that the system should be capable of supporting healthy infaunal communities should the organic matter loadings be reduced.

The infaunal community based classification (Table VIII-1) throughout Sesachacha Pond is fully supported by the lack of eelgrass habitat and the water quality data discussed in the text above.

Table VIII-1. Summary of Nutrient Related Habitat Health within the Sesachacha Pond Estuary on the eastern coast of Nantucket Island within the Town of Nantucket, MA, based upon assessment data presented in Chapter VII. The system is presently structured as a great salt pond consisting of a single basin formed from seawater entry to a coastal kettle pond.

Health Indicator	Sesachacha Pond System Main Basin
Dissolved Oxygen	**SI**[1]
Chlorophyll	**SD**[2]
Macroalgae	**--**[3]
Eelgrass	**--**[4]
Infaunal Animals	**SI**[5]**/SD**[6]
Overall:	**SD**

1 – oxygen depletions frequent to 4 mg/L., and periodically to <2 mg/L.
2 – chlorophyll levels generally >20 ug/L, reaching 60 ug/l and >100 ug/L in bloom periods.
3 -- macroalgae was difficult to assess due to poor light penetration, however, large accumulations of drift algae have not been reported for this system
4 – no evidence this basin is supportive of eelgrass.
5 – main basin low numbers of species (generally <6) moderate numbers of individuals, but dominated by opportunistic species (primarily *Streblospio*).
6 – western basin (Transect B, figure VII-9) infaunal community severely depleted, low numbers of individuals (≤72) & species (≤4).

H = healthy habitat conditions; MI = Moderate Impairment; SI = Significant Impairment; SD = Severe Degradation; -- = not applicable to this estuarine reach

VIII.2 THRESHOLD NITROGEN CONCENTRATIONS

The approach for determining nitrogen loading rates, which will maintain acceptable habitat quality throughout and embayment system, is to first identify a sentinel location within the embayment and second to determine the nitrogen concentration within the water column which will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target nitrogen level are determined, the Linked Watershed-Embayment Model is used to sequentially adjust nitrogen loads until the targeted nitrogen concentration is achieved.

Within the Sesachacha Pond System the most appropriate sentinel station location is generally in the center of the basin, but given the horizontally well mixed nature of this great salt pond, Station 1 in Figure II-1 was selected as the sentinel station for threshold development. This location was selected because it is relatively deep and has prior data collection from which to assess long-term trends. As noted in previous sections, concentrations at the sentinel station approximate concentrations throughout the pond waters (i.e. it is representative of other pond locations).

Following the MEP protocol, since eelgrass has not been documented in Sesachacha Pond, restoration of infaunal habitat is the restoration goal for this aquatic system. Infaunal animal habitat is a critical resource to the Sesachacha Pond System and estuaries in general. Since the infaunal community at all sites within the Pond are either dominated by organic matter enrichment species or are depleted, comparisons to the muddy basins of other estuarine systems in the MEP region were relied upon. This analysis would suggest that a healthy infaunal habitat would clearly be achieved at an average nitrogen level of TN <0.5 mg TN L^{-1}. This level was found for Popponesset Bay where, based upon the infaunal analysis coupled with the nitrogen data (measured and modeled), nitrogen levels on the order of 0.4 to 0.5 mg TN L-1 were found supportive of high infaunal habitat quality. Similarly, in the deeper basins of Three Bays System, healthy infaunal areas are found at nitrogen levels of TN <0.42 mg TN L^{-1} (Cotuit Bay and West Bay), with moderate impairment in areas where nitrogen levels of TN >0.5 mg TN L^{-1}.

