# Sesachacha Pond
# Annual Report
# 2003
# Town of Nantucket

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# EXECUTIVE SUMMARY

Sesachacha Pond is a coastal eutrophic salt pond located on the northeast part of Nantucket Island. The unique physical characteristics of Sesachacha Pond permit high salinities to be maintained when the pond is properly flushed to the sea via mechanical excavation.

In recent years due to poor openings and general precipitation there has been a trend in freshening of the pond causing degradation to winter flounder and blue back herring habitat. The reduced salinity and increased nutrient concentrations combined with warm water temperatures has caused an overall decline in marine fisheries.

The pond must remain open to the ocean for at least 6 days in the spring (figures 2 & 3) to ensure a proper volumetric exchange of water. During this spring opening, total nitrogen and phosphorus were temporarily reduced while salinity increased to 1997 concentrations (figure 4).

Nitrogen and phosphorus increased through the summer and fall reaching eutrophic levels, 0.7mg/l and 0.05mg/l respectively. Total organic nitrogen was generated in the pond while phosphorus entered the pond through the watershed. Secchi depths were low all year. Nutrients were not exported out of the pond in the fall.

Sesachacha Pond has been placed on the 1998 Massachusetts 303D list for impaired water bodies. Sesachacha Pond has been included in the Massachusetts Estuaries Project to determine TMDL’s for the pond and watershed areas.

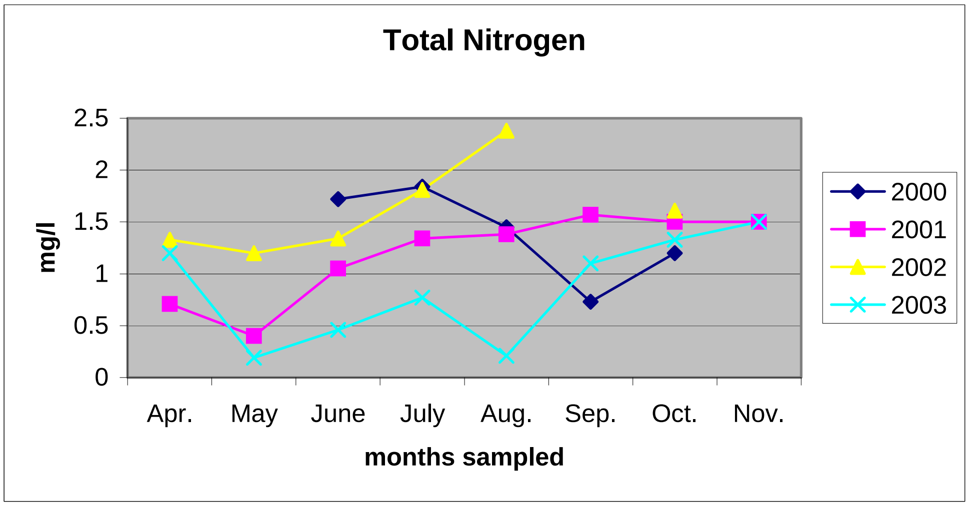
# INTRODUCTION:

Sesachacha Pond has been monitored since 1980 for water quality conditions by a variety of agencies. Historically, Sesachacha was opened to the ocean seasonally to enhance marine fisheries. Pond openings were discontinued for ten years during the 1980s. The absence of the openings resulted in an environmental change, moving from marine to a fresh water ecosystem. Public demand caused political pressures at the federal level to grant a home rule petition to open the great ponds.

Due in part to the watershed/pond ratio, water quality conditions in Sesachacha Pond is a reflection of the success or failure of pond openings. In spring 1991, Sesachacha Pond was opened to the sea. Due to inadequate opening practices, water quality in the pond did not improve in 1991 and 1992. In 1993, pond-opening methodology was revised. In 1993, water quality and marine fisheries in Sesachacha began to improve with an observable increase in marine fish diversity. Salinity and dissolved oxygen concentrations increased and stabilized through the most of the 1990s. In 1998 and through 2002, the pond began to freshen, nutrients increased and water clarity diminished due to lack of tidal flushing during the pond openings. Water quality degradation resulted in fish kills, phytoplankton blooms and poor water clarity.

Total nitrogen in 2000-2002 exceeded eutrophic levels for most months sampled. After the spring pond opening in 2003, there was an initial reduction in total nitrogen. However, nitrogen increased through the fall of 2003 to reach 1.5mg/l, eutrophic levels and secchi depths did not improve.

