Miacomet Pond
Annual Report
2003

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Introduction:

Miacomet Pond is located on the southwest portion of Nantucket Island. Miacomet Pond has a surface area of 47.29 acres and a watershed area of 970.61 acres. The pond is long and narrow extending an approximate mile in length. Heavy development has occurred in the watershed changing the characteristics of the pond's hydrology and water quality.

Development has altered two natural processes, (1) nitrogen/phosphorus cycles and (2) flooding. The change in land use has increased nitrogen and phosphorus concentration in the groundwater and inhibited or redirected the direction of groundwater flow. Housing densities have inhibited the percolation of precipitation, and have occupied large volumes of land previously open to groundwater filtration. Sedimentation and erosion has also increased as a result of the construction; roofs, lawns, driveways, and roads have also increased surface runoff volume. Physical manipulation by one Pond abutter has caused the pond to be narrowed and restricted.

Nutrient loading in Miacomet Pond has accelerated the eutrophication process. Deeper bottom areas are filled with decaying plant material. The shallowness of the pond prohibits a large storage of water. Large increases in precipitation combined with an already high groundwater level will flood the watershed rapidly. Nutrients carried by sediments and water flow advance the growth of nuisance vegetation in and around the pond. The pond will continue to shrink in over all volume while increasing the incidence of flooding over time.

Flooding:

Miacomet was flooded in the spring. One Miacomet Pond watershed resident demanded that Miacomet Pond be opened to the ocean to alleviate his flooded basement. Tracy Curley and Keith Conant met with Andrew Vorce, Nantucket Planning, to review flooding issues with regards to this watershed subdivision. We determined that Mizzenmast subdivision was poorly designed with regards to storm water. The road was designed too low for seasonal groundwater levels and was flooded annually. The catch basins were not being properly maintained. Homeowners could adjust their landscapes to improve percolation in the immediate flooding area. Opening Miacomet Pond would not resolve the flooding issue at Mizzenmast.

In response the Mizzenmast property owner's complaints and beginning on March 14, 2003, Conant and Curley recorded water depths at three monitoring wells located on Miacomet Road (Appendix B) on a weekly basis. The groundwater in the immediate Miacomet Pond area was 1.875 feet higher in 2003 than 2001. On April 14, groundwater began to recede as air temperature warmed. May 1, 2003 Curley submitted a letter to Board of Selectmen stating reasons not to open Miacomet Pond. On May 7, a public hearing was held by the Board of Selectmen to vote on whether Miacomet Pond should be opened for flooding issues. The selectmen voted to open the pond. The pond was opened on May 12, 2003. Appendix C contains field notes on chronology of events leading to decisions made and by whom.

METHODS:

Miacomet Pond is monitored by the Marine & Coastal Resources Department for water chemistry. Temperature, dissolved oxygen, salinity, clarity and overall depth are measured at two sites. Nutrient information was collected and analyzed 5 times this year at two sites.

There are four established sampling sites in Miacomet Pond. Site 1 is located at the north side of the pond near Mrs. Burchell's house. This site is closest to the wetland inlet of the northeast side of the pond. Site 1a is farther north towards the head of the pond. This site is very shallow generally only one-foot depth. Site 2 is located at the foot of the pond. Site 2a is half way between site 1 and site 2.

Surface Drainage Basin:

Miacomet Pond's water quality is directly related to its watershed characteristics. Important watershed characteristics are defined as area, soil types and erodibility, types of vegetative cover.

Area:
Miacomet Pond is 47.29 acres; the watershed area is 970.61 acres

Soil type and erodability:
The soil association in the watershed area is classified as "Evesboro association". The Evesboro association is one nearly level and gently sloping, excessively drained, where sand soils were formed in outwash deposits. At the southeast portion of the watershed area, the soil association is "Riverhead-Katama association". This classification is defined, as nearly level, well-drained, sand soils formed in glacial till and in outwash deposits.

Miacomet Pond possesses Evesboro and River-Katama soil type associations. These soil types are rapidly drained and have an excessively high permeability. According to the Soil Survey of Nantucket County, Massachusetts, this soil type has few options for septic tanks, and leach fields. Seepage of the effluent through the substratum causes the hazard of groundwater contamination. Nutrients seeping into the groundwater flow directly into the pond, accelerating the eutrophication process. With a high permeability, the erodability of soils is low. However, the paved road adjacent to the pond poses a problem. This paved road is tilted at an angle such that surface water run-off, with all its associated contaminant drains directly into the pond. This road also has fourteen breaks, which allow sediments to enter the pond during heavy rains. Sediment "fans" are observed at each one of these breaks.

