Technical Memorandum

FINAL

Water Quality Monitoring and Assessment of the Martha's Vineyard Island-Wide Estuaries and Salt Ponds Summary 2017 (year 2 of 3)

To:

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The Technical Memorandum on the results of the summer 2017 Martha's Vineyard Island-wide Water Quality Monitoring Program is organized as follows and mirrors the format of the 2016 water quality summary memo to ease the cross comparability of data from one year to the next:

1. Overview
    - Background
    - Need for a Monitoring Program
2. Summary of Sampling Approach for each of the estuaries and salt ponds of Martha's Vineyard. The following systems represent all the estuaries that will eventually be sampled under the unified monitoring program, however, a few were not sampled initially in year 1 of the program (sampled = X, not sampled = 0 in list below):

2016/2017
X/X 1) Lake Tashmoo (**Yes** - MEP Threshold
X/X 2) Lagoon Pond (**Yes** - MEP Threshold)
X/X 3) Oak Bluffs Harbor (**Yes** - MEP Threshold)
X/X 4) Farm Pond (**Yes** - MEP Threshold
X/X 5) Sengekontacket Pond (**Yes** - MEP Threshold
X/X 6) Cape Pogue / Pochet Pond (To Be Developed - MEP Threshold)
X/X 7) Katama Bay/Edgartown Harbor (To Be Developed - MEP Threshold)
0/0 8) Oyster Pond (To Be Developed - MEP Threshold)
X/X 9) Edgartown Great Pond (**Yes** - MEP Threshold)
0/X 10) Tisbury Great / Black Point Pond (**Yes** - MEP Threshold)
X/X 11) Chilmark Pond (**Yes** - MEP Threshold
0/X 12) Menemsha / Squibnocket Ponds (Yes - MEP Threshold)
0/X 13) James Pond (No - MEP Threshold)

3. Results of Sampling: Summary of Water Quality Results
    - Review of and comparison to historical data used in the MEP Reports
4. Trophic State: Water Quality/Eutrophication Status
5. Recommendations for Future Monitoring

Overview

Background: Coastal salt ponds and estuaries are among the most productive components of the coastal ocean. These circulation-restricted embayments support extensive and diverse plant and animal communities providing the foundation for many important commercial and recreational fisheries. The aesthetic value of these systems, as well as the freshwater ponds within their watersheds are important resources to both residents and the tourist industry alike. Maintaining high levels of water quality and ecological health in these aquatic systems (fresh and marine) is fundamental to the enjoyment and utilization of these valuable resources and the tax base and economy of all coastal communities.

Nutrient over-enrichment is the major ecological threat to water quality in the salt ponds and embayments across all the Towns of Martha's Vineyard, primarily via ecological degradation which results when nutrient loading exceeds the critical nutrient threshold i.e. the assimilative capacity (the highest level of loading without causing habitat impairments). Each aquatic system has its own specific threshold, based upon its configuration, mixing and flushing rates. Of the various forms of pollution that threaten coastal waters (nutrients, pathogens and toxics), nutrient inputs are the most ubiquitous, insidious and difficult to control. This is especially true for nutrients originating from non-point sources, such as nitrogen and phosphorous transported in the groundwater from on-site septic treatment systems, agriculture or even residential lawn fertilization. On-site septic treatment systems are the primary mechanism for waste disposal within the watersheds of nearly all the estuaries of Martha's Vineyard with the exception of Edgartown Great Pond. Edgartown Great Pond is in a somewhat different situation as the watershed to that system is partially sewered and wastewater is treated by a wastewater treatment facility. Nevertheless, the nutrient characteristics and ecological health of that system must be monitored given the wastewater treatment plant effluent does discharge to Edgartown Great Pond via groundwater and the pond only has tidal flushing during its periodic openings to the Atlantic Ocean thru managed breaching of the barrier beach. Additionally, Edgartown Great Pond does still support eelgrass habitat that is especially vulnerable to changes in nutrient concentrations and associated water clarity.

Since the primary nutrients, nitrogen and phosphorous, are natural components of estuarine and freshpond systems, it is important that management allow for the natural capacity of these systems to absorb watershed nutrient inputs. Through the coupling of monitoring data to the Massachusetts Estuaries Project (MEP) watershed loading analysis developed in collaboration with the Coastal Systems Program (CSP), the most cost-effective management strategies can be found to protect these valuable aquatic environments of Martha's Vineyard. Moreover, as nutrient load reduction strategies become implemented across the Island and in specific estuarine watersheds, maintaining the regular monitoring of nutrient related water quality is critical for assessing the extent to which a particular implementation approach is having its planned effect toward restoration and how much additional effort may be required.

Need for a Monitoring Program: Conserving and/or restoring the environmental health of coastal embayments and freshwater ponds is achievable, but only through proper management of the waters and watersheds of each. Managing environmental health requires a quantitative understanding of the biological and physical processes which control nutrient related water quality within a specific basin and the role of watershed inputs in the nutrient balance of the receiving waters. An essential step in managing these fresh and saltwater systems is to monitor their water quality. The results of a long- term monitoring effort are needed to determine the status and trend of each system's ecological health to assess the need for management actions and their success when implemented. Nutrient impaired systems can be restored, but require that long-term water quality data be coupled with higher-end ecological data to support the development of quantitative site-specific management plans.

As in 2016, the 2017 water quality monitoring of the fresh and saltwater systems of Martha's Vineyard was focused on summer-time conditions, as the warmer months typically have the lowest water quality conditions, which are the target of resource management. The Martha's Vineyard Commission as well as the Towns of Martha's Vineyard have a long history of monitoring of the Island's aquatic systems to support the protection and management of the natural resources of the Island. Generally, water quality monitoring has been undertaken by the MVC Water Resources Planner, Town Shellfish or Natural Resources Departments. These past efforts have also supported nutrient related estuarine analyses by the

Massachusetts Estuaries Project for restoration/protection of all the coastal systems of southeastern Massachusetts and specifically on the island of Martha's Vineyard. Over the past 8-10 years, the MEP has established the estuarine specific nitrogen thresholds for nearly all of the estuaries of Martha's Vineyard with the exception of James Pond, Oyster Pond, Katama Bay, Cape Pogue Bay and Pocha Pond. Field data collection has been completed under the umbrella of the MEP for future analysis of these remaining systems. Modeling and nitrogen threshold development is forth coming assuming funds can be garnered from the Town.

Water quality monitoring programs, like the unified Island-wide program initiated in the summer of 2016 across all the coastal systems of Martha's Vineyard, are the most efficient way to maximize the value of the results. The efficiency is achieved by structuring the sampling and analysis program such that results can be cross compared to historic water quality monitoring data and that collected throughout the region. For example, a similar unified monitoring program was initiated in 2010 covering all of the estuaries on Nantucket Island. Both the Vineyard and Nantucket programs utilize exactly the same sampling and analytical protocols ensuring seamless cross comparability. In this manner, inter-ecosystem comparisons can be made to better assess system health/impairment and function and formulate appropriate nutrient management strategies. This allows individual Martha's Vineyard Towns to directly benefit from lessons learned across the Island as well as throughout the wider region, be it Cape Cod or the Island of Nantucket.

Summary of Sampling Approach

Monitoring Project Team: To address the present nutrient related ecological health issues of the salt ponds and embayments across the Island of Martha's Vineyard and to provide necessary information with which to develop policies to protect and/or remediate these systems with regard to nutrient overloading, a long-term, unified monitoring effort was established for the summer 2016, which was continued and expanded in the summer of 2017, and coordinated through the Martha's Vineyard Commission (MVC). This unified monitoring program builds on the multiple and diverse historic water quality monitoring efforts. These prior monitoring efforts were undertaken beginning as early as 2000 and continued through around 2007 to support the baseline water quality monitoring needs of the Massachusetts Estuaries Project (MEP). In 2016 the MVC determined that the need for consistent water quality monitoring Island-wide required establishment of a Martha’s Vineyard Water Quality Monitoring Program. This program would build on the prior monitoring effort with technical support through the Coastal Systems Program (CSP) at the University of Massachusetts-Dartmouth, School for Marine Science and Technology (SMAST). The CSP had been responsible for the analysis of the prior water sampling results completed in the estuaries of Martha's Vineyard as part of the MEP nutrient thresholds development. The sampling under the new Monitoring Program was streamlined based upon the prior results to yield the necessary information and be sustainable over the long-term. The field and laboratory procedures and assays used in the new program were similar to those of previous years to ensure comparability. Water quality monitoring in 2016 and 2017 was completed as a collaboration between the Martha's Vineyard Commission (MVC) and the Coastal Systems Program.

The Martha's Vineyard Commission is serving as Project Leader and lead field organization and the Coastal Systems Program is providing laboratory services through the Coastal

Systems Analytical Facility at SMAST. Coordination and oversight of the program is by the MVC Water Resources Planner (Ms. Sheri Caseau) with CSP-SMAST providing the technical oversight, analytical support and data interpretation.

While the Martha's Vineyard Commission and its Water Resources Planner have extensive experience in water sample collection and have an inventory of necessary sampling equipment, some equipping and training of volunteers & staff prior to sampling was warranted to ensure that sampling protocols are understood and properly implemented (primary focus on any new staff and new sampling locations). Training took place in the early summer in advance of the July sampling events in 2016, with a refresher in 2017. The Coastal Systems Program has also been responsible for the development and coordination of the majority of the estuarine and pond water quality monitoring across southeastern Massachusetts, Cape Cod and the Island of Nantucket as well as the analysis of all the samples collected and synthesis of the resulting water quality data. As such, the CSP is able to leverage this comprehensive water quality database on an as needed basis to further evaluate results obtained from the Martha's Vineyard Island-wide monitoring program. It should also be noted that The Coastal Systems Analytical Facility, in addition to conducting research quality assays of environmental samples, has been cleared for regulatory nutrient related water quality assays in Massachusetts estuaries. This required review of all laboratory protocols, inter-calibration studies and blind performance and evaluation (P&E) samples (most recently 2015). In addition, laboratory QA/QC procedures were brought to “certification” standards and various agencies have reviewed MEP water quality data results. This makes the Coastal Systems Analytical Facility uniquely qualified for the conduct of low level environmental nutrient assays in a regulatory setting (TMDL’s) and this level of analytical rigor is the basis for the Martha's Vineyard Island-wide Water Quality Monitoring Program.

CSP scientists focused primarily on the analysis of samples collected from the Island- wide effort, data analysis and program coordination while the Martha's Vineyard Commission focused primarily on field sampling and data collection on physical parameters. Both participated in the compilation of field and laboratory data to provide an ecological overview of water quality conditions within each of the systems for the benefit and use by all the Towns of Martha's Vineyard. The goals of the monitoring program are to:

(1) determine the present ecological health of each of the major salt ponds and estuaries across the Island of Martha's Vineyard,

(2) gauge (as historical data allows) the decline or recovery of various salt ponds and embayments over the long-term (also part of TMDL compliance), and

(3) provide the foundation (and context) for detailed quantitative measures for proper nutrient and resource management, if needed, and to assess the success of implemented restoration alternatives,

(4) compliance monitoring to meet requirements of TMDLs as they are developed and as towns across the island move into implementation of restoration approaches,

(5) provide a mechanism to easily compare present water quality data to MEP established nutrient thresholds.

The latter points (3 & 4) are critical for restoration planning should an estuarine system be found to be impaired or trending toward impairment.

Water Quality Program Description: As was the case during historical sampling to develop the baseline water quality data sets in each estuary for the MEP as well as the sampling that took place in 2016-2017, sampling took place during the warmer summer months (July, August), the critical period for environmental management. Samples were collected in year 2 of the unified Island-wide Monitoring Program from 13 of 14 estuarine systems (Oyster Pond not sampled) and 1 freshwater pond (Looks Pond) as depicted in Figures 2-15 on dates (“events”) as summarized in Table 1a and Table 1b. Sampling followed the general schedule presented in Table 1c.

The Martha's Vineyard Commission oversaw the sampling and all samplers who were involved were given refresher “training” to meet QA requirements. The physical parameters measured in the estuaries included: total depth, Secchi depth (light penetration), temperature, specific conductivity/salinity (YSI meter), general weather, wind speed and direction, dissolved oxygen levels and observations of moorings, birds, shellfishing and unusual events (fish kills, algal blooms, etc). Laboratory analyses for estuaries included: salinity, nitrate + nitrite, ammonium, dissolved organic nitrogen, particulate organic carbon and nitrogen, chlorophyll *a* and pheophytin *a* and orthophosphate. The estuarine sampling in 2017 was based on completion of four (4) sampling events in July and August (see Table 1a, 1b, 1c for summary) with the exception of two estuaries (Farm Pond and Oak Bluffs Harbor which were sampled twice in July and once in August and once in September. The precise dates were selected based upon early morning mid-tides for tidal estuaries and simply in the early morning for salt ponds without tidal exchange (no inlet). The systems sampled were expanded over 2016 to include Looks Pond (freshwater), Tisbury Great Pond, James Pond and Menemsha/Squibnocket Ponds. Fresh Pond was not sampled in 2017,estuary samplings were expanded. Water samples were collected at 68 locations (1 station in Looks Pond, 67 estuarine stations) including sentinel stations established as part of the MEP nutrient threshold assessments. Sampling these stations generated a maximum of 81 samples per event (including multiple depths at deep stations, but not including QA samples). It should be noted that some systems had additional events (>4). QA samples were collected at ~5% of the stations for a given event. Data were compiled and reviewed by the Coastal Systems Program Analytical Facility staff and QA Officer for accuracy and evaluated to discern any possible artifacts caused by improper sampling, holding or storage technique.

Table 1a. Sampling Schedule for 2017 Martha's Vineyard Island-Wide Water Quality Monitoring Program

Month	Cape Pogue Bay	PochaPond	Katama Bay	Edgartown Great Pond	Chilmark Pond	Look Pond	Farm Pond
Jan							
Feb							
Mar							
April							
May							
June						June 21	
July	Jul. 12,27	July 12,27	Jul. 12,27	Jul. 13,31	Jul. 10,26	Jul. 27	Jul. 17
August	Aug. 15	Aug. 15	Aug. 15	Aug. 14	Aug. 8, 23	Aug. 24	Aug. 1,13,27
September	Sept. 25	Sept. 25	Sept. 25	Sept. 12		Sept. 27	
October					Oct. 5		
November							
December							
Totals	**4**	**4**	**4**	**4**	**5**	**4**	**4**

Table 1b. Sampling Schedule for 2017 Martha's Vineyard Island-Wide Water Quality Monitoring Program

Month	Oak Bluffs Harbor	Lake Tashmoo	Lagoon Pond	Sengekontacket Pond	Tisbury Great Pond	Menemsha Pond	Squibnocket Pond	James Pond
Jan								
Feb								
Mar			Mar. 6					
April								
May								
June								
July	Jul. 17	July 13,27	Jul. 17	Jul. 18	Jul. 11	Jul. 6,20	Jul. 5,19	Jul. 5,19
August	Aug. 1,13,27	Aug. 10,24	Aug. 1,16	Aug. 3,16,31	Aug. 8,18	Aug. 2,17	Aug. 2,17	Aug. 3,16
September			Sept. 13					
October					Oct. 3			
November								
December								
Total Events	**4**	**4**	**5**	**4**	**4**	**4**	**4**	**4**

Table 1c – Summary of sampling by station for each estuary / salt pond system. Systems in red were not included in year 1 of the monitoring program, but James Pond, Menemsha/Squibnocket Pond and Tisbury Great Pond (and Fresh Pond {2016, aka. Wigges Pond}, Looks Pond {2017}) were added into the sampling program in 2017. Oyster Pond was not sampled in 2016 or 2017.

Town	Embayment	Number of Stations	Sample Depths	Total Samples per Event	Total Samples per Summer
Edgartown	Sengekontacket Pond	SKT-2,3,4,5,6,7,,9	6 mid, 1 surf,btm	8	32
Oak Bluffs					
Edgartown	Cape Pogue Bay	POG-2,3,4,5	4 mid	4	16
Edgartown	Pocha Pond	PCA-1,3	2 mid	2	8
Edgartown	Katama Bay	KAT-1,2,3,4,5,7	6 mid	6	24
Edgartown	Oyster Pond	OYS-1,2,3,4	4 mid	4	16
Edgartown	Edgartown Great Pond	EGP-2,3,4,5,6,7,9,10,11	9 mid	9	36
Oak Bluffs	Wiggies Pond	FRS-1,2,3	3 surf,3 btm	6	24
	(aka Fresh Pond)				
Oak Bluffs	Farm Pond	FRM-1,2,3	3 mid	3	12
Oak Bluffs	Oak Bluffs Harbor	MV-15,16,14	2 mid, 1 surf,btm	4	16
Oak Bluffs	Lagoon Pond	LGP-2,4,8,9,11	3 surf, 2 surf,btm	7	24
Tisbury					
Tisbury	Lake Tashmoo	MV-21,2,3,4, sentinel	4 mid, 1 surf,btm	6	24
West Tisbury	James Pond	JMS-1,3,4	3 mid	3	12
West Tisbury	Looks Pond	LOOKS-4	1 mid	1	4
Chilmark	Menemsha Pond	MEN-2,3,5,6,7	5 surf,btm	10	40
Aquinnah					
Chilmark	Squibnocket Pond	SQB-1,3	2 surf,btm	4	16
Aquinnah					
Chilmark	Chilmark Pond	CHP-1,2,4,5,6,Upper	6 mid	6	24
Chilmark	Tisbury Great Pond	TGP-1,3A,4,5,6,7,8	6 surf, 1 surf,btm	8	32
West Tisbury					
Sub-Total				81	324
QA Samples @ 10%				3	
Grand Total					**336**

Figure 1 - Estuaries of Martha's Vineyard that have already undergone a minimum of 3 years water quality monitoring by the MVC with support from the Coastal Systems Program. Most estuaries already have regulatory nitrogen thresholds developed by the Massachusetts Estuaries Project (MEP). The Island-wide water quality monitoring program builds on this historical baseline data. Year 1 (2016) of the Island-wide water quality monitoring program covered all the estuaries except: Oyster Pond, Tisbury Great Pond, James Pond and Menemsha/Squibnocket Ponds, all of which (with the exception of Oyster Pond) were added in year 2 (2017) of the program.

