Analytical Laboratories located in Plainview, NY.. The water samples are tested for different forms of nitrogen: nitrate/nitrite-N, ammonia-N, organic nitrogen; collectively called nitrogen species. The techniques used for analysis include the following methods from Standard Methods for the Examination of Water and Wastewater (1995), 19th edition: Nitrate/nitrite-N (mg/L) 4500-NO_3 -E[1]& 4500-NO_2-B[1], Total Kjeldahl Nitrogen (mg/L) 4500-N_{org}-B[1], Ammonia-N (mg/L) 4500-NH_3-D[1]. Total Kjeldahl nitrogen determines organic-N and ammonia-N concentrations collectively. Organic-N is then calculated as difference of Total Kjeldahl nitrogen and ammonia-N that is determined by method 4500-NH_3-D[1].

Other Parameters – Further information collected at the sites include: the time the sample was taken (hour: minute); air temperature (°C); wind direction (1 of 8 directions); wind speed (estimate in 5 mph increments); wave height (0.5 ft increments); weather conditions (on a predetermined 1-6 scale); and any unusual conditions (i.e. odors, fish kills, water color, debris).

Figure 1. Map of Oyster Bay Estuary delineating position of monitoring stations

3. Results, Analysis, & Discussion

In 2002, Friends of the Bay monitored three water quality parameters: coliform bacteria, dissolved oxygen and nutrient enrichment by nitrogen. Furthermore, physical parameters such as salinity, turbidity, water and air temperature were measured and general observations on water and weather conditions were made. See Water Quality Data Sheet in Appendix 2 for a complete list of parameters monitored.

With the help of volunteers, our Environmental analyst monitored the quality of the water every Monday morning from April 8th until October 28th. Nineteen locations were monitored this year altogether on 29 monitoring days: four in Cold Spring Harbor, eight in Oyster Bay Harbor and seven in Mill Neck Creek (Figure 1).

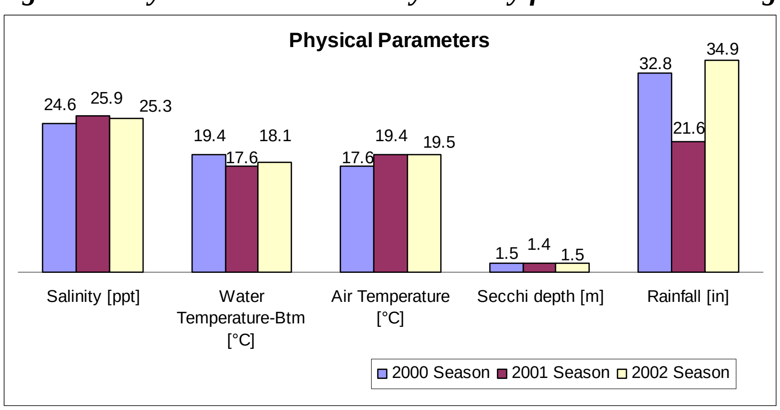
The data gathered in the 2002 season were analyzed spatially and temporally. The estuary was divided into three areas: Cold Spring Harbor, Oyster Bay Harbor and Mill Neck Creek. This division is a result of certain spatial characteristics of the estuarine environment such as, separate sources of fresh water/watersheds, differences in land use and partial physical separation by moraines. Such spatial analysis of the data was used previously by NCDH and also in previous FOB reports. Furthermore, in this report we have summarized the quality of water in (a Wildlife Refuge Area.?)

For each water quality parameter, the status of the entire bay is analyzed and the results are compared to the previous seasons. Each area is described separately and the seasonal variations in each parameter are discussed. The results are then compared to the NYS water quality standards.

3.1 Physical Parameters

Salinity, water temperature, air temperature, and water clarity were measured at each monitoring station throughout the season. Seasonal averages for each station are summarized in Appendix 3. Figure 2 shows the cumulative seasonal averages of monitored parameters for Oyster Bay in the previous three monitoring seasons.

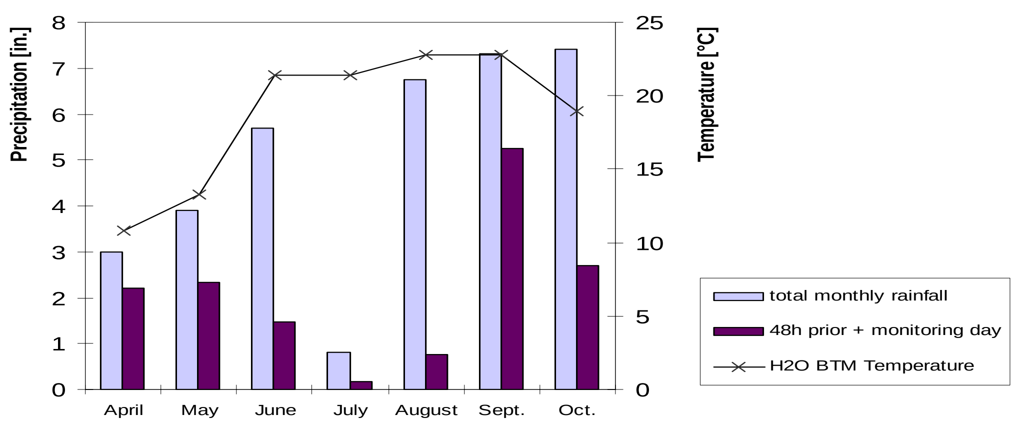
Figure 2. Physical conditions in Oyster Bay for three monitoring seasons



Salinity, temperature, tidal stage and rainfall all directly affect the levels of nutrients, dissolved oxygen and coliform bacteria in the water column. For example, the more saline the water the less oxygen the water will hold. Throughout the season, salinity in the estuary fluctuated between 20 and 30 ppt. This fluctuation is quite natural as salinity changes somewhat in marine environments with freshwater tributaries. The levels of dissolved salts are also influenced by tidal stage, rainfall and temperature. Appendix 4 contains tidal information for the 2002 monitoring season.

Rainfall directly influences coliform bacteria levels, water clarity, and the levels of nutrients in the bay. Compared to the two previous years, the 2002 monitoring season was marked by the highest level of precipitation. As shown in Figure 3, the Oyster Bay area received the most rain during the months of June, August, September and October. However, in April, May and September the rainfall events were concentrated around the monitoring days. Figure 3 also depicts a cumulative amount of rainfall that occured 48 hours prior to the monitoring day including the amount during the monitoring. Rainfall influences the results of monitoring the most when closest to the actual day of sampling.

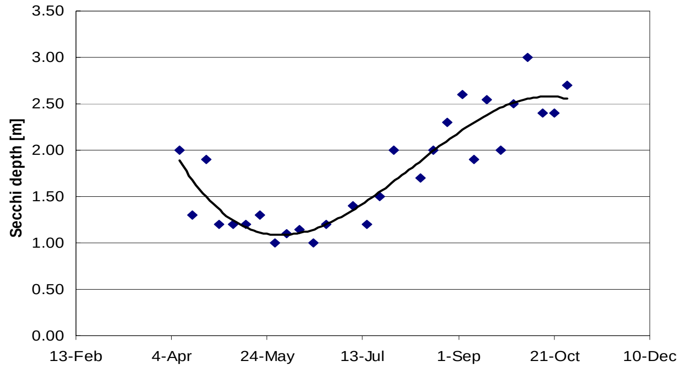
Figure 3. 2002 Monthly precipitation and average bottom water temperatures in Oyster Bay



Source: Rainfall data from Frank M. Flower and Sons Oyster Company

As shown in Figure 2, seasonal averages for water clarity, measured by a Secchi Disk, remained unchanged for three previous years. Differences of 0.1 meters are insignificant using the Secchi disc method. Figure 4 represents the typical seasonal profile of water clarity in Oyster Bay..

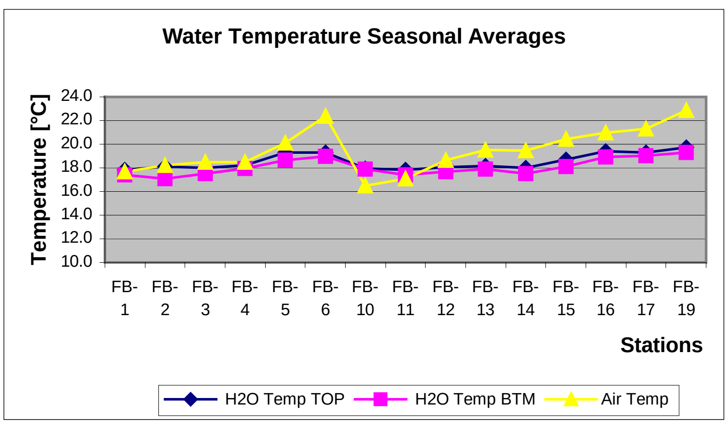
Figure 4. 2002 Water Turbidity Profile at FB-3 measured by Secchi disk method



Water clarity declines in late spring reaching its lowest levels in May, June and July and then begins to improve. Higher levels of turbidity, presented as reduced water clarity, seem to correspond with spring algal blooms reported by several authors (LISS, 1994).

As depicted in Figure 2, the average temperature on the bottom of the water column was slightly higher than last year. Figure 5 shows seasonal averages for water and air temperature at each monitoring station. The differences among the stations are mainly due to the lag in time when each station is monitored. Thus, stations that are monitored early in the morning (FB 1, 2, 10, 11) have lower average temperatures than stations monitored in later morning hours (FB 6, 17, 19). These differences (are particularly true?) about average air temperature. Water temperature is also affected by precipitation and the mixing of fresh and salt waters.

