Hummock Pond
Annual Report
2002

Prepared for:
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Introduction:

Hummock pond is a eutrophic coastal pond located on the southwest side of Nantucket Island. Hummock is approximately 142 acres in size with a surface drainage basin of approximately 2,2227 acres and a groundwater drainage basin of approximately 2,000 acres.

The surface drainage basin extends north and east of the head of Hummock. The basin encompasses Maxy's Pond, Crooked Lane, and one third of Sunset Hill. The surface divide extends south to Academy Hill School, "Five Corners", part of Prospect Cemetery, and encompasses Burnt Swamp. The surface divide then follows the configuration of the pond to Cisco Beach extending just north of Hummock Pond Road.

The groundwater drainage basin starts north of Rams Pasture and follows in a northward direction reaching Capaum Pond. The divide stretches east to West Chester Street encompassing "No Bottom Pond" and to the southwest through Burnt Swamp, Rotten Pumpkin Pond, and Larrabee Swamp and to Cisco Beach.

Hummock Pond accumulates water during the winter and generally floods in the spring. Flooded conditions of Hummock Pond can reach Millbrook Swamp and Madaket Road. During flooded conditions, the surface area of the pond increases from 140 acres to approximately 425 acres (Kortman and Knoecklein 1994).

Hummock Pond is opened to the sea twice per year to alleviate flooded conditions and to enhance marine fisheries. In addition, pond openings decrease nutrient concentrations and remove organic matter that accumulates in the pond from the bordering wetlands. Based on nutrient concentrations, Hummock pond has impaired water quality.

Methods:

Tracy Curley and Keith Conant monitored water quality in Hummock Pond from April to October. Temperature, dissolved oxygen, salinity, secchi depth, water depth and nutrient concentrations are measured at two established sites depending on weather conditions. Nutrient constituents are processed by Envirotech Laboratories located in Sandwich, MA.

Hummock Pond has seven established sites in the pond. The four sites, which are consistently monitored, are located from the boat launch to the foot of the pond.

Site 1 is located at the foot of Hummock Pond. This site is closest to the ocean and generally remains brackish throughout the year. The average depth is approximately 9ft. The bottom sediment is sand.

Site 3 is northward in a wider section of the pond. The water depth is approximately 6ft. The bottom sediment is mud.

Sampling consisted of recording temperature, dissolved oxygen, and salinity at one-depth intervals. Secchi was recorded at each site. At mid depth water was taken for nutrient analysis. Nitrate, nitrite, TKN, total nitrogen, and phosphorus were calculated.

Hummock Pond was opened to the ocean on April 25, 2002 and October 29, 2002. The spring opening lasted 5 days and the fall opening, 5 days. Due to lack of volume in the pond, Hummock did not stay open the usual 2 weeks.

2002 Water Quality Monitoring Results

Salinity:

Hummock contained very low salinity (3.3ppt) in April prior to the spring pond opening. The pond increased in salinity to 11.5ppt after the opening. The length of time the pond remains open to the ocean determines the amount of salinity change in the pond. This year, Hummock reached half the salinity as in past years when the pond had been open for 2 to 3 weeks. Salinity decreased by 1 to 2 ppt per month throughout the summer as the pond filled with groundwater. The pond salinity was 4ppt in October prior to the fall opening. Hummock cannot maintain saline conditions due to the physical characteristics of the pond.

The recorded salinity range of Hummock was 3.3ppt to 11.5ppt. During the spring opening, the ocean fills approximately half the pond (site 1 to site 4). Groundwater and surface water fill the head of the pond (site 5 to site 7). A salinity gradient occurs in Hummock Pond forming a wedge. The foot of the pond retains the largest salinity while the head continues to become fresh. November was not sampled due to conflicting scallop season.

Temperature:

During January, Hummock Pond was frozen. Temperature was 2C or below. Temperature increased during the spring remaining relatively uniform vertically from station 1 to 4. Water temperature peaked in August reaching maximum temperature (26.3C). One week later in August, temperatures began to cool to 23.3C. Temperature decreased each subsequent month to reach 9.9C in October, the last month sampled.