STATION LOCATION MAPS FOR ESTUARIES OF MARTHA'S VINEYARD

Figure 2 – Historic Sampling Points (yellow symbols) in Lake Tashmoo including MEP established sentinel station (new station between MV4 and MV5). Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

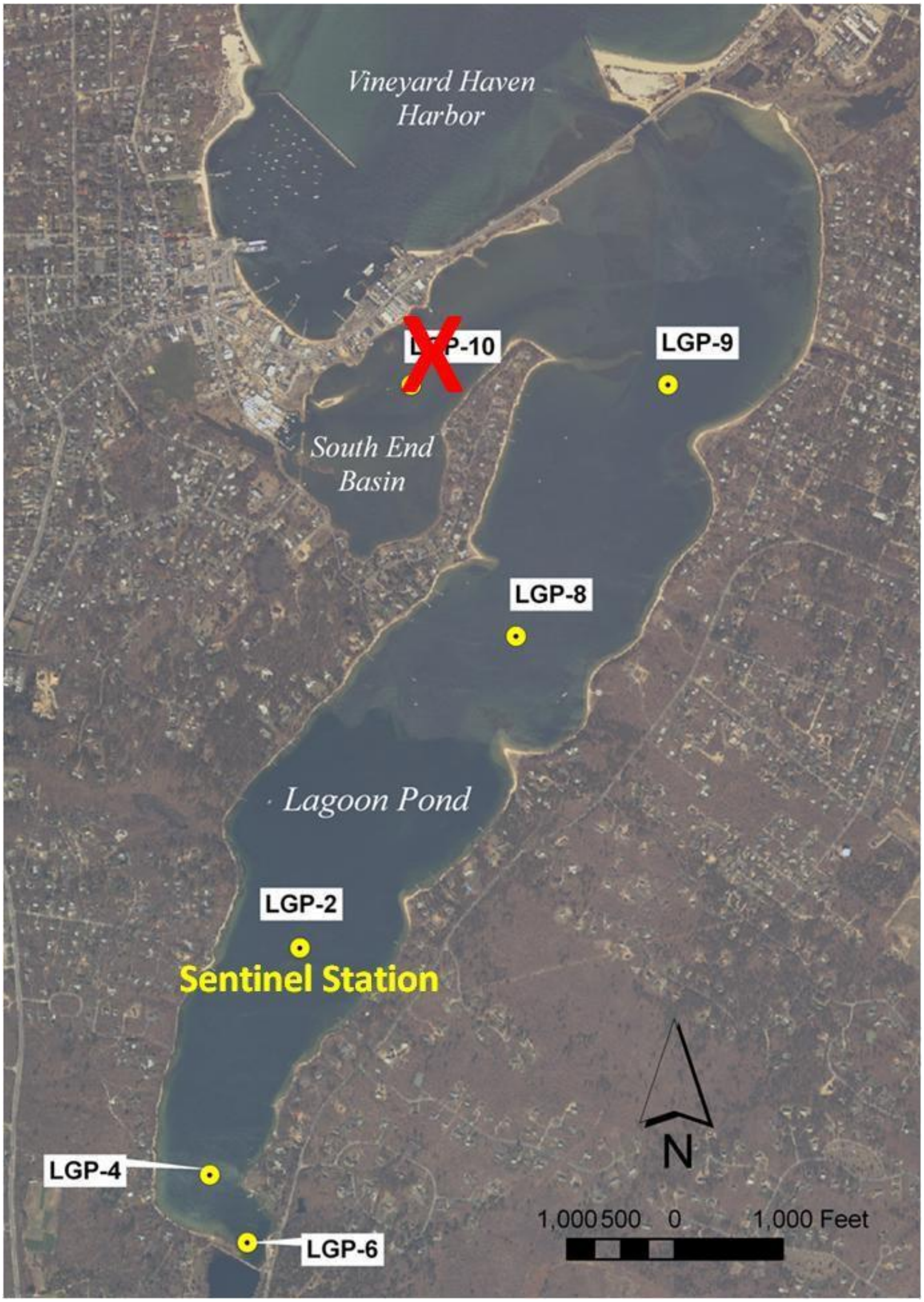


Figure 3 – Historic Sampling Points (yellow symbols) in Lagoon Pond including MEP established sentinel station LGP-2. Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

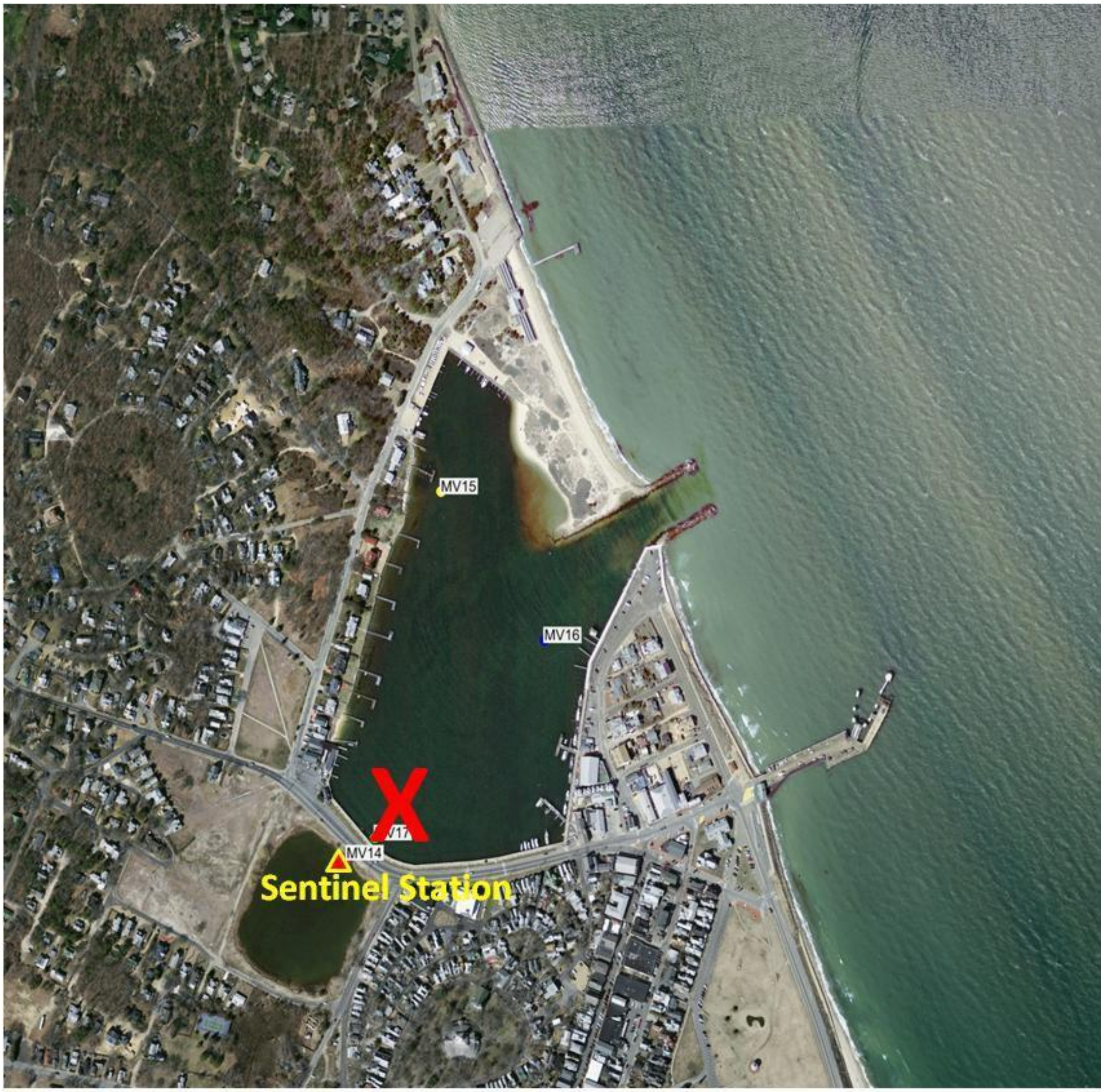


Figure 4 – Historic Sampling Points (white labels) in Oak Bluffs Harbor including MEP established sentinel station (MV-14) in Sunset Lake. Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

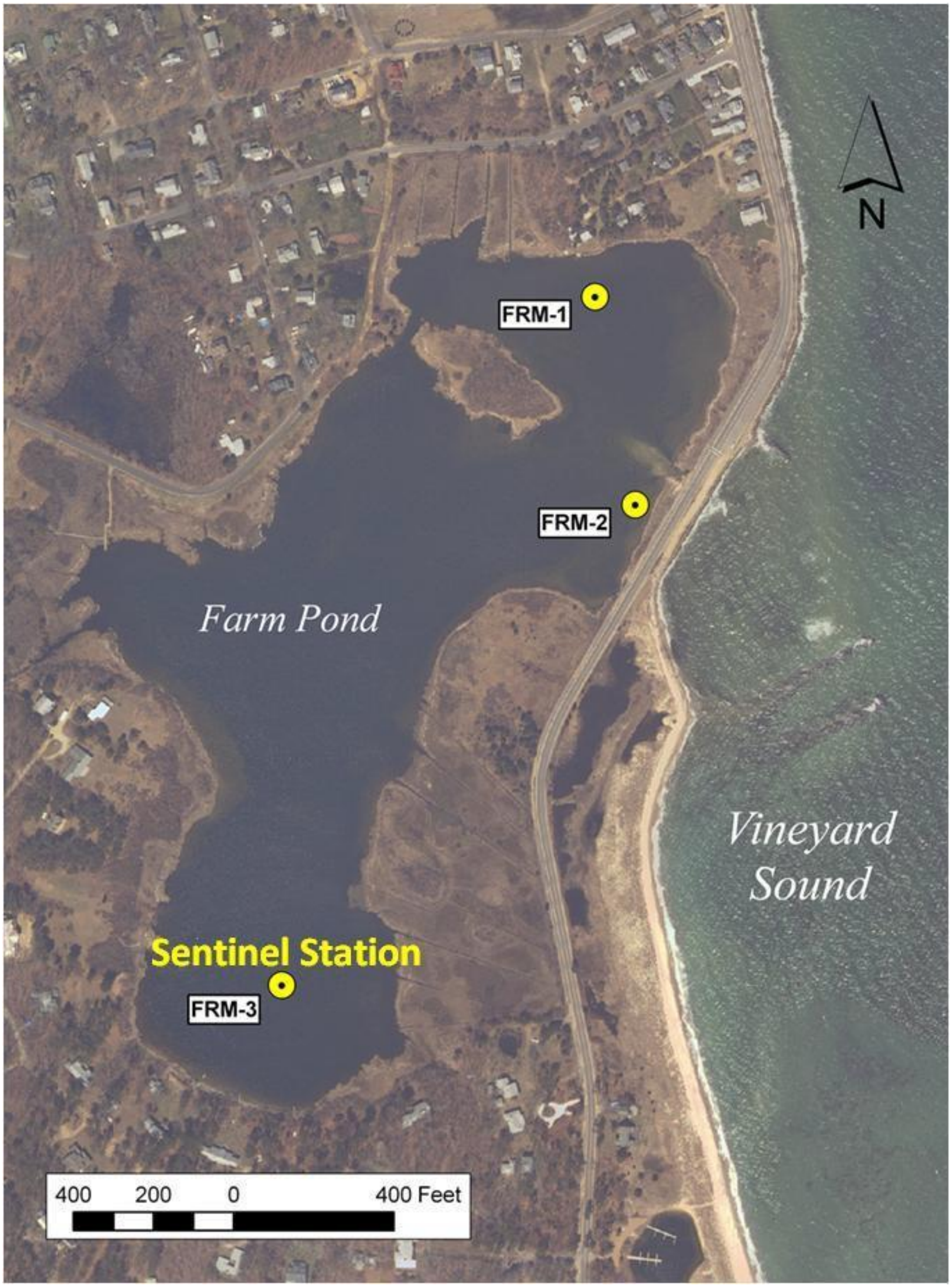


Figure 5 – Historic Sampling Points (yellow symbols) in Farm Pond including MEP established sentinel station FRM-3. Stations re-visited for 2016 and 2017 sampling seasons.

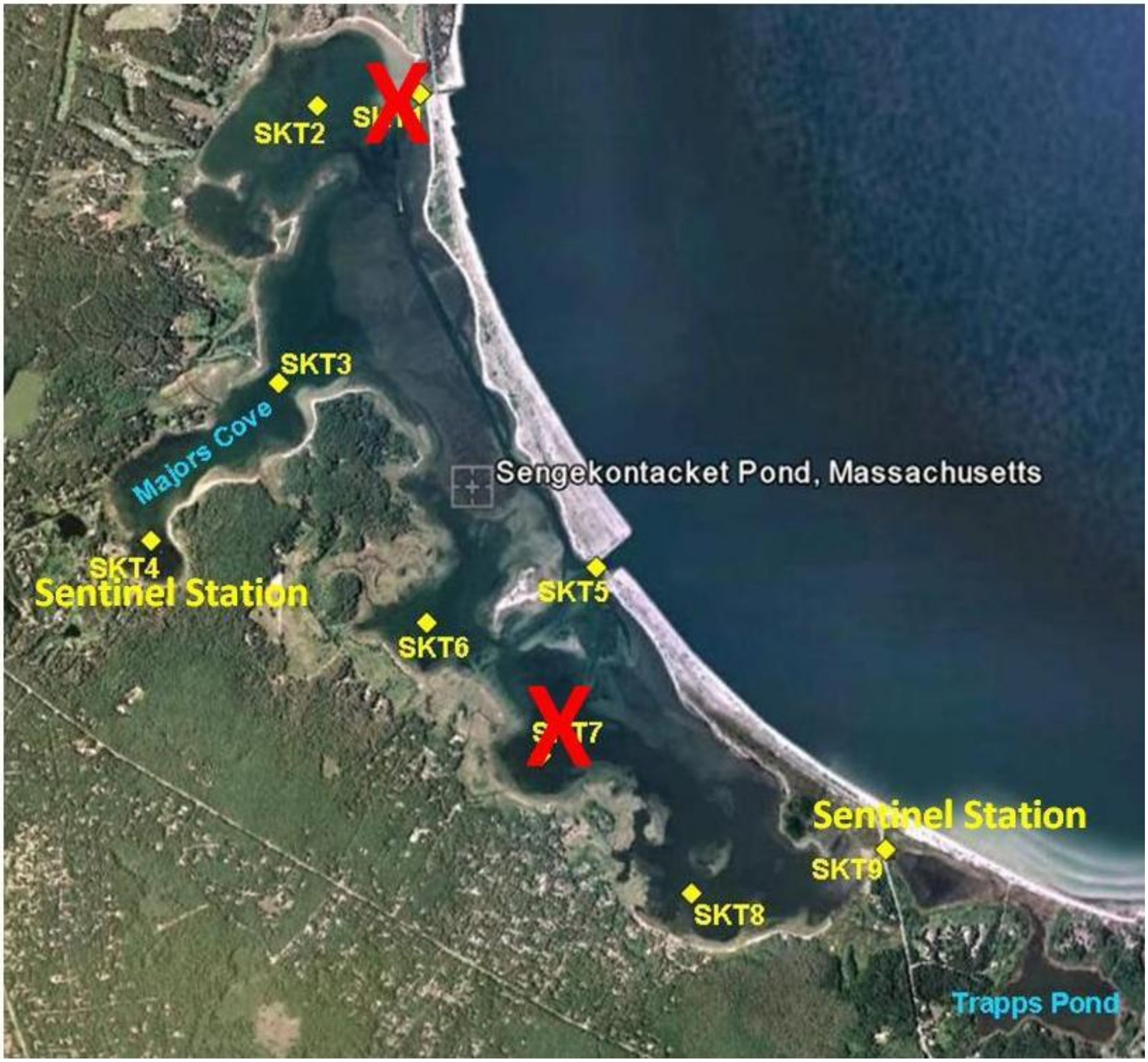


Figure 6a – Historic Sampling Points (yellow symbols) in Sengekontacket Pond including MEP established sentinel stations SKT-4 and SKT-9. Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

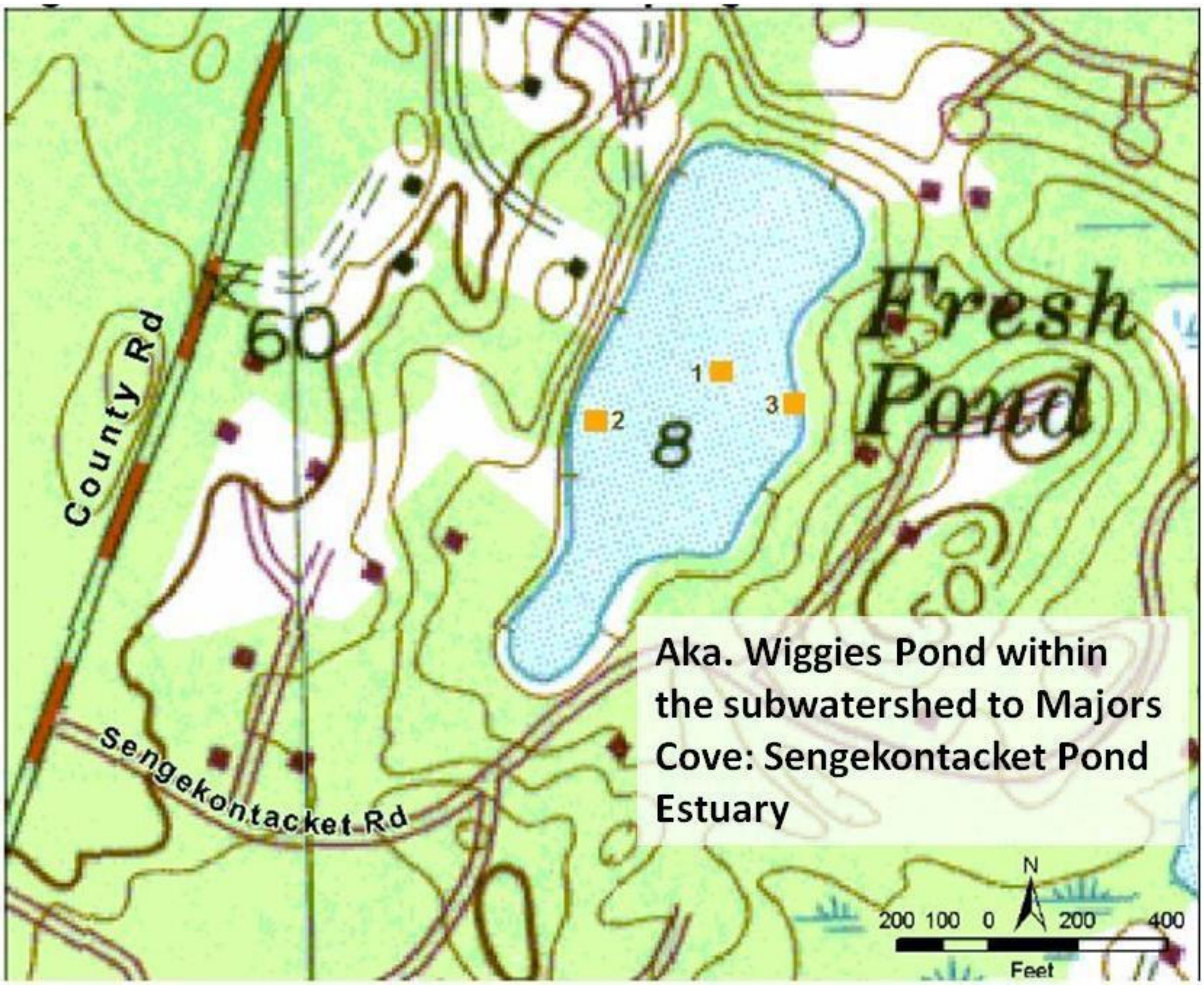


Figure 6b – Historic Sampling Points (yellow symbols) in Fresh Pond (aka. Wiggies Pond) within the subwatershed to Majors Cove located in the Sengekontacket Pond Estuary. Due to historic documented stratification, stations were sampled in 2016 at 2 depths each (surface and bottom). Stations 2 and 3 maybe re-oriented to run length wise across the pond for better spatial distribution. Fresh Pond was sampled in 2016, but not in 2017.