Figure 4. Seasonal Averages for Water and Air Temperature



As noted above, physical parameters influence water quality in a profound way. It is important to monitor these parameters as they help us to better understand temporal and spatial changes in the quality of the bay.

3.2 Coliform Bacteria

Coliform bacteria are introduced into the marine environment through various point and non-point sources such as surface water runoff, industrial and agricultural discharges or wastewater sewage discharges. In NYS, they are used as an indicator of the possible presence of human pathogens. The New York Code of Rules and Regulations (NYCRR) specifies levels of total and fecal coliform bacteria that should be met in bodies of water designated for different purposes. Waters used for shellfish cultivation and harvest have to meet the most stringent bacteriological criteria. Table 1 summarizes shellfish and bathing standards for total and fecal coliform bacteria enforced by NYS.

Table 1: NYS Coliform Bacteria Standards

	Shellfishing Open*	**Swimming Open****
Total Coliform	LOG AVG < 70mpn/100ml and If < 10% of samples do not exceed 230 *mpn/100 ml*	LOG AVG 30 days < 2,400mpn/100ml If < 20% of samples do not exceed 5,000 *mpn/100 ml* (min.5 samples)
Fecal Coliform	LOG AVG <14 mpn/100 ml and If < 10% of samples do not exceed 43 *mpn/100 ml*	LOG AVG 30 days < 200mpn/100ml (min. 5 samples)

* 6NYCRR §47.3
**6NYCRR §703.4 and NYS Sanitary Code

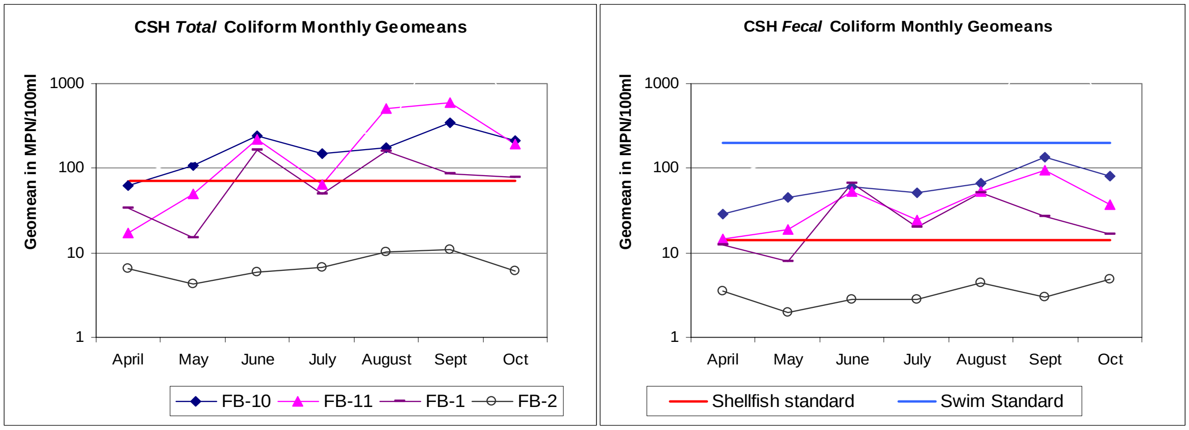
Total coliform and fecal bacteria levels were measured at all nineteen locations this year. Monthly geometric means are being used for the data collected in 2002 with NYS water quality standards. The seasonal geometric mean is being used to compare the 2002 data with data from previous years. The complete coliform counts for the entire Oyster Bay area are represented in Appendix 5.

Cold Spring Harbor

Four stations were monitored for coliform bacteria in Cold Spring Harbor this year. Stations 10 and 11 were added to this year's monitoring program. Coliform bacteria levels are reported as monthly logarithmic average (also known as the geometric mean). These monthly geomeans were compared to the NYS coliform bacteria standards for shell fishing and swimming.

Figure 5 represents the 2002 total and fecal coliform bacteria geometric means for each station. The monthly geomeans show that only one station in CSH (FB-2) complied with the NYS shellfish standards for the whole season. The other three stations failed to comply with the NYS shellfish standards for both total and fecal coliform bacteria for most of the monitoring season. However, all the stations were in compliance with the NYS standard for open swimming this year.

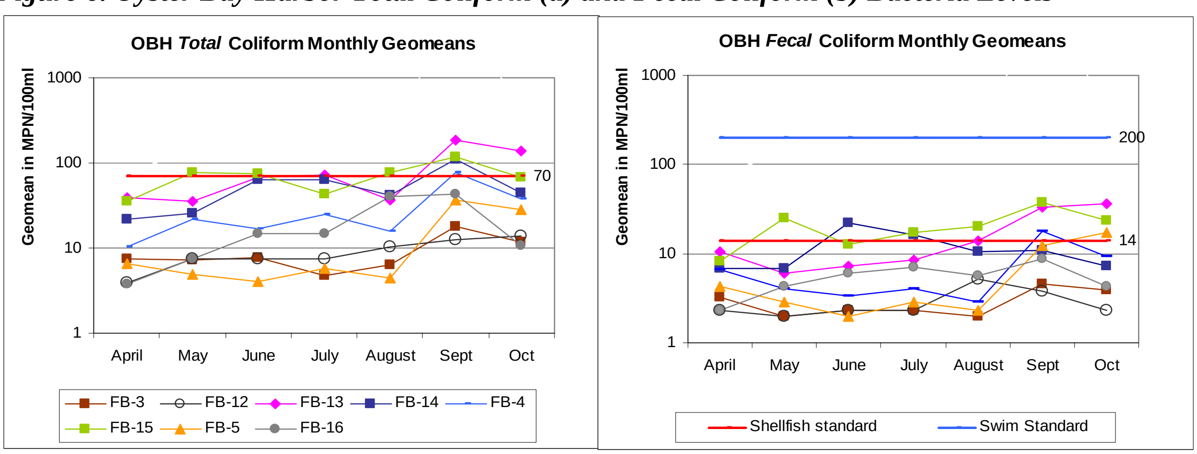
Figure 5. Monthly Geometric Means for Total and Fecal Coliform Bacteria in Cold Spring Harbor



Oyster Bay Harbor

A total of eight stations were monitored for coliform bacteria in Oyster Bay Harbor this year. Three stations (3,4,5) were monitored also in previous years and five new stations (12,13,14,15,16) were added to this monitoring season. The levels of total and fecal coliform bacteria, at three formerly monitored stations, dropped in comparison to previous years. In 2002, five stations (3,4,5,12,16) met the NYS water quality criteria for shell fishing. However, as can be seen from Figure 6, the total and fecal coliform bacteria monthly geomeans at stations FB-13, 14, and 15 failed to meet the standards on several occasions. On the whole, Oyster Bay Harbor's seasonal geomean for total and fecal coliform bacteria was superior to that of CSH and MNC waters.

Figure 6. Oyster Bay Harbor Total Coliform (a) and Fecal Coliform (b) Bacteria Levels



Mill Neck Creek

In 2002, seven stations were monitored in MNC for coliform bacteria pollution. Four stations (6,7,8,9) were monitored in previous years and three new stations (17,18,19) were added to the monitoring program this year. Due to the low tide, the station FB-18 was inaccessible 17 times out of 29 monitoring days. Therefore, the analysis is based on a much smaller pool of data, which might have affected the station's statistical analysis results.

The figures in Table 2 indicate that none of the stations in MNC met the NYS criteria for waters designated for shell fishing. Stations either exceeded the geometric mean standard or had more than 10% of samples over the set standard (90th percentile).

Table 2. Seasonal Geomeans and 90th percentiles for MNC stations

Station	Total Coliform Seasonal geomean	Total Coliform 90th percentile	Fecal Coliform Seasonal geomean	Fecal Coliform 90th percentile
FB-19	56	265	26	170
FB-17	47	360	14	54
FB-6	59	300	17	134
FB-7	94	450	36	284
FB-8	438	2510	143	1140
FB-9	298	2510	78	340
FB-18*	875	3380	134	293
NYS Standard	**70**	**230**	**14**	**43**

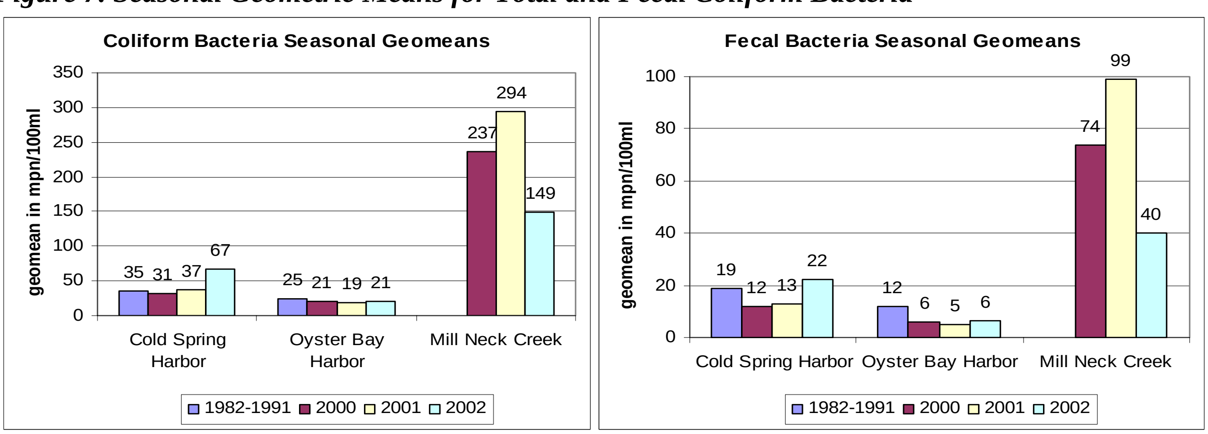
*based on limited data set

Station FB-8 had the highest overall fecal and total coliform bacteria geometric means while Station FB-9 had the second highest levels. The data suggest that the southern part of MNC (FB-8) is the largest contributor of coliform bacteria pollution in Mill Neck Creek. Station FB-18 shows high levels of coliform bacteria as well. However, more samples should be collected in the next season to conclude whether this station has indeed the highest levels of bacteria, . With only 12 samples (29 for other stations) in 2002, we are able to conclude that there is some indication that this station's level of bacterial pollution might be similar to that of station FB-8.

