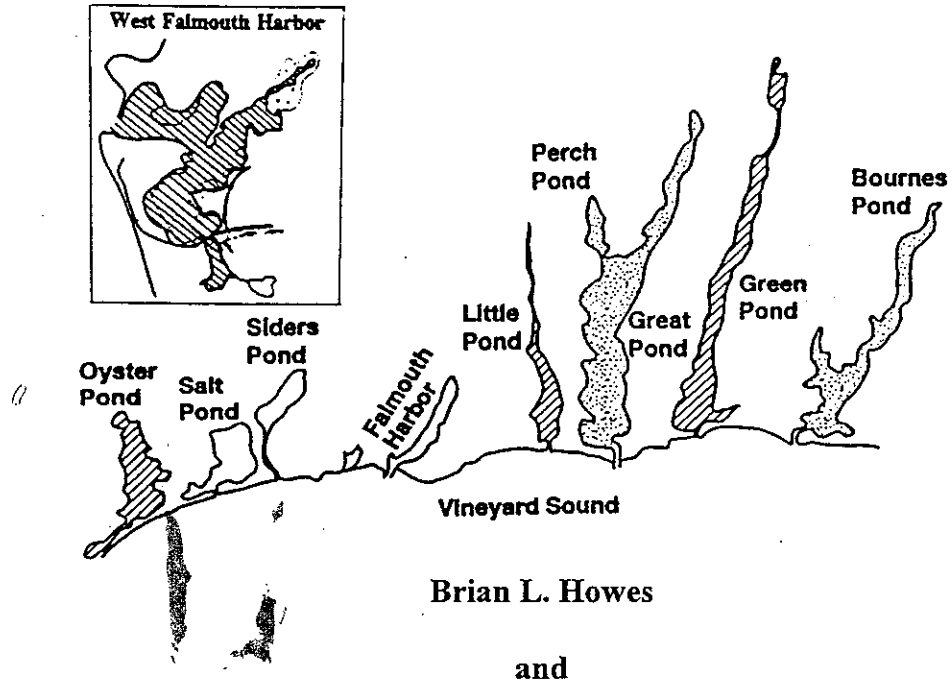
FALMOUTH POND WATCHERS

WATER QUALITY MONITORING OF FALMOUTH'S COASTAL PONDS: RESULTS FROM THE 1997 SEASON



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June, 1998

This cooperative project is conducted with support from the
Town of Falmouth Planning Office and
Falmouth Associations Concerned with Estuaries and Saltponds

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EXECUTIVE SUMMARY

Overview: The following is a data and result summary of the 1997 Falmouth Citizen's Coastal Salt Pond Monitoring Program ("Falmouth Pond Watchers"). Now entering its second decade, the results of this program have proven increasingly valuable in both efforts to preserve and protect the environmental quality of Falmouth's coastal salt ponds, and as a model for other coastal monitoring programs. The original intent of the Pond Watch Program was to quantify the health of Falmouth's Coastal Salt Ponds and provide an unbiased database on their nutrient levels relative to the Nutrient Overlay Bylaw. Over the course of the Program, restoration projects have been implemented (with significant reliance on the Pond Watch database) in Oyster and Little Ponds, with a smaller modification to the new bridge over Green Pond. In addition, the sewage effluent plume from Falmouth's Wastewater Treatment Facility is now discharging to West Falmouth Harbor. With these changes has been a shift in focus to documenting the effects of these significant changes in the nutrient dynamics within these ponds on their ecological health. Only through this long-term monitoring program can Falmouth "tune" its restoration projects and determine potential shifts in water quality resulting from increased nitrogen loading (e.g. WWTP or changing land-use) needed for the development of watershed management plans.