Figure 1: Average total nitrogen for 2000-2003




Increased development to the north of Sesachacha Pond has increased nutrient loading into Sesachacha Pond. Surface runoff and groundwater carry nitrogen and phosphorus to the pond changing water chemistry. This accelerated eutrophication process has made pond openings more critical in maintaining good water quality. A proper exchange of nutrient latent pond water with alkaline-rich ocean water is important in maintaining good water quality for marine life.

## Sampling Procedures and Equipment

Site 1: near Quidnet village approximately 1000 ft from shore
Site 2: deep water off shack approximately 1000 ft from shore to northwest
Site 3: near boat launch approximately 100 ft from shore
Site 4: deep water to southeast approximately 1200 ft from shore

Sampling protocol:
Sesachacha is sampled beginning in April through November. Temperature, dissolved oxygen and salinity were measured using a YSI 85. Measurements were recorded every 3-ft. Secchi depth was measured with a standard white secchi disk. A van dorhn was used to collect water at mid depth for nutrient analysis. Envirotech Laboratories conducted the nutrient analysis.

## Results and discussion:

Salinity

In order for Sesachacha Pond to maintain its salinity, the pond must remain open for at least 6 days in the spring for a proper exchange of salt water. The fall opening appears to be less significant in maintaining salinity than in the spring (Figure 2). If the total days open are combined for spring and fall, the overall salinity is dependent on primarily the spring opening (Figure 3). For example, in 2001 the total number of days open to the ocean was 10 and yet the salinity remained on average around 14ppt. In 2003, the pond was open for 6 days in the spring and the salinity rebounded to 21ppt on average.

The overall salinity in Sesachacha Pond ranged from 9 ppt to 27 ppt. Salinity tended to be stable vertically and horizontally in the water column. Salinity increased by 18ppt as a result of the spring opening and decreased by 2ppt after the fall opening.

The salinity in Sesachacha, this year, has reached a concentration that will supports adult winter flounder. Although winter flounder eggs can survive in a salinity range of 10ppt to 30ppt, there may not be many adults left to spawn in the pond. As a result of precipitation, poor pond openings, and groundwater infiltration, the pond's fish species have been reduced.

Figure 2: The number of days open to ocean in the spring and fall. Average salinity for years sampled

