Taylor

Areawide Planning and Management: Squibnocket Pond Coastal Resources Complex.

Arthur G. Gaines, Jr. and James M. Broadus
Marine Policy Center
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts

Final Report
February 9, 1990

Inferences from Historical Maps

Several historical maps of the Squibnocket area are available that provide insight into natural and human activities affecting the Pond, although this kind of evidence must be viewed with caution.

The Breachway

The oldest map examined is the so-called DesBarres map (1776), a surprisingly detailed map suggesting a thorough exploration of Squibnocket Pond--perhaps for its potential as a harbor. This map (Fig. 3, panel A) depicts the Long Beach/Squibnocket Beach barrier with a prominent breachway. No other map found portrays this feature, although the 1831 Dunham map marks the same site, "opening formerly here" (Fig. 4). The location of this former breachway appears to have determined one bound of the division between the two towns. Anecdotal evidence of Vanderhoop (1904), suggests the inlet closed in about 1818.

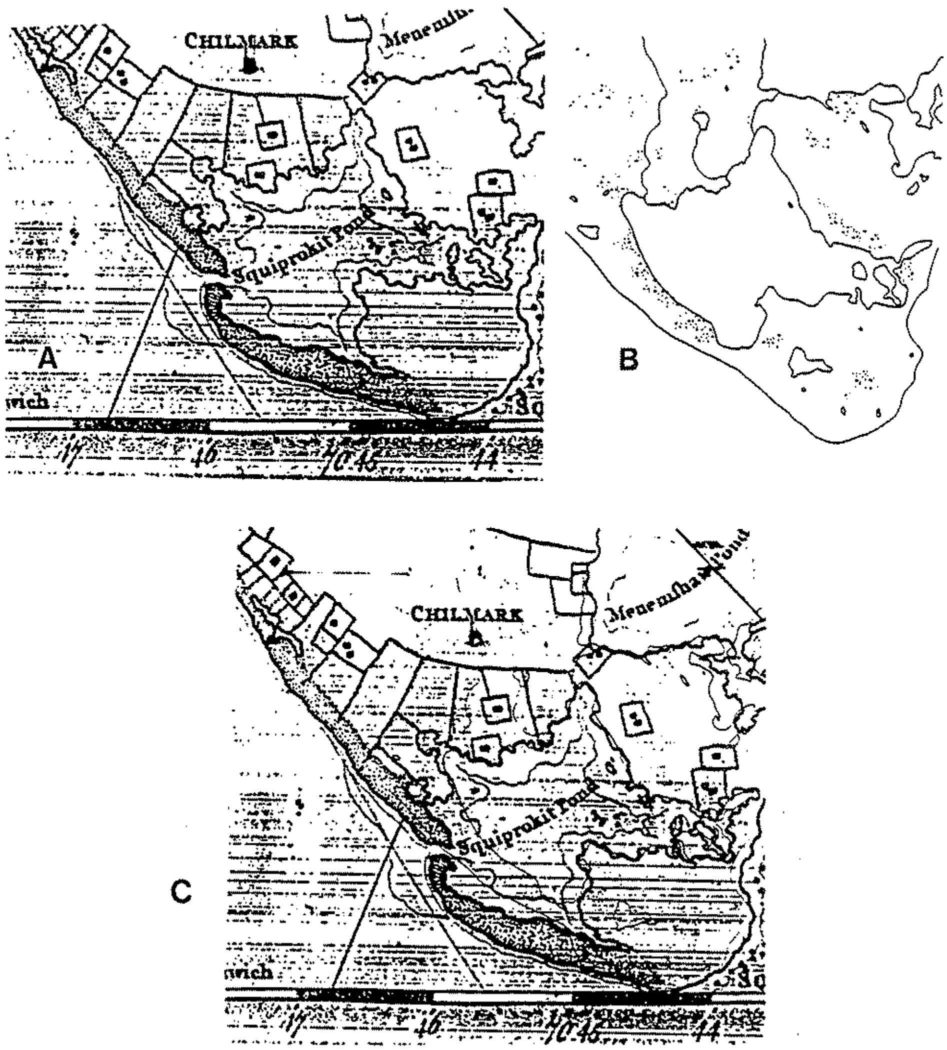

Figure 3. Detail of DesBarres map (1776) showing Squibnocket Pond area, compared with modern (U.S.G.S., 1972). A) DesBarres map; B) modern map; C) both maps overlaid.