Major Findings, 1997: With the diversity of habitats contained within Falmouth's Coastal Ponds, the ongoing changes in land-use and the Town's active Restoration Program, it is not surprising that significant changes from long-term trends were observed within specific regions during the 1997 field season. While many of the ponds continued previous trends (detailed below), the notable events were as follows:

(1) Great Pond continued to show poor water quality in its upper region, as evidenced by high nitrogen levels and bottom water dissolved oxygen levels periodically declining below 4 mg/L. After the heavy rainfall in late July and its associated low light, potential watercolumn stratification and watershed runoff, there was a low oxygen event and fish kill in the upper portion of the Pond (Stations 2-3). During this event relatively large schools of bait fish were washed up all along the windward shore of the this region of the Pond. Periodic low oxygen levels have been observed in 6 of the 8 years of monitoring of Great Pond, a more detailed ecological/land-use assessment of this pond should be undertaken over the next several years. Perch Pond, a sub-embayment to Great Pond has shown increased nitrogen levels in 1994-1997 compared to 1990-1993.

(2) Green Pond continues to have poor nutrient related ecological health in its upper reaches as seen in the high nutrient and periodic low dissolved oxygen levels. It appears that nitrogen levels in recent years (1993-1997) are higher than in earlier years (1987-1992) in the mid-pond region (Stations 2A & 3). This supports the contention that the zone of eutrophication is continuing to extend from the upper reaches of the pond toward the Sound. There is, at present, no evidence that this level of degradation has reached the lower pond region (Sations 4 & 5).

(3) The new Little Pond inlet design appears to be functioning well. Sediment accumulation within the inlet channel has been greatly reduced and tidal exchange enhanced. However, Little Pond remains highly nutrient overloaded with high nutrient levels and high a high frequency of low bottom water oxygen events. The final phase of the restoration plan for the pond, the extension of the inlet channel through the flood tidal delta to the depth of the pond basin should help alleviate the current eutrophic conditions by facilitating "deep" flow in the pond. The goal of the restoration of pond circulation is to improve nutrient related water quality through increased tidal export of nitrogen and organic matter.

(4) The freshening of Oyster Pond to reduce the degree of watercolumn stratification and bottom water hypoxia appears to be succeeding. The surface waters of Oyster Pond (0-2m) have returned to historic levels (ca. 2ppt). In addition, the depth distribution of salinity has nearly returned to

levels recorded in 1964. The result in 1997 was that nitrogen levels within the inner basins of the pond are well below 1987-1994 levels. Most significantly, the shallow basin which showed periodic anoxia and high levels of hydrogen sulfide from 1987-1994, has been continuously oxygenated from the fall of 1994 to present. In addition, the extent of the hydrogen sulfide zone in the deep southern basin diminished in 1997, periodically showing an interface at 6 meters depth compared to 4 meters found in most previous years. These findings indicate that there has been a large and significant improvement in the areal extent of bottom habitat within the Pond. In addition, white perch have returned to the Pond and appear to be showing high colonization and growth rates. However, Oyster Pond is now at its targeted management salinity and the recently installed weir/fishway at the outlet needs to be managed to prevent further salinity decline.

(5) West Falmouth Harbor did not exhibit any large declines in water quality even with the arrival of the WWTP effluent plume. However, the inner portions of the Harbor are beyond Nutrient Bylaw limits. It must be noted that the highest levels of nitrogen within the WWTP plume, resulting from higher N loading in recent years, have not yet reached Harbor waters. Ecological assay of the inner harbor would greatly increase the Town's ability to determine potential future impacts as the plume loading increases over the coming years. At present, the levels within in the Harbor are within the range predicted from earlier nitrogen modeling studies.

Regional Impact: Since the programs inception, the Pond Watchers have received numerous national awards for their efforts with 1997 being no exception. In addition to recognition again as a model program by the National Awards Council for Environmental Sustainability, the program has been profiled in several publications and will be a focus program for a new monitoring manual being produced for the Gulf of Maine. More detailed information on the ecological processes governing nutrient related water quality issues can be found in "Howes and Goehringer (1996), Water Quality Monitoring of Falmouth's Coastal Ponds: Results from the 1994 and 1995 Seasons" and "Howes and Goehringer (1996), The Ecology of Buzzards Bay: An Estuarine Profile. U.S. Fish and Wildlife Service Biological Report, September 1996" and "K.O. Emery (1997), A Coastal Pond: Studied by Oceanographic Methods with Epilogue: Oyster Pond-Three Decades of Change, by

Howes and Hart". A detailed synthesis of the Pond Watch data aimed at determining nitrogen loading thresholds should be forthcoming based upon promised extramural funding in 1998/99.