Vegetative cover in the pond:

Ceratophyllum demersum (coontail), Ruppia maritima (widgeon-grass), Potamogeton pusillus (thin-leaf pondweed), Potamogeton perfoliatus (clasping-leaved pondweed), Vallisneria americana (water celery), Utricularia (bladderwort), Najas (naiad), Lemna (duckweed), Decodon verticillatus (water willow)

Vegetative cover fringing along pond:
Solanum dulcamara (bittersweet nightshade), Typha latifolia (cattail), Phragmites communis (reed)

Vegetative cover information provided by Nantucket Resource Management Plan, March 1990 and "Diagnostic Water Quality and Aquatic Assessment for Miacomet Pond, Aquatic Control Technology, 1997. In ponds with higher nutrients, macrophytes are more abundant and weedy species more prevalent. Miacomet Pond is nutrient stressed and considered eutrophic.

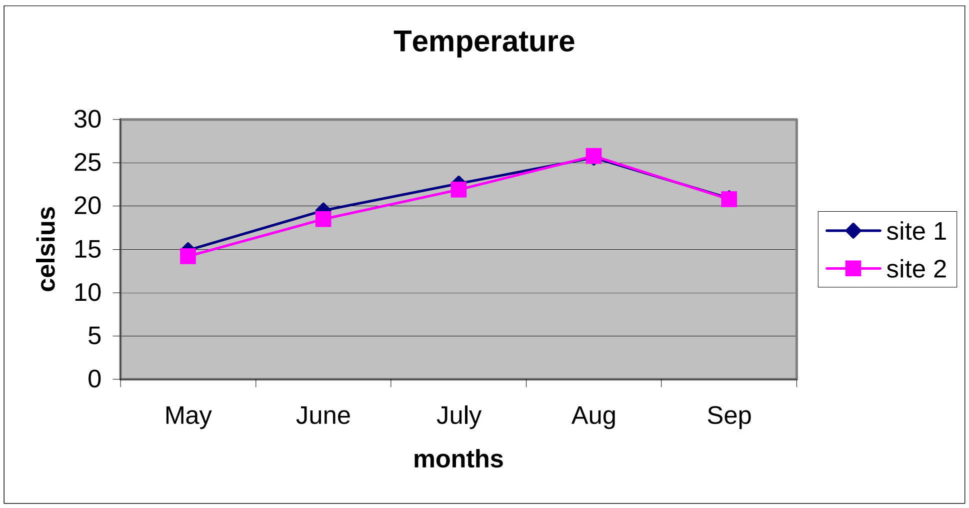
Miacomet Pond has several species of aquatic vegetation that are considered nuisance weeds. Those aquatic plants include coontail, water celery, pondweed, and clasping leaved pondweed. Infestations of nuisance weeds are a result of suitable habitat. Once plants are considered nuisance, it is difficult to reduce their biomass. Nearly all rooted plants derive nutrients from sediments. Weed infestation makes it difficult for fish species to forage, boats to maneuver, and anglers to fish. Weed infestation reduces the diversity of fish species in the pond. Game fish cannot maneuver through the weeds to forage limiting feeding success. High concentrations of weeds cause dissolved oxygen levels to fluctuate harming fish communities.

Water Quality Results:

Temperature:

The water temperature progressed through the typical heating curve with the pond frozen in the winter. Temperatures increased through the spring and peaked in the summer, and cooled in the fall. The highest water temperature was in August. The foot of the pond was slightly cooler than the head. Temperature was slightly cooler on the bottom than at the surface.

Figure 1



There was a weak thermocline observed at site 1 for the June and July sampling events. Solar radiation warmed the surface water while cooler groundwater filled the bottom layer of the pond.

Dissolved Oxygen:

Dissolved oxygen in Miacomet Pond appeared more erratic than in 2002. In 2002, the average dissolved oxygen followed a curve decreasing slightly in the summer and increasing in the fall. In 2003, the average dissolved oxygen decreased sharply in July, increased in August. Opening Miacomet Pond, changed dissolved oxygen causing greater fluctuations in dissolved oxygen concentrations (figure 2 & 3). Nitrogen and phosphorus concentrations were decreased through direct export out of the pond on May 12 and 20th. The pond opening increased the turbidity of the pond possibly resuspending bound nutrients into the water column. Filling with pond with groundwater increased nutrient concentrations.