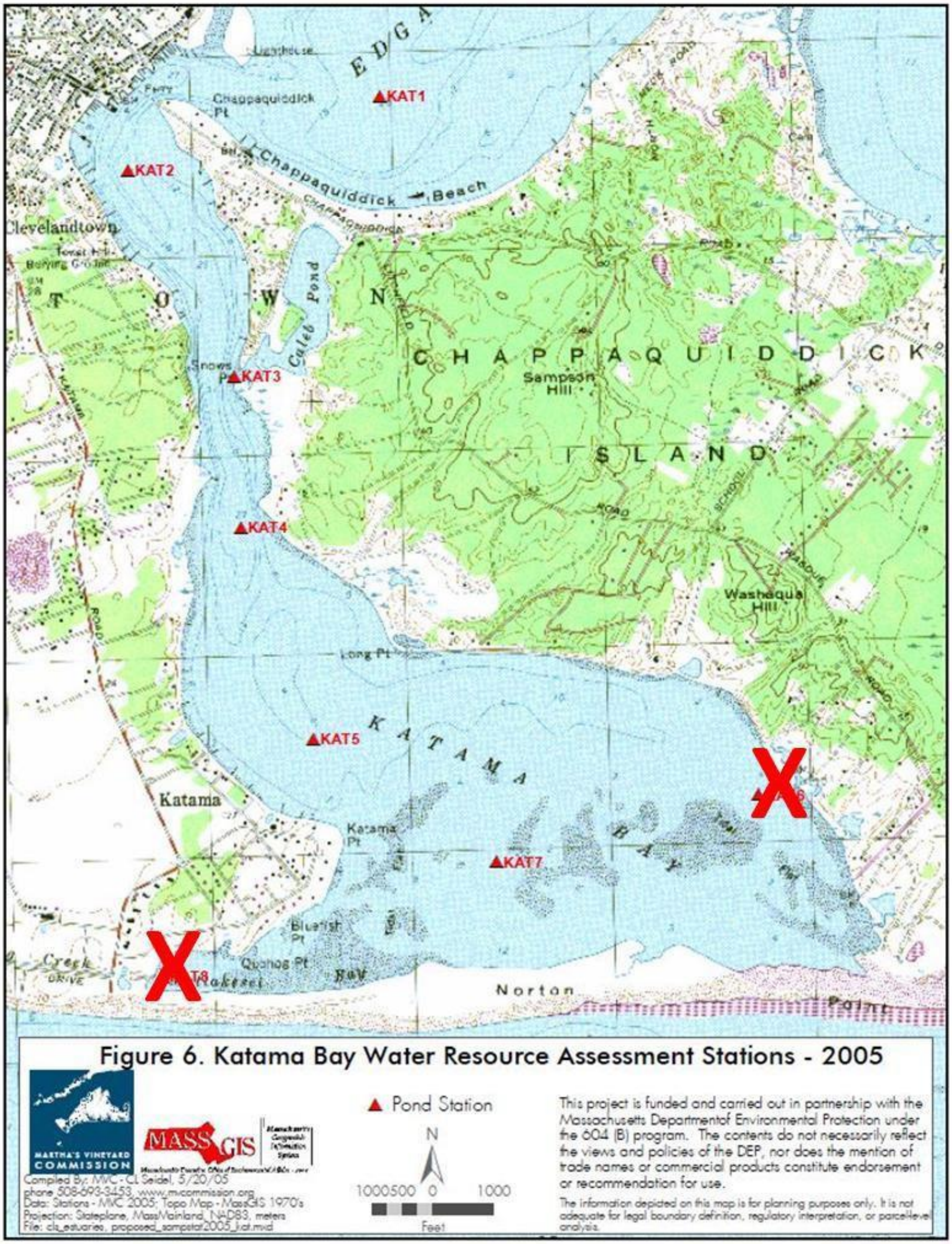


Figure 7 – Historic Sampling Points (red symbols) in Katama Bay. Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

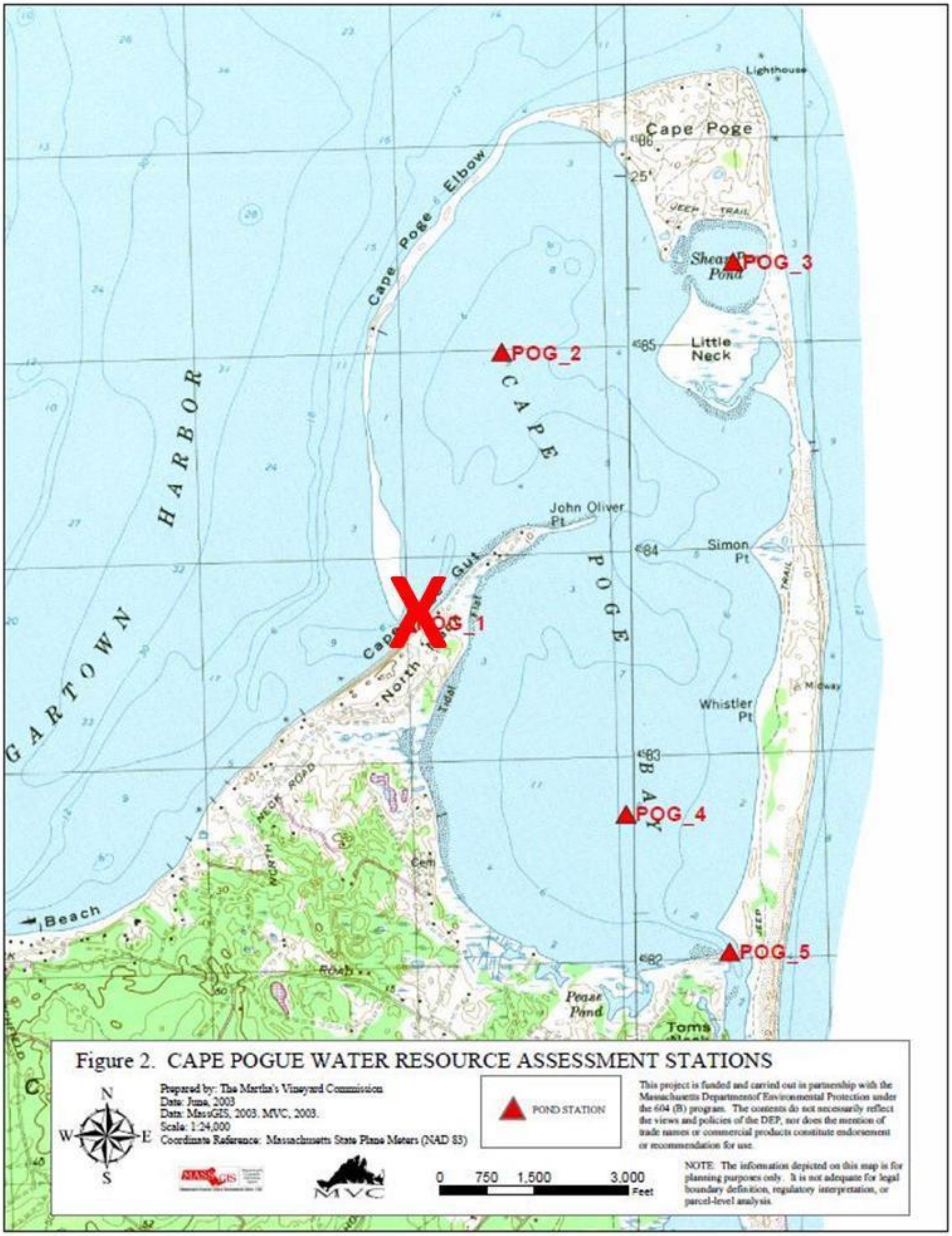


Figure 8 – Historic Sampling Points (red symbols) in Cape Pogue Bay. Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

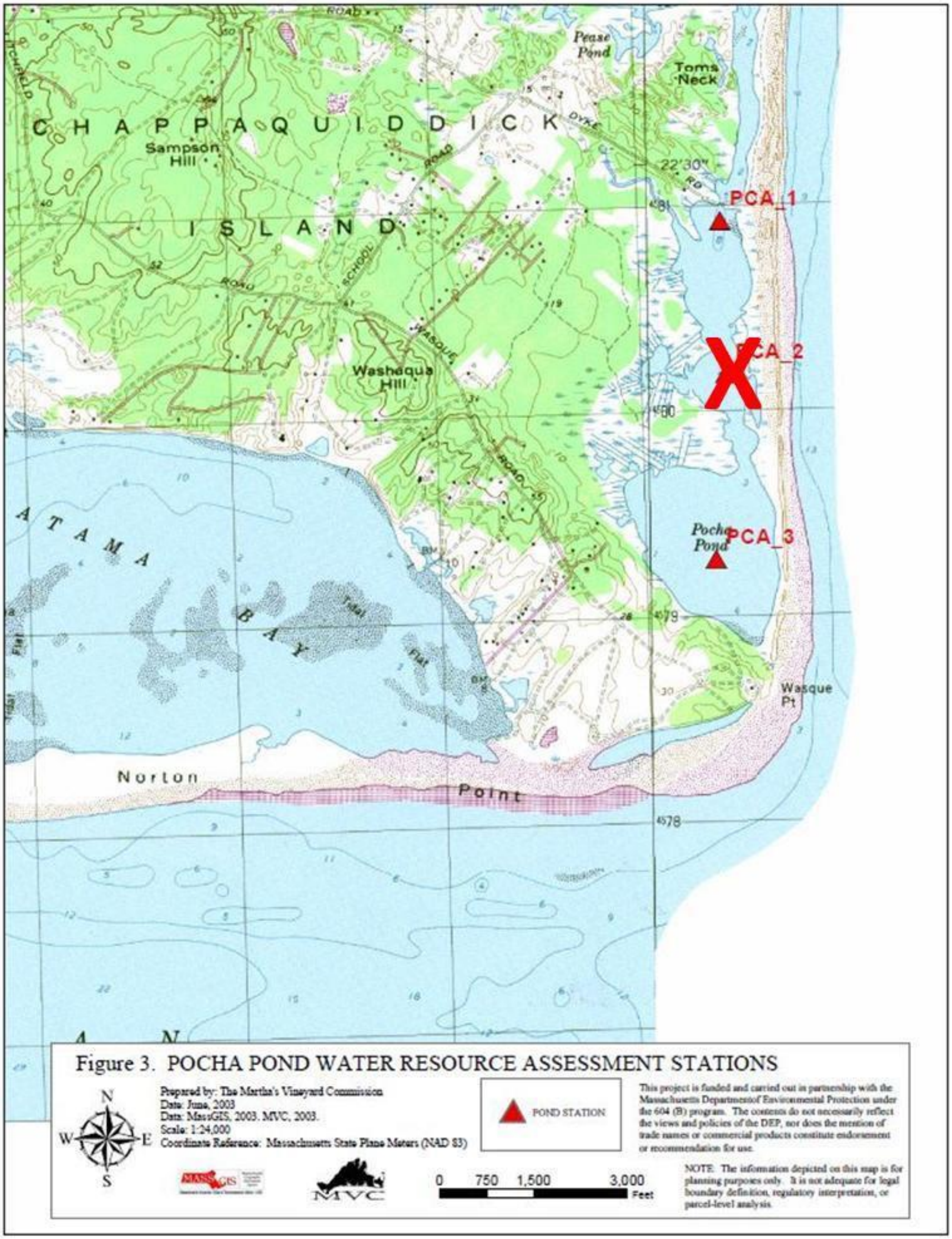


Figure 9 – Historic Sampling Points (red symbols) in Pocha Pond. Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

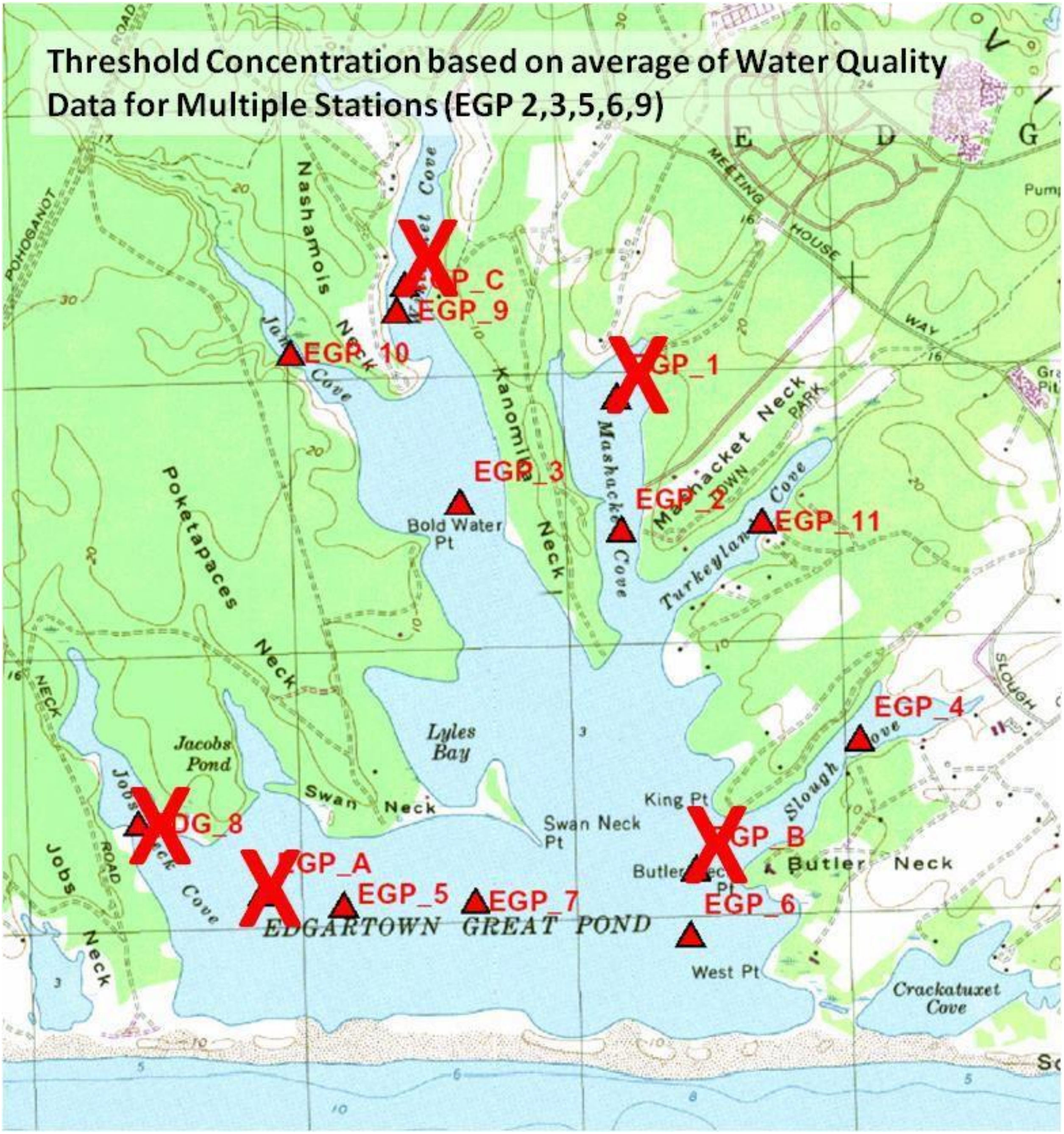


Figure 10 – Historic Sampling Points (red symbols) in Edgartown Great Pond including MEP established "sentinel station" (average of EGP 2,3,5,6,9). Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program.

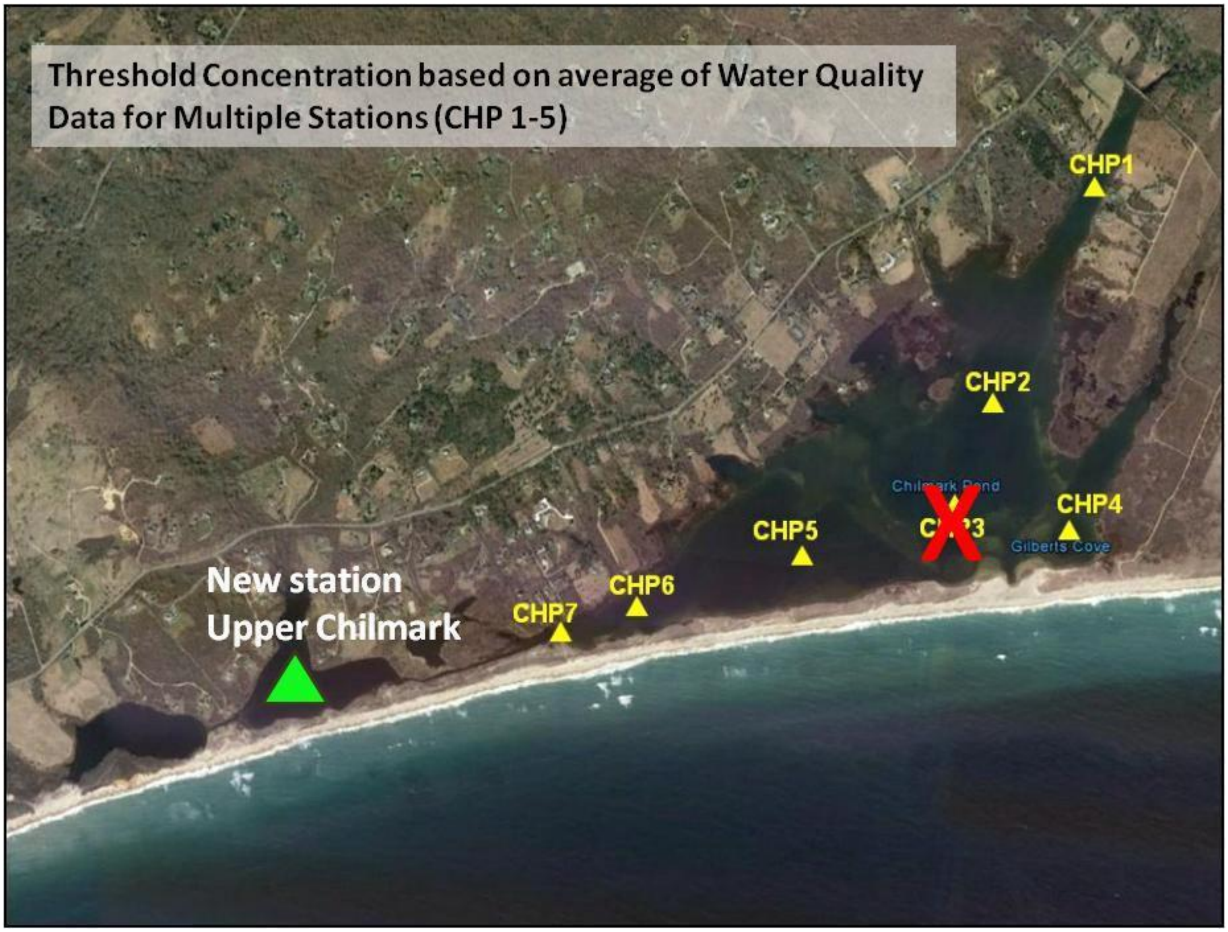


Figure 11 – Historic Sampling Points (yellow symbols) in Chilmark Pond including MEP established "sentinel station" (average of CHP 1-5). Stations re-visited for 2016 and 2017 sampling seasons. Stations denoted by a red X are historic stations that are not being sampled under the unified Island-wide Monitoring Program.

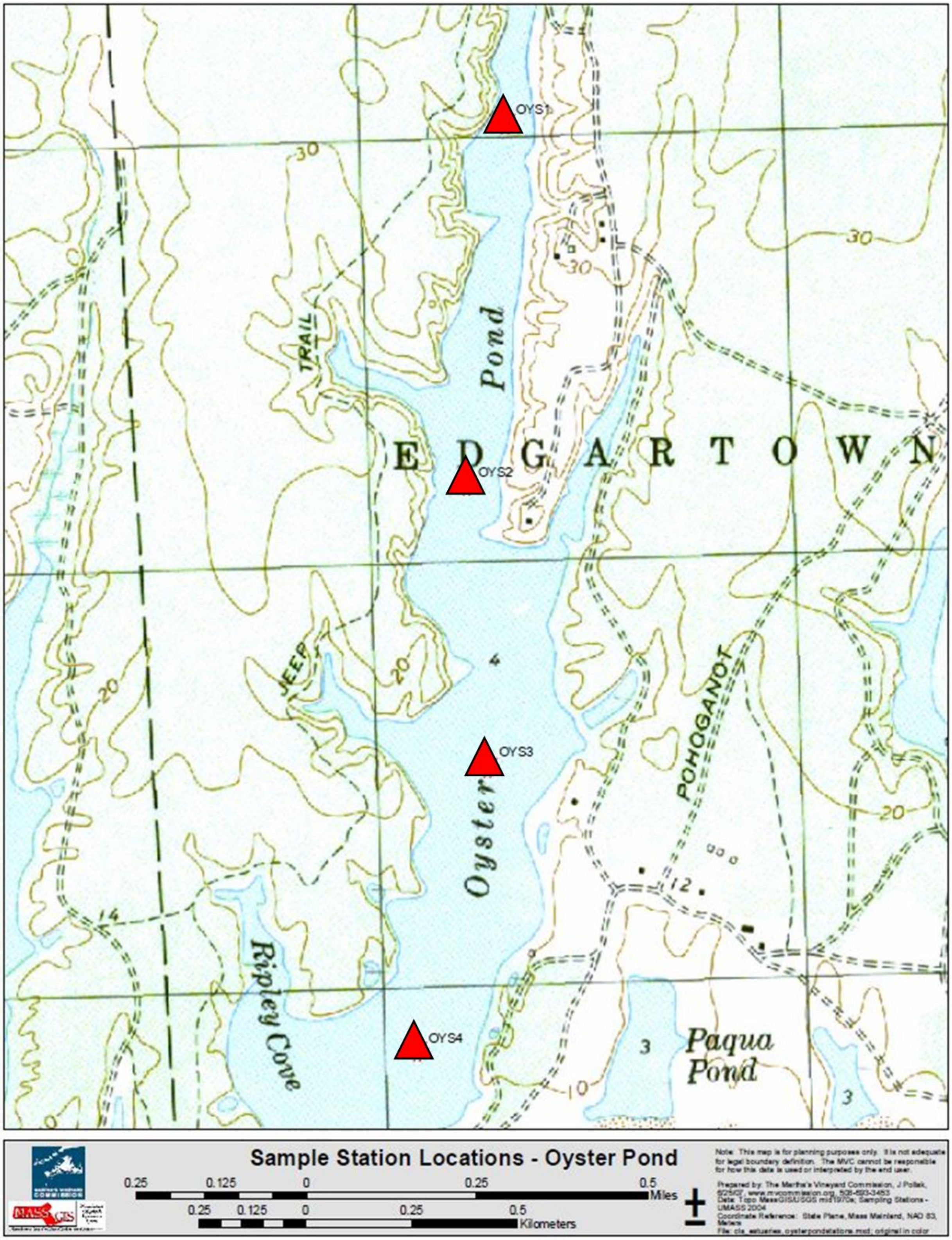


Figure 12 – Historic Sampling Points (red symbols) in Oyster Pond. Oyster Pond was not sampled in 2016 or 2017 but will be included in the island-wide program as funding becomes available.