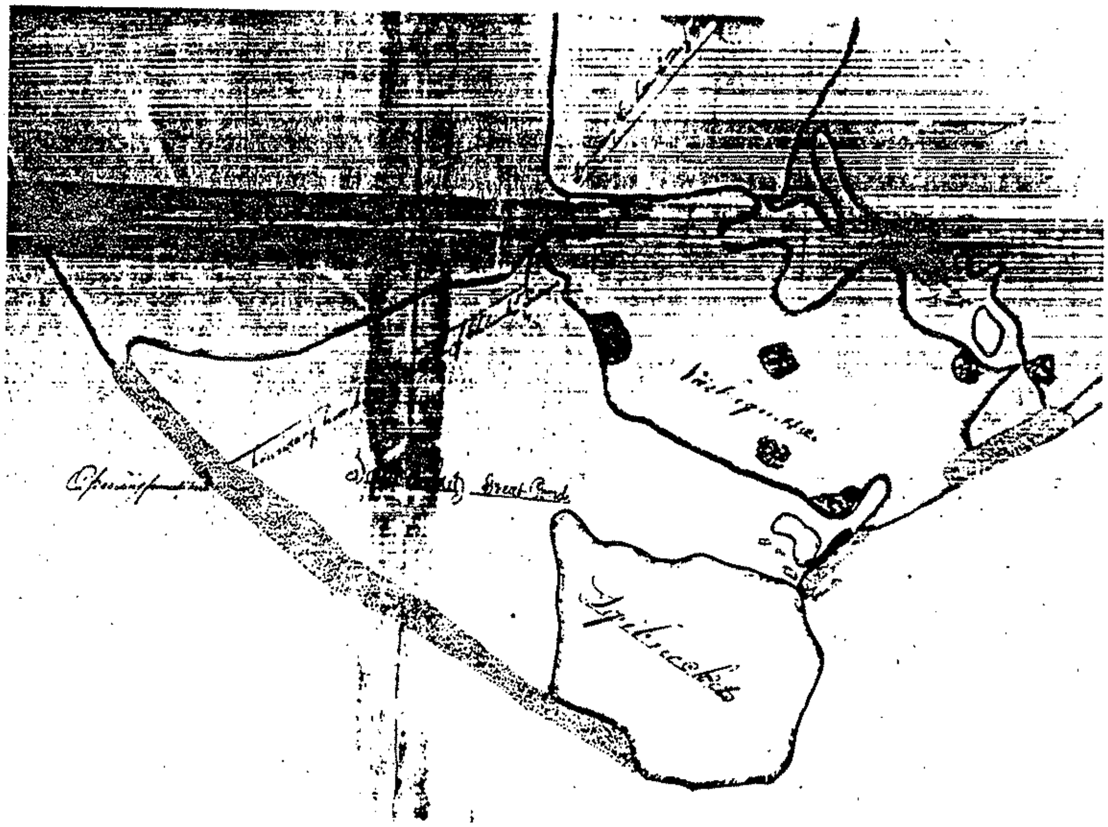

Figure 4. Detail of Dunham map (1831) showing location of former inlet in the barrier beach.