Dissolved oxygen decreased first in the bottom layers of water. In June, at site 1a, dissolved oxygen was lower on the bottom than sites 1 and 2. Site 1a is located towards the head of the pond where groundwater filling accounts for most of the pond volume. June contained more dissolved oxygen at the bottom than found in 2002. July had the lowest dissolved oxygen concentrations for months sampled with an anoxic layer sitting at the bottom of the pond. Generally, the low dissolved oxygen layer starts at the water sediment interface and expanded upwards and outwards as water temperature increases.

Dissolved oxygen in September was low. However, there may have been a malfunction in the YSI dissolved oxygen meter. All September oxygen readings were low for all areas sampled including Nantucket Harbor. Generally in September, as water temperature cools, the water column will regain dissolved oxygen levels.

Low dissolved oxygen concentrations cause the respiratory and metabolic activity of fish to be limited. The minimum amount of dissolved oxygen for survival varies with the time of exposure and fish species. Low oxygen levels make fish more susceptible to diseases. According to most state and federal standards minimum oxygen requirements for most fish do not fall below 5 mg/l. The minimum oxygen requirement for fish at a water temperature of 20 ºC is 7.8 mg/l; below this mark fish health is compromised. Dissolved oxygen levels were below 5 mg/l in July and August in the bottom layers of water.

For the average dissolved oxygen concentrations, there was enough oxygen above mid depth in the pond for fish to survive. On the average, dissolved oxygen concentration was above 5 mg/l for most months sampled. Oxygen increased as water temperature decreased.

Figure 2

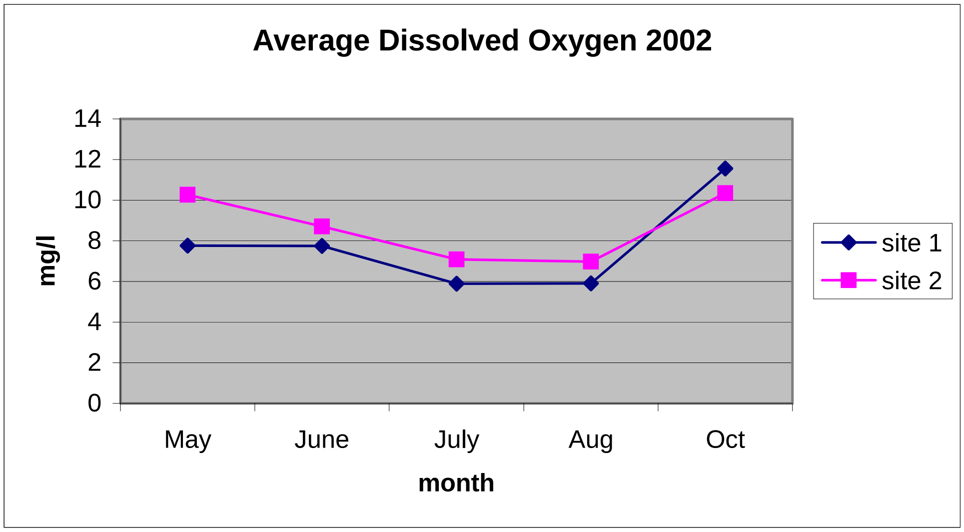
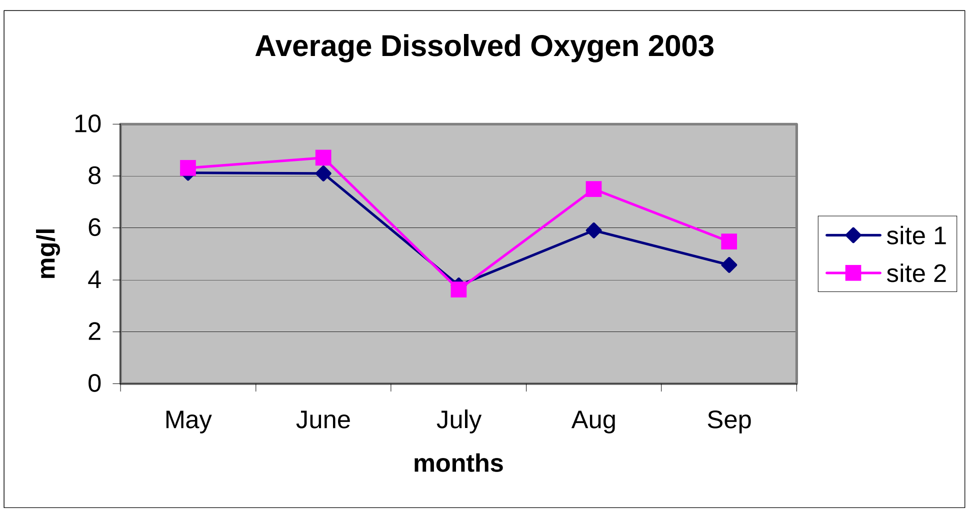