Dissolved Oxygen:

Dissolved oxygen remained at acceptable levels through June. In July and August, dissolved oxygen concentrations decreased in the last two feet of the water column. Sites 1 and 3 had low oxygen levels ranging from 2.01 mg/l to 0.85 mg/l in the last foot of water. Dissolved oxygen below 5mg/l is considered to be low oxygen concentrations. Low oxygen cause respiratory and metabolic activity of fish species to be compromised. Sites generally contain lower dissolved oxygen concentrations in the bottom layers of water during the warmer months. As water temperatures began to cool, dissolved oxygen increased slightly at the bottom layer of water. High dissolved oxygen concentrations returned in October.

Figures 1 and 2 depict average water quality conditions for both sites.

Figure 1: Average Salinity, Temperature and Dissolved Oxygen for Site 1

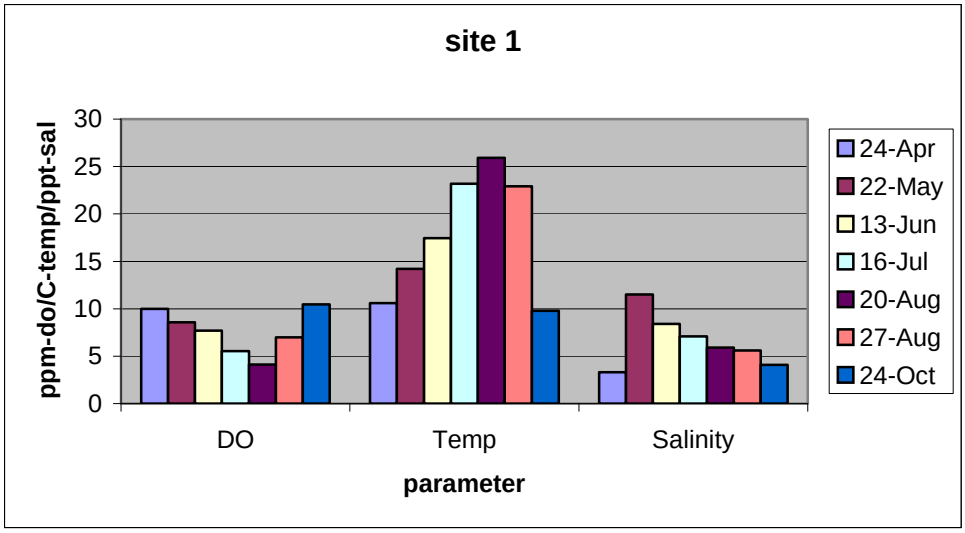
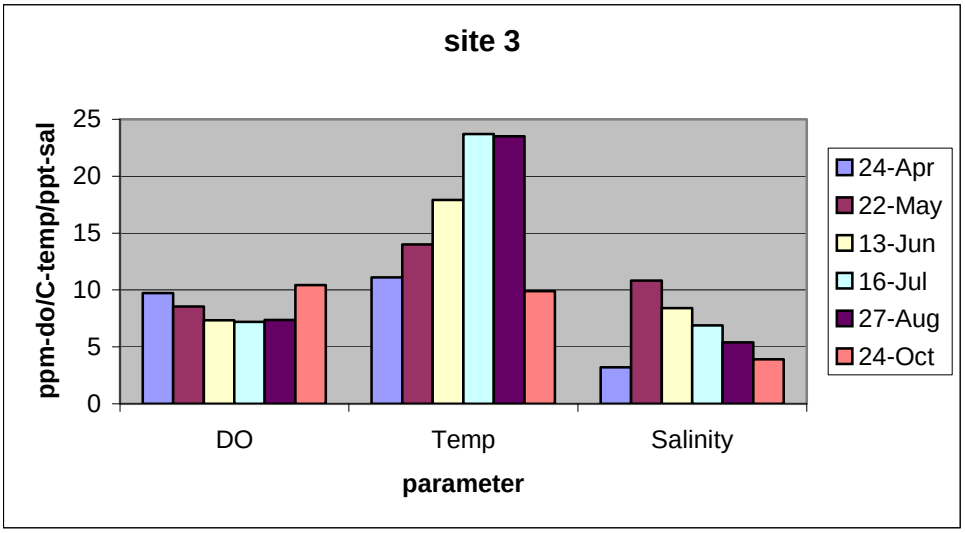