One consequence of an open breachway would be increased exchange between Squibnocket Pond and the sea. Under present conditions, salinity of the Pond water is about 10 o/oo (= 10 parts per thousand), about 1/3 full strength seawater. With an open inlet, salinity conditions may have been similar to those of Menemsha Pond, which has a permanent, structured opening, and which contains water of about 30 o/oo, only slightly more dilute than the coastal sea. While there is no reason to believe the breachway on the exposed beach at Squibnocket was a permanent one, it is likely the Pond had higher salinities during those periods it was open, and that the fauna and flora reflected the changes in environment. Ritchie (1969) believes that changes in composition of mollusk shells in strata of archeological sites around Squibnocket reflects changes associated with breaching events.

Another consequence of an open connection to the sea would be that the Pond surface elevation would be subject to changes forced by the semi-diurnal tide. As discussed below, the present restricted connection through Herring Creek effectively dampens out most of this effect. According to U.S.G.S. (1972) the present [average] surface elevation of Squibnocket Pond is 3 feet (0.91 m) above mean sea level, or about 1.6 feet (0.49 meters) above high tide level. This is probably an overestimate (because the semidiurnal flood tide current at Herring Creek lasts an average of nearly three hours daily), but it is likely that the effect of a free connection to the sea would be to lower the average surface elevation of the Pond, toward mean sea level.

Beach Migration and Erosion

A second salient observation from historical maps is transgression of the barrier spit at Squibnocket. A comparison of the DesBarres map with a modern U.S.G.S. topographic map (U.S.G.S., 1972) suggests a northward migration of the shoreline up to 425 meters (1,400 feet) over 196 years, or 2.2 meters/year (7.1 feet/year) on average (Fig. 3, C). This migration was not accompanied by appreciable narrowing of the mapped spit. Migration of the western limb of the barrier has been much less.

Compared to beach migration, erosion of the ocean coastline near Squibnocket has not been severe. This is probably a result of armoring of the shore by residual glacial boulders as the fine fraction was selectively removed over geological time, as the cliffs receded.

Herring Creek (Gay Head)

Both the DesBarres map and the Pease map (1866) depict the present Herring Creek as terminating a short distance inland from its mouth at Squibnocket Pond (Fig. 5), suggesting the