Oyster Bay Estuary

Overall the levels of coliform bacteria in the estuary marked significant changes since last year's monitoring season. As can be seen from Figure 5, seasonal geomeans suggest that the most pronounced changes in coliform bacteria levels were observed in Cold Spring Harbor and Mill Neck Creek.

Figure 7. Seasonal Geometric Means for Total and Fecal Coliform Bacteria



Oyster Bay Harbor (OBH) maintained similar levels for the past three years. It is encouraging to note that the addition of five new stations in this area did not adversely affect the OBH coliform bacteria seasonal mean. A decline of fecal coliform levels from a ten-year average for OBH is not a real change in levels. Rather it is caused by differences in data collection methods. The Nassau County Department of Health used to combine data from Mill Neck Creek with Oyster Bay Harbor data.

The apparent spike in the ***Cold Spring Harbor (CSH)*** coliform levels is primarily due to adding two new monitoring stations that are close to the shore (FB-10 and 11). (This suggestion is supported by the outcome of the comparison of this year's monthly geomeans with the data from previous years for two stations that were monitored consistently for three years.) This comparison indicates that the stations FB-1 and FB-2 did not show any significant changes in coliform bacteria levels throughout the last three monitoring seasons. Therefore, adding two new stations contributed to elevated levels of coliform bacteria in this area. As shown in Figure 5, these two new stations had a higher total and fecal coliform count than the other two stations in CSH for most of the season.

On a seasonal basis, the geometric mean for total and fecal coliform bacteria in ***Mill Neck Creek*** is clearly higher than the shellfishing standard (Table 1). However, the data in Figure 7 indicates a significant decrease in both total and fecal coliform bacteria levels compared to the results from the previous two years. A comparison of the three years of collected data for the stations that were monitored in previous years (FB-6,7,8,9) revealed that indeed there is some improvement in both total and fecal coliform levels in all the stations in the area (Table 3).

Table 3. Stations' seasonal geometric means for past three years

	FB-1		***FB-2***		***FB-3***		***FB-4***		***FB-5***		***FB-6***		***FB-7***		***FB-8***		***FB-9***	
	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC
2000	49	23	19	6	19	6	28	6	19	7	90	36	176	54	564	130	361	111
2001	117	38	11	5	11	4	26	6	24	7	138	40	201	77	560	192	480	165
2002	86	28	7	3	8	3	24	6	9	5	59	17	94	36	438	143	298	78

Bathing Waters

Table 3 applies the Bathing Water Quality Standards used by the Nassau County Department of Health in their water quality assessments of bathing beaches (Appendix 7). On the whole, bathing water quality in the estuary improved in 2002. Compared to the last season, stations FB-5, FB-6, FB-7 and FB-9 upgraded their seasonal ratings (shaded). The ratings of the rest of the stations remained unchanged since 2001. As summarized in Table 4, OBH exhibits the best water quality in the Oyster Bay estuary according to the NCDH bathing standards. Stations located in CSH were rated good to excellent. MNC waters received ratings all over the scale: from passable (8, 18) to excellent (17,19).

Table 4. Stations' Rating According to Bathing Water Quality Standards

Station name	St. No.	2002 Rating	2001 Rating
CSH South	FB-1	Very good	Very good
CSH North	FB-2	Excellent	Excellent
Plum Point	FB-3	Excellent	Excellent
Roosevelt Beach	FB-4	Excellent	Excellent

West Harbor	FB-5	Excellent	Very good
Mill Neck Creek-East	FB-6	Excellent	Very good
Mill Neck Creek -West*	FB-7	Very good	Good
Mill Neck Creek- South*	FB-8	Passable	Passable
Mill Neck Creek-North*	FB-9	Good	Passable
South Cold Spring Harbor Cove	FB-10	Very good	-
CSH Cove North Mooring Field	FB-11	Good	-
Seawanhaka Yacht Club PSTP outfall	FB-12	Excellent	-
Oyster Bay Cove	FB-13	Excellent	-
Whites Creek and OB-STP outfall	FB-14	Excellent	-
Beekman Beach and Mill Pond outfall	FB-15	Very good	-
Turtle Cove	FB-16	Excellent	-
Mill Neck Cove	FB-17	Excellent	-
The Birches STP	FB-18*	Passable	-
Flowers Oyster Hatchery	FB-19	Excellent	-

*based on limited data set

Although there were some improvements in coliform levels observed in 2002, waters in MNC and CSH show elevated levels of both total and fecal coliform bacteria. All of the MNC stations and three stations in CSH failed to comply with NYS standard for shell fishing waters. Furthermore, one station in MNC failed to comply on one occasion with the NYS standard for open swimming (FB-8, September). On the whole, it is very hard to draw any conclusions from just three years of data. However, the changes in Mill Neck Creek seem to be promising since this season had its highest precipitation in the past three years. Further management efforts should be directed towards remedying the waters of MNC and CSH.

3.2 Nutrient Enrichment by Nitrogen

Nutrients such as nitrogen, phosphorus and other minerals are essential elements that support life in the marine environments. However, in excess, nutrients promote the growth of phytoplankton resulting in planktonic (algal) blooms. During a course of a year, several blooms may occur. When the nutrients are depleted phytoplankton populations die off and sink to the bottom, contributing to large amounts of organic matter in the water (LISS, 1994). This organic matter decays while sinking and is further decomposed by bacteria in the estuarine sediments. While decomposing dead phytoplankton, bacteria consume oxygen. This depletion of oxygen may result in hypoxia (DO less than 3mg/L), specifically when the water column stratification hinders the oxygen replenishment. There is a general consensus among scientists that nitrogen is a limiting nutrient in saline waters (National Research Council, 2000). Therefore, in order to limit the propagation of phytoplankton in marine environments, nitrogen loadings into the waters have to be controlled.

There are four nitrogen species present in marine waters: ammonia-N, nitrate, nitrite and organic nitrogen. ***Organic nitrogen*** is present in the form of urea, amino acids, proteins and other compounds. (LISS, 1994) It can be bound to organic matter such as plants or algae. Dissolved forms of organic nitrogen come from sewage plants effluent, sewer overflow, failing septic systems and storm water runoff. Research suggests that dissolved forms of organic nitrogen are available to bacteria and phytoplankton populations and promote their growth (Stepanauskas, 1999). Yet, phytoplankton also utilize inorganic forms of nitrogen – ammonia-N, nitrate and nitrite. ***Nitrates and nitrites*** are carried into the marine waters by storm water runoff. However, they also come from nitrification of ammonia-N. High levels of ***ammonia-N*** may pose a danger to aquatic life. With rising temperatures and pH, ammonia ions (NH_4^+) change at increased rates into a unionized form of ammonia (NH_3). This form of ammonia is toxic to fish and aquatic plants. In 1989, the U.S. EPA proposed ambient water quality criteria for ammonia in salt water. The EPA recommends that continuous total ammonia levels should not exceed 0.72 mg/L for waters of these conditions: salinity 20 ppt, temperature 25 °C, pH 8. However, for slightly more alkaline conditions (pH 8.4) the criterion decreases to 0.30 mg/L. The nitrogen cycle in estuarine environments is very complex. Different species are assimilated by algae and bacteria and are transformed from one form to another. They are then trapped in the sediments and deposited from and released into the atmosphere.

The 1994 Long Island Sound Study identified several major sources of nitrogen. According to this study, natural sources such as atmospheric depositions, large tributary delivery and transport into its boundaries contribute to 43% of the total nitrogen load. The remaining nitrogen comes from human sources such as sewage treatment plants, failing septic systems and storm water runoff. LISS presented several management options for controlling the nitrogen load into the Sound. Two of them, sewage treatment plant upgrade for nitrogen removal and reduction of nitrogen from non-point sources, could potentially gain a 55% reduction of nitrogen load.