Figure 2: Average Salinity, Temperature and Dissolved Oxygen for Site 3



SECCHI DEPTH:

The secchi depth ranged between 2ft and 6.5ft, with a pond average of 3.4ft. Secchi depths were lowest in April prior to the spring opening. The high phosphorus concentrations in April relate to minimum secchi depths. Secchi depth was low for both sites all months sampled except October.

Table 1: Hummock Pond secchi depths for all sites

	April	May	June	July	Aug.	Oct.
site 1	2.16	2.83	3	3	3.9	6.5
site 3	2	2.33	3	3	4.16	4.7
site 6					3	

Nitrogen/Phosphorus Ratio

Nitrogen and phosphorus both provide the food source for phytoplankton growth. The ratio of nitrogen to phosphorus is necessary to determine which is the limited nutrient. Phytoplankton requires approximately 16 parts of nitrogen to 1 part of phosphorus to grow. Nitrogen is considered "limited" in Hummock Pond.

The concentration of nitrogen in the marine environment dictates phytoplankton production. However, an overabundance of either nutrient will result in a shift of phytoplankton species population or plant communities. The observed N/P ratio this year was recorded at approximately 6.

Nutrient ratios alone do not provide conclusive proof of limiting factors. Other considerations such as light, the movement of water, internal recycling and microbial processes should be taken into account.

Phosphorus:

Phosphorus is initially made available to living organisms through the weathering of rocks. Phosphorus is found in the environment as a form of soluble phosphate ions. Phosphate, which is applied to a lawn as fertilizer, becomes bound to soil particles. Phosphorus is a major eutrophication contaminant in surface water. Principal loading is due soil erosion.

Phosphorus levels exceeded 0.050 mg/l indicating enriched conditions. With the exception of August, phosphorus concentrations have exceeded 0.05mg/l on all sample dates. Phosphorus was highest in April prior to the pond opening. The pond opening provided an export of nutrients out of the pond. Phosphorus was below detection in August. The reduction in phosphorus concentration during the end of July and August correlate with groundwater flow.

Figure 3:

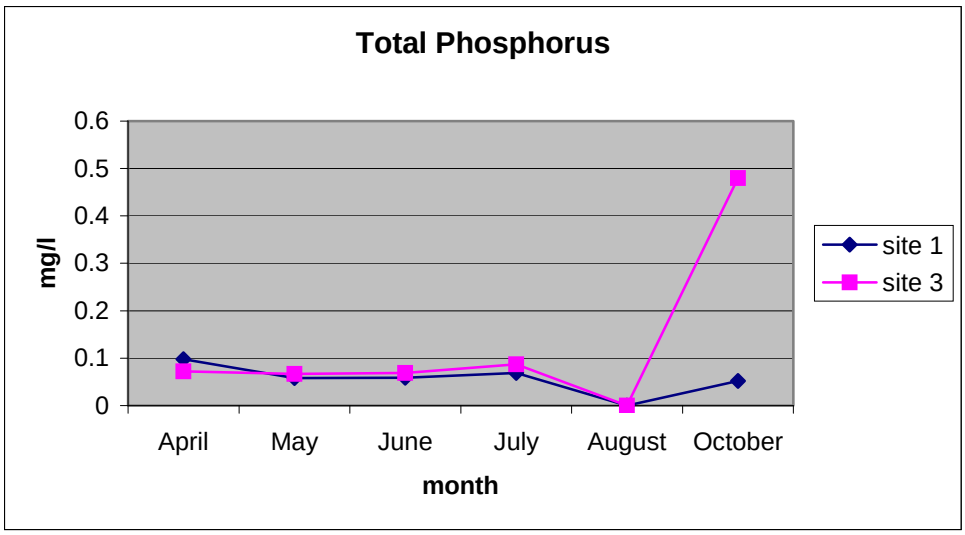
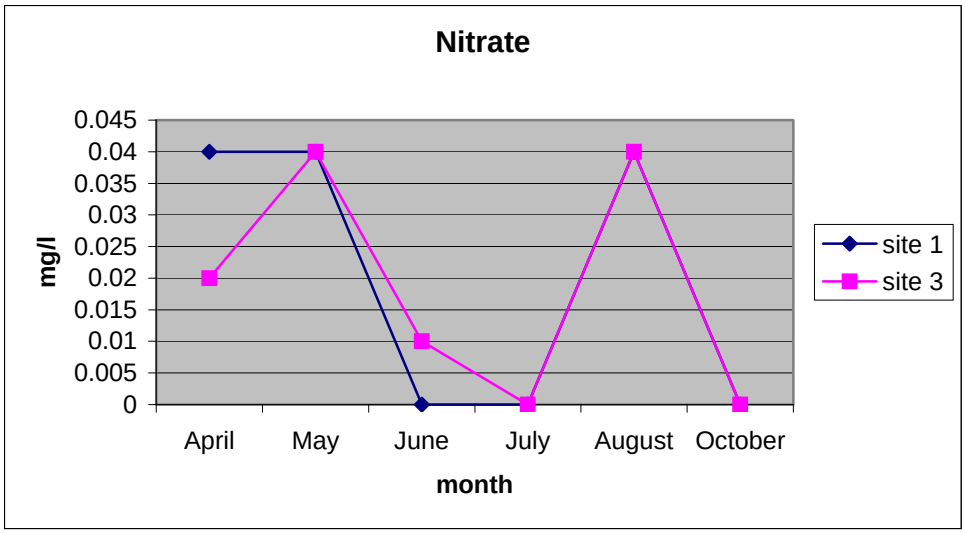


Figure 4:

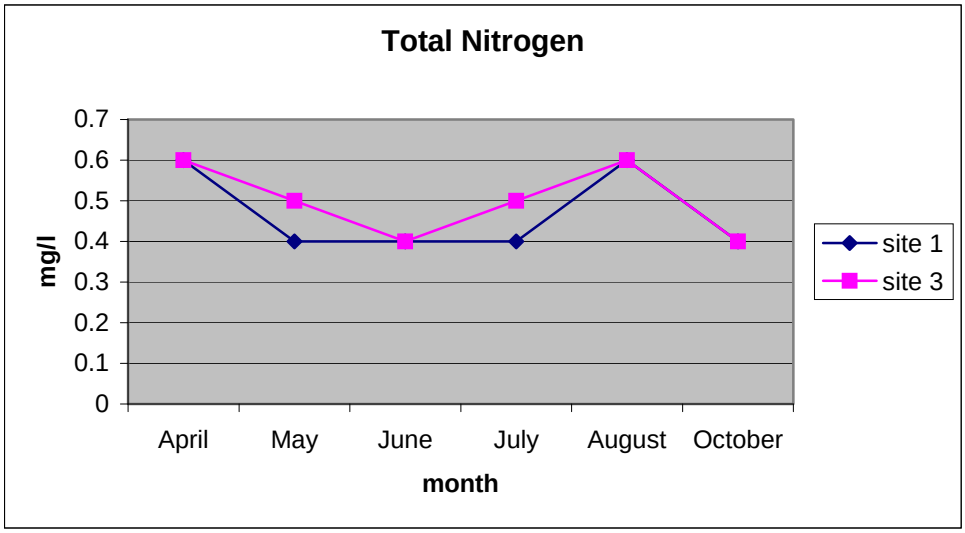


Nitrogen:
Nitrogen occurs in three major forms in aquatic systems (ammonia, nitrate and organic compounds). Nitrite is a fourth form; but due to its instability it exists for very short periods of time during the conversion between other forms. Nitrate and ammonia are readily available for uptakes by plants. Both forms can cause toxicity problems at high concentrations.