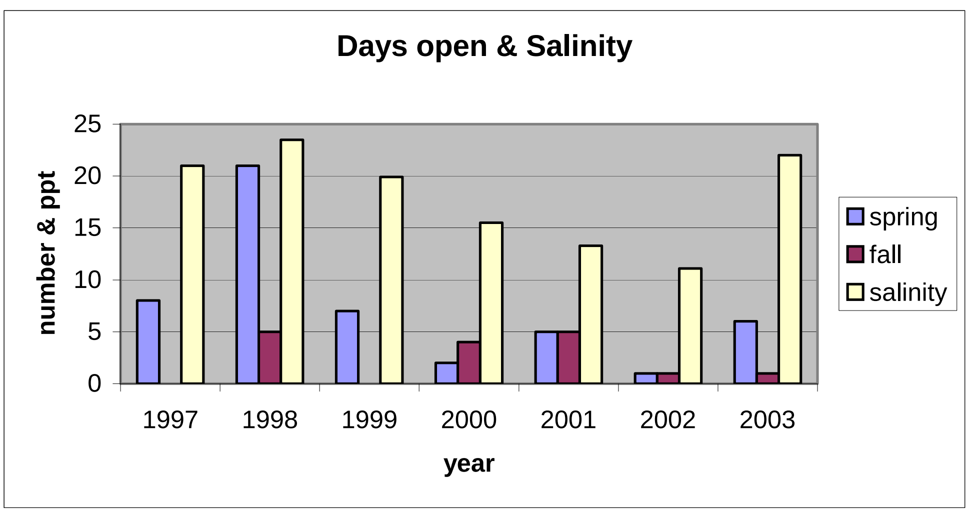


Figure 3: The total number of days open to ocean compared to average salinity

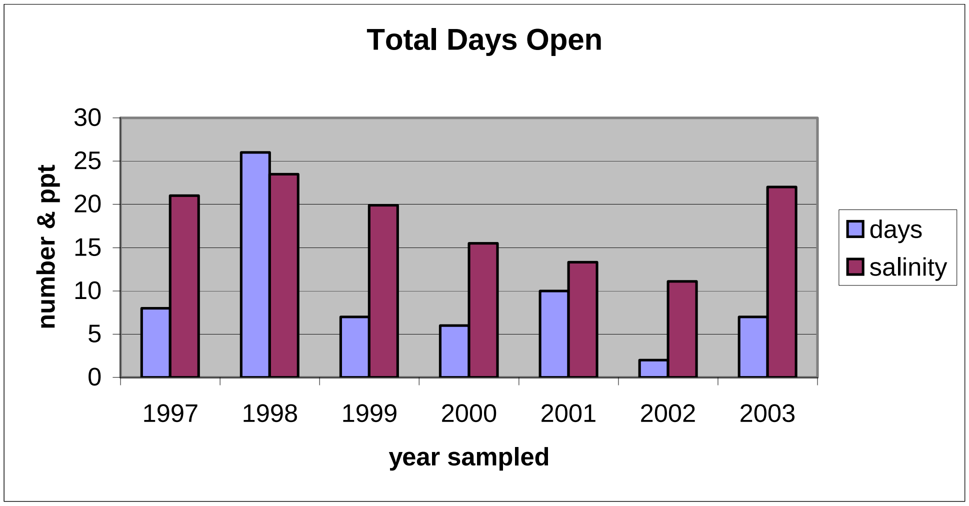
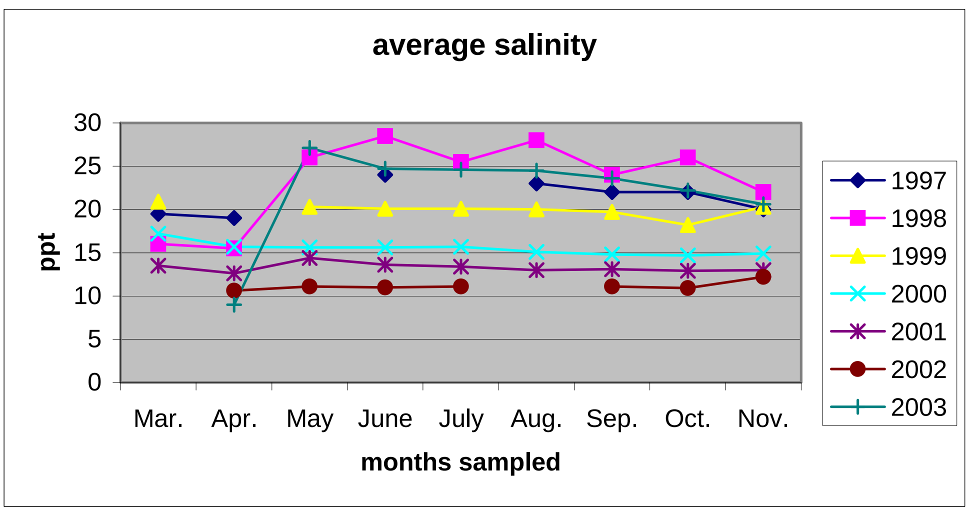