Figure 3



Nutrients

Most of the nitrogen measured was organic (TKN). Organic nitrogen is a measure of nitrogen in the form of plant material. The high concentration of nitrogen usually coincides with the low secchi depth measurements. Nitrogen was lower at site 1 in 2003 than in 2002 with the exception of July. Total phosphorus was equivalent in 2002 and 2003 with the exception of the fall. Total phosphorus was much higher in October 2002 than September 2003.

Figure 4: Nutrient Concentrations for 2002

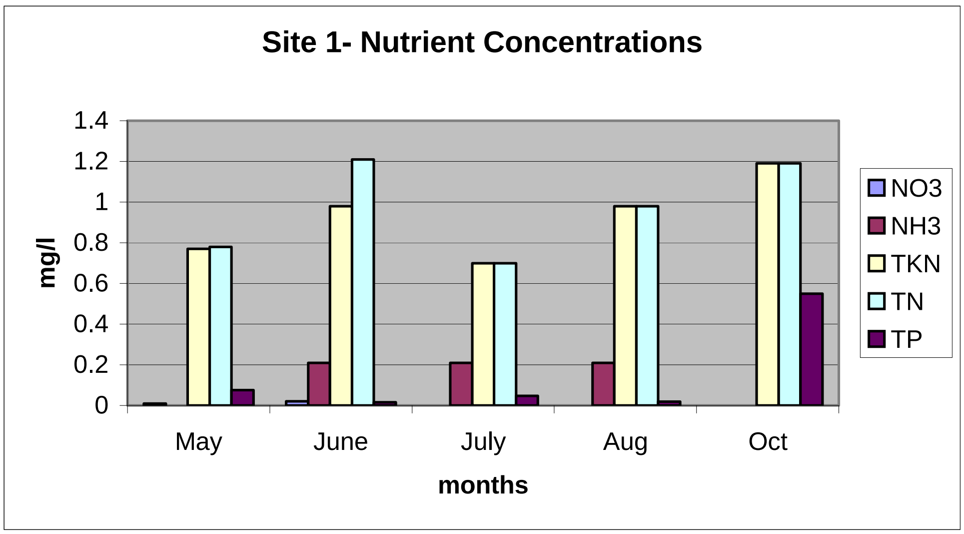
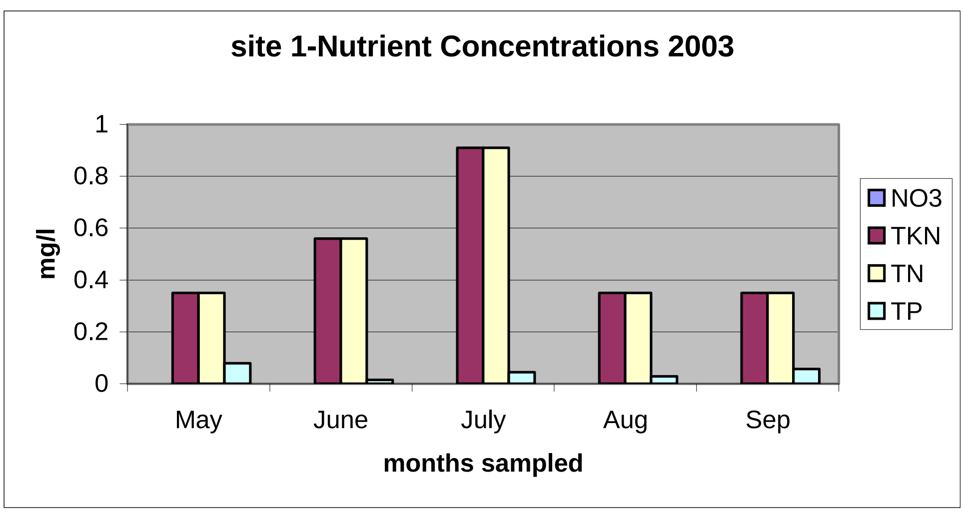


Figure 5: Nutrient Concentrations for 2003



There was a reduction of nitrogen in site 2 as a result of the pond opening. Total organic nitrogen was cut in half with the export of plant material out of the pond. Inorganic nitrogen was below detection for all month sampled in 2002 and 2003 with the exception of July in 2003. In July 2003, nitrogen of all species peaked at site 2.