As the concentration of nitrogen increases in the water column, more plants will grow. When these plants die, bacteria use dissolved oxygen from the water column to decompose the organic plant matter. This can result in ecosystem stress, due to oxygen depletion. Nitrate concentrations that exceed 0.07mg/l and total nitrogen that exceed

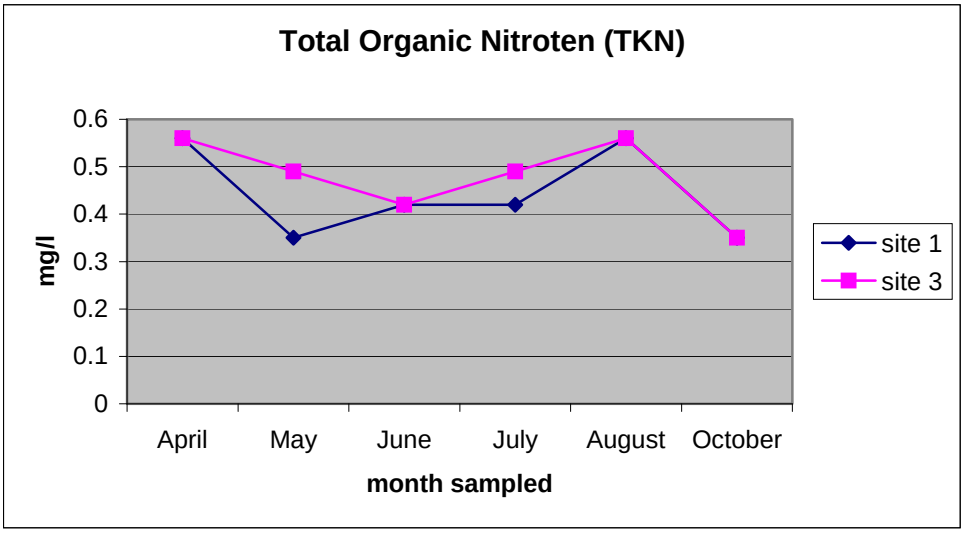
0.7mg/l indicate enriched conditions. Although nitrates did not exceed eutrophic conditions, total nitrogen concentrations were very high at site 3. Nitrates peaked in August and decreased through the fall. Nitrogen enters the pond through the watershed or is recycled internally during the warmer months.

Figure 5:



In June and July, there is no detectable concentration of inorganic nitrogen or nitrate. Nitrate has been incorporated into plant material. Organic nitrogen increased throughout the summer months.

Figure 6:



Discussion:

The result of the spring opening was a flow of saltwater into the pond increasing the salinity from 3.3ppt to 11.5ppt. Nitrogen and phosphorus were exported out of the pond. The water clarity increased slightly. The purpose of the spring opening is to allow oceanic phytoplankton, and anadromous fish to enter the pond. The pH of the pond water becomes more alkaline with the addition of saltwater. Water quality improves for fish species.

Inorganic dissolved nitrogen (nitrate) tends to accumulate during the summer. Shifts in nitrate concentrations can impact water transparency and phytoplankton populations. As nitrogen concentration peaked in August, dissolved oxygen levels were low. Dissolved oxygen was lost in the bottom layer of water as bacterial respiration took place. Organic nitrogen was very high in April and August.

Since nitrogen and phosphorus provide the food source for phytoplankton production, the N/P ratio is significant in determining nutrient loads. Hummock Pond is generally nitrogen limited. The N/P ratio in 2001 was 9.4 units and 6 units in 2002. Nitrogen was lower this year.

Although the pond was not sampled after the fall opening, certain trends generally appear. During the fall opening, the salinity generally increases slightly. The head volume of water is less than the spring; thus, the pond closes faster. Nitrate levels generally are reduced, although nitrates were not consistently high this year. Total organic nitrogen is generally not flushed during the fall opening and remains in moderate in concentrations. Phosphorus, dissolved oxygen, and alkalinity concentrations generally increase.