Figure 4: Average Salinity of Sesachacha Pond 1997-2003



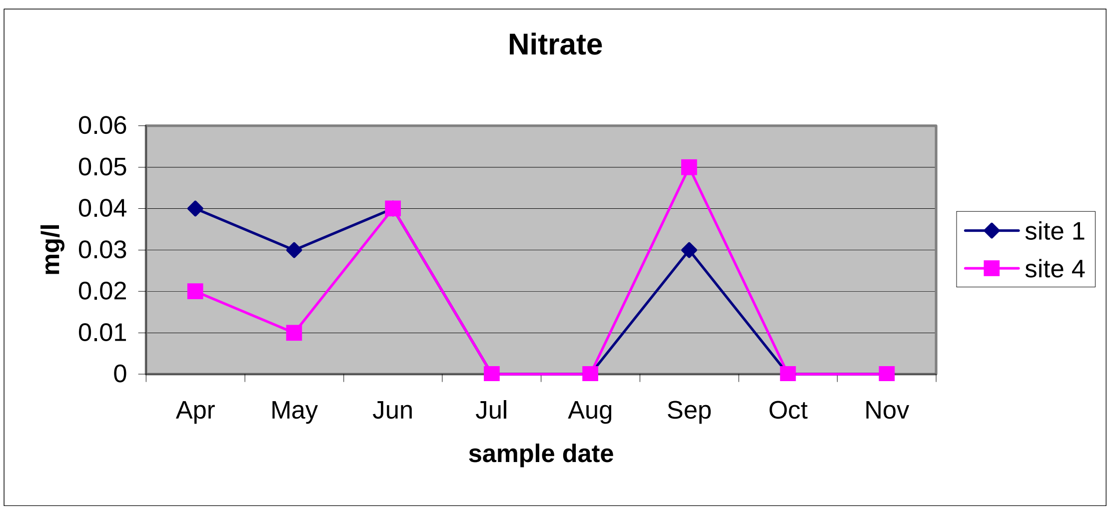
## Nitrogen

Nitrogen has decreased since last year. Total nitrogen levels recorded this year were lower ranging from 0.19 ppm to 1.54 ppm. The spring opening caused an initial reduction in nitrogen in 2003. Total nitrogen concentrations, which exceed 0.7 mg/l, indicate enriched conditions. In the months of April, July, September, October, and November, Sesachacha had high concentrations of nitrogen.

Nitrogen is limited in Sesachacha Pond and limits primary production of aquatic plants. As nitrate levels increase, phytoplankton, macroalgae (seaweed), epiphytes (plants that attach) reproduce. The greater the concentration of nitrogen in the water column, the more plants will grow. When these plants die, bacteria use dissolved oxygen from the water column to decompose the organic plant matter. Oxygen depletion can result in ecosystem stress.

Nitrate concentrations increased in May after the pond opening as it did in 2002. This may be due to nutrient rich groundwater filling the pond after the draining. Nitrogen is accumulating in Sesachacha Pond.

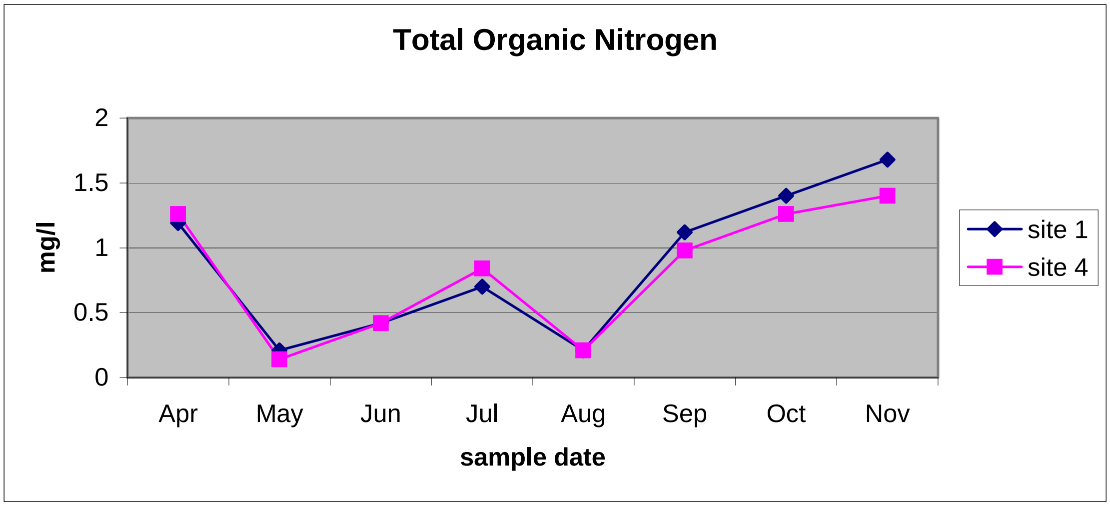
Figure 5




In July and August, there is no detectable concentration of inorganic nitrogen or nitrate. Nitrate has been incorporated into plant material. Organic nitrogen increased May through July, dipped in August and increased through the fall.

Total organic nitrogen decreased after the spring opening indicating an export of nitrogen out of the pond. The pond was open for 6 days in the spring permitting nitrogen removal from the system. Nitrogen concentrations exceeded eutrophic levels in the spring, mid summer and fall. Organic nitrogen is generated in the pond.