Sesachacha Pond currently has a low watershed nitrogen load, with external loading dominated by direct atmospheric input, and moderate summer input from its sediments and only periodic tidal exchange. The result is nitrogen levels reaching 1.5 mg TN L^{-1} and average TN levels of ~ 1 mg TN L^{-1}. Therefore it is not clear if average summer TN levels can be reduced to <0.5 mg L^{-1} or if this level has been achieved at any time in past centuries. The Pond was always cited to be used for shellfish transplanting and therefore likely has been somewhat nitrogen enriched, supporting moderate phytoplankton levels. Therefore, the MEP Technical Team determined that a higher TN level <0.6 mg TN L^{-1} would likely support a moderately impaired infaunal community, yet conditions that should also support shellfish. The modeling simulations in Section VIII-3 targeted the 0.5 mg TN L-1 for healthy habitat and also assessed a higher level of 0.6 mg TN L-1 for a moderately impaired condition that may be more reflective of the natural condition of this system in its present configuration. It is important to note that the modeled maximum and average TN levels are likely conservative estimates as they do not include potential reductions in the rate of sediment nitrogen regeneration often associated with the lowering of nitrogen enrichment of embayment waters.

VIII.3 DEVELOPMENT OF TARGET NITROGEN LOADS

After developing the dispersion-mass balance model of Sesachacha Pond to simulate conditions that exist as a result of present management practices, the model was used to simulate a modified management approach that could be followed to improve water quality conditions in the pond year-round.

The habitat quality in Sesachacha Pond has been historically moderate to poor, depending on the intensity of management, specifically the frequency and duration of openings to the ocean. Throughout the 1980's, the pond was not actively managed (openings ceased), and salinities dropped as low as 2 ppt in 1989. It was in this year that the Town sought the proper environmental permits that would allow again the periodic breaching of an inlet to the Atlantic Ocean, in order to improve water quality conditions. Beginning in the early 1990's, with the permits in place, the latest era of active management of Sesachacha Pond began. Presently, Pond water quality is managed by bi-annual breachings of the barrier beach, once each in the spring and fall (Curley, 2004). Other breaches are cut as required in order to lower the water level of Pond when it threatens lower lying properties along its shore (Conant, 2006).

Between 1967 and 2005, there have been only seven years where maximum recorded salinities have been equal to or greater than 25 ppt (see Chapter 6). Five of those years fall within the 10-year period from 1996 through 2005, which indicates that present management practices have been more effective in controlling conditions in the pond.

With a goal of seeking further improvements in water quality conditions in the Pond, an alternate management scheme was modeled using the dispersion-mass balance model developed for Sesachacha Pond. One goal of this proposed management scenario is to prevent salinity in the pond from dropping below 22 ppt at any point of the year. Another goal is to reduce TN concentrations in the pond during the summer months, when benthic regeneration and algae production is greatest. Both of these goals are related, as better flushing management results in both higher salinities and lower nitrogen levels in pond waters. A simple way to achieve these goals is to add an additional mid-summer breach event each year.

To model the effect of adding this mid-summer breach, first, the spring-to-fall 2003 time period was modeled. This period was selected because it offers a good approximation of typical conditions with regard to the duration of the spring-time opening (6 days), water quality data was available for this period, and the average net fresh water recharge rate (2.2 ft^3/sec) could be determined by an analysis of the salinity data records from 1998, 2003, 2004 and 2005. Similar to the results of the modeled 2004 spring-to-fall season discussed in Chapter VI, Figures VIII-1 and VIII-2 show comparisons between measured data and concentrations predicted by the pond model. The resulting average modeled salinity over the whole modeled period is 24.7 ppt, and the average TN concentration is 0.87 mg/L.