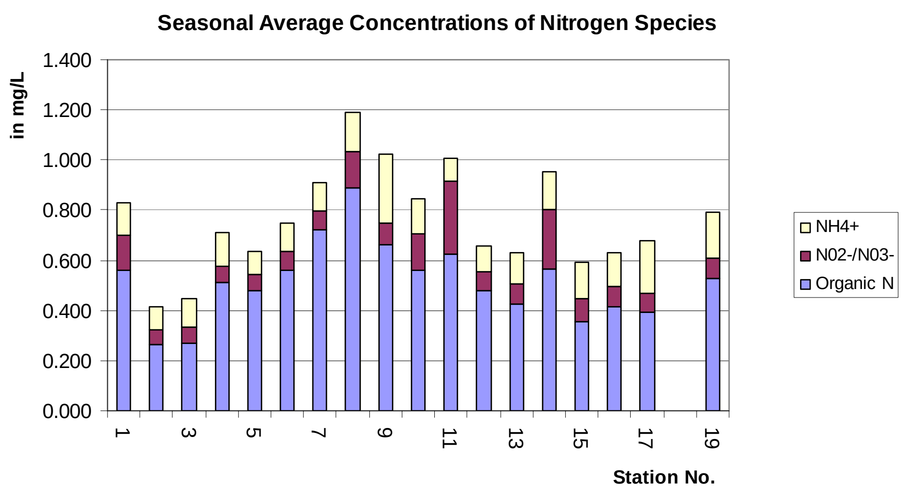
Nitrogen water quality standards vary across the U.S. Some states follow total maximum daily loads (TMDL) criteria. Others use site-specific or waterbody-based ambient nutrient levels (National Research Council, 2000). New York State has not yet adopted water quality standards for nitrogen for the Long Island Sound. However, the NYS DEC has adopted a total nitrogen

(TN) guideline of 0.5 mg/L for the Peconic Bay estuary surface water (Suffolk County Department of Health Services, 1999). This guideline is based on the 1988-1990 summer data correlation of the mean TN levels with an occurrence of dissolved oxygen standard violations. The 1999 Comprehensive Conservation and Management Plan for the Peconic Bay Estuary proposed a change of this guideline to 0.45 mg/L based on more recent data (1994-1996). Even more stringent criterion of 0.4 m/L TN is being considered for shallow waters in order to protect eelgrass habitat areas.

LISS established a target of 58.5% nitrogen reduction from the 1990 baseline for cumulative point and non-point in-basin sources (NYS DEC, 2000). This target is to be achieved through maintaining maximum annual loads of nitrogen at 11 management zones. The first 40% of the 58.5% reduction should be accomplished by August 2004.

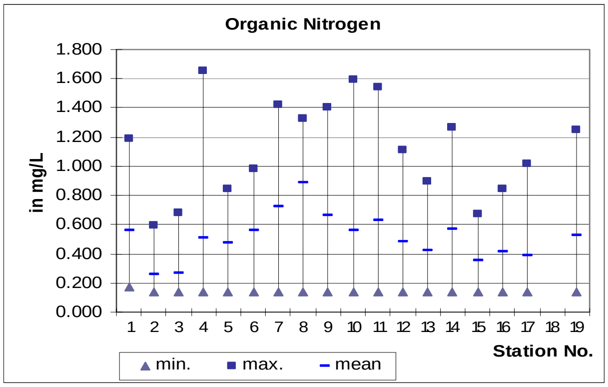
FOB started monitoring nitrogen in 2002 with the goal of establishing a baseline of data and identifying possible areas of concern in the estuary. FOB monitored three species of nitrogen at nineteen sites in the Oyster Bay estuary: ammonia-N, nitrate/nitrite-N and organic-N. Samples were collected and analyzed once a month from April to October. However, site FB-18 was monitored only once during the season and therefore was excluded from the analysis. Furthermore, two data points for organic nitrogen (FB10, FB11-April/02) and one data point for ammonia (FB3-August/02) were possible outliers and were also excluded from the analysis. Figure 8 shows seasonal averages of nitrogen species for all monitored stations. If we were to follow the NYS DEC guideline for the Peconic Bay estuary, all stations except for FB-2 and FB-3 would have exceeded the total nitrogen seasonal mean of 0.5 mg/L.

Figure 8. Nitrogen species representation for 18 stations in Oyster Bay Estuary



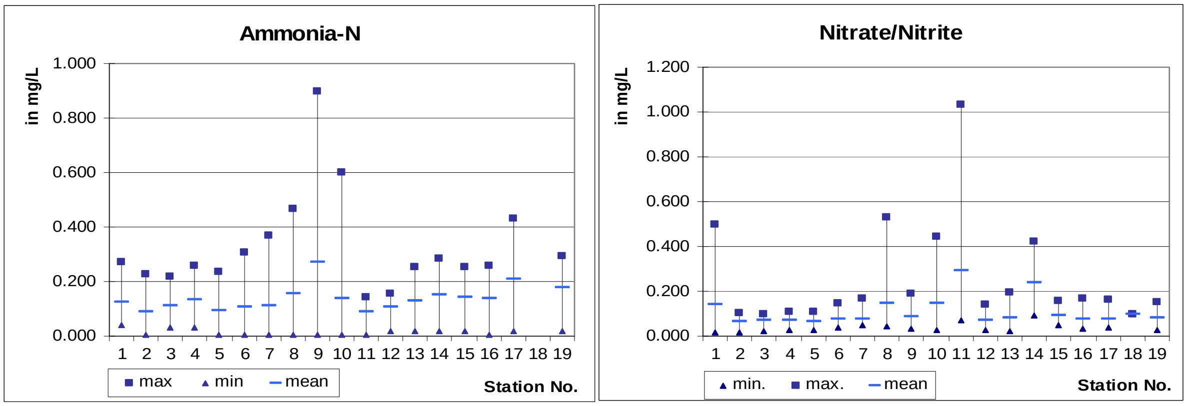
Organic-N is the prevailing species in Oyster Bay waters which account for 50 to 75% of total nitrogen at OB sites. The highest levels of organic nitrogen were measured at sites in Mill Neck Creek (FB-7,8,9), Cold Spring Harbor (FB-1,10,11) and two stations in OBH (FB-4,14). The levels of organic nitrogen for most of the sites peaked in the months of April, July, August and October. It is not clear why this pattern has occurred, as it follows neither the rainfall events nor tidal flooding. This pattern may be connected to algal blooms that occurred this year. However, to prove this hypothesis we would need to correlate N levels with an indicator of algal bloom such as levels of chlorophyll a.

Figure 9. Mean and range values for organic nitrogen in Oyster Bay waters.



MNC stations (FB-9, 8, 17, 19) demonstrated the highest average seasonal concentrations for ***ammonia-N*** in Oyster Bay waters. Ammonia-N levels remained quite low (< 0.1 mg/L) for the first half of the monitoring season. In August, they started to climb reaching an average concentration of 0.29 mg/l in October. In September and October, ammonia-N levels reached concentration above 0.5 mg/L at couple of stations.

Figure 10. Mean and range values for ammonia-N and nitrate and nitrite in Oyster Bay waters



On the whole, ***nitrate/nitrite-N*** levels in Oyster Bay waters were quite low with a seasonal mean of 0.11 mg/L for the whole estuary (Figure 10b). The stations in CSH exhibited the highest levels of nitrate/nitrite-N. The highest seasonal average concentrations were measured at station FB-11 in CSH and FB-14 in OBH. These two stations might be possibly receiving runoff which carries fertilizers. Elevated levels of nitrate/nitrite-N were detected also at stations FB-10 and FB-8 in October and FB-1 in May.

The first nitrogen monitoring season provided some interesting results as follows: 1) organic nitrogen is the dominant nitrogen species in the Oyster Bay estuary accounting, in some areas, for up to 75% of the total nitrogen; 2) two stations have possible problems with fertilizer runoff, as their nitrate/nitrite-N levels are more than twice the seasonal mean for the whole Oyster Bay estuary; 3) with the exception of the two stations seasonal means of total N levels have exceeded 0.45mg/L – a recommended guideline for controlling hypoxia in Peconic Bay Estuary.

3.3 Dissolved Oxygen

The Long Island Sound Study (LISS), a cooperative effort of the federal, state and local governments, concluded that low dissolved oxygen (hypoxia) poses the most serious threat to the health of the Sound ecosystem. The waters of the western and central portions of the Sound exhibit hypoxia through the months of July, August and September. During these months, dissolved oxygen concentrations in the top level of the water column are typically 5-9 mg/L. While on the bottom they get as low as 3-4 mg/L (LISS, 1994).

All aquatic life depends on oxygen availability in the water column. Low levels of oxygen have multiple affects on the marine ecosystems such as a change of species behavior, sensitive species growth impairment and in severe conditions, death of large populations of fish and other species. LISS summarized the effects of different oxygen impairment levels on some organisms of the Long Island Sound. An excerpt of these findings is presented in Table 5.

Table 5. Dissolved oxygen concentrations and their corresponding effects on some of the living resources (LISS, 1994)

Dissolved oxygen concentrations above the pycnoline (top of the water column)	
4-5 mg/L	Suitable for many species and life stages, may result in limited biological consequences
3-4 mg/L	25-50% mortality of larval lobsters (based on 4-day long experiments)
2-3 mg/L	50-95% mortality of larval lobsters (based on 4-day long experiments)
Dissolved oxygen concentrations above the pycnoline (top of the water column)	
4-5 mg/L	Protective for most biological consequences
3-4 mg/L	Protective for many biological consequences, reduced growth of juvenile Am. Lobster, grass shrimp, summer flounder (12-day experiments)
2-3 mg/L	Impaired finfish habitat (reduced abundance), mortality of larval grass shrimp and mud crabs (12-day experiments)
1-2 mg/L	Impaired lobster and finfish habitat, 10-90% mortality of some non-larval species (4-day experiments)
0-1 mg/L	Many severe consequences, even at short exposures

In bodies of water, oxygen is replenished from the atmosphere and by plant and algal photosynthesis. While aquatic plants and algae produce oxygen during the day, throughout the night the process is reversed. So, the consumption of oxygen increases resulting in the lowest possible levels in the early morning hours. Several other factors influence the amount of dissolved oxygen found in a particular body of water:

- water temperature - cooler water holds more oxygen; therefore, warm summer waters can be particularly stressful for marine organisms.
- salinity – with increasing salinity the capacity of water to hold oxygen diminishes.
- water turbidity - poor water clarity prevents sunlight from reaching oxygen producing aquatic plants lower in the water column.