Dedication: We wish to dedicate this report and the upcoming years sampling to two of our long standing Pond Watchers, Don Zinn and Robert Roy. Both were active participants in the program since its inception and their passing leaves us with fond memories of their unwavering enthusiasm for the goals of the program and their many years of support and dedication to preserving our valuable coastal resources through this effort. In addition, we will miss the input of K.O. Emery, whose early work on Oyster Pond was fundamental to the restoration project for that pond and whose interest in the Pond continued through recent years.

COASTAL SALT POND REPORT CARD

Pond	Ability To Make Bylaw Limit	Overall Water Quality	1992	1993	Status 1994	1995	1996	1997
Green Pond								
Upper	Fail	Poor	Same	Same	Same	Same	Same	Declining
Lower	Fail	Moderate	Declining	Declining	Declining	Declining	Same	Same
Great Pond								
Upper	Fail	Poor	Same	Same	Same	Same	Same	Same
Lower	Fail	Good	Improving	Declining(?)	Declining	Declining	Same	Same
Perch	Fail	Poor	Same	Same	Declining	Declining	Declining	Same
Bournes Pond								
Upper	Fail	Mod.-Poor	Same	Same	Declining	Same	Same	Declining (?)
Lower	Fail	Moderate	Improving	Improving	Same	Same	Same	Same
West Falmouth Harbor								
Upper	Fail	Good	?	?	Declining(?)	Declining	Same	Same
Lower	Pass	Good	?	?	Same	Same	Same	Same
Little Pond								
Upper	Fail	Poor	Same	Same	Same	Same	Same	Same
Lower	Fail	Mod.-Poor	Same	Improving	Moderate	Same	Same	Same
Oyster Pond								
Shallow Basin	Fail	Poor	Improving	Improving	Same	Improving	Improving	Improving
Deep Basin	Fail	Poor	Same	Same	Same	Same	Improving	Improving {?}

Figure 1.

the pond. Data through 1997 confirm that the circulation in the pond needs to be restored to the "test study" levels. It should be noted that even with the current problem, the conditions within the pond have improved over pre-restoration conditions. However, the high nitrogen levels, algal blooms and frequent oxygen depletion of bottom waters will likely continue until the last portion of the restoration plan (a channel through the flood tidal delta) is completed. The Town Engineer, George Calaise, is currently working to address this problem.

At present, Little Pond is highly nutrient overloaded and exhibits a high frequency of low oxygen events. However, there is some slight evidence of declining nitrogen levels in the lower basin since the inlet reconstruction. Given the high nutrient pool stored within the pond sediments prior to restoration of free tidal exchanges, it was expected that from 3-5 years would be required before nutrient "depuration" would occur within the lower basin (which contains ca. half or the pond area). However, Little Pond receives high levels of nitrogen input in ground water concentrated at the inner most portions, resulting in nitrate levels in head waters of greater than 0.7 mg N/L. The high annual nitrogen loading may be shifting the pond towards phosphorus limitation in the upper reaches (Figure 4), although light is the predominant limiting factor to benthic algal production during most of the summer season. The need for watershed nutrient source reduction cannot be evaluated until circulation within the pond is restored and its full effect determined.

Oyster Pond: For the past several years, the inlet channel to Oyster Pond has been allowed to accumulate sediment in order to "naturally" restrict tidal flows to the pond. As a result the salinity of pond waters has been reduced through groundwater inflows to ca. 2 ppt, from a high of 16 ppt

after the inlet opening in the late 1980's (Figure 7). The placement of the new hydrologic control structure (weir) at the inlet to the pond (between the 1997-1998 field seasons) will allow maintenance of pond salinities at current levels. However, this will require a slight lowering of a portion of the Trunk River channel to 1994 levels in order to give flow control over to the weir. This will also serve to lower the pond levels from their current long-term high to the early 1990's levels.