Figure 6:  Total Organic Nitrogen for sites 1 and 4 in 2003




Dissolved Oxygen

Dissolved oxygen was supersaturated in April as a result of phytoplankton bloom.  After the opening and reduction of nitrogen, dissolved oxygen concentration were near the saturation point.  Water clarity improved slightly indicating a reduction in phytoplankton cells.  Dissolved oxygen remained stable through most of the water column in June although the bottom layer was hypoxic.  Bacterial respiration was active in June and July.  The bottom two feet of water in July became anoxic.   Nitrate was below detection in July as nitrogen was incorporated into plant cells.   Phytoplankton population probably crashed in August/September.  In August, dissolved oxygen was lower throughout the water column, 2mg/l below saturation point.  Water clarity improved by one half foot.  In September, dissolved oxygen increased slightly and water clarity increased another one half foot.  Dissolved oxygen concentrations were good throughout the water column in October and November.

The reduction of nitrogen as a result of the spring opening improved summer dissolved oxygen concentrations.  There was no fish kill this year.

Nitrogen/Phosphorus Ratio

It is important to determine which nutrient may be in shortest supply in relation to the needs of plants (phytoplankton or rooted aquatic plants).  For it is the relative abundance of this nutrient which will control or "limit" primary production in the water body.  An increase in the amount of the limiting nutrient should result in a proportional amount of additional production, and vice versa.  This limiting nutrient concept or "Law of the Minimum" is an important principle because it explains the response of a waterbody to increases in watershed pollution, but also indicates the priority of which elements should be reduced to effect a change in the pond conditions.

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 Sesachacha 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. There is a build of nutrients in the pond during the winter most likely a result of poor fall openings. Prior to the spring opening, nutrients are found in the highest concentrations.

Figure 7

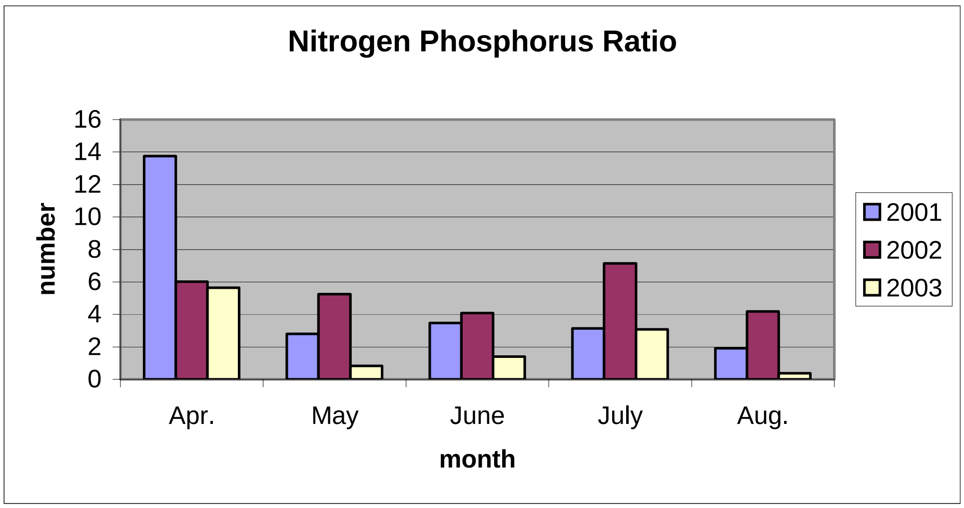
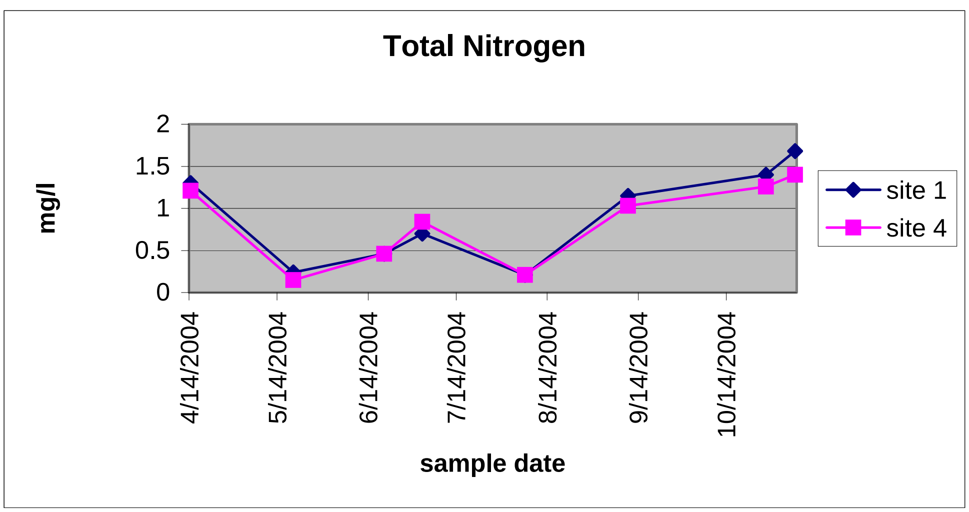