- nutrients - excess nutrients can cause an algal bloom which blocks sunlight from aquatic vegetation lower in the water column. When algae dies and sinks to the bottom, the bacteria involved in decay of the plant material consume a significant amount of dissolved oxygen. This reduces the amount available for fish and other benthic (bottom dwelling) organisms.
- mixing of the waters – stagnant waters and waters that are stratified hinder transport of oxygen into lower levels of the water column.

NYS established saline water quality standards for dissolved oxygen as follows (6NYCRR §703.4):

- the waters designated for shell fishing (class SA), primary and secondary contact recreation (SB, SC) should not have less than 5 mg/L of dissolved oxygen at any time.
- the waters suitable for secondary recreation, fishing and fish propagation (I) should not have less than 4 mg/L of dissolved oxygen at any time.
- the waters suitable for fishing and fish survival (SD) should not have less than 3 mg/L of dissolved oxygen at any time.

Friends of the Bay monitored dissolved oxygen levels in the whole water column at 15 sites in the Oyster Bay estuary. Hypoxic conditions were observed from mid June until the end of September. Dissolved oxygen readings were taken on a weekly basis from early morning hours (stations in CSH) until noon (stations in MNC). The lowest levels seasonally and individually were measured in CSH. This is partially due to the stations being monitored after dawn. The highest seasonal averages were monitored in MNC.

Altogether 393 readings were taken for dissolved oxygen at the bottom and 392 at the top of the water column between the beginning of April and the end of October. As summarized in Table 6, almost 34% of samples measured for bottom dissolved oxygen levels were below the NYS standard of 5 mg/L. At the surface, 16 % of the readings that did not comply with the NYS standard of 5mg/L. Ten percent of the bottom water column samples exhibited serious hypoxia in concentrations below 3mg/L. Half of those readings were below 2 mg/L. On three occasions, FOB monitored levels below 1 mg/L.

Table 6. Samples below NYS water quality standard for dissolved oxygen

	Bottom DO		Top DO	
	# samples	%samples	# samples	% samples
< 5 mg/L	133	33.8%	61	15.6%
< 4 mg/L	69	17.6%	29	7.4%
< 3 mg/L	39	9.9%	7	1.8%
< 2 mg/L	18	4.6%	2	0.5%
< 1 mg/L	3	0.8%	0	0.0%
> 5 mg/L	260	66.2%	331	84.4%

Each station in the Oyster Bay estuary failed to meet the NYS standard of 5 mg/L at least 5 times during the monitoring season. In CSH, 50% of the DO samples at the bottom failed to meet this standard. Table 7 provides more details about each monitoring station.

Table 7. Number and percentages of samples within given dissolved oxygen ranges for 2002 monitoring season

Station #		Total # of samples	Number of samples within given range						Percent of samples within given range					
			5-4 mg/L	4-3 mg/L	3-2 mg/L	2-1 mg/L	0-1 mg/L	>5 mg/L	5-4 mg/L	4-3 mg/L	3-2 mg/L	2-1 mg/L	0-1 mg/L	> 5 mg/L
FB-1	Top DO	27	4	5	0	0	0	18	15%	19%	-	-	-	67%
	Btm DO	27	4	2	4	4	0	13	15%	7%	15%	15%	-	48%
FB-2	Top DO	27	4	5	0	0	0	18	15%	19%	-	-	-	67%
	Btm DO	27	4	2	4	4	0	13	15%	7%	15%	15%	-	48%
FB-3	Top DO	27	1	2	0	0	0	24	4%	7%	-	-	-	89%
	Btm DO	27	4	2	0	0	0	21	15%	7%	-	-	-	78%
FB-4	Top DO	26	0	0	0	0	0	26	-	-	-	-	-	100%
	Btm DO	26	5	1	0	0	0	20	19%	4%	-	-	-	77%
FB-5	Top DO	25	1	1	0	0	0	23	4%	4%	-	-	-	92%
	Btm DO	26	3	3	1	0	0	19	12%	12%	4%	-	-	73%
FB-6	Top DO	25	2	0	0	0	0	23	8%	-	-	-	-	92%
	Btm DO	25	6	1	0	0	0	18	24%	4%	-	-	-	72%
FB-10	Top DO	27	4	2	3	2	0	16	15%	7%	11%	7%	-	59%
	Btm DO	27	1	2	4	4	3	13	4%	7%	15%	15%	11%	48%
FB-11	Top DO	27	6	3	2	0	0	16	22%	11%	7%	-	-	59%
	Btm DO	27	3	2	5	3	0	14	11%	7%	19%	11%	-	52%
FB-12	Top DO	27	3	1	0	0	0	23	11%	4%	-	-	-	85%
	Btm DO	27	6	2	1	0	0	18	22%	7%	4%	-	-	67%
FB-13	Top DO	27	1	2	0	0	0	24	4%	7%	-	-	-	89%
	Btm DO	27	5	3	1	0	0	18	19%	11%	4%	-	-	67%
FB-14	Top DO	27	3	0	0	0	0	24	11%	-	-	-	-	89%
	Btm DO	27	4	4	0	0	0	19	15%	15%	-	-	-	70%
FB-15	Top DO	26	0	0	0	0	0	26	-	-	-	-	-	100%
	Btm DO	26	6	3	0	0	0	17	23%	12%	-	-	-	65%
FB-16	Top DO	26	1	1	0	0	0	24	4%	4%	-	-	-	92%
	Btm DO	26	4	3	1	0	0	18	15%	12%	4%	-	-	69%
FB-17	Top DO	25	1	0	0	0	0	24	4%	-	-	-	-	96%
	Btm DO	25	4	0	0	0	0	21	16%	-	-	-	-	84%
FB-19	Top DO	23	1	0	0	0	0	22	4%	-	-	-	-	96%
	Btm DO	23	5	0	0	0	0	18	22%	-	-	-	-	78%

As mentioned above, the most severe conditions were measured in Cold Spring Harbor (Figure 11 and 12). Additionally, with a one time exception (FB-11)(BTM DO?), levels at all CSH stations were below 5 mg/L from mid June until the beginning of September. Station FB-10 consistently measured levels below 2 mg/L for seven weeks. On three occasions, twice in July and once in September, FOB recorded levels below 1mg/L. DO levels at stations FB-1 and 11 were below 2 mg/L during July and the beginning of August.

Figure 11. Dissolved oxygen levels at FB-10 and FB-11 in CSH

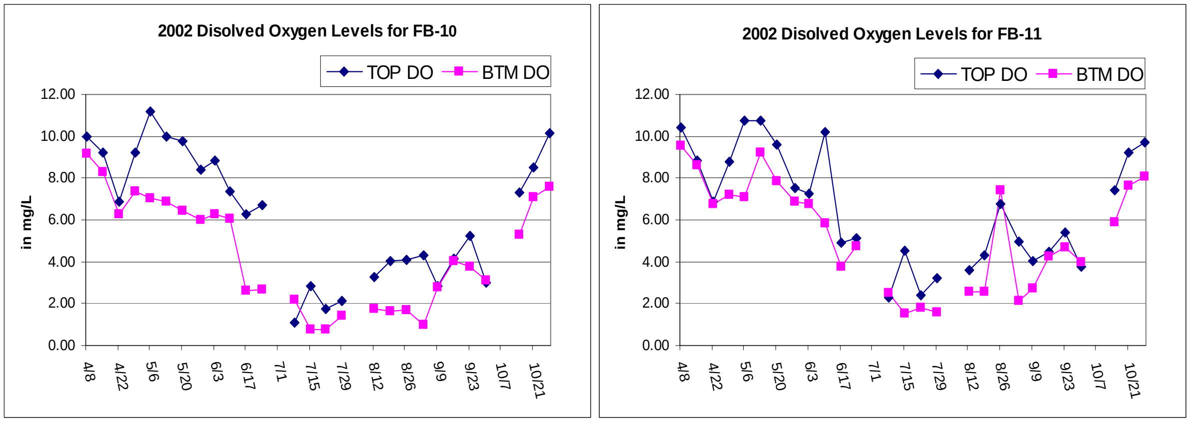
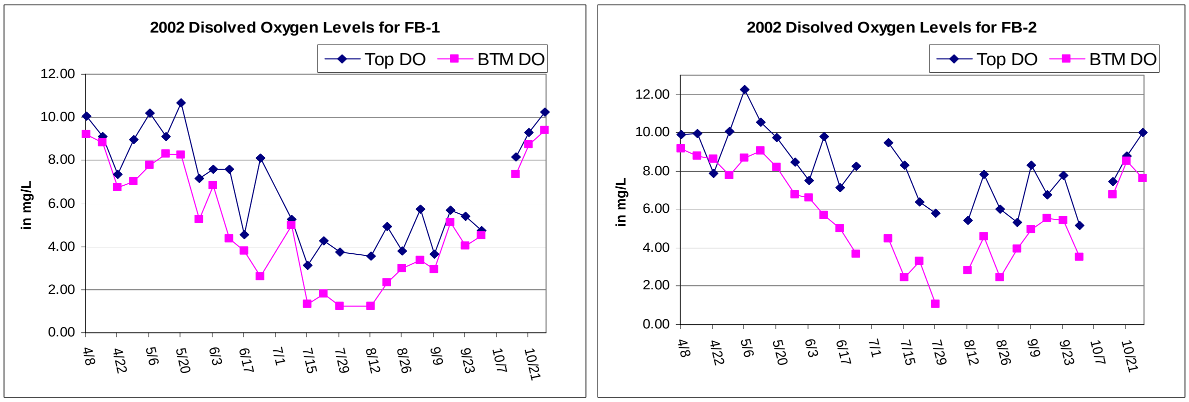


Figure 12. Dissolved oxygen levels at FB-1 and FB-2 in CSH



On the other hand, only mild hypoxia was observed in Oyster Bay Harbor. On one occasion the bottom water DO level dropped below 3mg/L at four stations (12,13,16,5). For most of the season the DO levels remained above 4mg/L. In OBH, 30% of bottom water samples and 10% of surface water samples failed to meet the NYS standard of 5mg/L. The surface water at two stations FB-4 and FB-15 has always maintained levels above 5 mg/L. This positive result might be attributed to the source of freshwater at these stations (Mill Pond at FB-15 and STP outfall at FB-4. Figure 13 and 14 depict dissolved oxygen levels at four OBH stations.