Oyster Pond has been a brackish embayment to Vineyard Sound throughout the late 20th Century. Tidal exchanges were restricted with the construction of the railroad late in the last century, which caused the pond systems to shift from more marine forms to their current fresh/brackish forms. The increased tidal exchanges of the late 1980's caused a major habitat change from their established brackish forms. However, due to the tortuous nature of the inlet channel the increased tidal flows were only periodic and the salinity of the pond unstable. In addition, with the increased salinity levels, watercolumn stratification within the pond appears to have become pronounced, with the bottom waters of each of the 3 basins becoming devoid of oxygen during each summer (and sometimes year-round, Figure 8). The result of the increased salt inputs (in the late 1980's) was both to cause major disruption to the established ecological communities and to render a large portion of the pond bottom habitat non-usable for benthic animals and fish.

Restoring the pond to its longer-term salinity levels, both in surface and bottom waters (Figure 7), appears to have restored the quality of the pond systems as well. For example, White Perch,

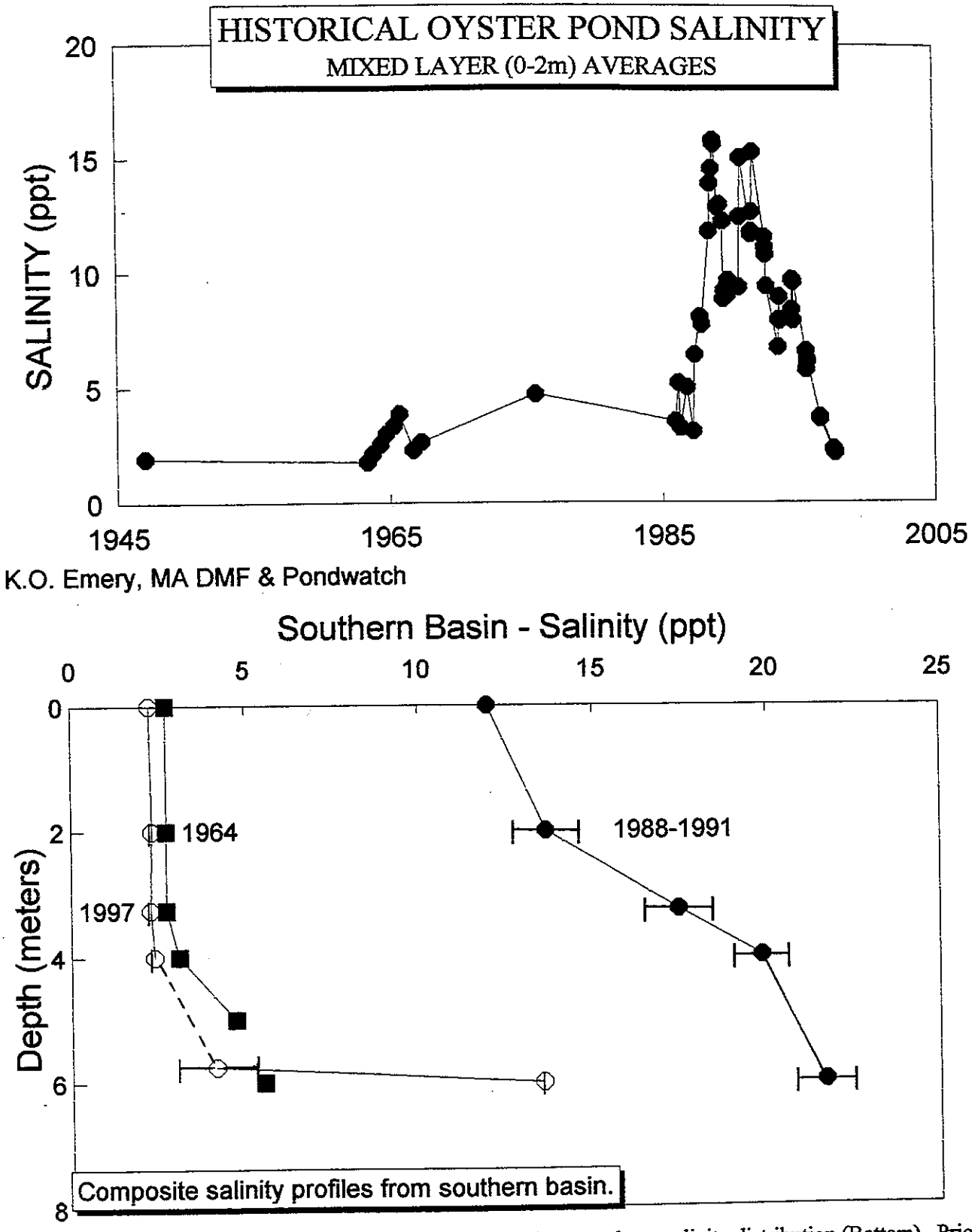
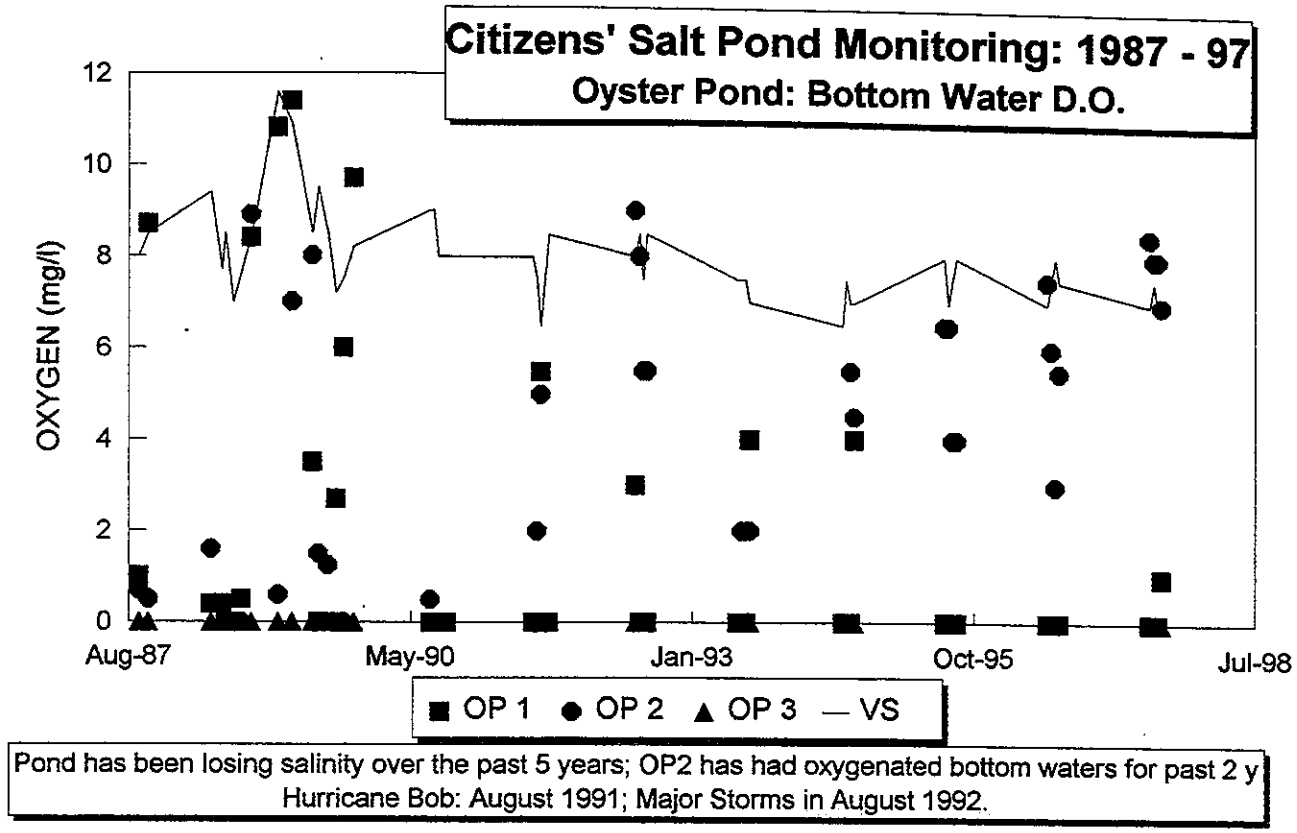


Figure 7. Oyster Pond historical surface water salinities (Top) and watercolumn salinity distribution (Bottom). Prior to the inlet alteration in the late 1980's, salinity levels were typically in the 2-4 ppt range. Increased tidal flow caused the large salinity increase in both surface and bottom waters which resulted in a major shift in pond ecology as communities changed from brackish to more marine species.