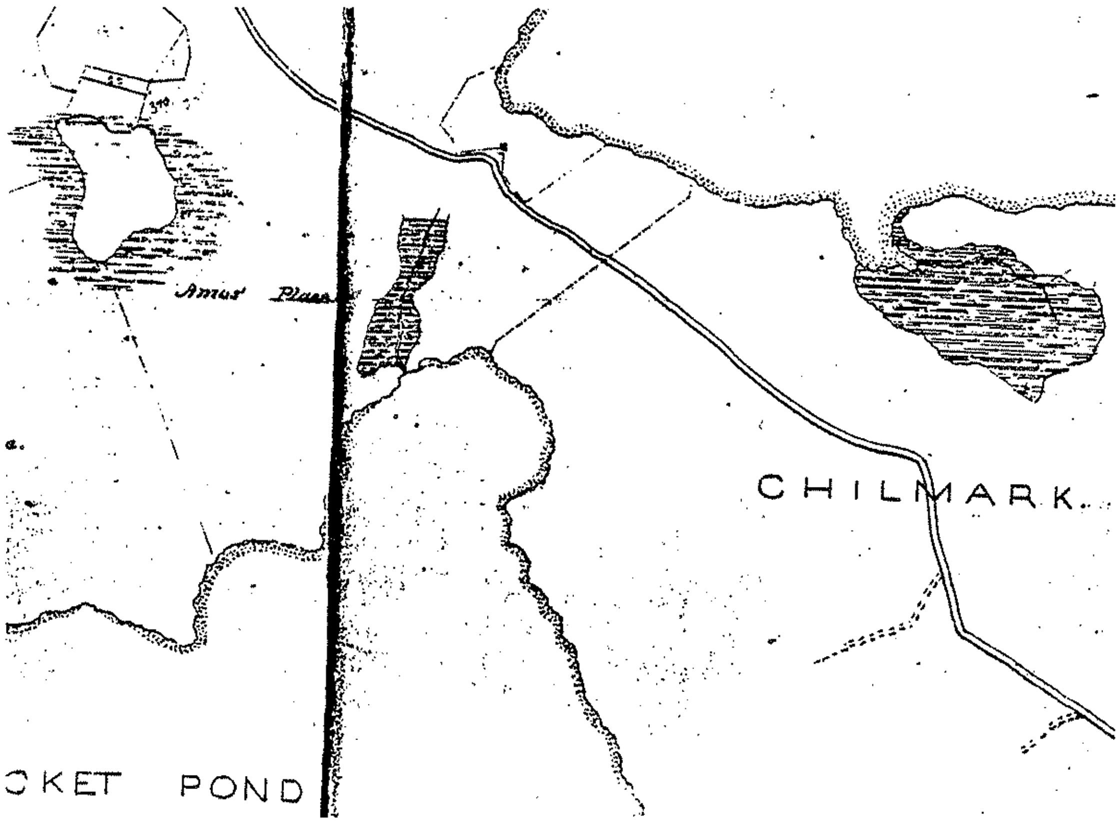

Figure 5. Detail of Pease map (1866) depicting Herring Creek as terminating without connecting to Menemsha Pond.

present connection with Menemsha Pond was established later. This evidence supports anecdotal accounts (e.g., Vanderhoop, 1904) that the Herring Creek connection was created by man. If this is correct, then Herring Creek would originally have been a freshwater stream leading only to Squibnocket, rather than a brackish, tidal creek connecting the two ponds. A potable water source at this location would have served the adjacent Hornblower II prehistoric indian site (Ritchie, 1969).

Unfortunately, the mapped evidence is equivocal. The stream is a minor geographic feature on the scale of mapped features, and its representation is sensitive to predilections and priorities of the map maker. For example, the Walling map of 1855 shows the connection as it exists today, while the Pease map, dated 11 years later, does not.

Because of the importance of this connection between the ponds, additional information was obtained through a direct field examination of Herring Creek. This examination tended to support the view that connection is artificial. Central parts of the Creek pass through deep, apparently artificial trenches through rocky glacial ridges, connecting small natural wetlands in depressions between Squibnocket and Menemsha Ponds. Both ends of Herring Creek have been deepened and are bordered by small rubble jetties.

Our working hypothesis at the moment, therefore, is that the connection between Squibnocket Pond and Herring Creek was artificially created between 1776 and the mid 19th century. According to Belding (1921) many coastal ponds in Massachusetts were modified during the 19th and early 20th centuries in connection with management of the anadramous alewife fishery (see discussion of alewives in Appendix 1). Two examples on Martha's Vineyard are "Herring Creek" connecting Edgartown Great Pond and Katama Bay in Edgartown, and a less well known ditch between Katama Bay and Pocha Pond, across Chappaquiddick Island. We have by no means yet exhausted all lines of evidence to prove the case one way or another for Gay Head Herring Creek, or to specify an exact date for its construction.

The consequences of connecting the two ponds could be quite important. For example, a principal mechanism for natural breaching of a barrier spit is accumulation of freshwater in the closed pond until a storm or other event initiates flow across the beach. This rapidly leads to dramatic excavation of a gut by the ebbing water, in a matter of hours producing a breachway that then remains open for a variable period depending upon wave action and longshore sediment transport on the seaward side. At other sites along the south shore of Martha's Vineyard, breachways thus produced stay open for a period ranging from days to weeks. With creation of a drain between Squibnocket and

Menemsha Ponds, no such head of fresh water could accumulate and the tendency for breaching of the barrier would be reduced.