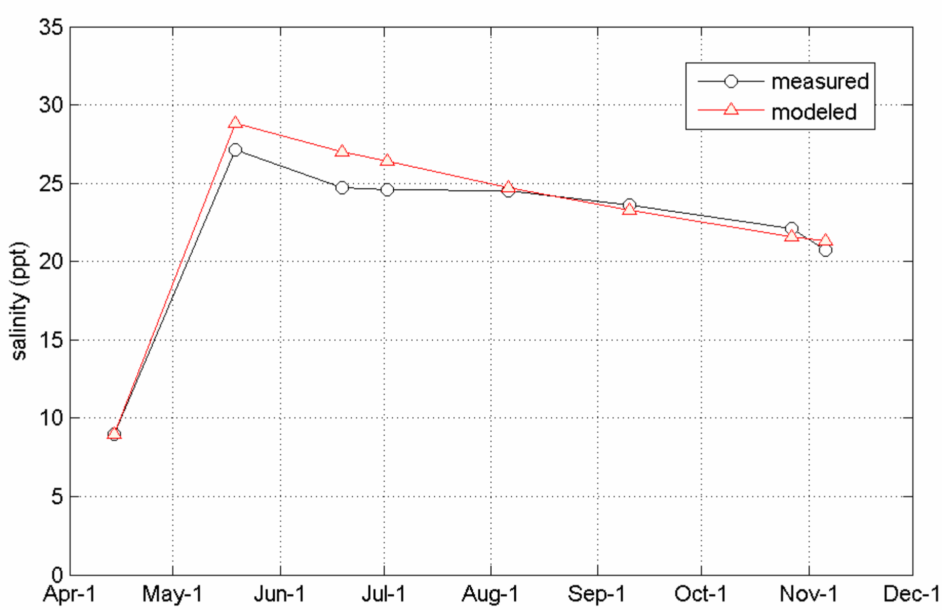

Figure VIII-1. Comparison of measured (black circles) and modeled (red triangles) salinities through the summer of 2003 (R^2=0.74, RMS error=1.31 ppt). Present conditions with pond openings in Spring and Fall.

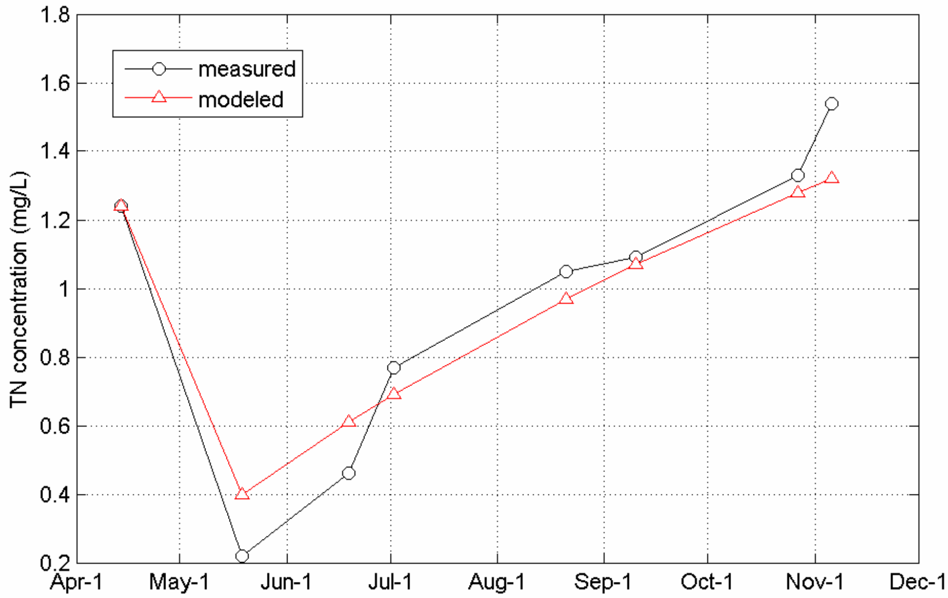

Figure VIII-2. Comparison of measured (black circles) and modeled (red triangles) TN concentrations through the summer of 2003 (R^2=0.83, RMS error=0.13 mg/L). Present conditions with pond openings in Spring and Fall.

After modeling the 2003 season, the alternative of including a mid-summer breach was modeled. For this scenario, the mid-summer breach was made 90 days after the closure of the first breach. This breach was modeled as if it were as successful as the spring 2003 breach, which lasted for six days.

A comparison of modeled salinities, showing results for runs with the mid-summer breach and without (i.e., present management practice) is presented in Figure VIII-3. After the second breach, salinities rise above 30 ppt. At the end of the simulation period, the pond salinities with the mid-summer breach are approximately 5 ppt greater then the salinities under existing management conditions (i.e. spring and fall breaches only). Both model runs include a fall breach which only draws down the pond volume, but does not permit tidal exchange with the ocean. This is the typical effect of the fall breach. The average salinity for the mid-summer breach run is 26.0 ppt, which represents an improvement of 1.3 ppt over the entire modeled period.