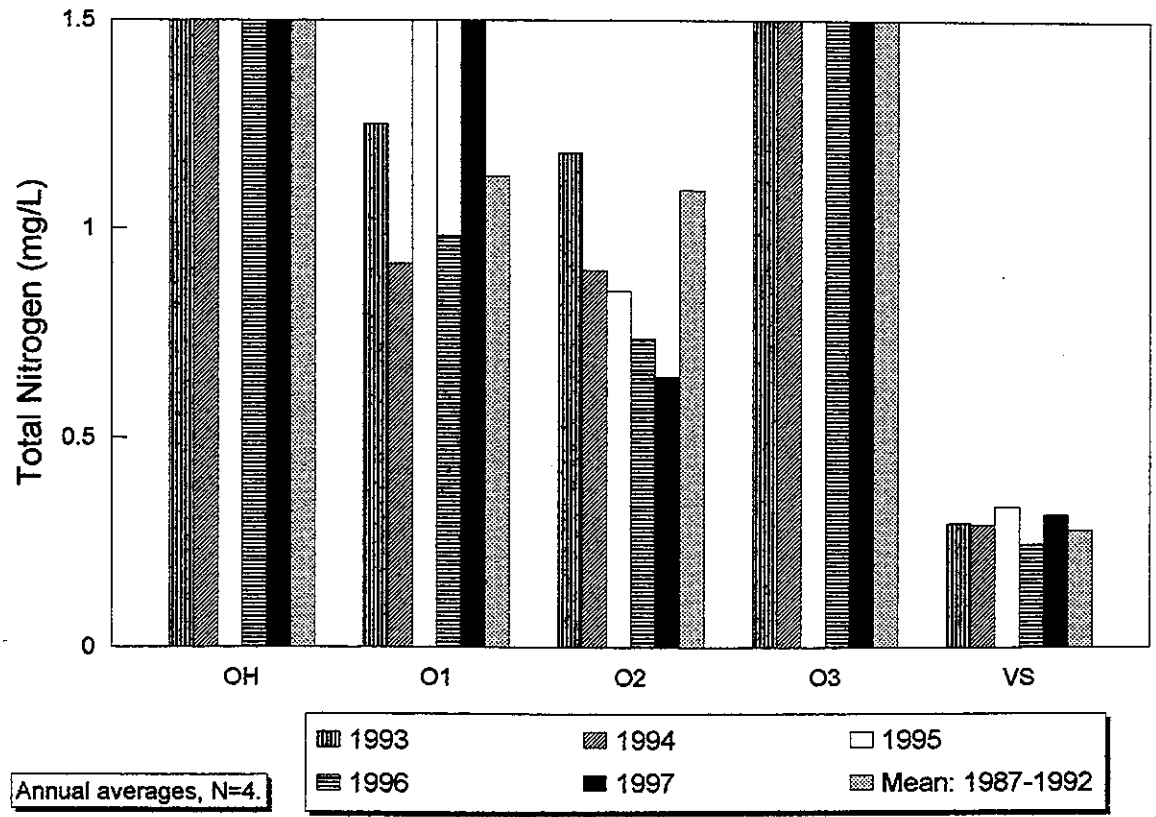


Figure 8. Oyster Pond average bottom water oxygen (Top) and total nitrogen (Bottom) levels during 1997. The freshening of the pond, 1995-1997 (Fig. 7), has resulted in a decrease in summer stratification such that the mid-basin has been oxygenated since the fall of 1994 and nitrogen levels have declined. The depth of the top of the hydrogen sulfide-high nitrogen zone of the deep basin has also declined from 4 m to 6 m over this same period (not shown).