Figure 6: Nutrient Concentrations 2002

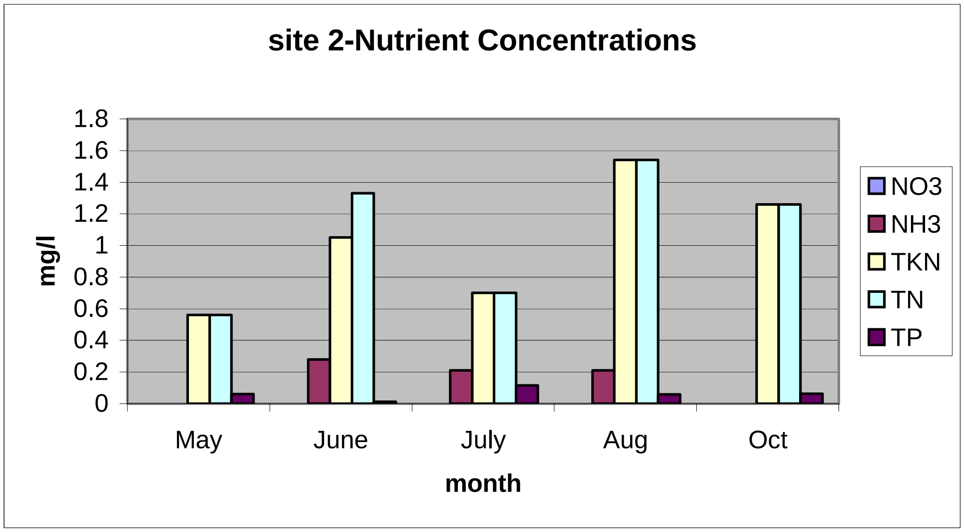
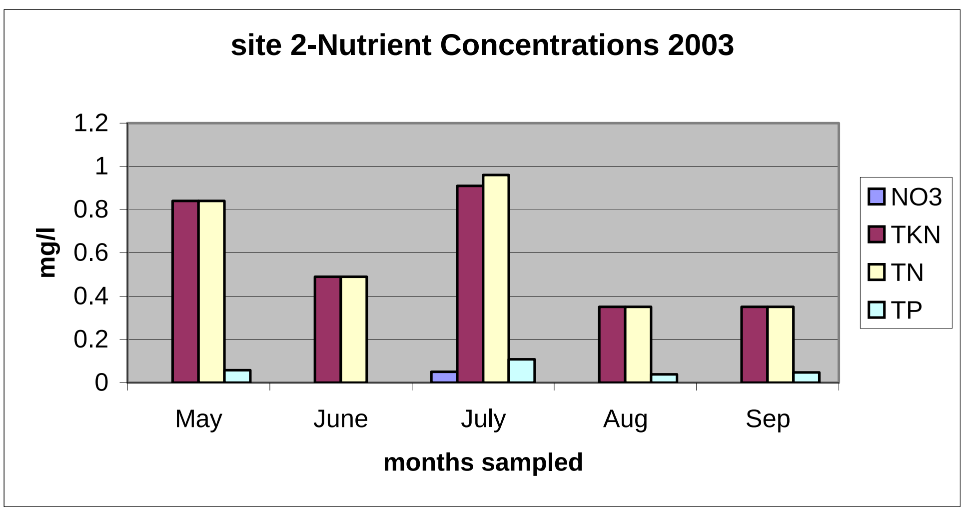


Figure 7: Nutrient Concentrations 2003



Phosphorus for 2002 and 2003 followed similar concentration variations for months and sites sampled. Therefore, the pond opening did not appear to affect phosphorus concentrations in the pond. Phosphorus was high in May due to the surface runoff occurring in March. Phosphorus was low in June as it was incorporated into plant tissue. Phosphorus peaked at site 2 in July as a result of the release from anoxic bottom conditions. Phosphorus decreased again in August as it was incorporated into vegetation. Phosphorus increased in September.

Phosphorus is a greater contaminant in surface water than nitrogen. Since, phosphorus is the limited nutrient it is a factor that control vegetative growth, both planktonic and macroalgae. Principal loading to water bodies is through erosion during a heavy rain. Miacomet received a lot of rain in March. Miacomet Road is paved and graded to drain in the pond. Breaks in the roadways bring sediment and phosphorus into the pond during rain events.