A second obvious consequence of creating the Herring Creek connection is creation of a herring or alewife run from Menemsha into Squibnocket (see Appendix 1). Prior to excavation of the Creek, the run could only have existed when Squibnocket Pond had a breachway, and then the fish would presumably have migrated into Herring Creek from the Squibnocket Pond side. Harvesting of the fishery would have occurred at the south end of the present Herring Creek, rather than at the north end, as it is currently practiced.

Third, the cutting of Herring Creek provides a stable, though restricted, supply of seawater to Squibnocket. The effect overall probably has been to stabilize the aquatic environment as a low salinity coastal pond; in contrast, intermittent opening to the sea results in wide salinity excursions over time.

A final comment has to do with rising sea level. The best current estimate of local relative sea level rise in recent centuries is about 1 foot/100 years (30 cm/100 years). Therefore, since the earliest available map was produced (1776), sea level at Squibnocket has risen about 2 feet (0.6 meters). While resulting inundation is not evident from the historical maps, sea level rise over the past century could have had a significant impact on flow between Squibnocket and Menemsha (limiting channel depth at the Squibnocket end presently averages 54 cm (1.8 feet).

The Artificial Opening

The 1897 U.S. Coast & Geodetic Survey map (U.S.C.&.G.S., 1897) shows a small connection between Squibnocket Pond and the sea at the east side of Great Island. A detail from a later, more legible edition of this map is shown in Fig. 6. At present there is no connection to the sea at this site, but there are remains of a wooden sluiceway, constructed of heavy planking on pilings forming a double walled structure. This structure runs from the low glacial bluff into the sea. The interior is filled with beach sand and cobbles. On the Pond side, road modifications, natural filling and brush conceal the feature, although stoneworks, perhaps walls of the sluiceway, are evident in the marshy cove margin near Great Island.

Although Belding (1921) refers to an artificial Herring run at Squibnocket (which he distinguishes from "Gay Head Herring Creek"), the photo he gives of this structure (Fig. 7) does not resemble the remains at the site shown on the 1897 map. This photo looks more like a site near the present Chilmark town