Figure 13. Dissolved oxygen levels at FB-5 and FB-16 in OBH

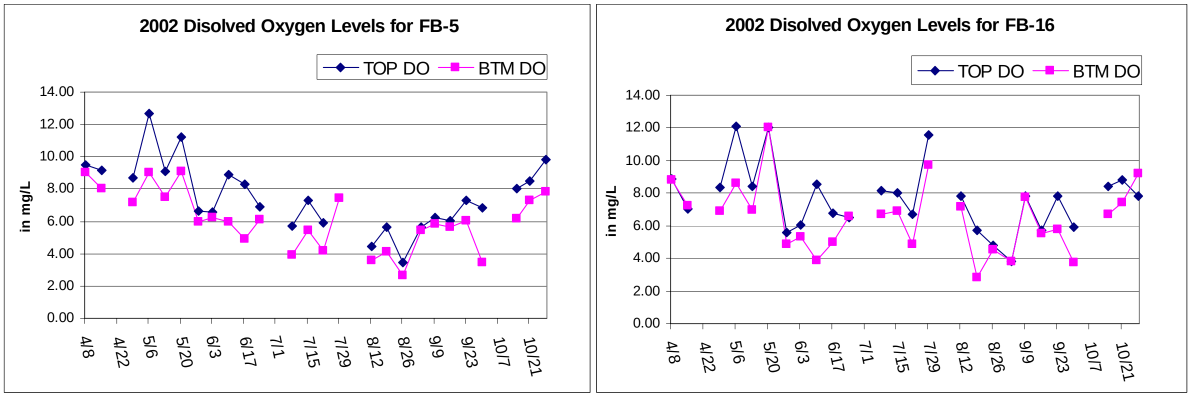
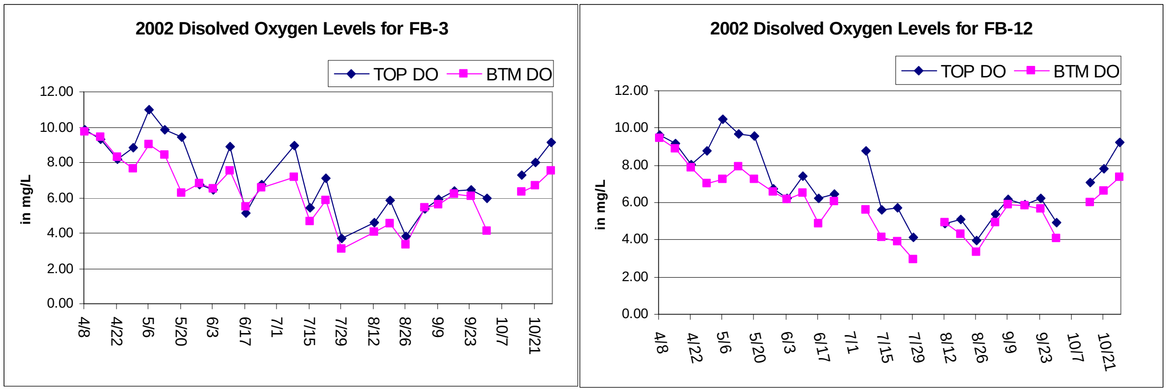
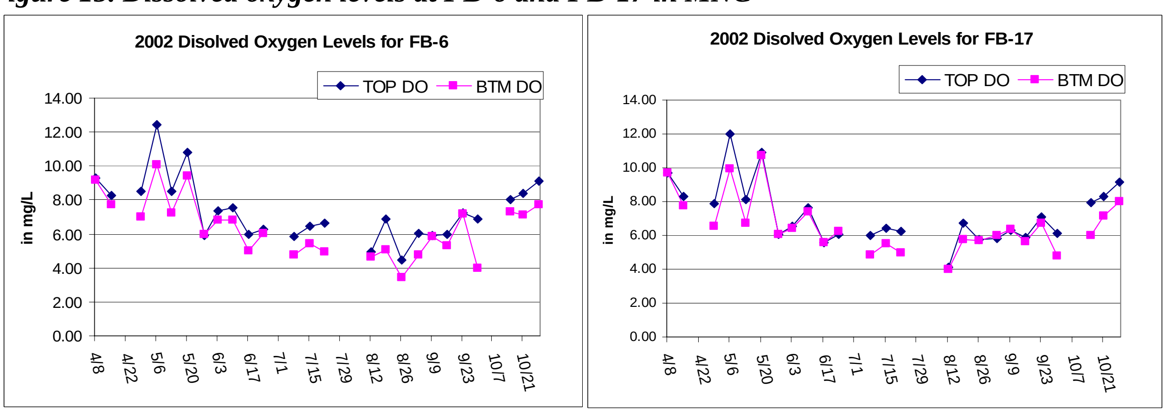


Figure 14. Dissolved oxygen levels at FB-3 and FB-12 in OBH



In Mill Neck Creek, DO levels stayed above 4 mg/L (Figure 15). Only 22% of bottom water and 5% of surface water samples failed to meet the NYS standard of 5 mg/L. Thus, MNC stations recorded the smallest number of the NYS DO standard violation in the whole Oyster Bay estuary. However, this relatively positive result does not necessarily mean higher water quality. Rather, it may be attributed to the fact that these stations were monitored just before noon; thus water had time to replenish some of the oxygen lost during the night. It is possible that more severe conditions would have been found if the monitoring of MNC stations were done early in the morning.

Figure 15. Dissolved oxygen levels at FB-6 and FB-17 in MNC

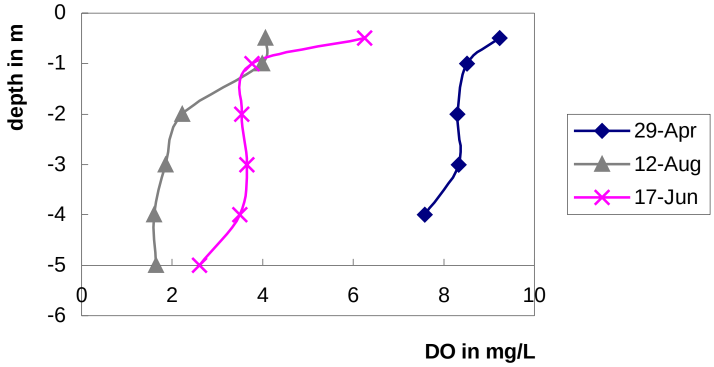


4. Program Recommendations

A. Proposed changes to monitoring procedures

1) Reduce the number of DO readings along the water column. In previous years, FOB monitored DO levels at 0.5m from the bottom, 0.5m from the surface and at one-meter intervals in between. If the station was 5 m deep a total of six readings were taken at one time. Thus, FOB took a total of over 2,000 DO readings in the last season. This extensive monitoring resulted in time no longer spent on the water. The average monitoring round of the Oyster Bay estuary lasted four hours. This proved to be too long to record the early morning hour levels of DO at Mill Neck Creek. The data revealed that there is little stratification present in the water column. The most pronounced differences between surface and bottom levels of DO were recorded in Cold Spring Harbor. The Figure below shows the DO stratification at FB-10. It is suggested that a maximum of four readings would be taken at each station. Two at the surface: at 0.5 and 1 m and two at the bottom 0.5 and 1m above the bottom. This change in monitoring procedures would significantly reduce the monitoring time and be sufficient to catch the changes in DO levels along the water column.

Figure. DO Stratification of Water Column at FB-10



2) Alternate the sequence in which the stations are monitored. Last monitoring season the stations were monitored always in the same sequence: from CSH (early morning) to MNC (noon). The data gathered was confined to that sequence: lowest levels of DO were measured in CSH, highest at MNC. However, while we have idea basic understanding of how low the levels of DO go in CSH, we do not have the same information about MNC. Monitoring these stations at noon does not tell us what the levels are in the early morning hours before DO levels are replenished from photosynthesing plants. Therefore, it is suggested that the monitoring sequence be changed at least once in the season; preferably in months when hypoxia occurs (June-September).
3) MNC station FB-18. Due to the low tide, the station FB-18 was inaccessible 17 times out of 29 monitoring days. This posed a problem to the data analysis. For example, there were insufficient data points to calculate monthly geomeans. Therefore, it is suggested that an adjustment be made to secure continuous monitoring of this station. This could be achieved by moving this station to a closer location that would allow for consistent monitoring from April to October.