Figure 13 – Historic Sampling Points (red symbols) in Tisbury Great Pond including MEP established "sentinel station" (average of TGP 4,5,6) and TGP7. Stations denoted by a red X are historic stations that are not being sampled under the unified Island-wide Monitoring Program. Tisbury Great Pond was not sampled in 2016 but was included in the island-wide program in 2017.

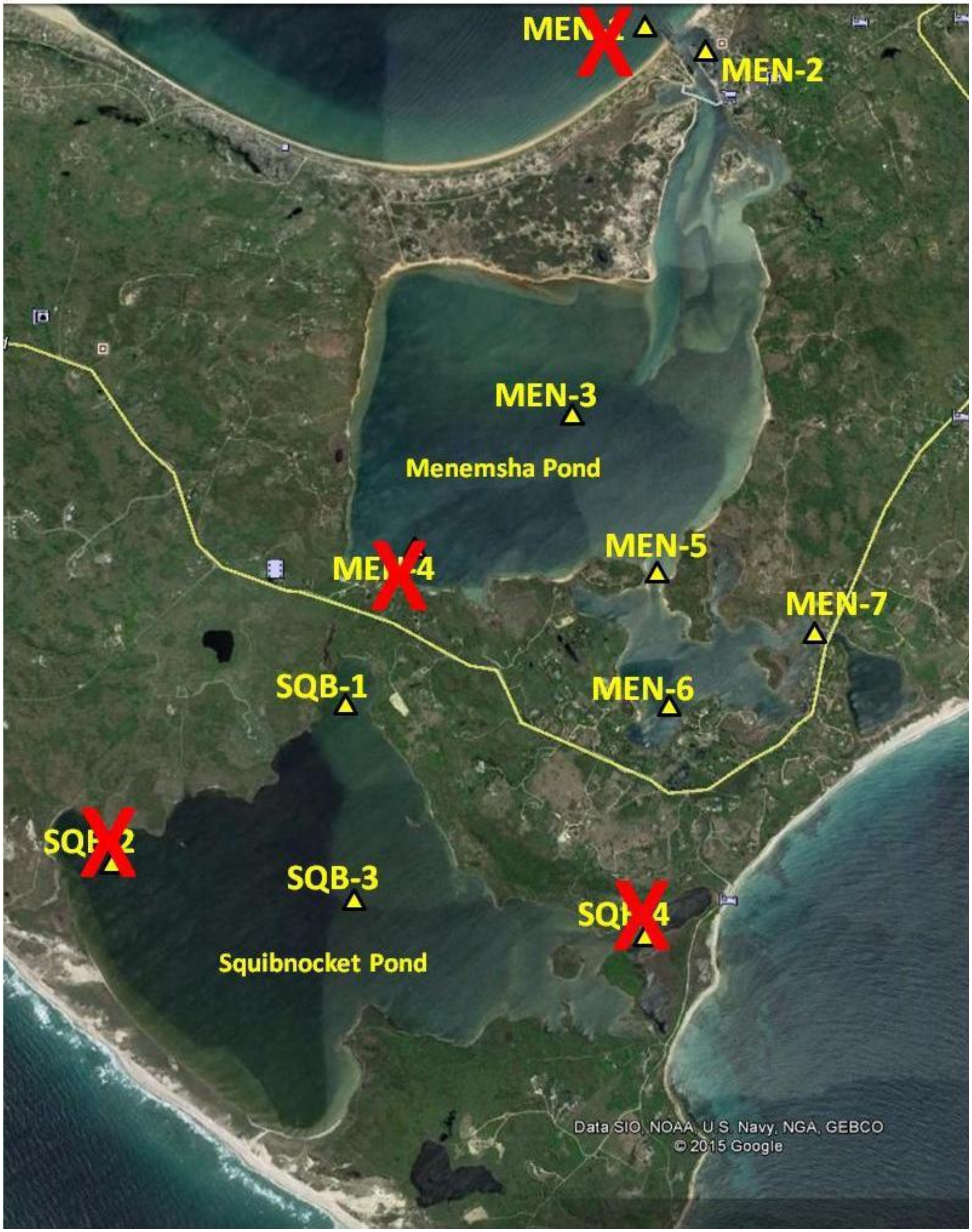


Figure 14 – Historic Sampling Points (yellow symbols) in Menemsha Pond and Squibnocket Pond including MEP established sentinel station. Stations denoted by a red X are historic stations that are not being sampled under the unified Island-wide Monitoring Program. Menemsha / Squibnocket Ponds were not sampled in 2016 but was included in the island-wide program in 2017.

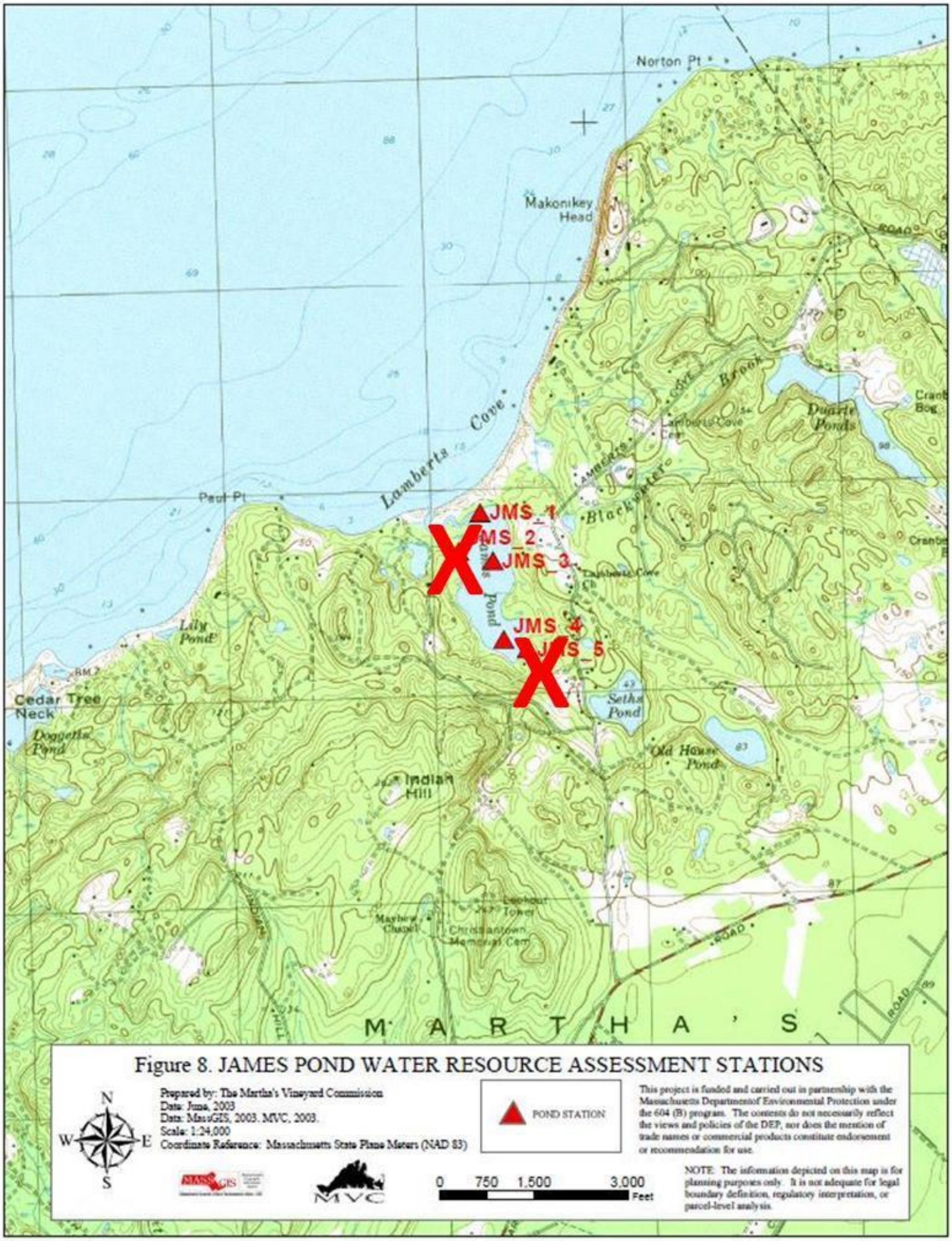


Figure 15 – Historic Sampling Points (red symbols) in James Pond. Stations denoted by a red X are historic stations that are no longer being sampled under the unified Island-wide Monitoring Program. James Pond was not sampled in 2016 but was included in the island-wide program in 2017.

Summary of 2017 Water Quality Results for Martha's Vineyard Island-wide Sampling

Water samples collected in July through September in the estuarine systems of Martha's Vineyard indicate that organic nitrogen (dissolved + particulate) dominates the Total Nitrogen pool (2017: 88%-99%, 2016: 94%-98%) with the majority (2017: 46%-90%, 2016: 57%-78%) of the TN pool comprised of dissolved organic nitrogen (DON) and particulate organic nitrogen (PON) accounting for the remainder (2017: 20%-53%, 2016: 20%-40%). Meanwhile, bio-available nutrients in the form of nitrite and nitrate (NOx) and ammonium (NH_4) account for only 1%-12% in 2017 (2016: 1%-8%) of the water-column Total Nitrogen pool (Table 2, Figure 17, Appendix A). This contrasts with the fact that virtually all of the nitrogen entering from the watershed is in bioavailable forms, primarily as nitrate. These results are typical for estuarine systems throughout New England, where nitrogen is the nutrient responsible for eutrophication and therefore the nutrient critical for management. As previously observed, the predominance of organic nitrogen in the Total Nitrogen (TN) pool in these systems indicates that phytoplankton are effectively converting the bioavailable inorganic forms of nitrogen into organic forms (e.g. biomass). Where tidal flushing is effective, much of this particulate matter along with dissolved nitrogen forms is washed out of the system resulting in good water clarity as seen in the greater secchi depth readings and lower chlorophyll levels in the basins nearest the tidal inlets, such as in Lagoon Pond (LGP-9, average secchi depth 3.52m) and the Edgartown Harbor / channel into Katama Bay (KAT-2, average Secchi depth 2.48m). Summary data is presented in Table 2 and Total Pigment concentrations are plotted in Figures 16a-16m. By comparison, in Chilmark Pond, which is only periodically opened to flushing with the Atlantic Ocean, average secchi depths were low across all the stations ranging from 0.68m to 1.70m and DON (63%) and PON (25%) accounted for almost all of the TN pool. The high proportion of TN as particulate and dissolved forms is consistent with the growth of phytoplankton, hence high Total Pigment concentrations (Chlorophyll a+Pheophytin a = 8.60 ug/L (range: 5.0-14.5 ug/L) averaged across all stations, 10 ug/L being indicative of impairment). Similarly, in Tisbury Great Pond which is also only seasonally opened to the Atlantic Ocean, average Secchi depths were also low across all the stations ranging from 0.63m to 1.31m and DON (46%) and PON (53%) accounted for almost all (99%) of the TN pool. The high proportion of TN as PON and DON is consistent with the high phytoplankton biomass as indicated by the Total Pigment concentrations (Chlorophyll a+Pheophytin a = 23.4 ug/L (range: 15.2-36.6 ug/L) average of all stations.

As part of the data analysis, the role of nitrogen as the nutrient to be targeted for management was confirmed by evaluating the molar ratio of bioavailable nitrogen and phosphorus. This ratio, also called the Redfield Ratio, gives a general assessment of nitrogen versus phosphorus as the critical nutrient of eutrophication (nutrient impairment). Values much less than 16 (<10) indicate nitrogen additions will stimulate plant growth and much greater than 16 (>22), that phosphorus may be the concern.

For almost all of the estuarine stations sampled in Martha's Vineyard estuaries in 2017, N/P values averaged 3 and were generally less than 6 and virtually always less than 8, indicating nitrogen is the nutrient to be managed. Only the periodically opened Edgartown Great Pond and Chilmark Pond showed periodic high N/P ratios indicating that phosphorus may also be of concern. This likely relates to the periodic openings to salt water exchange which has resulted in a freshening of these salt ponds, 18.9 PSU and 11.8 PSU, respectively. While these ponds still provide marine habitats, their lower tidal exchanges may be causing a need for additional phosphorus control (in addition to nitrogen). If this also occurs in 2018 monitoring it may be useful to conduct a more definitive analysis on N versus P stimulation of phytoplankton.

As a general rule, within each estuary, those basins that have more tidal flushing have higher water clarity, lower phytoplankton biomass and TN levels. This can be most clearly seen in Menemsha-Squibnocket Ponds, where the main basin of Menemsha Pond supports total chlorophyll a levels of ~4 ug/L and the tidally restricted tributary basin of Squibnocket Pond ~9 ug/L. The longer residence time of water in a basin allows for a greater buildup of nitrogen and for phytoplankton growth as seen in the high pigment levels. It is this lower flushing, higher residence time scenario that increases the sensitivity of these basins to nitrogen inputs compared to the adjacent higher flushed basins under similar nitrogen loading rates. This effect is seen in Total Pigment levels being lowest (3.0 - 7.0 ug/L) in well flushed systems across the Island, such as lower Lagoon Pond, Katama Bay, Cape Pogue Bay and Oak Bluffs Harbor (Table 2). These chlorophyll a levels are indicative of generally high water quality conditions and can be supportive of both eelgrass and benthic animal habitat. Where tidal flushing is more restricted as in Chilmark Pond, water clarity is relatively poor as shown by generally shallower Secchi Depth recordings and high total pigment concentrations, (2017: 8.6 - 23.4 ug/L, 2016: 4.27 - 24.16 ug/L, and also in Tisbury Great Pond (2017: 15.2 – 36.6 ug/L,Table 2). These chlorophyll a levels are indicative of nutrient enrichment and are generally associated with impairments to eelgrass and benthic animal communities, as was found by the MEP assessments. These general patterns are consistent with summer time results from across the estuaries of Martha's Vineyard in 2016 and 2017 as well as from other estuaries across Cape Cod and Nantucket. As such, the estuaries of Martha's Vineyard should continue to be monitored to be able to establish trends as towns across the island move into nutrient management to meet the MEP established nitrogen thresholds for restoration. The need for long-term monitoring is reinforced by the fact that in almost all estuaries sampled in 2016 and 2017, 2017 typically shows significantly higher total chlorophyll a levels. While this is likely the result of different meteorological and environmental conditions in 2017 (it effected multiple estuaries) determining the “typical” estuarine conditions requires multiple years of monitoring data collected in a uniform manner.

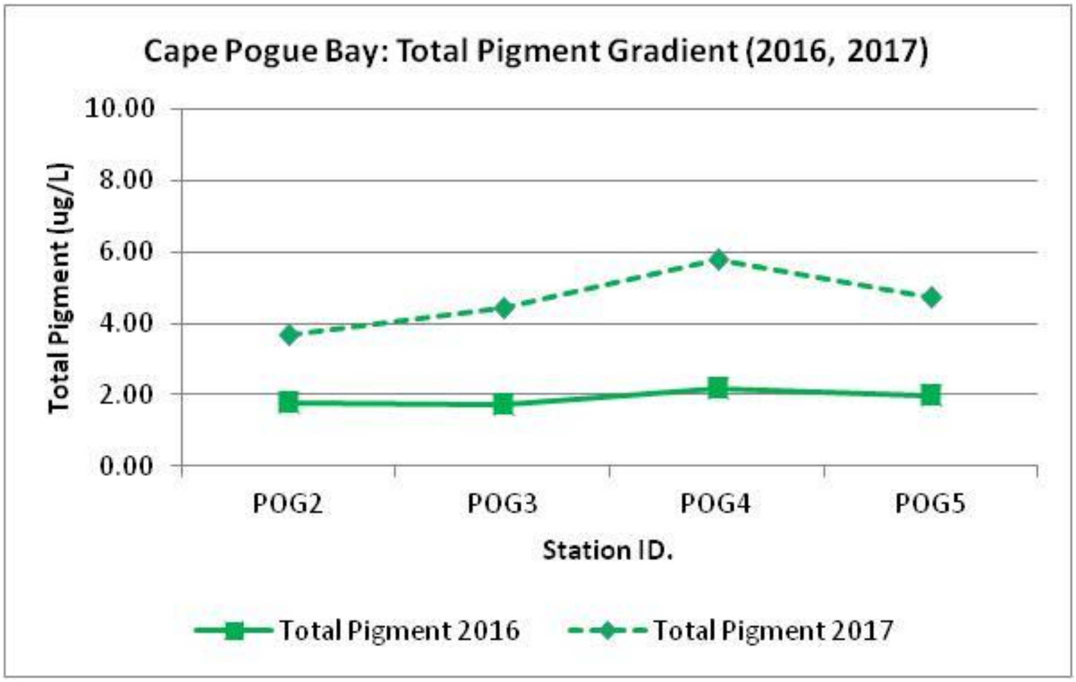


Figure 16a. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Cape Pogue Bay (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

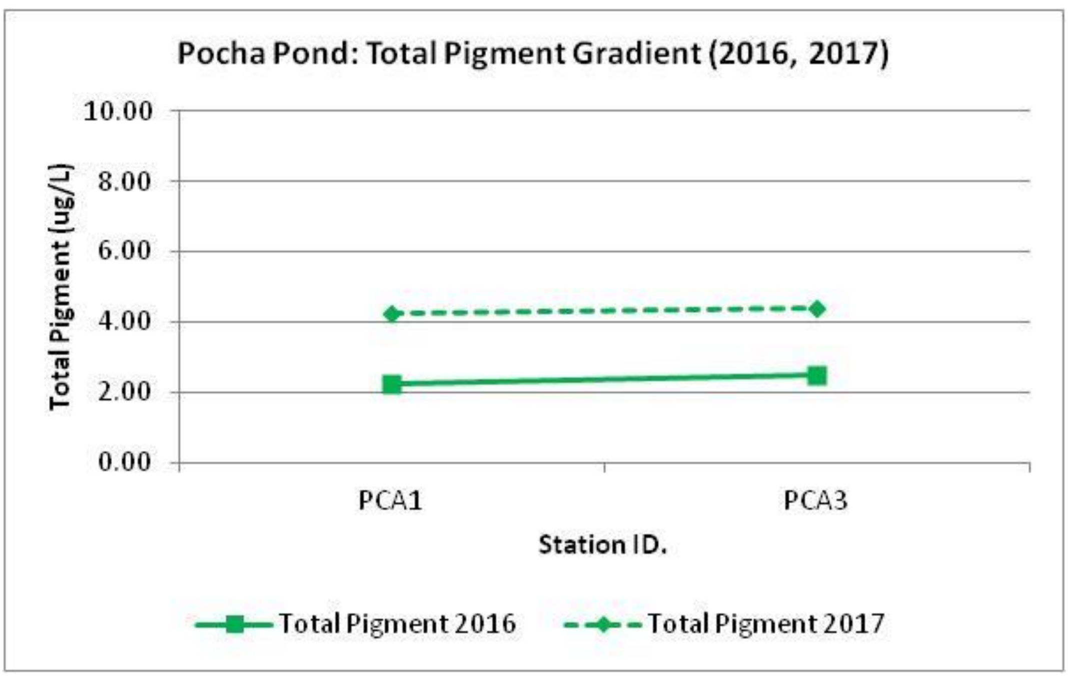


Figure 16b. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Pocha Pond (Summer 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