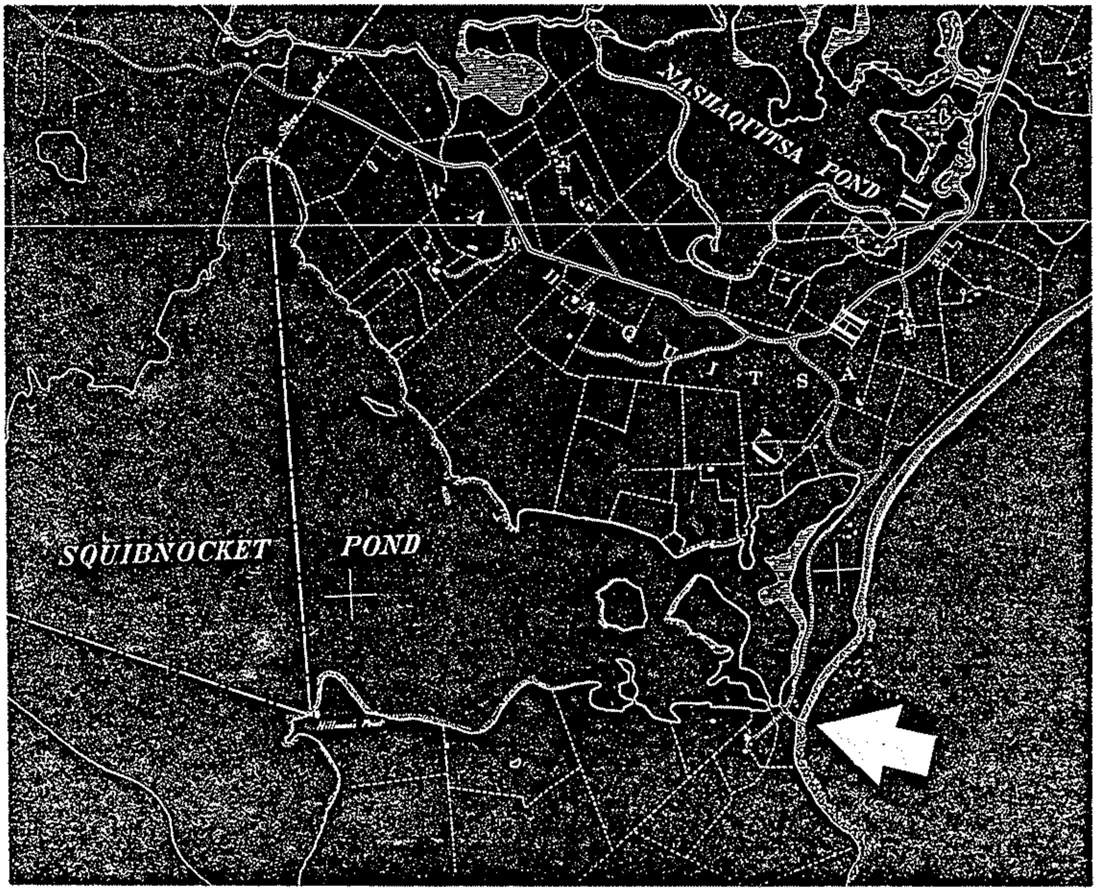

Figure 6. Detail of U.S. Coast & Geodetic map showing the location of an artificial connection to the sea at Great Island. The earliest map in this series showing this feature is dated 1897-98.

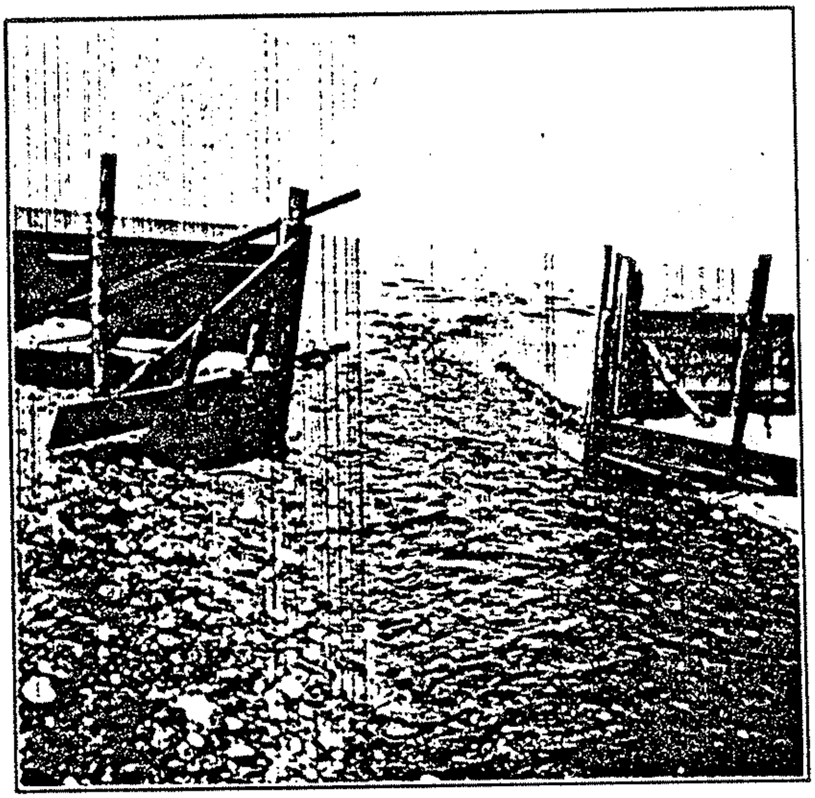

Figure 7. Photo of artificial herring run at Squibnocket, according to Belding (1921). This does not correspond with the site mapped in Fig. 6.

parking area at the extreme east cove of Squibnocket, another promising location for an artificial opening, but one for which there is no map evidence. The wooden pilings standing in the beach at this site are believed to be part of a bulkhead constructed to hold up the bank for a parking area.