4) MNC stations FB-9 and FB-8. These two stations were moving stations – they did not have a fixed location. FB-8 moved down towards the Beaver Lake and FB-9 up the Oak Neck Creek with the tide. It is suggested that these stations should assume a location that can be monitored consistently despite tidal stage or alternatively they should have set boundaries within which they move. Ideally this would be in a 10-20m radius. If movable stations are still preferred for some reason, then it would be good to record the GPS coordinates from where the samples were taken.
5) Focused study of pollution problems in CSH and MNC. A focused study of CSH inner harbor and MNC Beaver Lake and Oak Neck Creek area could provide more insight into pollution sources in these areas of concern. Perhaps a partnership with a research or educational organization would provide necessary insight into a such a design of study.

B. Take Action

Friends of the Bay needs to continue initiating water quality improvement programs by participating in studies and applying for grants to reduce pollution threats in Oyster Bay and Cold Spring Harbor. Our participation in the Bayville Cesspool Study in 2001 and our Bilge Sock Education program in 2002 have continued to facilitate such efforts. However, such programs should continue and the effort should be more focused in the Cold Spring Harbor area in order to identify and alleviate its low dissolved oxygen levels, high coliform counts and high nutrient input.

All waters in the Oyster Bay estuary need protection. However, the management efforts should be more focused on the areas of concern, e.g. CSH Inner Harbor and MNC Beaver Lake and Oak Neck Creek area.

C. Continue Partnerships

Our supporting members, businesses and volunteers allow Friends of the Bay to host our Volunteer Water Quality Monitoring program. For example, partnerships with the Nassau County Department of Health, on boat-volunteers and Friends of the Bay's intern Colin Lindsay were invaluable this monitoring season. Additionally, the new partnership with South Mall Analytical Labs, has enabled Friends of the Bay to test for nitrogen species. Thereby, establishing a nitrogen baseline to help identify trends and high nitrogen areas in Oyster Bay and Cold Spring Harbor.

It is our volunteers who fulfill a multitude of roles by participating in sample collection, data recording and boat operations. Individually they bring fun, humor, personal skills and compassion for the environment to the program. All the individuals listed in the acknowledgements use their volunteering opportunity to get involved in protecting the estuary.

Although we have a great volunteer base, all but three of our on boat volunteers reside in Oyster Bay. This indicates that Friends of the Bay is not extending our reach into Cold Spring Harbor and inviting citizens to become involved in our monitoring program. Reflecting upon this, further efforts should be made to invite Cold Spring Harbor residents to join us aboard the Baywatch II during the 2003 season.

D. Look to the Future

To further refine our understanding of our local waters, Friends of the Bay is considering additional sites and parameters for testing.

(Lowest dissolved oxygen readings of Cold Spring Harbor and Oyster Bay is the first station monitored within our monitoring study.?) Installing a stationary probe will allow us to constantly monitor fluctuations of dissolved oxygen, salinity, and water temperature at FB-1. Such an instrument would also allow us to identify how long FB-1 remains hypoxic and to compare dissolved oxygen readings with that of other stations.

Apparent color - Apparent color is an easy way to get general information about what material is dissolved or suspended in the water. Water with very little dissolved or suspended material appears blue in color. The presence of dissolved organic matter such as decaying plant matter can result in water color of yellow or brown. The presence of dinoflagellates can produce a reddish or deep yellow color. Water that is rich in phytoplankton and algae appears green. Runoff can result in a variety of colors including yellow, red, brown or gray.

Chlorophyll a - In addition, to measuring apparent color, it is ideal to measure chlorophyll levels within Oyster Bay and Cold Spring Harbor. A chlorophyll test would measure the concentration of algae in the water column. Thus, identifying if algal blooms are influencing water clarity.

Wildlife Populations - Being on the water at sunrise, for six hours a week, affords us many opportunities to observe and identify wildlife undisturbed by human activities. Osprey, hawks, terns, egrets, herons, ducks, swans, geese, Diamondback Terrapin turtles, Moon, Comb and Lion's Mane jellies and Horseshoe Crabs are some of the wildlife we observe. Turtles, fish, jellies, and birds as indicator species, are the first to exhibit the effects of environmental change. Acknowledging this, Friends of the Bay will add wildlife monitoring to our weekly monitoring study. Not only will this allow our volunteers to become more familiar with the environment around them, but it will also create an additional baseline of information, providing further indications of environmental stress in the Oyster Bay - Cold Spring Harbor Estuary.

E. Continue to Invest in Equipment

Investment in the maintenance of Friends of the Bay's monitoring equipment is important to obtaining accurate readings. This year both the YSI 85 and 58 were sent for maintenance during the monitoring season. Thus, valuable data was lost due to the repairs. An upgrade of equipment may be inevitable if the equipment failures continue. Without the use of similar monitoring devices, we will be unable to collect the targeted information for this study.

Equipment and services on the Friends of the Bay water quality monitoring program "wish list" which would enable us to add the above mentioned parameters and improve the monitoring program include:

★ Weather station instrumentation (automated rainfall gauge, high and low thermometer, barometer, wind direction and speed)
★ Pelican case to store YSI equipment in
★ Electrical cord spool
★ Two Color printers
★ Apparent Color meter
★ Binoculars
★ 55 feet of 1/4 inch stainless steel cable
★Large plastic storage containers with lids

5. Conclusions

Friends of the Bay's Water Quality Monitoring Program has developed, within the four years, into a well-conceived periodic monitoring program of several important water quality parameters throughout the Oyster Bay waters. Ten more sites were added to the monitoring program in 2002 reaching a total of nineteen. Four stations were monitored in Cold Spring Harbor, eight in Oyster Bay Harbor and seven at Mill Neck Creek. This monitoring season was marked by better spatial distribution of the monitoring sites covering new locations and adding a new monitoring parameter to the program.

In the spring of 2002, Friends of the Bay initiated a Bilge Sock Education program by distributing bilge socks and educational pamphlets to inboard motorboat owners in the hope of preventing oil pollution in Oyster Bay and Cold Spring Harbor. Additionally, FOB installed three monitoring boards that inform the public about weekly changes in the water quality in their area. Further public outreach was achieved also through a regular column in the Enterprise Pilot – "How's the Water".

Three major water quality parameters were monitored in 2002: coliform bacteria levels, dissolved oxygen levels and enrichment of the water by nitrogen. Analysis of this season's data provided many interesting insights into the quality of the estuary.

While coliform bacteria levels still present a challenge in regard to the NYS standard for shell fishing, one positive development was observed. The data indicate that MNC waters marked the first significant decrease of both total and fecal coliform levels in three years. These changes seem to be promising especially since this season had its highest precipitation level in the past three years. On the other hand, the data gathered at two new stations in inner CSH indicate that this area is suffering from a multitude of pollution problems: high levels of coliform bacteria, severe hypoxia and enrichment by nutrients. A further investigation into pollution sources in CSH might point into specific areas of concern.

The first nitrogen monitoring season provided an initial glance at nutrient enrichment problems in Oyster Bay Estuary. The total nitrogen levels revealed yet another area of concern at stations in CSH and MNC. Yet, the total nitrogen levels in the whole estuary suggest that more attention should be paid to nitrogen loadings that enter the embayment.

All waters in the Oyster Bay estuary need protection. However, management efforts should be more focused on areas of concern such as, CSH Inner Harbor, MNC Beaver Lake and Oak Neck Creek area.

Friends of the Bay looks forward to working with volunteers, government agencies, and fellow not-for-profit organizations in the 2003 monitoring season. Together, we will continue to improve and expand our monitoring efforts. Hopefully, these efforts will provide a link to show how investment in water quality protection is improving the quality of water in Oyster Bay and Cold Spring Harbor.

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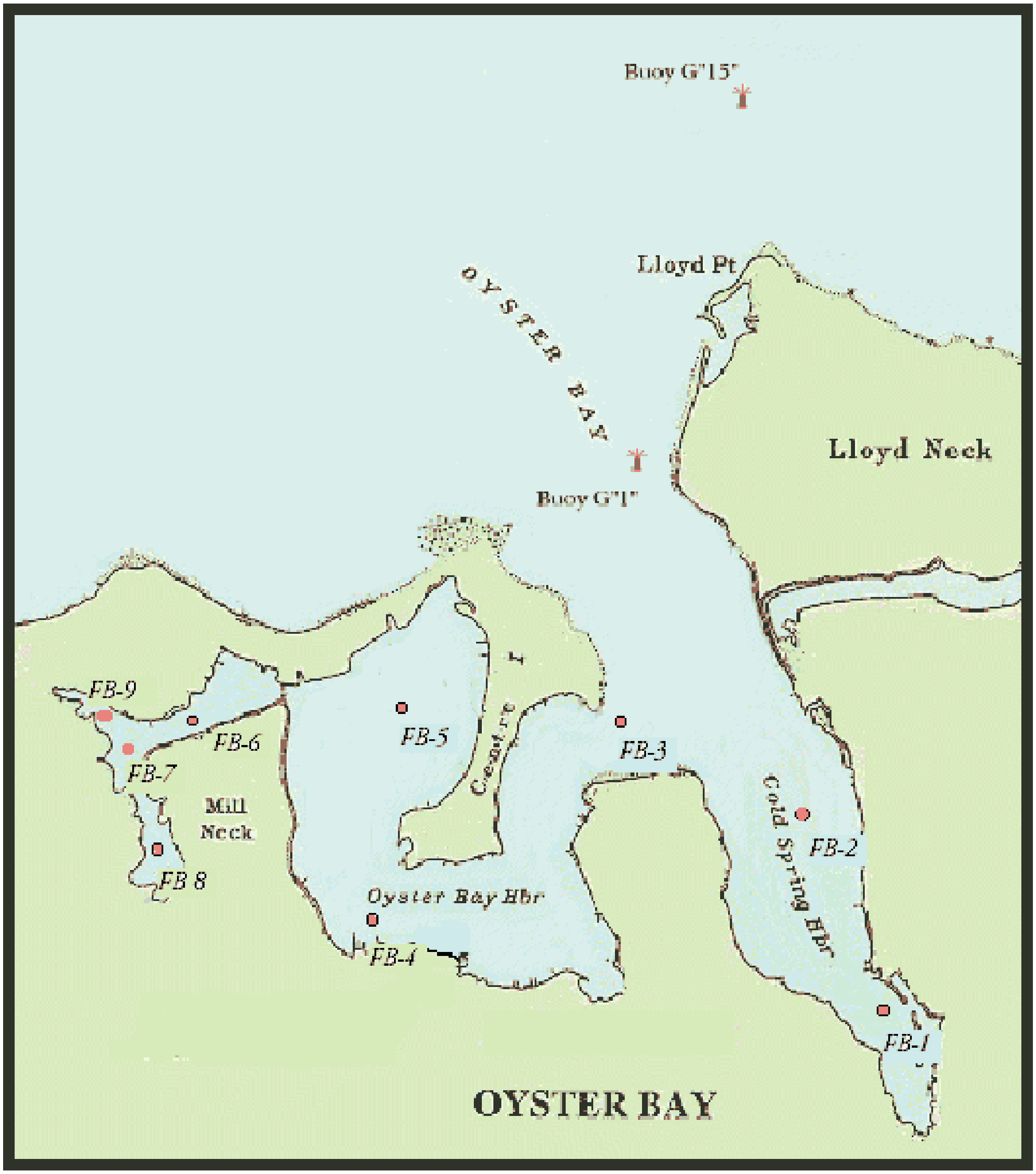
Appendix 1: Map of Monitoring Locations