Figure 8: Total Phosphorus at site 1 for 2002 & 2003

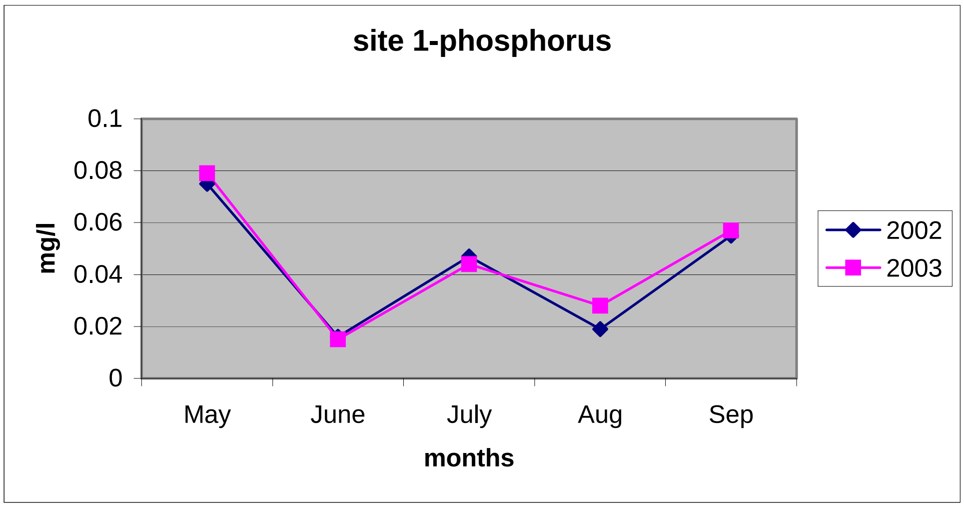
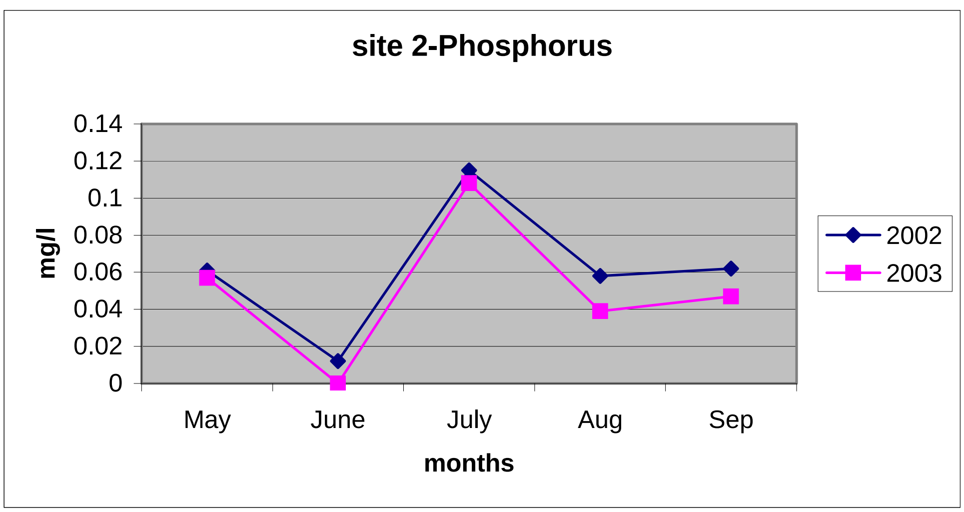


Figure 9: Total Phosphorus at site 2 for 2002 & 2003



Salinity

The pond opening affected salinity in Miacomet Pond. In 2002, the salinity for sites 1 & 2 for all months sampled was 0.1ppt. In 2003, salinity rose to 0.3ppt at site 1 and 0.4ppt at site 2. Salinity decreased during the summer as the pond filled with groundwater. Normal salinity values resumed in August and September at sites 1 & 2, respectively.