Given the dimensions of the sluiceway at Great Island, it is unlikely it provided much exchange compared with a natural breachway. From the scale of this structure, and its primary purpose (i.e., to attract and provide access for alewives) it is possible the structure served mainly to discharge pond water, and that appreciable flood waters did not enter at high tide.

Other Minor Features

The DesBarres (1776) map depicts a number of minor features of interest. All of the small islands presently existing in the eastern coves are recognizable, as is the diminutive Strawberry Island (see Fig. 3, A and C). Desbarres even mapped prominent boulders in the Pond; the solitary boulder portrayed directly above "S" on his map (Fig. 3A) is currently located nearer the present shoreline and is covered with oysters. Given the rise in sea level over the centuries, these boulders may at the time have been inter-tidal, while they are at present totally submerged. The cove shown at the extreme west side of the Pond is currently a wetland.

Lily Pond, the small pond behind the dune near the town line is also portrayed by DesBarres; this seemingly ephemeral feature, a shallow freshwater panne trapped against a small glacial hill by the dune ridge, has existed in this spot for over two centuries.

MANAGEMENT CONSIDERATIONS

Because of the complexity of natural systems, management decisions surrounding coastal resources generally need to be based upon incomplete information--hopefully the best information available. Since more than one political entity has jurisdiction over parts of Squibnocket Pond, unilateral management measures may be subject to challenge by other interested parties. As is normally the case in management of limited resources the questions of allocation and distribution of benefits need to be addressed.

Exchange with the Sea

For several years it has been proposed to construct an opening between Squibnocket Pond and the sea. Our review of historical information indicates that the Pond formerly had a natural breachway on the spit near Squibnocket Beach, and two small artificial connections to the sea of which one, Herring Creek, is still open. Because of the importance of salinity and flushing in terms of habitat, the extent of exchange with the sea is of primary importance to living coastal resources of the Pond and the larger sphere of biota and human activities that depend on them. As indicated earlier, the conspicuous marine invertebrates in the Pond are at or near their lower salinity tolerance limit; and the abundant submerged aquatic vegetation present is of a freshwater variety, presumably near its upper limit of salinity.

A question that must inevitably be addressed is what would be the biological response to increased exchange? This question is vastly more difficult to answer than may seem to be the case. One is inclined to assume organisms favoring higher salinities would be enhanced or introduced, while those favoring lower salinities or fresh water would decline. This is an oversimplification, however, because, for example, the introduction of predators, competitors, nuisance species or diseases can have an over-riding affect. In the case of Squibnocket Pond, management options regarding exchange with the sea would probably be reversible and any one would not preclude future adoption of alternatives.

Decreased exchange with the sea

As one management option the present connection to the sea could be modified to prevent the incursion of seawater, so that over a few years Squibnocket Pond would become a fresh pond. It would become the largest freshwater pond on Martha's Vineyard and could provide the Island with increased habitat diversity for wildlife, as well as recreational and artisanal commercial potential. The Pond in this condition may be a better alewife spawning area than at present, if one or more fish ladders were provided to insure access by the adults.

As a fresh pond, Squibnocket Pond may have high dissolved organic carbon content, given that its principal streams drain wetlands and are stained brown with "tannins". The Pond may also be subject to catastrophic inundation by the sea during storms, with habitat instability associated with abrupt changes in salinity. If the Pond level were allowed to rise significantly, it could increase the potential for natural breaching of the barrier. An estimated 3 to 6 years would be required to flush out existing seawater and several additional years for expression of the direct biological response to the change.

Free exchange with the sea

An unstructured natural inlet to the sea, occurring naturally or induced through human activities, would cause a major alteration in the salinity and flushing of Squibnocket Pond. The resulting pond may well resemble Menemsha Pond in terms of living coastal resources and habitat. Data of Walsh et al. (1979) indicate the salinity of Menemsha Pond departs very little from Vineyard Sound (see Table 6), despite known sources of fresh water entering the Pond.