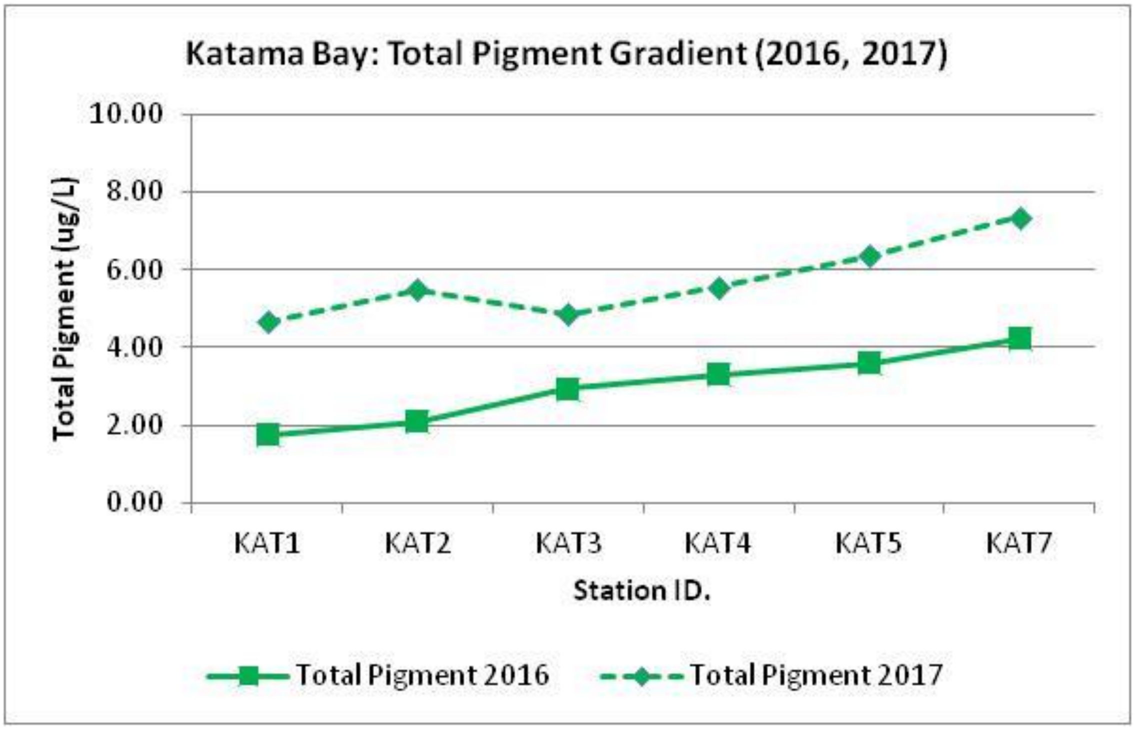


Figure 16c. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Katama Bay (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

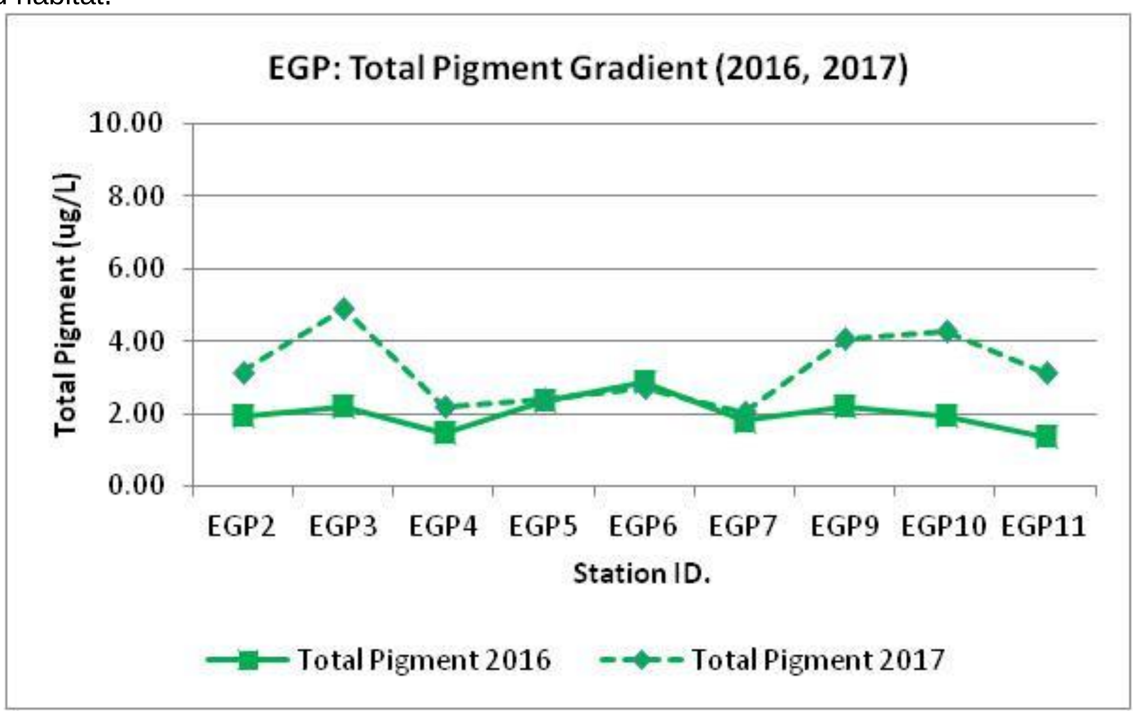


Figure 16d. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Edgartown Great Pond (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

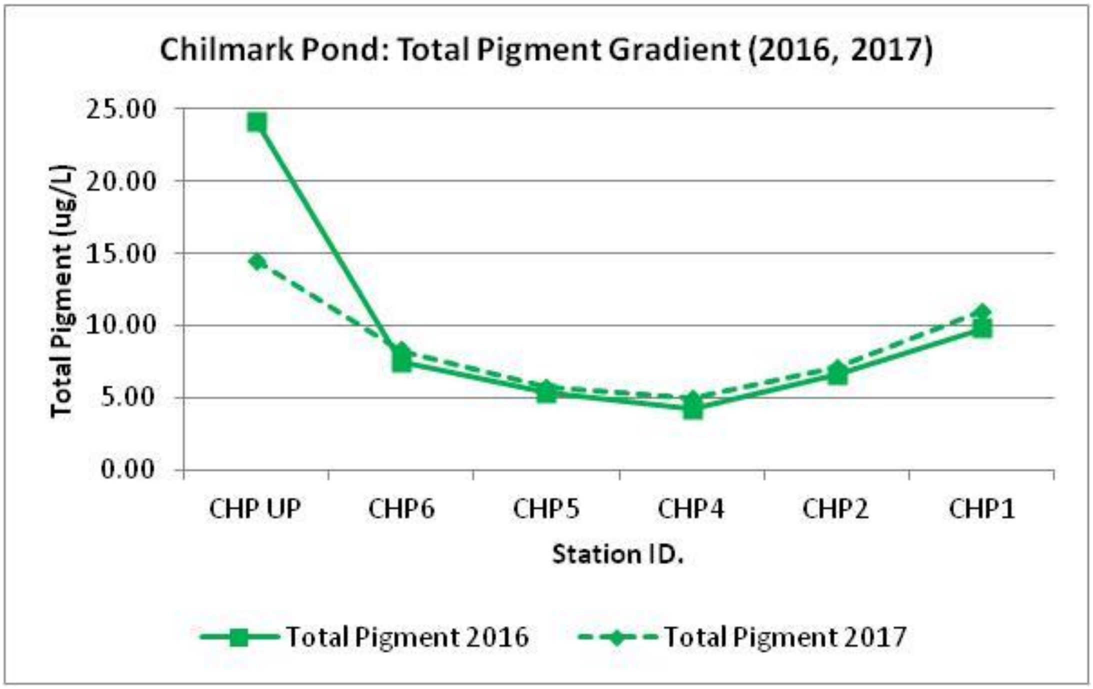


Figure 16e. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Chilmark Pond (Summer 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

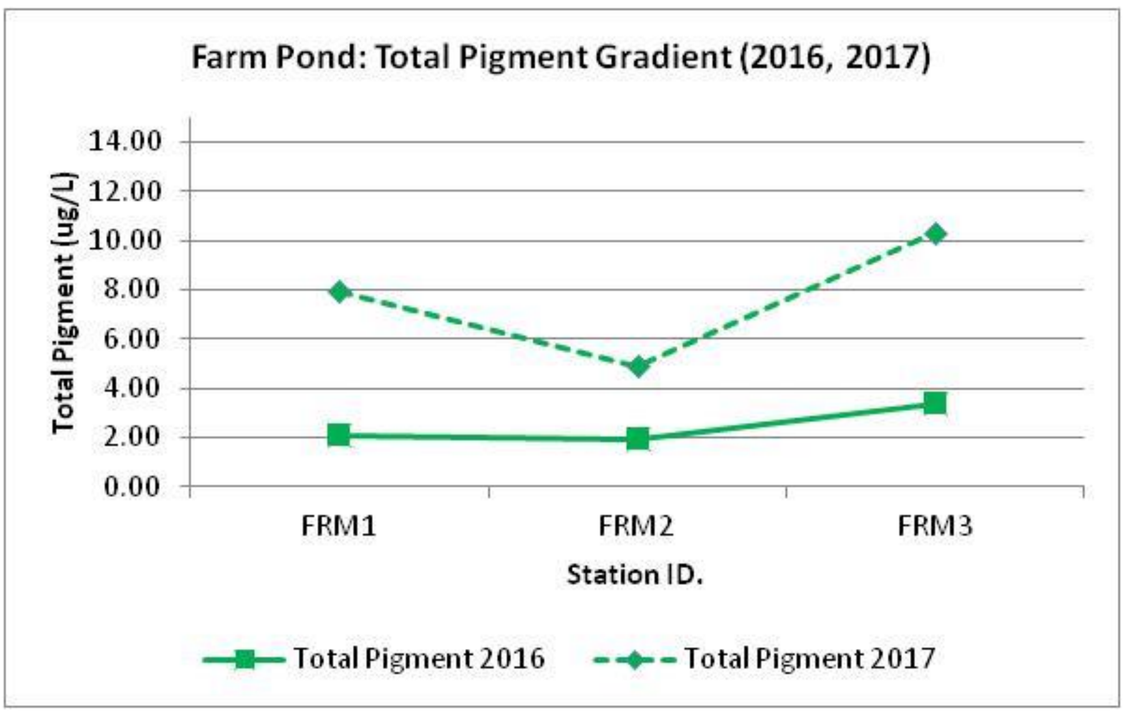


Figure 16f. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Farm Pond (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

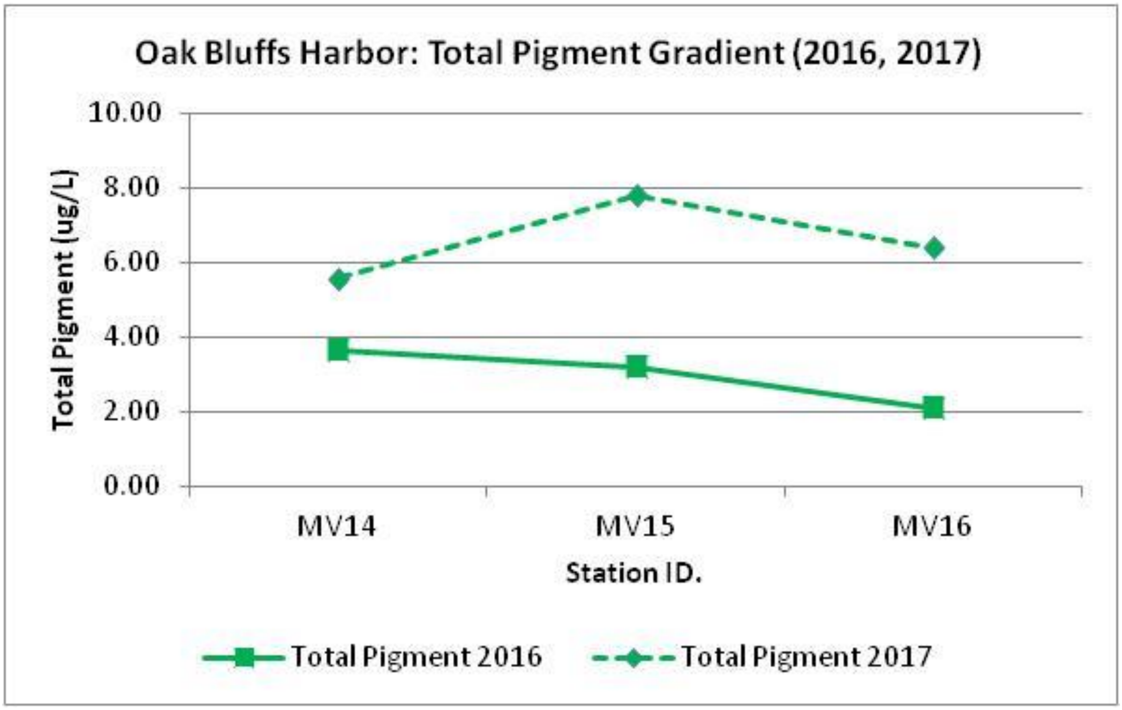


Figure 16g. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Oak Bluffs Harbor (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

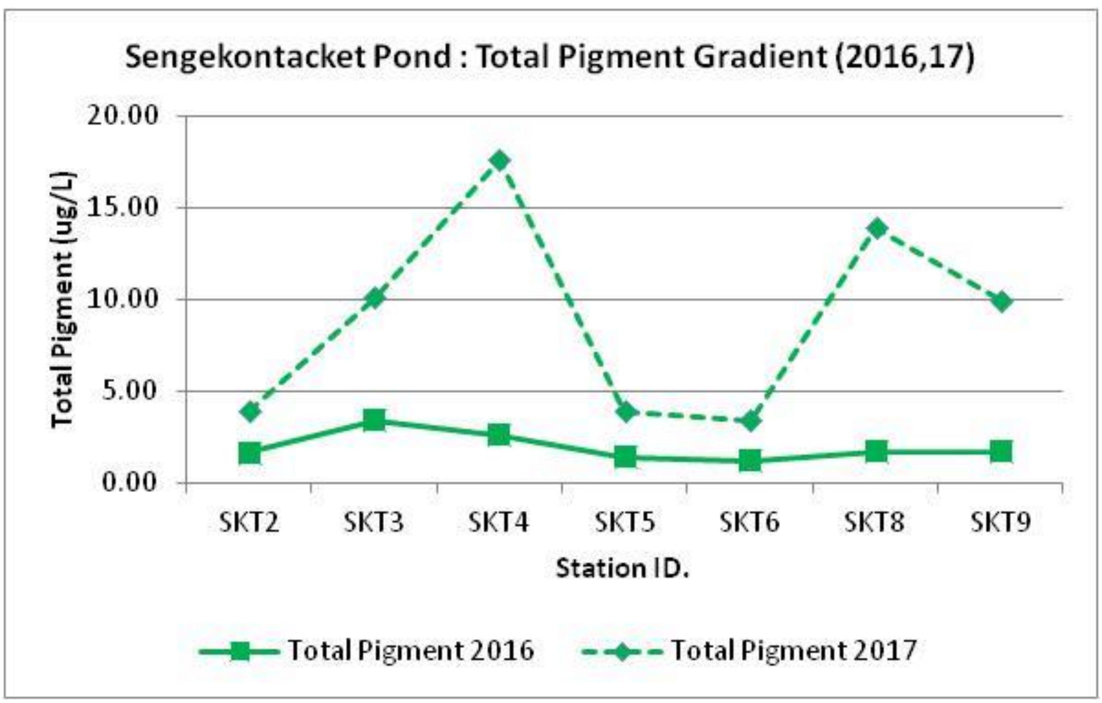


Figure 16h. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Sengekontacket Pond (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

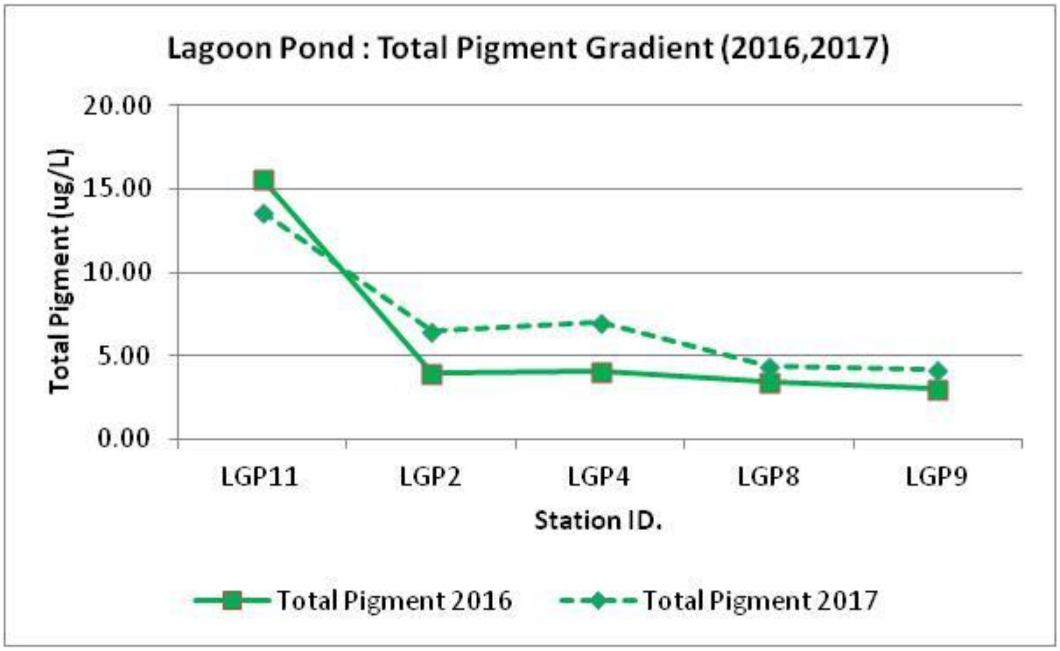


Figure 16i. Station averages of total pigment (chlorophyll a + pheophytin *a*) in Lagoon Pond (Summer 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

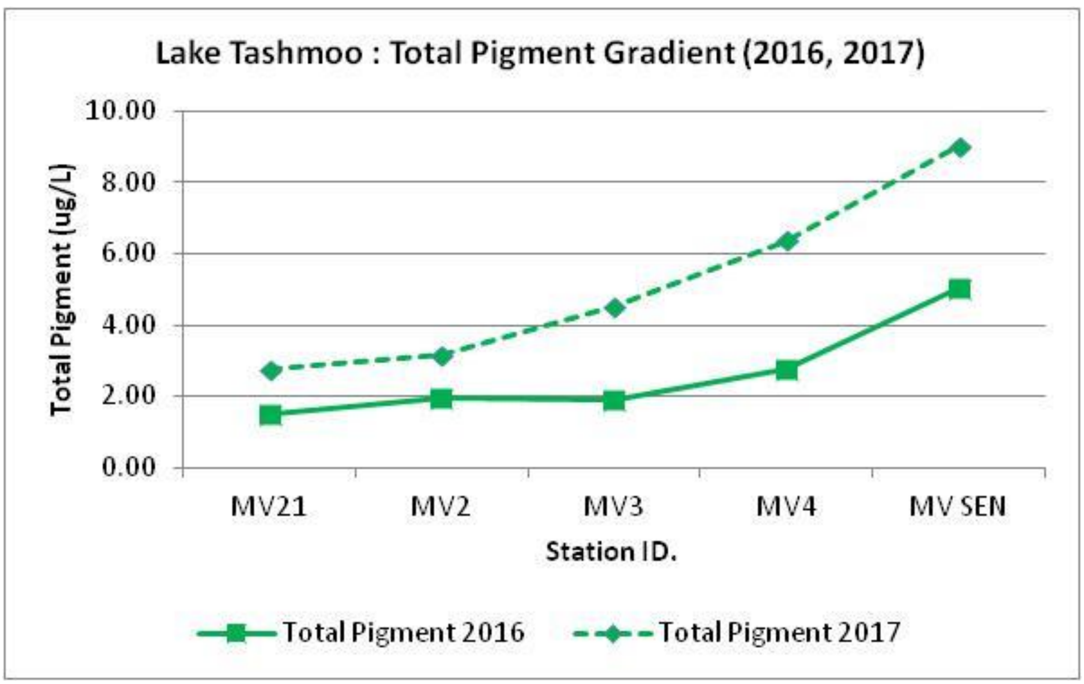


Figure 16j. Station averages of total pigment (chlorophyll a + pheophytin *a* in Lake Tashmoo (Summer 2016 and 2017 sampling season). Levels greater than 10 ug/L typically indicate impaired habitat.