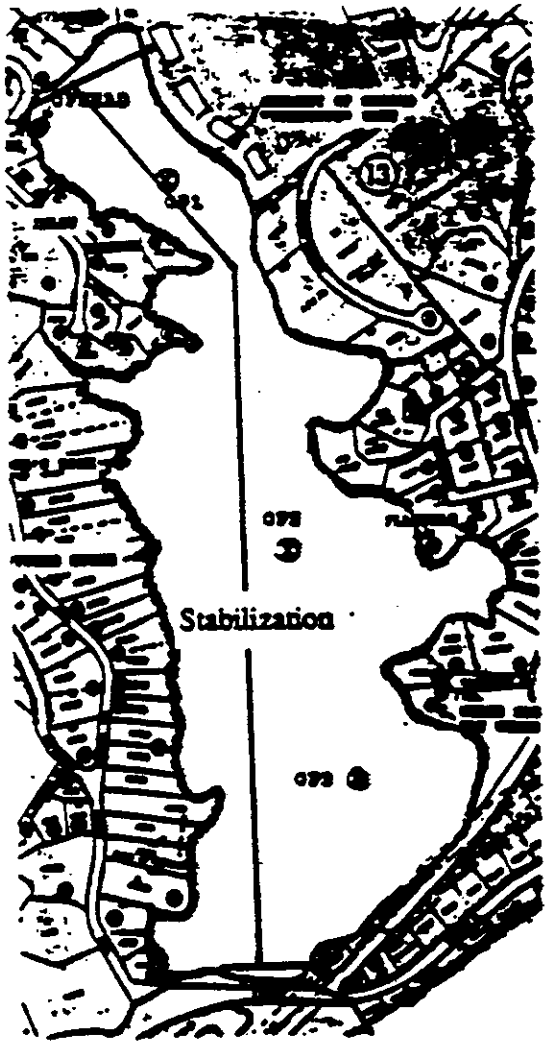
which were lost from the pond waters in the early 1990's, have returned and appear to be regaining former population levels and growth rates (J. Dowling, pers. obs.). Watercolumn stratification has been weakened during summer by the lower salinities and oxygen has been found in the mid-basin from fall 1994 through the 1997 season. This increased ventilation is paralleled by a major decline in the nitrogen levels in this basin over the past 4 years. In addition, the anoxic-high nutrient bottom water zone in the deep basin is slowly being reduced by increased vertical mixing. During the 1997 field season the depth to the top of this zone was slightly less than 6 meters compared to ca. 4 meters in previous years. It appears that if tidal flow to the pond can be properly managed by adjusting the weir elevation to maintain the current salinity of pond waters, the habitat quality of the pond will be restored. While continued monitoring by Pond Watchers (with Oyster Pond Environmental Trust) will serve to "tune" the weir adjustments, it appears that Oyster Pond is currently improving ecologically in response to the Town's management practices.

Great Pond: The upper region of Great Pond again showed poor nutrient related water quality in 1997. The nitrogen levels in the upper arm of the pond and in Perch Pond have typically exceeded 0.75 mg N/L throughout the 1990's. This high level of nitrogen loading results from the integration of watershed nitrogen loading with the relatively low tidal flushing of these restricted sub-systems. Perch Pond exhibits higher nitrogen levels (>1/3) than its source water (GT5 & GT6) primarily due to the shoaling of its short inlet to central Great Pond. Perch Pond has shown increased nitrogen levels in 1994-1997 compared to 1990-1993. Maintenance of the Perch Pond/Great Pond tidal flow should be evaluated if secondary signs of eutrophication become apparent.

Appendix IV. Ability of Ponds to Meet Threshold Criteria for Coastal Overlay Bylaw

Oyster Pond station locations and Water Quality Designation as identified by Coastal Pond Overlay Bylaw (adopted by Falmouth Town Meeting, April. 1988) and actual designations according to the Bylaw as measured by Falmouth Pondwatchers.

Water Quality Designation
Identified by Bylaw



Actual Designation as Measured
by PONDWATCHERS

"Critical Eutrophic Levels" as designated by Coastal Pond Overlay Bylaw
(Total Nitrogen as Average Over Year)

> 0.75 mg/l	= Above Highest "Critical Eutrophic Levels"	X
0.5 - 0.75 mg/l	= Intensive Water Activity Area	□
0.32 - 0.5 mg/l	= Stabilization Area	O
< 0.32 mg/l	= High Quality Area	