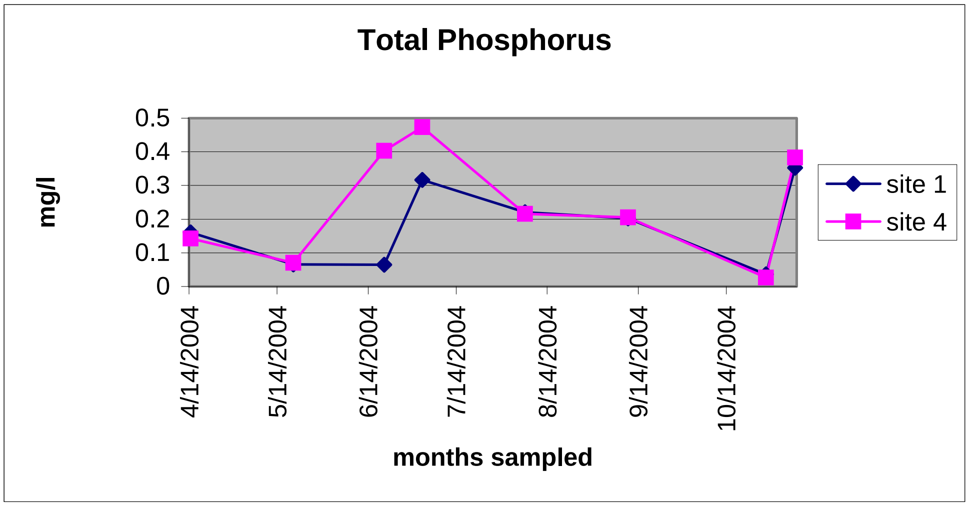

Figure 8



Phosphorus

Phosphorus levels exceeding 0.05 mg/l indicate enriched conditions. Sesachacha had high concentrations of phosphorus for all months sampled except June.

Figure 9

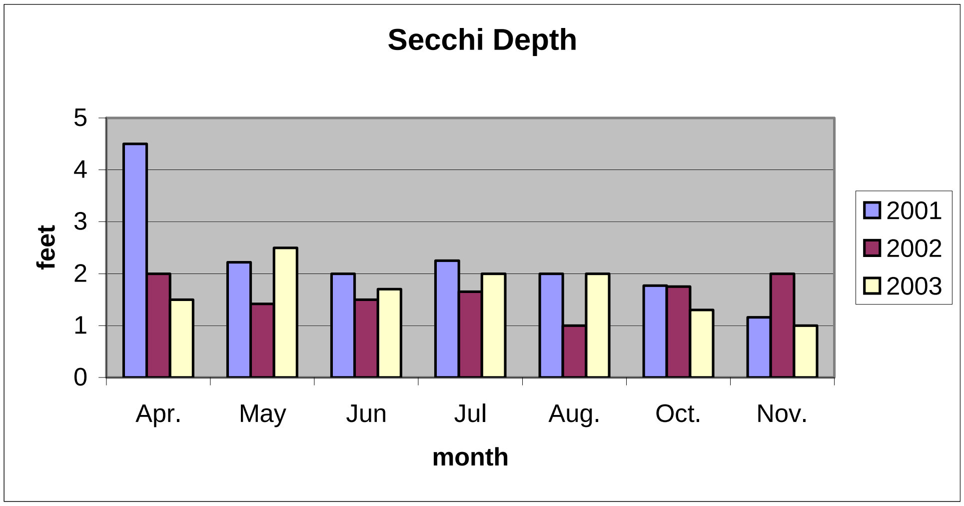



Nutrient ratios alone do not provide conclusive proof of limiting factors. Other considerations such as light, the movement of water, internal recycling or microbial processes are also reviewed. Secchi depth measures light. Although there was a reduction in overall nitrogen from two years past, secchi depth did not increase as a result. Perhaps phosphorus is triggering the summer phytoplankton bloom.

Water Clarity

Secchi depth was comparable to the last two years.