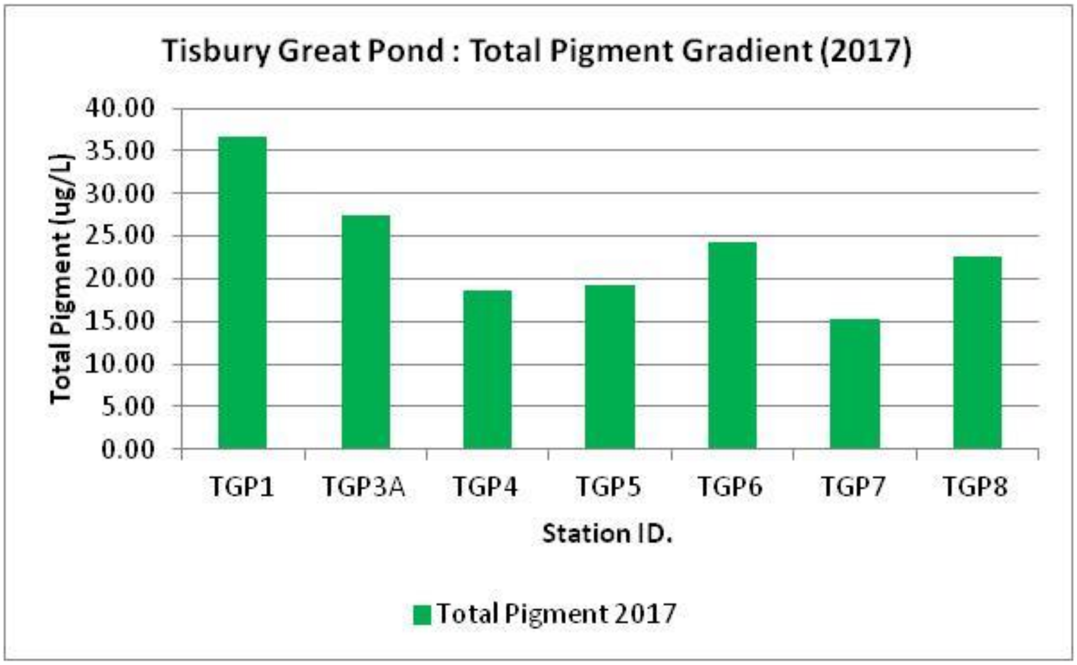


Figure 16k. Station averages of total pigment (chlorophyll a + pheophytin *a* in Tisbury Great Pond (sampling started in summer 2017). Levels greater than 10 ug/L typically indicate impaired habitat.

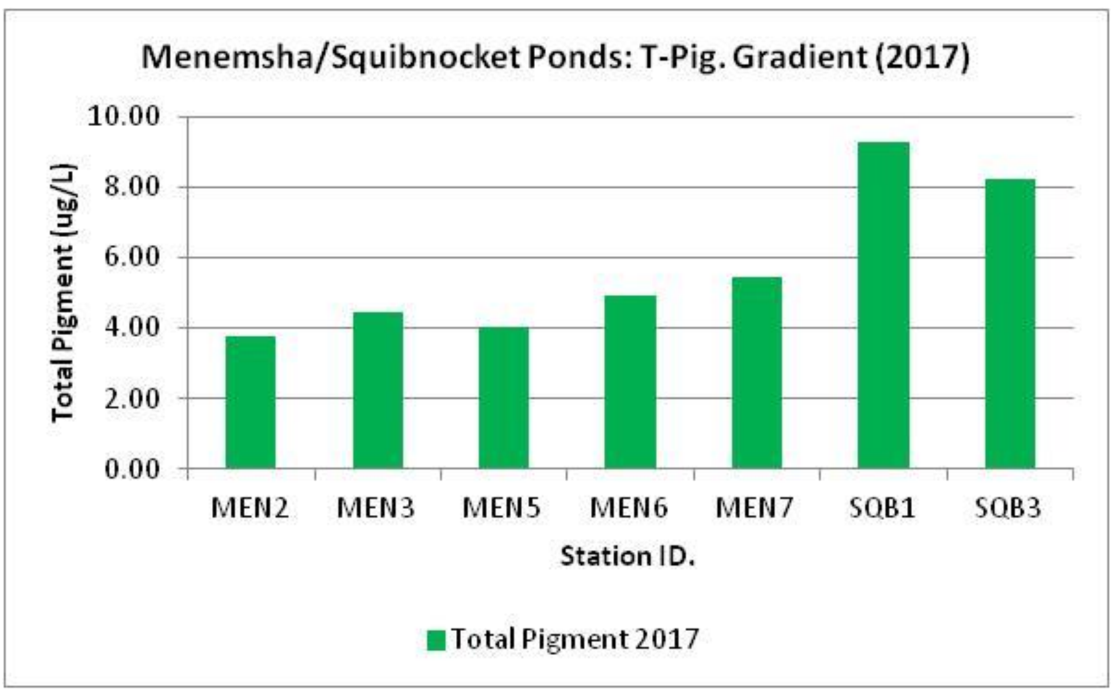


Figure 16L. Station averages of total pigment (chlorophyll a + pheophytin *a* in the Menemsha-Squibnocket Pond system (sampling started in summer 2017). Levels greater than 10 ug/L typically indicate impaired habitat.

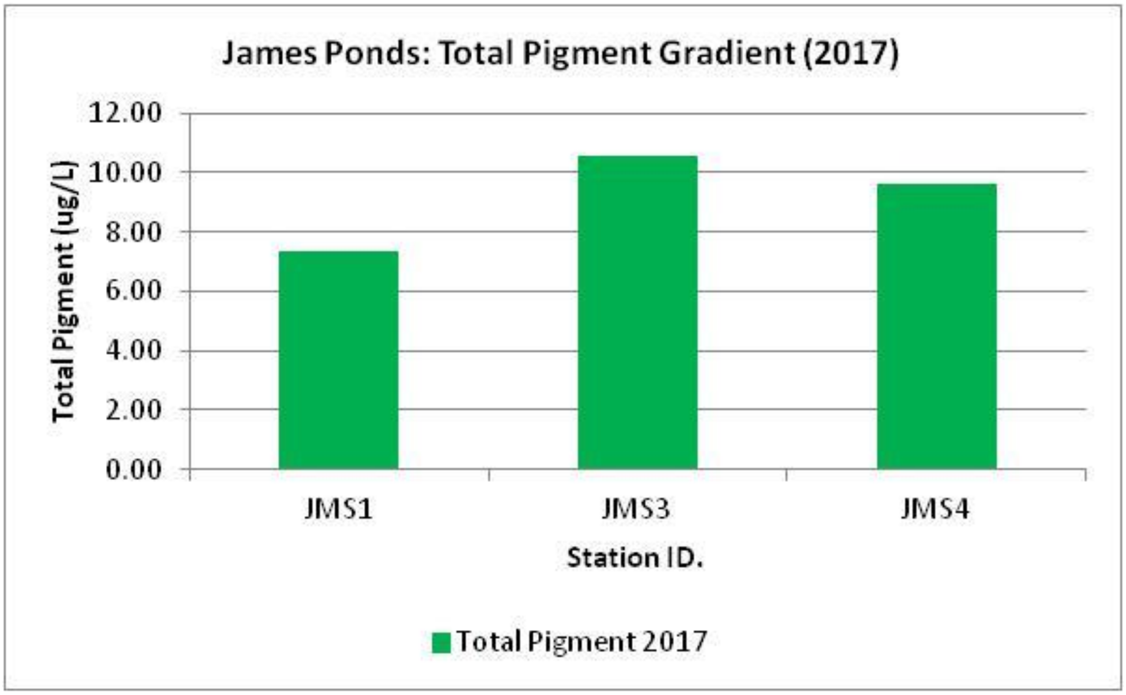


Figure 16M. Station averages of total pigment (chlorophyll a + pheophytin *a* in the James Pond system (sampling started in summer 2017). Levels greater than 10 ug/L typically indicate impaired habitat.

A general view of the status of each estuary can be derived from their average Total Nitrogen (TN) values. Averaging over entire estuaries is useful for comparing systems, but it should be noted that it ignores the nutrient gradients that occur within each system. In 2017 (2016 values in [ ]) for Martha's Vineyard estuaries that exchange tidal waters year round via a fixed inlet, TN levels were lower than tidally restricted and periodically opened basins. This is clearly apparent when the open basins of Lake Tashmoo 0.311 (mg/L) [0.359 mg/L], Lagoon Pond 0.332 mg/L [0.396 mg/L], Oak Bluffs Harbor 0.393 [0.397 mg/L], Katama Bay 0.363 mg/L [0.404 mg/L], Sengekontacket Pond 0.393 mg/L [0.430 mg/L], Pocha Pond 0.412 mg/L [0.449 mg/L], and Cape Pogue Bay 0.361 mg/L [0.458 mg/L], are compared to the restricted/closed basins of Farm Pond 0.512 mg/L [0.478 mg/L], Edgartown Great Pond 0.419 mg/L [0.522 mg/L], and James Pond 0.618 mg/L [not sampled in 2016]. As mentioned above, this “flushing effect” is very clear in Menemsha Pond 0.348 mg/L [not sampled in 2016] compared to its tributary tidally restricted Squibnocket Pond 0.768 mg/L [not sampled in 2016], which has very low watershed loading yet high TN.

By comparison, the average TN concentration in Chilmark Pond, which is only periodically open to flushing with Atlantic Ocean water when the barrier beach is breached, was 0.574 mg/L [0.927 mg/L]. In Tisbury Great Pond, also only periodically open to low nutrient ocean water, TN levels in 2017 were 0.780 mg/L [not sampled in 2016]. The significantly higher concentration of total nitrogen in Chilmark Pond and Tisbury Great pond compared to systems that exchange water with the ocean or sound suggests that the frequency and efficacy of the annual openings in these closed systems plays a major role in maintaining the ecological health of these great salt ponds. Moreover, the noticeably lower TN levels in Chilmark Pond (2017 vs. 2016) suggests that the efficacy of the opening in a given year is critical to subsequent summer water quality conditions. As such, monitoring the water quality in these closed systems as well as in tidally restricted systems such as Squibnocket Pond, Farm Pond and James Pond (small occluded culvert, TN level 0.618 mg/L) is critical for properly managing the nitrogen concentration at the MEP established sentinel stations. Additionally, as stated in 2016, the importance of effective openings for managing closed salt ponds such as Chilmark Pond and Tisbury Great Pond would warrant consideration of monitoring openings in a specific manner in order to develop pond specific criteria to guide the timing of the openings and the most favorable conditions for maximizing effectiveness (e.g. wind strength and direction, tidal conditions, pond water levels). To the extent that pond openings can be made more effective and nitrogen levels decline, other nitrogen management alternatives become less necessary.

Average TN levels in each of the estuaries are significantly higher than historical average TN values in the “offshore” or boundary stations such as MV6 located offshore from Lake Tashmoo (0.270), station offshore Pleasant Bay (0.232 mg/L) and station NTKS located in Nantucket Sound (0.290-0.294 mg/L). The higher observed levels within the estuaries compared to the offshore waters which enter on flood tide results from the nitrogen entering the waters of estuarine basins from the surrounding watershed. The level of TN increase depends largely on the rate of tidal exchange and the magnitude of the watershed loading. All TN values and plots are summarized and presented in Table 2a and Figure17.

In reviewing the 2017 and 2016 dissolved oxygen data, it does not appear that there is sufficient temporal sampling in two years of four summer time sampling events per year to capture the critical minimum oxygen levels. Therefore, while assessment of the oxygen levels in each estuary was performed (20% low DO, Table 2a), it will be necessary to conduct a multi-year composite analysis once sufficient data has been collected. It is also possible to strengthen the dissolved oxygen data base in specific estuarine basins, building on the monitoring results. We have made some recommendations which we have noted at the end of the discussion section.

Comparison of the 2017 data with historical MEP baseline: At all sites, historical TN levels were compared to 2017 and 2016 TN concentrations. The length of the historical water quality data record that was used as the baseline for the Massachusetts Estuaries Project (MEP) varied from 3-7 years. Historical data presented here are from the MEP Nitrogen Threshold Reports for: 1) Edgartown Great Pond, 2) Chilmark Pond, 3) Lake Tashmoo, 4) Lagoon Pond, 5) Oak Bluffs Harbor, 6) Farm Pond, 7) Sengekontacket Pond, 8) Tisbury Great Pond and 9) Menemsha Pond - Squibnocket Pond. It should be noted that Looks Pond is truly freshwater, salinity $\leq$0.05 PSU, and is located within the watershed to the James Pond system. Neither James Pond (estuarine) or Looks Pond (fresh) received specific analysis under the MEP. Fresh (Wiggies) Pond was sampled in 2016 but was not re-sampled in 2017.

Not all sites sampled historically were sampled in 2017 as the Island-wide water quality monitoring was designed specifically to meet the needs of compliance monitoring rather than establishing a water quality baseline for modeling as completed by the MEP. However, the vast majority of stations sampled in 2016 were re-sampled in 2017. Those stations that were sampled in 2017 are compared to both the 2016 data as well as the historical data provided in Tables 3 through 11. While Tisbury Great Pond was assessed under the MEP, water quality monitoring was not undertaken in 2016 due to limited funds, however, it was sampled in 2017. The Menemsha Pond and Squibnocket Pond system, evaluated in the summer of 2016 under the MEP for nitrogen threshold development was integrated into the Island-wide monitoring program for the summer of 2017. Cape Pogue Bay, Pocha Pond and Katama Bay are potentially to be evaluated by the MEP in the future and the 2017 and 2016 water quality data will be utilized in that assessment. James Pond is not presently slated for MEP analysis, however, it was integrated into the Island-wide water quality monitoring program for the summer 2017. Water quality data collected in James Pond will serve to extend any existing baseline data, which would subsequently be used by Coastal Systems Program scientists should the Town of West Tisbury want an MEP level assessment of the pond in the future.

Edgartown Great Pond: The 2017 and 2016 Edgartown Great Pond TN data generally compares well with historical data from the same sampling stations sampled by the MVC as part of the Island-wide Water Quality Monitoring Program (Figure 18, Table 3). Not all of the historical sites were sampled in 2017 or 2016, specifically EGP-1,8,A,B,C. In general, TN levels at all the stations sampled in 2017 were slightly lower than the previous year and 2016 levels were slightly lower than the station averages from 2003 to 2006. This steady lowering of TN levels has been anticipated as the historic high nitrogen groundwater plume from discharge at the previous WWTF has been flushing out, lowering its load to the pond. In addition, the Town of Edgartown has modified the pond opening protocol over the past decade to increase the volumetric exchange that occurs with each opening, resulting in lower post-breach nitrogen levels in pond waters. The 2017 TN concentrations ranged from 0.390 mg/L - 0.502 mg/L. In 2016 TN concentrations ranged from 0.469 mg/L - 0.552 mg/L whereas the historical TN data at the same stations ranged from 0.582 mg/L - 0.711 mg/L. The MEP TN threshold was set at 0.50 mg/L as an average of stations EGP- 2,3,5,6,9. The historical average TN concentration at the time the MEP analysis was completed for those 5 stations was 0.597 mg/L. Based on the 2017 and 2016 data, the average TN concentration for those same stations was 0.447 mg/L and 0.523 mg/L respectively, slightly lower than the threshold in 2017 and slightly above the 0.50 mg/L MEP threshold in 2016 but lower than it was historically. The lowering of TN is consistent with observations of water clarity, eelgrass coverage and shellfish production in this Great Pond. Given the inter-annual variability, monitoring should continue to confirm that levels have dropped below the MEP threshold. It may also be worthwhile to compare the duration of the openings in both 2017 and 2016 as that may indicate another reason for the lower levels in 2017 and underscore the importance of maintaining effective pond openings.

Chilmark Pond: The 2017 Chilmark Pond TN data appears to have dropped compared to the 2016 data which generally showed an increase in Total Nitrogen concentration compared to the levels previously documented from the same sampling stations sampled by the MVC as part of establishing the water quality baseline for the Massachusetts Estuaries Project. The MEP baseline was based on data from 2004 (Figure 19, Table 4). TN levels in 2017 were lower than in 2016 across all the stations whereas 2016 levels at all the stations sampled were high compared to the nitrogen threshold developed by the MEP. The 2017 TN concentrations ranged from 0.533 mg/L - 0.642 mg/L. The 2016 TN concentrations ranged from 0.797 mg/L - 1.096 mg/L, higher than the 0.704-0.808 mg/L range found in the historic data. Both data sets are significantly higher than the MEP TN threshold of 0.50 mg/L as an average of stations CHP-1,2,4,5, needed for restoration of pond habitats. This can be seen more clearly in the average TN concentration for those same stations historically (0.744 mg/L, 2004), in 2016 (0.877 mg/L) and in 2017 (0.588 mg/L). The high levels of TN in Chilmark Pond above the MEP threshold are consistent with the elevated levels of total pigment observed during the summer 2016 water quality monitoring, however, as TN levels dropped in 2017, this resulted in a noticeable drop in total pigment, particularly at station CHP-UP. While it is not possible to confirm a trend with only the 2016 and 2017 data, Chilmark Pond must be closely observed as the monitoring program continues to determine if nitrogen levels are increasing due to increased inputs or reduced flushing or decreasing due strictly to better openings. As with other closed salt ponds on Martha's Vineyard, it would be useful to compare the difference in the duration of openings undertaken in both 2016 and 2017 to ascertain the degree to which that may be driving the lower TN levels observed in 2017.

Lake Tashmoo: The 2017 Lake Tashmoo TN data generally compares well (albeit slightly lower) with historical data and the 2016 from the same sampling stations sampled by the MVC as part of the Island-wide Water Quality Monitoring Program (Figure 20, Table 5). As in 2016, not all of the historical sites were sampled in 2017, specifically MV-1 and MV-5. In general, TN levels in 2017 and 2016 at all the stations sampled were nearly the same (+/-) than the station averages from 2001 to 2007. The TN concentrations in 2017 ranged from 0.258 mg/L - 0.362 mg/L. In 2016 the TN concentrations ranged from 0.273 mg/L - 0.355 mg/L whereas the historical TN data at the same stations ranged from 0.314 mg/L - 0.360 mg/L. The lowest TN concentration observed in 2017 (0.258 mg/L) and 2016 (0.273 mg/L) was at station MV- 21 closest to the inlet of the system and was slightly lower than the historical average at that station (0.314 mg/L) as determined by the MEP. It is not possible based on two year to determine if this is “real” or not, but in any case it does not reflect any substantive positive shift in the habitat health of the basin (0.258, 0.273 and 0.314 mg/L all indicate high quality waters at MV-21). The MEP TN threshold was set at 0.36 mg/L at a sentinel station (MV- SEN) to be located between MV-4 and MV-5. As this is a new station sampled for the first time in 2016 there is no historical data at this location. Based on the 2017 and 2016 data, the average TN concentration for the MEP established sentinel location is 0.362 mg/L and 0.482 mg/L respectively, 2017 level being only slightly above the 0.360 mg/L MEP threshold and indicative of the need to stay focused on some nitrogen management while also monitoring levels to see if they really remain at the threshold level in years to come. The TN concentrations observed at MV-SEN in 2017 and 2016 are consistent with the higher total pigment concentrations measured at that location compared to lower levels at stations closer to the inlet. The stations that had lower TN concentrations, total pigment levels were commensurately lower. Interestingly, while TN levels across all stations were nearly the same as in 2016, total pigment levels in 2017 were slightly higher than in 2016, possibly due to meteorological differences from one summer to the next. While still below the 10 ug/L threshold for moderate impairment, monitoring should continue to determine if there is a trend over multiple years.