The attendant comparison of modeled TN is presented in Figure VIII-4. The mid-summer breach lowers TN levels by 0.50 mg/L to approximately 0.40 mg/L. At the end of the simulation period, TN concentrations are 0.4 mg/L lower after the mid-breach simulation compared to the concentrations for the simulations of existing conditions. The average TN level for the entire simulation period also drops to 0.68 mg/L, which is a substantial improvement of 0.09 mg/l over modeled 2003 average conditions.

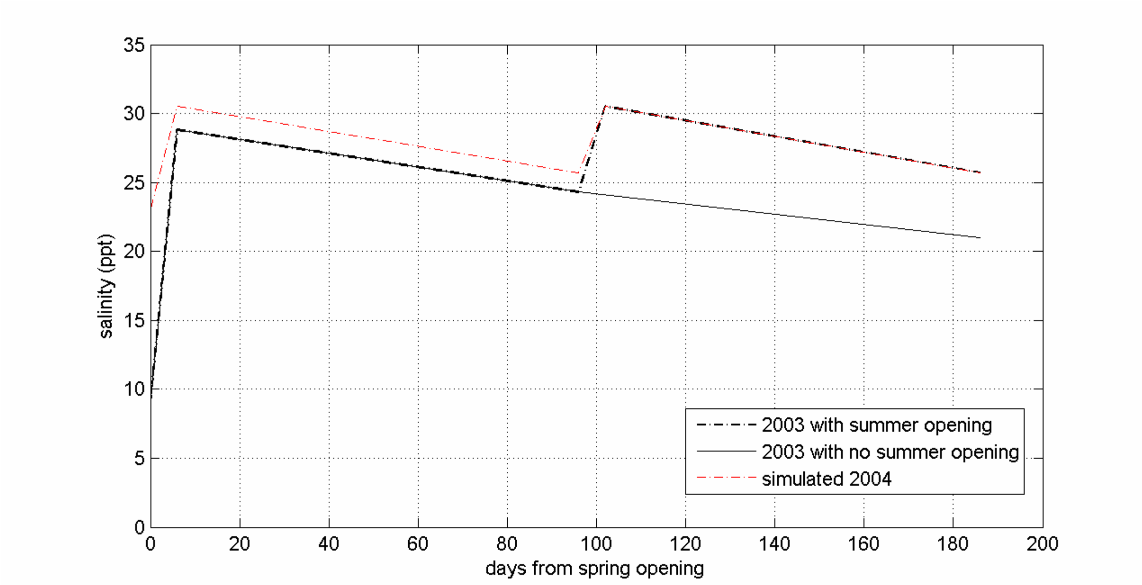

Figure VIII-3. Comparison of modeled 2003 salinities for case where the pond is breached only in the spring (thick black dot-dashed line) and also when it is breached an additional time mid-summer. Model results for the following 2004 spring- to-fall season (thin red dash dot line) show how salinities change if the mid-summer breach is performed again.

