Miacomet Pond
Annual Report
2002

Tracy Curley
Town Biologist
Marine & Coastal Resource Department
34 Washington Street
Nantucket, MA 02554

Executive summary:

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.

Increased nutrients have led to increases in vegetation (phragmities & pond weeds). As a result, eutrophication has increased and 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.

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. The Department of Environmental Protection has monitored Miacomet Pond. In 1995, the DEP found that Miacomet does not meet state standards for fish consumption due to mercury levels above (.5ppm Hg). The Health Department has shone that during certain summers the waters have been unsafe for swimming due to fecal coliform counts above (200 fcu/100ml).

In response to public concerns, the Marine & Coastal Resource Department applied and received a Massachusetts Watershed Initiative Grant. Applied Science Associates was contracted to develop a computer model to understand the hydrology, water quality, and total maximum daily load scenarios. The study monitored nutrients and groundwater levels in order to develop management strategies to improve water quality conditions and to understand the flood capacity of the pond. The nitrogen-loading model found that the sources entering from the watershed consisted of 44% from wastewater, 32% from fertilizer, and 24% from atmospheric deposition. The nitrogen calculator can predict the quantity of nutrients that would be added with changes in land usage, i.e. further development in the watershed area. Phosphorus in the groundwater was also measured to predict loading in the future; the data collected was congruent with that collected ten years ago. The model can be used to predict long-term elevations and decreases from

precipitation to within 1/10 of a foot; however short term water level increases from storm events cannot be accurately determined. The model is interactive and can be accessed on the Internet via A.S.A.'s web site in order to run nutrient and precipitation scenarios.

METHODS:

The Marine & Coastal Resource Department monitored Miacomet Pond for water quality parameters. Temperature dissolved oxygen, salinity, secchi depth, and overall depth is measured at two sites. Nutrient information was collected and analyzed 5 times this year.

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 (wideon-grass), Potamogeton pusillus (thin-leaf pondweed), Potamogeton perfoliatus (clasping-leaved pondweed), Vallisneria americana (water celery), Utricularia (bladderwort), Najas (niaid), Lemna (duckweed), Decodon verticillatus (water willow)

Vegetative cover fringing along pond:
Solanum dulcamara (bittersweet nightshade), Typha latifolia (cattail), Phragmities 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.

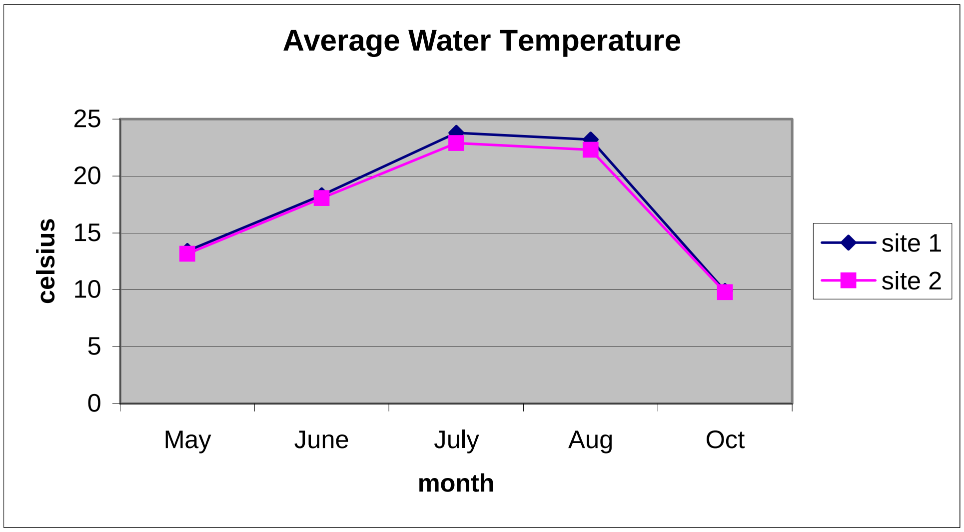
Miacomet Pond has several species of aquatic vegetation that are considered nuisance weeds. Those aquatic plants include coontail, water celery, pondweed, and clasping leaved pondweed. Infestations of nuisance weeds are a result of suitable habitat. Once plants are considered nuisance, it is difficult 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:

Water temperature was slightly warmer at the head of Miacomet Pond than at the foot. The surface water temperature between the two sites varied approximately by one degree, and from top to bottom the change in temperature was less than one degree. 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 cool in the fall.

FIGURE 1



There was a weak thermocline observed at site 2 for the July, and August sampling events. Solar radiation warmed the surface water faster than cooler groundwater could fill the bottom layer of the pond. The variation in temperatures was only one degree. Due to the deeper water at site 2, water temperature warmed and cooled slower than the other sites.

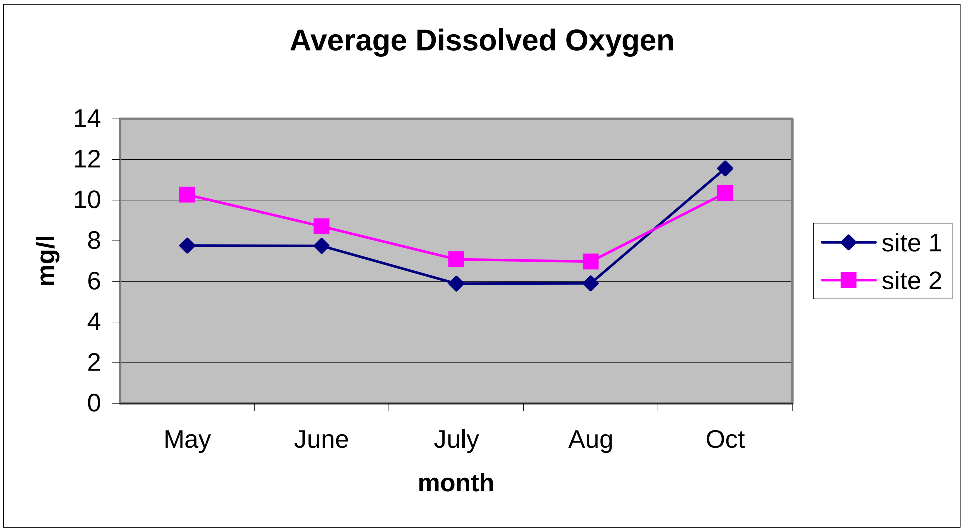
Dissolved Oxygen:

In the bottom layers of water, Miacomet had oxygen problems again this year. The low dissolved oxygen layer starts at the water sediment interface and expanded upwards and outwards as water temperature increased.

During June, sites 1 and site 2 were hypoxic one foot from the bottom. In July sites on the bottom were anoxic. In August site 2 at 9.4 ft. was near to hypoxic, and site 1 at 5 ft. was anoxic. As water temperatures cooled in September, the water column regained dissolved oxygen to increase above hypoxic 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 June, July and August in the bottom layers of water.

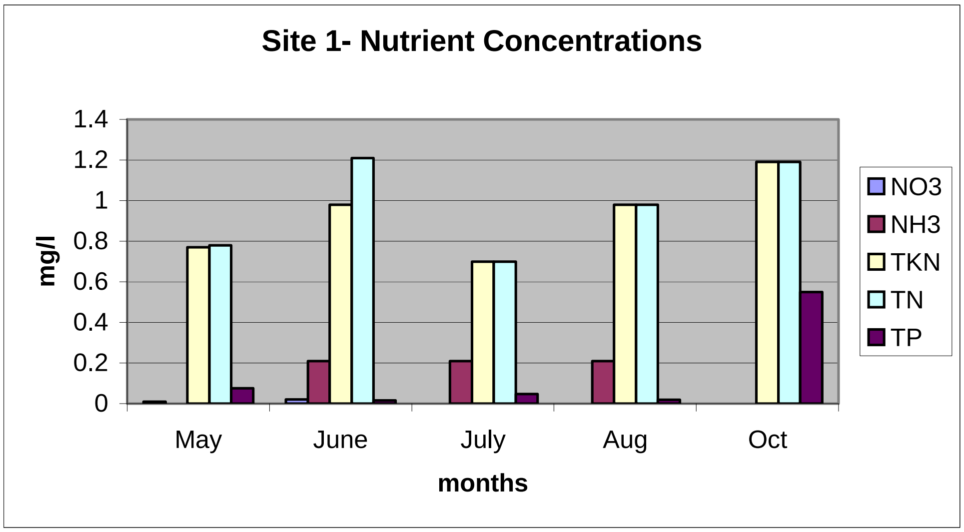
FIGURE 2



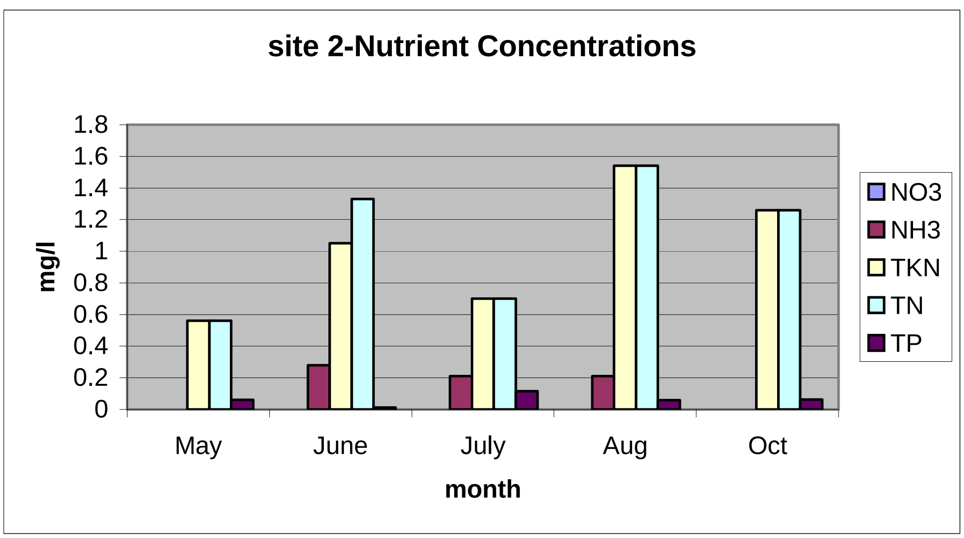
For the average dissolved oxygen concentrations, there was enough oxygen above mid depth in the pond for fish to survive. On the average, dissolved oxygen concentration was above 5 mg/l for most months sampled. Oxygen increased as water temperature decreased.

Nutrients

Total nitrogen levels demonstrate severely degraded water quality conditions for all sample dates. 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. In June and October, there were sharp increases in ammonia and total nitrogen at site 1.



Site 2 varied slightly from site 1, peaking in nitrogen in August. Nitrate was below



detection for all months sampled. Phosphorus was high in all months sampled except June. Miacomet is a fresh water pond and is phosphorus limited. Phosphorus is a greater contaminant in surface water. Principal loading to water bodies is through erosion. 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.

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 combined with its size are the reasons why it is now considered 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 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. Great care should be taken in further build out, and construction of more septic systems, so as to minimize contributions from wastewater and increased surface run off. Lastly, 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 stormwater into the pond is degrading water quality within the pond. Individual leaching systems should be installed in the older developments to treat stormwater.