Lagoon Pond: The 2017 and 2016 Lagoon Pond TN data generally compares well with historical data from the same sampling stations (Figure 21, Table 6), however, the 2017 observations do appear lower than both the 2016 TN levels as well as the average of the historical data (2002-2007). Not all of the historical sites were sampled in 2017 (LGP-6,10 excluded) or 2016, specifically LGP-10. In general, TN levels in 2017 were all slightly lower than in 2016 and in 2016 at all the stations sampled TN levels were nearly the same (+/-) as station averages from 2002 to 2007. In 2016, TN concentrations at 3 out of 5 stations sampled (LGP-2,4,8) were slightly higher than the historical averages and slightly lower at 2 of 5 stations (LGP-6,9). The 2017 TN data ranged from 0.295 mg/L - 0.360 mg/L whereas the 2016 TN concentrations ranged from 0.317 mg/L - 0.460 mg/L and the historical TN data at the same stations ranged from 0.333 mg/L - 0.418 mg/L. The lowest TN concentration observed in 2017 (0.295 mg/L) and 2016 (0.317 mg/L) was at station LGP-9 closest to the inlet of the system and was slightly lower than the historical average at that station (0.333 mg/L) as determined by the MEP. The MEP TN threshold was set at 0.35 mg/L at the sentinel station (LGP-2). Based on the 2017 and 2016 data, the average TN concentration for the MEP established sentinel location was 0.346 mg/L and 0.432 mg/L respectively, above the 0.35 mg/L MEP threshold in 2016 but the same as the threshold in 2017. The MEP determined historical average for station LGP-2 was 0.360 mg/L indicating that TN concentrations still need to be carefully monitored and managed in this system as the 2017 are very close to the historical long term average. As such inter-annual variability may result in TN levels being above/below the threshold and the historical average in a given year. Even though TN levels were slightly lower in 2017 compared to 2016, Total pigment levels in 2017 were nearly the same as in 2016. As in 2016, in the lower tidal reaches (LGP-8,9) total pigment was generally low (4.34 ug/L and 4.21 ug/L respectively) with the exception of observed total pigment levels at LGP-11 (2017, 13.63 ug/L) and 12 which were between 15 ug/L and 17 ug/L in 2016, well over 10 ug/L which is a typical threshold for sign of impairment. LGP-12 was not sampled in 2017. Uppermost stations continue to show the effects of nitrogen enrichment.

Oak Bluffs Harbor: Like the 2016 Oak Bluffs Harbor TN data, the 2017 data generally compares well with both the 2016 data and the historical data from the same sampling stations sampled by the MVC as part of the Island-wide Water Quality Monitoring Program (Figure 22, Table 7). Not all of the historical sites were sampled in 2016 or 2017, specifically MV-17. In general, TN levels in 2017 and 2016 at all the stations sampled were nearly the same (+/-) as station averages from 2001 to 2007. In 2017, TN concentrations were slightly higher at all stations compared to MEP historical data whereas in 2016, TN concentrations were slightly higher than the historical average at 2 of the 3 stations sampled (MV-14,15) and slightly lower at 1 of 3 stations (MV-16). The 2017 TN concentrations ranged from 0.342 mg/L - 0.431 mg/L and in 2016 TN concentrations ranged from 0.306 mg/L - 0.463 mg/L compared to the historical TN data at the same stations which ranged from 0.325 mg/L - 0.392 mg/L. The lowest TN concentration observed in 2017 (0.342 mg/L) and 2016 (0.306 mg/L) was at station MV-16 closest to the inlet of the system and was slightly higher in 2017 but slightly lower in 2016 than (but not significantly different from) the historical average at that station (0.325 mg/L) as determined by the MEP. The MEP TN threshold was set at <0.45 mg/L at the sentinel station (MV-14 in Sunset Lake). Based on the 2017 data, the summer time average TN level at MV-14 was 0.431 mg/L and based on the 2016 data, the average TN concentration for the MEP established sentinel location was 0.463 mg/L, slightly below in 2017 and slightly above the 0.45 mg/L MEP threshold in 2016. The MEP determined historical average for station MV-14 was 0.392 mg/L suggesting that TN concentrations may have increased above historical levels and fluctuate around the threshold level therefore, they still need to be managed in this system. This station will be the focus of trend analysis as more data becomes available. It is not clear if the increase, if “real”, is the result of occlusion of the tidal channel or an increase in nitrogen inputs.

Farm Pond: The 2017 and 2016 Farm Pond TN data generally compares well with historical data from the same sampling stations sampled by the MVC as part of the Island-wide Water Quality Monitoring Program (Figure 23, Table 8). All of the historical sites have been included in the island-wide program and were sampled in both 2017 and 2016. In general, TN levels in 2017 where slightly lower than historical levels with the exception of station FRM-3 which was slightly higher and 2016 data at the stations sampled were nearly the same or slightly lower than the station averages from 2002 to 2008. In 2017, TN concentrations were slightly lower than the historical average at 2 out of 3 stations sampled (FRM-1,2) and slightly higher at 1 of 3 stations (FRM-3, MEP sentinel station). The 2017 TN concentrations ranged from 0.430 mg/L - 0.610 mg/L compared to the 2016 TN concentrations which ranged from 0.427 mg/L - 0.544 mg/L whereas the historical TN data at the same stations ranged from 0.505 mg/L - 0.530 mg/L. The lowest TN concentration observed in 2017 (0.430 mg/L) was at station FRM-2 (close to inlet) whereas in 2016 (0.427 mg/L) it was at station FRM-1 located at the end of the pond and also close to the inlet of the system and was slightly lower than the historical average at that station (FRM-1, 0.516 mg/L, FRM-2, 0.505 mg/L) as determined by the MEP. The MEP TN threshold was set at 0.45 mg/L at the sentinel station (FRM- 3). Based on the 2017 and 2016 data, the average TN concentration for the MEP established sentinel location is 0.610 mg/L and 0.544 mg/L respectively and remains significantly above the 0.45 mg/L MEP threshold. The MEP determined historical average TN concentration for station FRM-3 was 0.530 mg/L indicating that TN concentrations in 2016 and 2017 were higher than the historical average and therefore nitrogen management is still needed in this system. The higher TN concentration observed at FRM-3 in 2017 is consistent with the slightly higher total pigment concentrations measured across the pond in 2017, however, it should be noted that as in 2016, total pigment in 2017 was generally low and consistent with the observed TN concentrations. However, in 2017 at FRM-3, T-pigment levels approached the 10 ug/L threshold indicative of impaired water quality.

Sengekontacket Pond: As in 2016, the 2017 Sengekontacket Pond TN data generally compares well with historical data from the same sampling stations sampled by the MVC as part of the Island-wide Water Quality Monitoring Program (Figure 24, Table 9). Most of the historical sites were sampled in both 2017 and 2016 with the exception of SKT-1 and SKT-7. In general, TN levels in 2017 generally were similar to historical levels with the exception of two stations (SKT-4 and 9) that were higher. In 2016 TN levels at the stations sampled were generally higher than station averages from 2003 to 2009. In 2016, TN concentrations were higher than the historical average at 6 out of 7 stations (SKT-2,3,4,5,8,9) and in 2017 in only 2 of 7 stations (SKT-4 and SKT-9). The 2017 TN concentrations ranged from 0.256 mg/L - 0.518 mg/L whereas in 2016 TN concentrations ranged from 0.427 mg/L - 0.544 mg/L and the historical TN data at the same stations ranged from 0.299 mg/L - 0.545 mg/L. The lowest TN concentration observed in 2017 and 2016 was at station SKT-6 located closest to the inlet of the system and was lower or the same as the historical average at that station (0.256 mg/L and 0.299 mg/L respectively vs. 0.302 mg/L) as determined by the MEP. The MEP TN threshold was set at 0.35 mg/L at the sentinel stations (SKT-4 and SKT-9). Based on the 2017 and [2016] data, the average TN concentration at the MEP established sentinel locations was 0.518 mg/L [0.437 mg/L] and 0.521 mg/L [0.509 mg/L] respectively, well above the 0.35 mg/L MEP threshold. The MEP determined historical average TN concentrations for stations SKT- 4 and SKT-9 were 0.406 mg/L and 0.445 mg/L respectively, indicating that TN concentrations in 2017 and 2016 were higher than historically and therefore still need to be managed in this system. The levels at these two stations in 2017 were higher compared to data from 2016 indicating inter-annual variability that must be accounted for by continuing to sample consistently across all the stations previously sampled in 2016 and 2017. The higher TN concentration observed at SKT-4 in 2016 and 2017 is consistent with the slightly higher total pigment concentrations measured at SKT-4 and SKT-3 (both associated with Majors Cove), however, it should be noted that total pigment was generally low and consistent with the TN concentrations measured in 2016 but in 2017, total pigment levels were significantly higher, potentially due to higher TN levels in 2017, and exceeded the standard 10 ug/L threshold indicating continuing (and possibly increasing) impairment of water quality. As such it is critical to continue monitoring nutrient related water quality in this estuary.

Tisbury Great Pond: The 2017 Tisbury Great Pond TN data collected by the MVC Island-wide Water Quality Monitoring Program generally exceeded the historical data from the same sampling stations used by the MEP (Figure 25, Table 10). Not all of the historical sites were sampled in 2017, specifically TGP-2,3,and 9. Unfortunately, Tisbury Great Pond was not sampled in 2016 so the 2017 data can only be compared to the historical averages established by the MEP (1995-2007 and 2011). The 2017 TN concentrations ranged from 0.950 mg/L - 0.706 mg/L whereas the historical TN data at the same stations ranged from 0.422 mg/L - 0.785 mg/L. The lowest TN concentrations observed in 2017 (0.706 mg/L and 0.712 mg/L) were at station TGP-4 located just south of the confluence between Town Cove and Pear Tree Cove and TGP-7 closest to the periodically opened inlet of the system. TN levels at both of these stations were ~0.2 mg/L higher than the long term historical average at the same stations (0.528 mg/Land 0.509 mg/L respectively) as determined by the MEP. It is not possible based on one year to determine if this represents a “real” change in the system or merely reflects a specific year of opening success. However, it does indicate that high TN levels can periodically occur in the Pond (very likely due to the duration of the periodic opening to the Atlantic Ocean). The MEP TN threshold was set at 0.46 mg/L at a sentinel station (average of TGP-4,5,6) and 0.48 mg/L at a secondary station TGP-7. Based on the 2017 data, the average TN concentration for the MEP established "sentinel" location (average of TGP- 4,5,6) is 0.752 mg/L, well above the 0.46 mg/L MEP threshold. Average 2017 TN concentrations at station TGP-7 was 0.712 mg/L, also above the 0.48 mg/L threshold at this secondary sentinel station. All of these results are consistent and clearly indicate the need for a combination of nitrogen management and more effective openings for habitat restoration. The higher TN concentrations observed at all stations supported the high total pigment concentrations measured at each monitoring location in 2017. The role of nitrogen in stimulating phytoplankton biomass is also seen in the observation from stations that had lower TN concentrations (TGP-4,5,7) also having commensurately lower total pigment levels. Additional monitoring data will be required before accurate trend analysis can be conducted for this system.

Menemsha Pond and Squibnocket Pond: The 2017 Menemsha Pond and Squibnocket Pond TN data from the MVC Island-wide Water Quality Monitoring Program is directly comparable to the historical data set from the same stations used in the MEP (Figure 26, Table 11). Not all of the historical sites were sampled in 2017, specifically MEN-1,4,7,8,9,10 and SQB-2,4. Unfortunately, Menemsha / Squibnocket Ponds were not sampled in 2016 so only the 2017 data can be compared to the historical averages established by the MEP (2000 - 2012). None-the-less the 2017 TN concentrations for the main basin of Menemsha Pond were not significantly different from the historical data (2017 = 0.288-0.311 mg TN/L; historic = 0.287-0.338 mg TN/L). Squibnocket Pond also showed little change from historic TN levels (2017 = 0.754-0.783 mg TN/L; historic = 0.763-0.769 mg TN/L). However, the 2017 results do indicate a potential increase in TN in Nashaquitsa Pond (2017 = 0.405 mg/L; historic data = 0.341 mg/L)., which the MEP had identified as having declining water quality. It may be that this increase is the result of a reduction in tidal flows between Menemsha main basin and Nashaquitsa Pond or possibly a localized increase in N load. The lowest TN concentrations observed in 2017 (0.288 mg/L and 0.301 mg/L) were at station MEN-2 located just inside the inlet to Menemsha Harbor and MEN-3 located just inside the main basin of Menemsha Pond where Menemsha Channel enters the main basin funneling low nutrient water from Vineyard Sound into the overall system. TN levels at both of these stations were ~0.08 mg/L lower than the long term historical average at the same stations (0.341 mg/L and 0.385 mg/L respectively) as determined by the MEP. However, this difference is at the limit of detection and is only based on 1 year of MVC monitoring so additional data will be needed to determine if it is a new condition (e.g. increased tidal exchange possibly) or merely natural inter-annual variation.

In Menemsha Pond, the MEP TN threshold was set at 0.35 mg/L for eelgrass restoration at an integrated sentinel station (average of MEN-4,5,8,9,10) and in Squibnocket Pond the threshold was set at 0.50 mg/L for restoration of benthic animal habitat (average of SQB-1,2,3,4). A direct comparison of the 2017 data to the MEP threshold for Menemsha Pond and Squibnocket Pond is not possible because specific stations that comprise the averages were not sampled. Sampling of all stations included in the TMDL threshold in Menemsha Pond for eelgrass should be considered for 2018 as resources allow. It does appear that sampling only 2 stations in Squibnocket Pond instead of the 4 sentinel stations (SQB 1-4) is appropriate, as TN levels remain well above the TMDL threshold. As found throughout the MVC Island-Wide Monitoring effort, phytoplankton levels were found to vary directly with TN levels. By example the relatively low TN levels in Menemsha Pond are consistent with the low total pigment observations (3.76 ug/L - 5.45 ug/L) and in Squibnocket Pond, the higher TN levels are in line with the higher observed total pigment levels (8.23 ug/L - 9.28 ug/L). The elevated TN and total pigment levels in Squibnocket Pond are clear indication of the need for a combination of nitrogen management and more effective flushing through the culvert connecting Squibnocket Pond to Menemsha Pond. Total pigment levels or chlorophyll-a levels that exceed the standard 10 ug/L threshold generally indicates impairment of water quality. As such it is critical to continue monitoring nutrient related water quality in this estuary.

James Pond: As of this date, MEP assessment, modeling and nutrient threshold analysis to sustain or restore key estuarine habitats within James Pond has not been conducted. As such, there is limited information available as a point of comparison for the water quality monitoring data collected during the summer 2017 field season. As historical monitoring data becomes available, those data can be integrated into future water quality summary reports generated annually as part of the Island-wide Water Quality Monitoring Program. Nevertheless, the 2017 TN concentrations in James Pond can be compared to other estuaries on Martha’s Vineyard that have undergone full threshold analysis. In 2017 TN levels in James Pond ranged from 0.556 mg/L - 0.729 mg/L, with the lowest TN concentrations found in the mid to upper portions of the Pond at stations JMS-4 (0.556 mg/L) and JMS-3 (0.570 mg/L), respectively. Unlike many estuaries assessed across the region, the highest TN levels in James Pond were in the lower pond closest to the inlet to the system where low nutrient water is exchange with each tide. The extent that this pattern in water quality is due to the basin circulation which shoals to the east of the inlet (0.25 m) compared to the main basin (0.9 m) will be examined in coming years. The moderate TN levels in the main basin in 2017 are consistent with the moderate to high total pigment concentrations measured at each monitoring location (7.37 ug/L - 10.55 ug/L) and indicate a moderate level of impairment is likely in this system. Total pigment levels or chlorophyll-a levels that exceed the standard 10 ug/L threshold generally indicates impairment of water quality. As such it is critical to continue monitoring nutrient related water quality in this estuary and if the 2017 observations are sustained, then conducting MEP higher level habitat surveys should be considered.

Trophic State of the Estuaries of Martha's Vineyard (2017)

The Trophic State of an estuary is a quantitative indicator of its nutrient related ecological health and is based on concentrations of Nitrogen, Secchi Depth, lowest measured concentrations of Dissolved Oxygen (average of lowest 20% of measurements), and Chlorophyll-*a* pigments (surrogate for phytoplankton biomass). Trophic health scales generally range from Oligotrophic (healthy-low nutrient) to Mesotrophic (showing signs of deterioration of health due to nutrient enrichment) to Eutrophic (unhealthy, deteriorated condition, high nutrient, large phytoplankton blooms, oxygen depletion). The Trophic Health Index Score used here is a basic numerical scale based on criteria for open water embayments and uses the above mentioned measured parameters to create a habitat quality scale (Howes et al. 1999, http://www.savebuzzardsbay.org). For the estuaries of Martha's Vineyard, a trophic index score was calculated for each sampling location for each sampling year, (2017, Table 12; 2016, Table 13). It is important to understand that the Index is useful as a guide and provides a simple way to integrate the multiple parameters related to nutrient related habitat health, but it is not comprehensive. For example in estuaries, such as those on Martha's Vineyard, there are only periodic depletions in bottom water dissolved oxygen, generally related to nutrient enrichment coupled with periodic meteorological events. While these short-term depletions have important ecological consequences, they are difficult to capture in programs that sample 4 or 5 dates per summer. Therefore, there is always some uncertainty in the Index until several years of data are available. However, in the almost 100 estuaries where this Index has been used, it has been good in determining general nutrient related health and has been very useful in prioritizing systems for more detailed analysis (e.g. continuous DO recorders, benthic animal surveys, etc). It should be noted that the issue primarily relates to the key habitat metric of dissolved oxygen, as the other water quality parameters do not change as rapidly as dissolved oxygen, which can vary 10 mg/L in a single day. Therefore, the MVC monitoring program should be accurately capturing estuarine nutrient and phytoplankton levels. It should be noted that as more oxygen data from the monitoring program is available, the Index becomes more robust, as has been found in MEP analyses of Cape Cod estuaries. Based upon the available results it is possible to assess the nutrient related health of the basins within each of the 14 estuarine systems included in the Martha's Vineyard Island-wide Water Quality Monitoring Program for 2017.

The Health Status of each site was based on the Health Index Score, which is determined from the numeric data collected during the sampling events (Tables 1c and 2a). The ranges of Index scores that fall within a particular Health Status determination are given at the bottom of Table 12. Figures 27-38 show the distribution of Health Status throughout each estuary based on the 2017 monitoring program results. The colors of each triangle in the figures represent the Bay Health Index status of its site (upper triangle reflective of 2016 conditions, lower triangle reflective of 2017 conditions) and follow the designation scheme below:

Color	Health Status
Blue	High Quality
Blue/Yellow	High-Moderate
Yellow	Moderate
Yellow/Red	Moderate/Fair
Red	Fair/Poor

Edgartown Great Pond: During summers of 2016 and 2017 Edgartown Great Pond supported relatively high water quality (High/Moderate) throughout all of its basins, with slightly lower (Moderate) water quality in only 1 tributary basin, Turkeyland Cove in 2016 (Figure 25). While a pair of years is not diagnostic, of the 9 stations sampled, 5 showed changes between the years, with 4 of 5 showing slight improvements in 2017 compared to 2016. It is important to note that by 2017 5 of 9 stations were supporting high water quality with the remainder with high-moderate water quality. Most of the high water quality was found in the more open water portions of the estuary.

Edgartown Great Pond appears to currently have only modest nutrient related impairments and is maintaining some high quality estuarine habitat. Throughout this salt pond, the Index was lowered primarily by water clarity, nitrogen level and degree of oxygen depletion. The relative uniformity of the status indicators is frequently seen in large salt ponds which only have periodic connection to offshore waters (e.g. no regular tidal exchange). In these settings salt ponds become similar to fresh ponds with mixing and circulation mainly through wind driven water movements rather than tidal currents. The result is that water quality indicators become relatively uniform throughout the basin except if there are narrow enclosed tributary basins where groundwater and surface water carrying watershed derived nutrients enter. This is the case in Edgartown Great Pond where the existing modest impairment is seen primarily in the tributary basins. This contrasts with tidal estuaries where watershed inputs are typically entering mainly in the inland most reaches with twice a day entry of high quality marine waters through the tidal inlet. This structure sets up water quality gradients within the estuary, typically with poor water quality in the inner tidal reaches grading to high water quality near the tidal inlet.

At present, it appears from the Health Index results that the periodic tidal breaching of the barrier beach to create periodic tidal exchange is sustaining high-moderate water quality throughout Edgartown Great Pond. It is likely that this also is the result of the decline in the historic nitrogen load from the now decommissioned WWTF. The current level of water quality is improved over that observed during the MEP assessment which was at TN levels >0.1 mg TN/L higher. If monitoring over the next few years continues to find these results, it may be appropriate to conduct a more detailed habitat evaluation relative to the Clean Water Act TMDL.