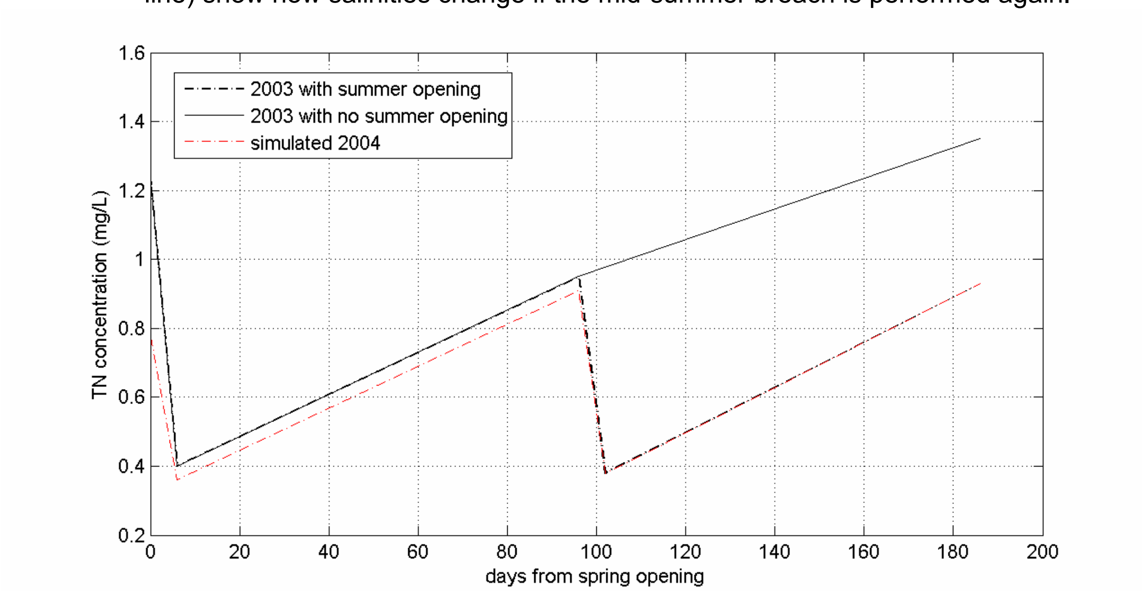

Figure VIII-4. Comparison of modeled 2003 TN for case where the pond is breached only in the spring (thick black line) and also when it is breached an additional time mid-summer (dot-dashed line). Model results for the following 2004 spring- to-fall season (thin red dash dot line) show how TN concentrations change if the mid-summer breach is performed again.

The simulation was re-run through the same 2003 spring-to-fall period in order to investigate how the mid-summer breaching would affect water quality starting the following spring. These results are presented also in Figures VIII-3 (salinity) and VIII-4 (TN). The final salinity of the 2003 mid-summer breach is 25.7 ppt. The salinity drops through the winter to 23.3 ppt, at which point the spring (2004) breach is made. Assuming that the spring and mid-summer breaches of the following year are as successful as the actual 2003 spring breach, the simulation shows that salinities never drop below 25 ppt after the spring, and average 27.4 ppt over the course of the entire simulation period.

A similar improvement in the TN concentration in the following year was found, with the simulated spring level set to 0.82 mg/L. This starting concentration was derived using the difference in the TN concentrations computed at the end of the 2003 simulations with and without the mid-summer breach. This difference was determined to be 0.42 mg/L, and was assumed to carry through to the simulated 2004 spring. This 0.42mg/L difference was subtracted from the measured 2003 pre-breach concentration of 1.24 mg/L to arrive at the modified starting concentration of 0.82 mg/L.. Simulation results from the second consecutive year with a mid-summer breach show that the TN concentration never rises above 1.00 mg/L, and that the average TN concentration is 0.64, which is a 0.13 mg/L improvement over average conditions computed for the 2003 season without a mid-summer breach.

Model results indicate that water quality improvements that may provide more stable environment for flora and fauna is possible with the addition of a successful mid-summer breach. Data indicate that openings as short as six days are sufficient to provide sufficient tidal flushing and raise salinity levels near 30 ppt. Pond salinity is a useful indicator of breach success, as opposed to the duration of the opening. With the mid-summer breach, it should be possible to maintain salinities above 25 ppt and TN concentrations below 1.00 mg/L.

A significant improvement in the nitrogen related health of Sesachacha Pond infaunal animal habitat would result from the above modeled addition of a mid summer opening. It would be possible to use the monthly monitoring data to indicate when the mid-summer breach should occur. The primary indicator would be when the pond salinity drops below 25 ppt. The secondary indicator would be when the pond TN concentration rises above 0.95 mg/L. If this strategy is followed in the future, the result would be year-round salinities above 22 ppt and TN concentrations below 1.00 mg/L. It is important to note that the modeled maximum and average TN levels are likely conservative estimates as they do not include potential reductions in the rate of sediment nitrogen regeneration often associated with the lowering of nitrogen enrichment of embayment waters.

It should be noted that the above mentioned management scenarios oriented around altering the timing of breaches of the barrier beach, effective as these may be, are contingent on the ability of the Town of Nantucket to obtain necessary permitting of such actions. Breaching of the barrier beach is necessarily subject to compliance with applicable federal, state and local statutes and regulations.