Figure 10

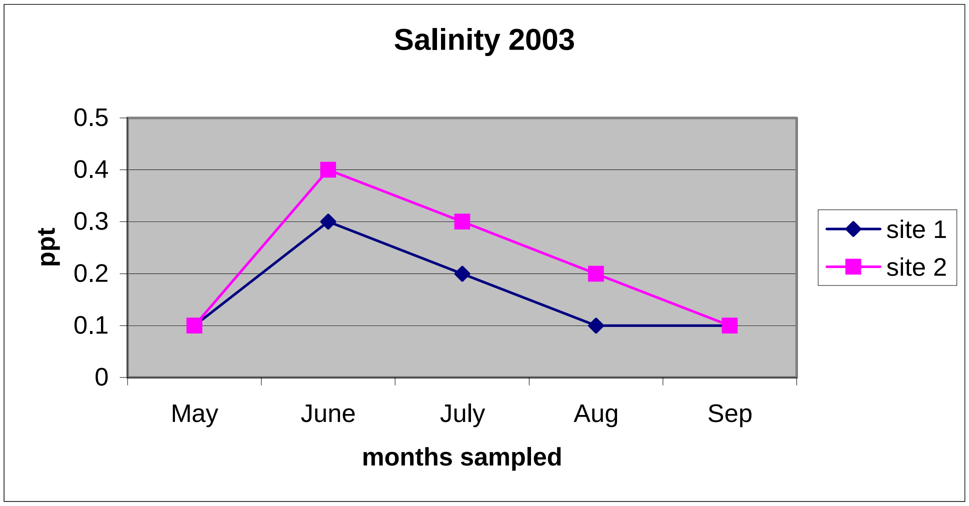
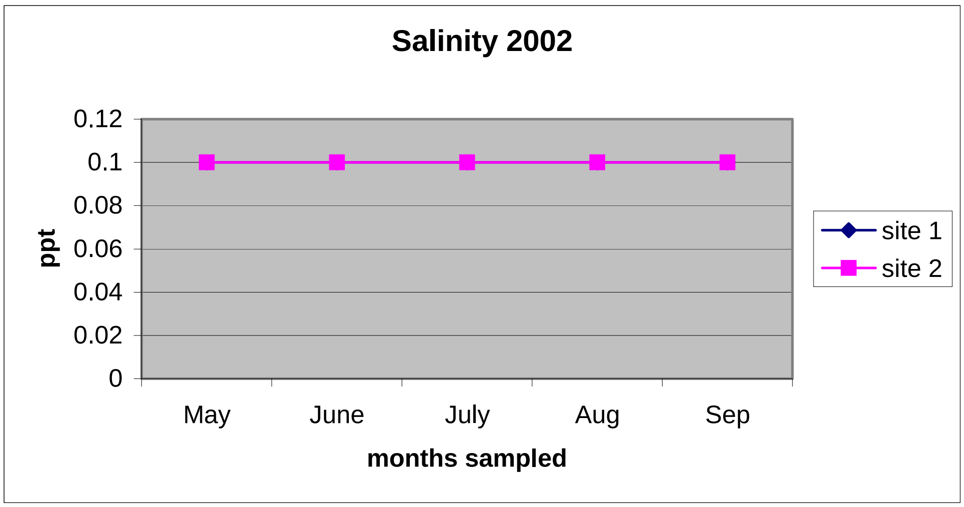
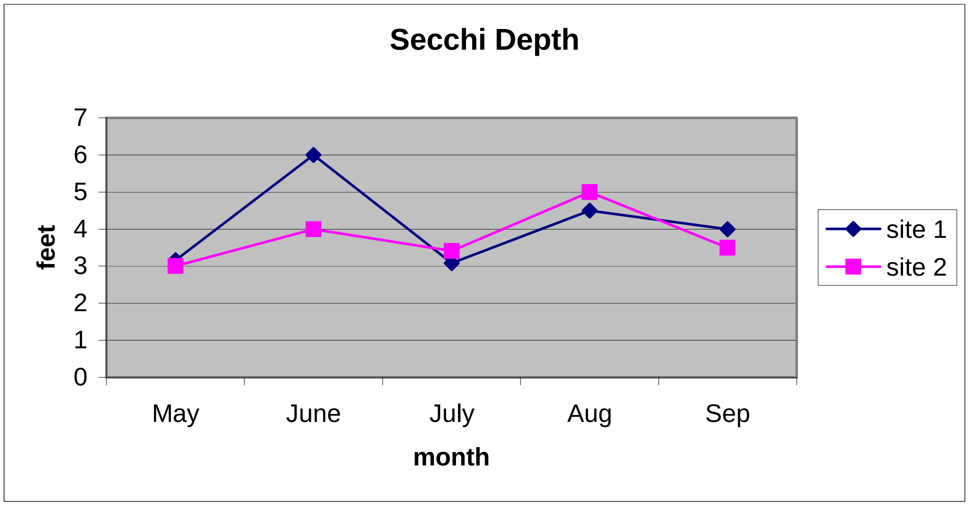