From the general relationship between the volume of tidal exchange and the cross sectional area of natural inlets, it is possible to estimate the size of an unstructured inlet for Squibnocket Pond for different tidal range scenarios (Table 11). For perspective, the present inlet to Menemsha Pond has a cross sectional area of about 38 m^2 (410 ft^2) according to Moody (1988). This is about 30% of the predicted equilibrium cross sectional area for an unstructured inlet at Menemsha Pond. The very long inlet channel at Menemsha would have the effect of reducing the natural cross sectional area.

An inlet that resulted in tidal fluctuations matching scenario C (Table 11) would result in a major increase of flushing in Squibnocket Pond. In principle it could reduce residence time of seawater in the Pond from about half a year to about a week. Tidal flushing similar to that of Menemsha Pond would result in a residence time of less than four days. In this hypothetical example the salinity of the Pond would be about 0.1 o/oo lower than undiluted seawater of 31 o/oo.

The site of an artificial inlet would have a major effect on its stability, and hence on the maintenance needed to keep it open. An unstructured inlet at the site of the historical inlet at Squibnocket Beach would most probably be unstable and require repeated opening, like other artificial inlets to coastal ponds on the south shore of Martha's Vineyard. An unstructured inlet in the barrier spit could also be subject to horizontal migration, a process that would destroy the dunes presently located there. An inlet located near Nashaquitsa Cove at the east end of the Pond would probably be partially cut in glacial deposits and may be more resistent to migration. It would be exposed to storm waves of infinite fetch, however, and shoaling would most likely occur near the mouth.

An alternative site for an artificial inlet would be at Herring Creek, presently connecting Squibnocket Pond to Menemsha Pond through a restricted channel. At this site glacial and wetland deposits would be encountered, and the state highway would need to be crossed. However, inlet migration and sediment transport would probably pose little problem in the sheltered waters of the Ponds. An inlet at this site would affect and be affected by the fact that Menemsha Pond itself has an inlet. The need for increased flow at this inlet may necessitate modifications to the artificial structures that currently stabilize it. Increased flow could also affect sediment transport at Menemsha inlet.

The effect of an inlet of natural dimensions on salinity of the Pond would be expressed rapidly--perhaps a matter of several days. The response of organisms to the change would begin within a period of days and major changes directly associated with the opening would probably be complete in a few years. For example, the effect on alewives may not be evident in less than 3 to 6 years.

Controlled exchange with the sea at intermediate levels

It may be desirable to have the capability of managing exchange with the sea at intermediate levels. For example, in the event of an oil spill it would be useful to be able to close the Pond entirely for several days. If it is considered desirable to increase the salinity of the Pond to the range where commercial shellfish (except scallops) might grow, this may be possible with only minor modification to the existing Herring Creek. For example, if the amount of seawater entering the Pond could be doubled, from about 11,500 m^3/day to 23,000 m^3/day, the salinity of the Pond would rise from 10 o/oo to approximately 20 o/oo, which is well within the range for oysters and clams. The required 23,000 m^3/day is less than currently leaves the Pond on average with ebb tide, and it is less than 1% of the likely exchange through a natural inlet.

The present cross sectional area of Herring Creek where it enters Squibnocket Pond is about 1.7 m^2 (18 ft^2). The culvert that conducts Herring Creek under the state highway, and associated concrete structure, is only one of the sites that may provide an opportunity to regulate flow.

Salinity changes in the Pond accompanying doubled flood tide input of seawater would occur most rapidly over the first several months; in about six months, one half of the total expected salinity change would likely occur. Half of the remaining expected change would occur over the next six months. Little cumulative change in salinity would be expected after three years. The direct biological response could be in a state of flux for several years beyond that.