Appendix 2. Water Quality Monitoring Data Sheet

Appendix 3. Seasonal Averages of the Monitoring Parameters

Appendix 4. 2002 Tide Table for Oyster Bay waters

Appendix 5. 2002 Coliform Bacteria Counts

Appendix 6

Appendix 7. Bathing Water Quality Standards

The following rating criteria are being applied to the bathing waters of Nassau County:

EXCELLENT - To obtain this rating a bathing beach must have a cumulative (seasonal) log average of total coliform not greater than 70, and individual total coliform counts of greater than 330 shall not have appeared in more than 10 percent of the total number of samples.

VERY GOOD - To obtain this rating a bathing beach must meet the following: (a) its cumulative (seasonal) log average of total coliform must not be greater than 240 - (b) no 30 day running log average result of total coliform shall be greater than 500 - (c) individual total coliform counts shall not be greater than 5,000 for more than 20 percent of the total number of samples.

GOOD - To obtain this rating a beach shall: (a) have a cumulative log average of total coliform not greater than 240 - (b) individual total coliform counts shall not be greater than 5,000 for more than 20 percent of the total number of samples.

*FAIR - To obtain this rating a beach must have the following: (a) no 30 day fecal coliform log average shall be greater than 200 (b) no 30 day total coliform log average shall be greater than 2,400 - (c) individual total coliform counts shall not be greater than 5,000 for more than 20 percent of the total number of samples.

*PASSABLE - Meets "Fair" rating, but has a 30 day fecal coliform log average exceeding 200.

*EXCEEDS NEW YORK STATE HEALTH DEPARTMENT STANDARDS FOR BATHING WATER QUALITY - A beach receives this rating when the 30 day log average for total coliform goes over 2,400 at any time during the bathing season, or when more than 20 percent of the samples taken in the- season contain total coliform counts in excess of 5,000.

*Fecal coliform test used in evaluation of beaches not attaining at least "Good" water quality.

Source: Nassau County Department of Health: *1974 Surface Water Quality Assessment Report*

Appendix 8. Concentrations of Different Nitrogen Species in Oyster Bay Waters in mg/L

Station	15-Apr				13-May				10-Jun				15-Jul				9-Aug				16-Sep				15-Oct			
Station	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N	NH_4^+	$N0_2^-/N0_3^-$	TKN	Organic N
FOB-1	0.10	0.10	9.94	9.94	0.10	0.50	0.81	0.81	0.04	0.05	0.48	0.44	0.081	0.017	0.644	0.563	0.075	0.05	1.260	1.190	0.218	0.104	0.390	0.172	0.270	0.181	0.450	0.180
FOB-2	0.10	0.10	10.4	10.4	0.10	0.05	0.14	0.14	0.02	0.05	0.14	0.14	0.006	0.015	0.420	0.420	0.025	0.05	0.616	0.591	0.143	0.079	0.140	0.140	0.225	0.103	0.338	0.140
FOB-3	0.10	0.10	0.28	0.28	0.10	0.06	0.14	0.14	0.03	0.05	0.14	0.14	0.075	0.023	0.757	0.682	0.755	0.05	1.060	0.305	0.143	0.092	0.140	0.140	0.220	0.100	0.438	0.218
FOB-4	0.10	0.10	0.28	0.28	0.10	0.07	0.14	0.14	0.03	0.05	0.14	0.14	0.260	0.027	0.701	0.441	0.035	0.05	1.680	1.650	0.180	0.085	0.168	0.140	0.228	0.106	1.000	0.772
FOB-5	0.10	0.10	0.84	0.84	0.10	0.05	0.14	0.14	0.02	0.05	0.20	0.18	0.055	0.027	0.672	0.617	0.006	0.05	0.672	0.672	0.135	0.065	0.140	0.140	0.235	0.106	0.988	0.753
FOB-6	0.10	0.10	0.84	0.84	0.10	0.07	0.14	0.14	0.02	0.05	0.14	0.14	0.006	0.036	0.981	0.981	0.085	0.05	1.010	0.925	0.143	0.092	0.140	0.140	0.305	0.144	1.060	0.755
FOB-7	0.10	0.10	0.70	0.70	0.10	0.06	0.20	0.20	0.02	0.05	0.14	0.14	0.006	0.050	1.180	1.180	0.075	0.05	1.490	1.420	0.113	0.069	0.140	0.140	0.368	0.169	1.630	1.260
FOB-8	0.10	0.10	0.70	0.70	0.20	0.11	1.09	0.89	0.02	0.13	1.34	1.32	0.006	0.045	0.785	0.785	0.006	0.05	1.040	1.040	0.465	0.061	0.476	0.140	0.305	0.530	1.630	1.330
FOB-9	0.10	0.10	0.56	0.56	0.15	0.03	0.76	0.61	0.02	0.05	0.14	0.14	0.006	0.053	1.400	1.400	0.085	0.05	1.370	1.290	0.900	0.133	1.290	0.390	0.650	0.188	0.888	0.238
FOB-10	0.10	0.10	0.56	0.56	0.10	0.11	0.14	0.14	0.02	0.13	0.36	0.35	0.006	0.026	1.600	1.590	0.006	0.06	1.010	1.010	0.143	0.147	0.140	0.140	0.600	0.445	0.688	0.140
FOB-11	0.10	0.10	1.54	1.54	0.10	0.07	0.25	0.25	0.02	0.30	0.34	0.32	0.006	0.290	0.925	0.925	0.142	0.11	1.040	0.895	0.135	0.126	0.140	0.140	0.130	1.030	0.438	0.308
FOB-12	0.10	0.10	0.56	0.56	0.10	0.05	0.14	0.14	0.02	0.05	0.73	0.71	0.075	0.029	1.180	1.110	0.145	0.05	0.588	0.443	0.143	0.086	0.140	0.140	0.155	0.138	0.413	0.258
FOB-13	0.10	0.10	0.42	0.42	0.14	0.07	0.14	0.14	0.02	0.05	0.14	0.14	0.061	0.021	0.953	0.892	0.105	0.05	0.981	0.876	0.210	0.070	0.476	0.266	0.255	0.193	0.500	0.245
FOB-14	0.10	0.10	0.70	0.70	0.12	0.17	0.14	0.14	0.03	0.13	0.62	0.59	0.016	0.420	1.290	1.270	0.285	0.40	1.060	0.775	0.235	0.094	0.252	0.140	0.260	0.355	0.600	0.340
FOB-15	0.10	0.10	0.56	0.56	0.10	0.08	0.14	0.14	0.02	0.05	0.25	0.23	0.055	0.063	0.476	0.413	0.255	0.05	0.925	0.670	0.218	0.149	0.364	0.146	0.255	0.159	0.575	0.320
FOB-16	0.10	0.10	0.84	0.84	0.10	0.08	0.17	0.17	0.02	0.05	0.48	0.46	0.006	0.031	0.672	0.635	0.255	0.05	0.532	0.277	0.258	0.067	0.392	0.140	0.230	0.169	0.613	0.383
FOB-17	0.10	0.10	0.56	0.56	0.10	0.08	0.14	0.14	0.02	0.05	0.14	0.14	0.430	0.037	1.060	1.020	0.365	0.05	0.785	0.420	0.143	0.064	0.140	0.140	0.300	0.161	0.613	0.313
FOB-18	0.10	0.10	1.12	1.12																								
FOB-19	0.10	0.10	0.84	0.84	0.10	0.13	0.14	0.14	0.02	0.05	0.14	0.14	0.360	0.029	0.953	0.924	0.265	0.05	1.510	1.250	0.293	0.064	0.364	0.140	0.295	0.153	0.563	0.268
FB-1 btm													0.230	0.021	1.570	1.550												
FB-1 mid													0.210	0.016	0.532	0.322												
FB-5 btm													0.260	0.032	1.910	1.650												

*data excluded from the analysis as outliers