Figure 11



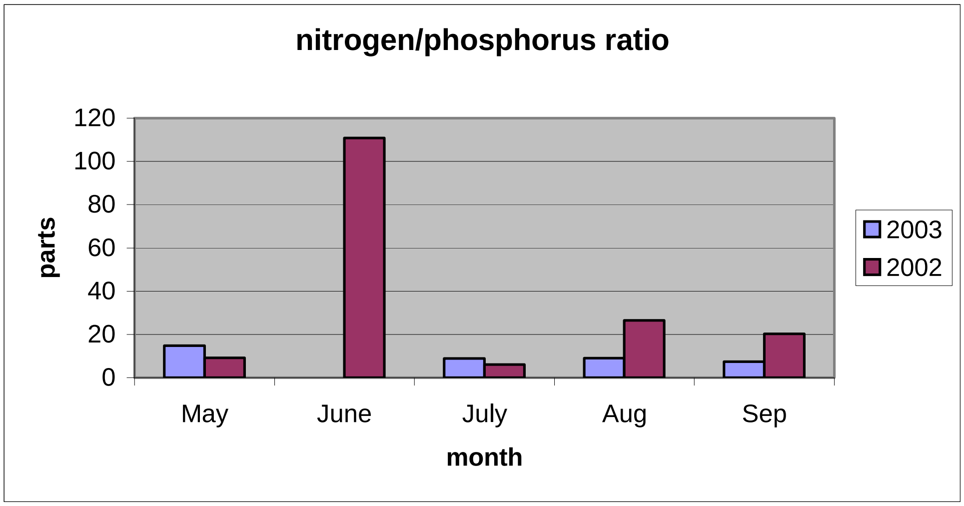
Secchi Depth

Secchi depth was low in May and July. Nutrients were high in May prior to the opening and in July. In July, phosphorus and nitrogen concentrations were high (eutrophic). Low secchi depth correlated with the high planktonic material in the pond. June and August had high secchi readings that correlated to low nutrient levels in the pond. Phosphorus was the limiting nutrient in August and below eutrophic concentrations.



Summary and Conclusions:
Miacomet Pond is one of the few fresh water ponds on Nantucket with a large surface area (47.3 ac), and an even larger watershed, roughly 20:1. The land uses in this watershed has caused Miacomet to become eutrophic. Nutrient loading, nitrogen and phosphorus, has led to hypoxic events during the warm summer months. The nutrients have from time to time switched their role as the limiting contributor. In 2002, Miacomet Pond was nitrogen limited in May and July and phosphorus limited in June, August, and September. In 2003, Miacomet Pond was nitrogen limited for all months sampled. Phosphorus was available and utilized in the same way in 2002 and 2003. Although in 2002, the phosphorus concentration were more critical as phosphorus was the limiting nutrient.

Figure 13: N/P Ratio for 2002 and 2003 at site 2



In Valiela's report which accompanied ASA's report on Miacomet, the nitrogen loading model calculated that atmospheric deposition accounted for 50% of the nitrogen load to the watershed. This however is a constant out of our immediate control, and does not reflect the total loads to the pond from the watershed. Upon further investigation of this report one finds that the largest contributor of N from the watershed is from septic systems, and is on the order of 44%. Fertilizer from the watershed to the pond contributed 32% of the total N load.

In order to further understand the role of N loading in the watershed to the pond, the watershed was further broken down into four sub-watersheds based on topographical and groundwater flow conditions (map 1). In sub-1 the largest contributor of N to the pond is from fertilizer, which amounts to 52%. The golf course has been estimated to contribute 23% of the total N to the pond in the form of fertilizer; residential lawns in comparison have been estimated to contribute 9% of the total. In subs- 2,3, and 4 the major contributor of N to the pond comes in the form of wastewater from septic systems, these percentages are 65%, 59%, and 53% respectively (Valiela).

Management strategies for the future, with concern for the health of Miacomet Pond should take into account land uses and planning in the surrounding watershed. Natural vegetation and open space should be maintained in order to uptake N loading from atmospheric deposition. Golf course management and fertilizing practices should be investigated to find more innovative alternatives to decrease N + P loading to the pond.

The Marine Department will continue to monitor Miacomet Pond to follow trends and changes in the pond's chemistry. Conclusions would be to manage the watersheds land uses with greater scrutiny, i.e. the easement for the golf course expansion was not the best land use with regards to the health of the pond. The nitrogen loading calculator from

ASA's computer model will be used to asses increased N loads to the pond from increases in build out.

Flooding should be addressed within each private development to eliminate Miacomet as the retention basin. The current practice of directing storm water into the pond is degrading water quality within the pond. Individual leaching systems should be installed in the older developments to treat storm water.