Figure 10



## PHYSICAL FEATURES:

The drainage basin of Sesachacha Pond covers approximately 800 acres. The watershed to pond ratio is low (3:1). The surface area of the pond during “normal conditions” covers 266 acres. The “flooded conditions” of the pond covers 279 acres. The approximate pond volume for “normal” and “flooded” conditions is 2183 acre-ft and 3129 acre-ft, respectively.

Sesachacha Pond experiences a periodic fluctuation in water level as a result of pond openings. Theoretically, water level reaches maximum prior to a spring opening, and minimum after the pond has established equilibrium with the ocean. Shortly after this balance is reached, the channel closes and the pond surface area begins to increase. At minimum, or equilibrium pond level the surface area is 266 acres with a volume of 2183 acre-ft or 710 million gallons. At the maximum flooded condition, the pond has a surface area of 279 acres with a volume of 3219 acre-ft or 1 billion gallons. This represents a change of approximately 341 million gallons of water during a “good” pond opening.

The mean and maximum depths during equilibrium conditions are 8.2 and 18 ft, respectively. Mean and maximum depths during flooded conditions are 11.5 and 21 ft, respectively. The pond has two deep basins; one located on the east side with a maximum depth of 21ft and the other on the west side with a maximum of 18ft. The water depth between the two basins average 14 ft.

## SURFACE DRAINAGE BASIN:

Sesachacha Pond’s water quality if directly related to its watershed characteristics. The important physical properties of the watershed are drainage basin size, soil permeability, erosion qualities, and vegetative cover.

Drainage basin: The watershed area is approximately 800 acres and the pond is 266 acres. The watershed to pond area ratio is 3:1. Therefore, disturbances within the watershed should have minimal affects to pond water quality. However, pond water lost to the ocean during openings takes longer to replace by surface and groundwater flows.

Soil permeability and erosion qualities: The Plymouth-Evesboro association surround 80% of Sesachacha Pond. Plymouth-Evesboro is a gently sloping excessively drained, sandy soil formed in glacial till and in outwash deposits. Medisaprists-Berryland Variant association surround 20% of Sesachacha Pond to the southwest. This association is nearly level, very poorly drained muck soil formed in organic deposits; sandy soil formed in outwash deposits. Sand and cobble are found along the shoreline and extend to the 12ft contour. Organic muck is found in deeper contours.

Most of the development around Sesachacha Pond is located in the Plymouth-Evesboro Association. The permeability of this soil is rapid. Septic tanks placed on the downward slope to the pond will increase seepage of effluent into the pond and groundwater. Nutrients are entering Sesachacha Pond though groundwater infiltration.

Vegetative cover: A wetland is to the northwest of the pond contributes to Sesachacha Pond's ecosystem. The wetland produces peat, which stabilizes sediment during flooded conditions. Peat is the result of recycled nutrients and organic matter from a wetland system. Peat provides structural biomass to the ecosystem. Nitrogen becomes mineralized in the sediment and can be used for plant growth. Bulrush grows in the "intertidal area" of the pond. Spartina grows along the peripheral upland of the bulrush. North of the spartina, woody vegetation exists. The change in upland vegetation is a result of underlying sediments. As organic material accumulates, the elevation around the pond increases. Phragmites and cattails are growing along the wetland border.

## SOURCES OF CONTAMINATION:

Sesachacha Pond has the following sources of contamination to water quality: septic systems, stormwater overflow pipe entering beneath Polpis Road, wetland, paved roads, precipitation and deposition, internal recycling, underground storage tanks, fertilizer applications.

Groundwater entering Sesachacha Pond has increased in nitrate concentrations due to septic system leachates. The leaching field effluents of a conventional septic system contain 40 to 60 mg/l of nitrogen and 8 to 38 mg/l of phosphorus. Effluents contain a large number of pathogenic bacteria and viruses. Virus inactivation times in groundwater are approximately 120-200 days.

The direct discharge pipe that drains the adjacent wetland entering beneath the road is a contamination source. The organic that are carried by the pipe provide a food source for bacteria. Wetlands by nature provide habitat for a variety of animals that contribute many bacteria strains as well as nutrient concentrations.

During storm events, surface runoff carry heavy metals from roadways, volatile organic compounds, oils and grease from cars; pathogenic bacteria and viruses from septic systems, suspended solid, nutrients, pesticides and herbicides from lawns and the golf course. The possible location of the surface water divide encompasses part of the Sankaty Golf Course causing additional water quality problems during storm events.