Chilmark Pond: The MVC Island-Wide Water Quality Monitoring Program supported a status assessment of Chilmark Pond based on the 2016 and 2017 results. The integrated Health Index indicates that nutrient related water quality throughout Chilmark Pond (including the western most tributary basin) is impaired based on its moderate to poor summertime water quality (Figure 26). Key parameters (water clarity, nitrogen levels, oxygen depletion and phytoplankton biomass) are all consistent with a nutrient enriched basin, with poor clarity, periodic oxygen depletions and high phytoplankton biomass. As noted for Edgartown Great Pond, Chilmark Pond has relatively uniform water quality due to its only periodic tidal exchange. Although the general moderate-poor Health Status of Chilmark Pond basins has not changed significantly based on the metrics, the TN levels varied significantly from 2016 to 2017, showing much higher summertime TN levels throughout the pond in 2016. This difference is almost certainly the result of the success of the pond opening in the 2 years, as watershed loading has not declined. However, given that the levels in TN and associated water quality metrics have indicated impairment to key habitats within the pond in the historic surveys, 2016 and 2017, it appears that nitrogen management remains necessary to restore this salt pond. However, since 2017 supported the highest water quality on record, it is likely that continued efforts to improve the quality of the openings should yield significant improvements should a refined and focused opening protocol coupled to estuarine response in Chilmark Pond be implemented.

Lake Tashmoo: Lake Tashmoo is a classic simple estuary with a single tidal inlet, a linear basin to inland headwaters. As such it has highest quality waters near the tidal inlet with a slight decline in quality to the head water station (MVSEN, Figure 27). Lake Tashmoo was found to be moderately impaired by nitrogen in the MEP analysis, based mainly on declines in eelgrass coverage and benthic animal communities, with some periodic DO depletions. The present analysis of water quality parameters is consistent with the MEP water quality assessment. There remains a modest nitrogen enrichment and some oxygen decline, but generally good water clarity and low phytoplankton biomass compared to other estuaries (e.g. Cape Cod and Buzzards Bay). These latter parameters are supporting the eelgrass beds that remain in the system. Eelgrass is typically associated with the highest quality waters and estuarine habitat, but as the coverage is declining and showing signs of stress (e.g. significant epiphytic growth), it appears that nitrogen is just above its threshold level, as was confirmed in the 2016 and 2017 TN measurements.

During summers of 2016 and 2017 Lake Tashmoo supported high water quality throughout its mid and lower basins, with slightly lower (High/Moderate) water quality in the upper basin, which contains the MEP sentinel station (Figure 27). TN levels in the upper basin in 2017 were approaching the systems TN threshold, although still exceeded it. Multiple years of high water quality need to be observed before it is clear if the system has restored its water quality and at present the near threshold values observed in 2017 fall in the range of natural variation for this system. However, Heath Status of the basins of Lake Tashmoo will be tracked closely as the MVC Water Quality Monitoring Program continues.

Lagoon Pond: Lagoon Pond, like Lake Tashmoo, is a classic simple estuary with a single tidal inlet, a relatively linear basin to inland headwaters. Lagoon Pond has a single headwater "stream" and pond with a direct discharge to the uppermost estuarine reach. As such its highest quality waters are near the tidal inlet, with a slight decline in quality to the head water station (LGP-6 Figure 30). The innermost shallow region of South End Basin is highly nitrogen enriched (LGP-11 and LGP-12) with low oxygen and phytoplankton blooms, in a restricted area with limited flushing. The deeper waters in the upper pond, nitrogen loading and flushing differences result in the entire upper pond showing slight nutrient related impairment (i.e. High-Moderate water quality). Similarly, Lagoon Pond was found to be impaired by nitrogen in the MEP analysis, based mainly on declines in eelgrass coverage and benthic animal communities, with some periodic DO depletions. The present analysis of water quality parameters is consistent with the MEP water quality assessment. Except for the innermost region of South End Basin, Lagoon Pond currently supports only moderate impaired water quality, consistent with its remaining eelgrass areas and benthic animal communities. The water quality impairment is primarily due to modest nitrogen enrichment and periodic oxygen declines, but generally good water clarity and low phytoplankton biomass compared to other estuaries (e.g. Cape Cod and Buzzards Bay). These latter parameters are supporting the eelgrass beds that remain in the system. Eelgrass is typically associated with the highest quality waters and estuarine habitat, but as the coverage is declining, it appears that nitrogen levels remain above the threshold level for high quality estuarine habitat, in the 2016 and 2017 TN measurements. The observed inter-annual variation underscores the need for multi-year monitoring to assess “real” changes in water and habitat quality.

Oak Bluffs Harbor: Oak Bluffs Harbor is a heavily altered coastal salt pond that has an engineered tidal inlet, which supports twice daily tidal exchange with the high quality waters of Vineyard Sound. The system consists of a main basin with a smaller basin (Sunset Lake) connected through a culvert. Given its small size and tidal exchange the main basin supports relatively high and uniform water quality, while enclosed tributary basin of Sunset Lake is showing some nutrient related impairment (Figure 31). The Sunset Lake moderate water quality (impairment) results from its elevated nitrogen levels, reduced water clarity and periodic oxygen depletion. Oak Bluffs Harbor was also found to be impaired by nitrogen in the MEP analysis, based mainly on declines in eelgrass coverage and benthic animal communities, with some periodic DO depletions. The present analysis of water quality parameters is consistent with the MEP water quality assessment. Sunset Lake is likely being impacted both by its local sub-watershed and it hydrodynamics, but a specific analysis needs to confirm if altering the tidal flows would be sufficient for its restoration. However, given its function as a harbor and its structure the main basin is currently supporting high water quality with some benthic animal impairment possibly due mainly to its structure and use. Although 2 years of data is insufficient to accurately determine water quality trends, it appears that TN levels are higher in 2016 and 2017 and overall water quality was slightly lower than observed historically (2001-20017). It will take more results to confirm that the trend is not due merely to inter-annual variations. An analysis of changes in N loading and tidal flushing should be considered if the 2018 monitoring data is consistent with the results from 2016 and 2017. In any case, Oak Bluffs Harbor and Sunset Lake continue to support generally moderately impaired water quality.

Farm Pond: Farm Pond is a heavily altered coastal salt pond currently with a tidally restricted inlet. Coastal processes have damaged the culvert and it is slated to be replaced. The MEP determined that properly restoring tidal exchange with a new culver/channel structure would be sufficient to restore Farm Pond water and habitat quality, without additional actions. The 2016 and 2017 water quality is similar to that assessed by the MEP. Due to the reduced tidal exchange, Farm Pond water quality parameters (Figure 32) are relatively uniformly distributed, with only a slightly higher quality waters in the upper basin near the restricted tidal culvert (i.e. it is operating like Chilmark Pond or Edgartown Great Pond). Water quality is presently moderate being impaired by elevated nitrogen levels with associated periodic oxygen declines and reduced clarity. The restored monitoring in 2016 and 2017 will provide an excellent baseline for assessing restoration success related to the future installation of the new tidal inlet. Both the 2016 and 2017 monitoring results underscore the continuing need for restoration of tidal exchange to this system, as it remains significantly above its nitrogen threshold level.

Sengekontacket Pond: Sengekontacket Pond is a coastal lagoon formed behind a barrier beach with 2 engineered tidal inlets that are periodically dredged to maintain tidal exchange with Nantucket Sound. Water quality within the Sengekontacket Pond System is heterogeneous, with high quality waters throughout the main basin and lower quality waters in its tributary basins. The main tributary basin of Majors Cove is less well flushed than the main basin, with resulting slightly lower water quality due to nitrogen enrichment, lower water clarity and periodic oxygen depletion. The other major tributary basin, Trapps Pond, shows a greater reduction in water quality, being more nitrogen enriched, with lower clarity and greater oxygen depletion than Majors Cove (Figure 33, (SKT-9). The Trapps Pond monitoring station is located at the tidal culvert between the main basin and Trapps Pond and is only monitored on the ebbing tide so that Trapps Pond waters are being evaluated. However, it is likely that water from the uppermost tidal reach in this tributary basin is of even lower quality than the measured outflowing water. It appears that the impaired water and habitat quality within Trapps Pond is due to its restricted tidal exchange, which is inadequate to maintain low TN levels with its present watershed nitrogen loading. While most of the Sengekontacket Pond estuary is supporting high water quality, the tributaries of Major's Cove and Trapps Pond continue to show moderate nitrogen related impairments. Data from the 2016 and 2017 monitoring effort showed higher TN levels than historically in both basins and a lower health status in 2017 than 2016. Only continued monitoring will determine conditions are truly declining, but the available data are a cause for concern.

Katama Bay: Katama Bay is functionally a large enclosed basin with a single tidal inlet. However, it is periodically altered by coastal processes that open a tidal inlet to the Atlantic Ocean through the southern barrier beach, such as happened within the last decade. As such the pond's tidal flushing can vary significantly between a 1 and 2 inlet system. During the 2016 monitoring effort, Katama Bay supported generally high quality waters throughout, with only the innermost region near the barrier beach showing only slightly lower quality waters (Figure 34). However, in 2017 all of the stations within the main basin were showing slightly higher TN levels and lower water quality than 2016, and slight water quality impairment. This slight impairment was due to lower clarity associated with elevated phytoplankton biomass and nitrogen and some oxygen depletion. The cause of this impairment is most likely associated with tidal flushing (possibly slight decline of flushing), the location being furthest from the entry of high quality water through the inlet coupled to nitrogen inputs from the western shore of the basin.

Cape Pogue Bay-Pocha Pond: One of the largest estuaries in the region is the Cape Pogue Bay-Pocha Pond System. This estuary has a single natural tidal inlet and tributary basins. The main basin and nearest the tidal inlet is Cape Pogue Bay. This basin has a small tributary basin to the east (Shear Pen Pond), which is a tidally connected salt pond and a large tributary basin to the south (Pocha Pond) which is a large basin connected through a long tidal channel. It appears that the basin was formed by coastal processes building a large barrier beach system to enclose the basin based on the geomorphology. Water quality within this large estuary appears to be primarily based on the physical structure and tidal exchange, primarily related to distance from the tidal inlet. Watershed nitrogen loading plays only a background role in this system. Overall there are high quality waters throughout the main basin (Cape Pogue Bay) and only slightly lower quality waters in the tributary basins (Figure 35-36). The main basin generally has low nitrogen and phytoplankton levels with high clarity and only modest oxygen depletions, in contrast the tributary basin of Shear Pen Pond, has slightly elevated nitrogen and modest oxygen depletions. These conditions in salt ponds, like Shear Pen Pond, is typically associated with low tidal exchange. Nitrogen can become elevated for 2 reasons, (1) high nitrogen inputs, (2) low rates of output (e.g. flushing). To date the inlet to Shear Pen Pond has not been evaluated for any restrictions or occlusion, which would address this issue. The major tributary basin of Pocha Pond is generally showing high water quality in both 2016 and 2017 with some slight impairment due to elevated nitrogen and periodic oxygen depletion in its lower tidal reaches, although at lower levels than Shear Pen Pond. However, it appears that water quality in both tributary basins is determined primarily by the amount of tidal exchange. Fortunately, the overall water quality of Cape Pogue Pond and Pocha Pond basins is currently relatively high.

Recommendations for Future Monitoring

Due to the critical importance of dissolved oxygen to the ecological health of an estuarine basin, specific locations may need additional data in coming years to support more quantitative analysis for restoration. The few stations selected should collect high frequency data using automated sensors. This is only needed when the low frequency sampling of the monitoring program suggests that a problem may exist in a specific basin. At this point, the assessment of Lagoon Pond upper, Lake Tashmoo sentinel basin and Majors Cove would likely be improved (less uncertainty) by conducting this analysis at some time in the future. However, procedural steps should also be implemented to strengthen the oxygen data base from the on-going monitoring program. Specifically, continue doing Winkler Titrations on water samples where meter readings of D.O. are < 5mg/L. Winkler titration is a more accurate and precise method for quantifying dissolved oxygen concentrations. This prevents future decisions from being misled by oxygen meter data that was erroneously low due to a problem during field collection.

While more data is needed for developing many restoration alternatives for implementation and ascertaining trends of water quality conditions as estuaries are managed, the 2016 and 2017 Monitoring Program data sets has brought forward a positive action that can serve as a solid base for future adaptive management strategies. As mentioned in 2016 and supported by the 2017 data, for the salt ponds that are only periodically breached to allow temporary tidal exchange it appears that an analysis of present opening protocols coupled to estuarine response may provide a means to achieve partial improvement in the short term. While opening analysis was performed for salt ponds during the Massachusetts Estuaries Project, it was not possible to determine the effectiveness through follow on changes in water quality. Of particular note are Edgartown Great Pond where there appears to be a long-term trend to greatly improved water quality and Chilmark Pond which has highly variable water quality from year to year apparently due to opening success (at this point Tisbury Great Pond was only monitored in 2017). A recommendation to leverage the monitoring results is to track the opening efforts of the various groups conducting the openings and as possible collect a few samples at strategic times that capture the “opening success”. Over time this will allow a data based evolution of the opening protocols to maximize their positive impacts on the ponds. CSP should be consulted in advance of collecting samples around openings and closings of beach breaches to insure the validity of the sampling.

In addition, for specific systems such as Menemsha Pond / Squibnocket Pond and Tisbury Great Pond whose MEP nitrogen thresholds are based on an average of water quality data from multiple stations, it is critical that the Island-wide water quality monitoring program collect samples from each station comprising the average. Otherwise it will not be possible to correctly determine if the MEP threshold is being attained. However, the additional stations should be undertaken in basins that are approaching their threshold nitrogen values. For example in Menemsha Pond additional stations should be considered for 2018, but not in Squibnocket Pond as it remains well above its target TN value.

Similarly, it appears from the water quality analysis that some basins are currently supporting high water quality, near their TDML levels. It is reasonable to begin planning for targeted data collection on benthic habitat and review of eelgrass distributions to evaluate if habitat is also improving and if the systems are close to restoration.

Embayment	Sample ID	Secchi average (meters)	Secchi Depth % of WC	20% Low DO (mg/L)	20% Low DO (% Sat.)	Salinity (ppt)	Avg. PO4 (mg/L)	Avg. NH4 (mg/L)	Avg. Nox (mg/L)	Avg. DIN (mg/L)	Avg. DON (mg/L)	Avg. TDN (mg/L)	Avg. POC (mg/L)	Avg. PON (mg/L)	Avg. TON (mg/L)	Avg. TN (mg/L)	Avg. Chla (ug/L)	Avg. Phaeo (ug/L)	Chla/Phaeo Ratio	Avg. Total Pig (ug/L)
CAPE POGUE BAY	POG2	3.20	61%	5.40	76%	30.9	0.013	0.011	0.004	0.014	0.242	0.256	0.336	0.060	0.301	0.315	2.65	1.01	0.71	3.66
CAPE POGUE BAY	POG3	2.31	78%	5.23	68%	30.9	0.015	0.021	0.004	0.026	0.302	0.327	0.387	0.069	0.371	0.397	3.01	1.42	0.66	4.43
CAPE POGUE BAY	POG4	2.52	75%	4.93	70%	30.9	0.012	0.013	0.004	0.017	0.298	0.315	0.464	0.084	0.382	0.399	3.68	2.09	0.64	5.76
CAPE POGUE BAY	POG5	1.91	91%	4.62	66%	30.6	0.012	0.026	0.006	0.032	0.221	0.253	0.443	0.081	0.302	0.335	2.84	1.87	0.60	4.71
POCHA POND	PCA1	1.59	80%	4.56	65%	30.4	0.013	0.030	0.006	0.036	0.300	0.336	0.487	0.085	0.385	0.422	2.81	1.42	0.63	4.22
POCHA POND	PCA3	1.57	96%	4.78	62%	30.2	0.009	0.025	0.005	0.029	0.293	0.323	0.447	0.081	0.374	0.403	3.06	1.31	0.67	4.37
KATAMA BAY	KAT1	2.69	33%	5.37	72%	30.9	0.016	0.021	0.005	0.026	0.218	0.244	0.347	0.060	0.278	0.304	3.09	1.57	0.67	4.66
KATAMA BAY	KAT2	2.48	53%	5.23	68%	30.6	0.021	0.025	0.007	0.032	0.261	0.293	0.415	0.076	0.337	0.369	3.87	1.59	0.68	5.47
KATAMA BAY	KAT3	2.25	33%	5.17	70%	30.4	0.021	0.025	0.007	0.031	0.264	0.296	0.387	0.071	0.335	0.367	3.21	1.62	0.65	4.84
KATAMA BAY	KAT4	2.54	28%	5.27	68%	30.3	0.025	0.026	0.009	0.034	0.250	0.284	0.442	0.084	0.334	0.368	4.00	1.55	0.70	5.55
KATAMA BAY	KAT5	1.91	86%	5.29	74%	30.4	0.029	0.026	0.006	0.032	0.249	0.280	0.461	0.089	0.338	0.370	4.67	1.68	0.72	6.35
KATAMA BAY	KAT7	1.18	97%	5.14	68%	30.1	0.022	0.022	0.005	0.026	0.258	0.284	0.572	0.114	0.372	0.398	5.61	1.73	0.72	7.35
EDGARTOWN GREAT POND	EGP2	2.59	92%	5.40	70%	19.0	0.003	0.024	0.007	0.031	0.323	0.354	0.480	0.087	0.410	0.441	2.63	0.52	0.79	3.15
EDGARTOWN GREAT POND	EGP3	2.50	72%	5.74	75%	19.5	0.002	0.022	0.006	0.028	0.330	0.359	0.644	0.119	0.449	0.477	4.31	0.57	0.89	4.88
EDGARTOWN GREAT POND	EGP4	2.11	100%	4.94	68%	18.7	0.002	0.023	0.018	0.040	0.277	0.318	0.416	0.073	0.350	0.390	1.65	0.55	0.74	2.20
EDGARTOWN GREAT POND	EGP5	2.26	95%	5.31	68%	19.2	0.002	0.034	0.008	0.041	0.377	0.418	0.454	0.084	0.461	0.502	1.90	0.49	0.77	2.39
EDGARTOWN GREAT POND	EGP6	2.24	96%	5.76	74%	19.3	0.002	0.017	0.007	0.024	0.278	0.302	0.500	0.092	0.370	0.394	2.18	0.54	0.78	2.72
EDGARTOWN GREAT POND	EGP7	2.61	96%	5.08	69%	19.4	0.002	0.025	0.007	0.032	0.263	0.295	0.430	0.072	0.336	0.368	1.58	0.43	0.78	2.01
EDGARTOWN GREAT POND	EGP9	1.99	95%	4.55	63%	17.4	0.002	0.044	0.008	0.031	0.268	0.299	0.614	0.117	0.390	0.421	3.23	0.84	0.81	4.07
EDGARTOWN GREAT POND	EGP10	1.79	93%	4.89	68%	18.9	0.002	0.025	0.008	0.033	0.262	0.295	0.663	0.127	0.389	0.422	3.50	0.77	0.81	4.27
EDGARTOWN GREAT POND	EGP11	1.26	100%	5.42	68%	18.7	0.002	0.029	0.009	0.038	0.236	0.274	0.456	0.083	0.318	0.356	2.49	0.65	0.79	3.14
CHILMARK POND	CHP UP	1.23	79%	7.21	85%	0.4	0.020	0.013	0.007	0.020	0.377	0.396	1.008	0.160	0.537	0.556	5.54	8.93	0.47	14.47
CHILMARK POND	CHP6	0.68	100%	5.04	57%	9.5	0.005	0.047	0.018	0.065	0.330	0.394	0.883	0.140	0.469	0.534	5.56	2.74	0.64	8.30
CHILMARK POND	CHP5	1.70	86%	5.63	69%	12.4	0.002	0.071	0.026	0.097	0.369	0.466	0.734	0.112	0.481	0.578	2.78	2.97	0.51	5.75
CHILMARK POND	CHP4	1.45	93%	5.44	68%	12.7	0.002	0.049	0.021	0.070	0.376	0.446	0.535	0.086	0.462	0.533	2.96	2.01	0.58	4.97
CHILMARK POND	CHP2	1.56	63%	5.94	74%	12.5	0.004	0.074	0.032	0.106	0.366	0.471	0.827	0.127	0.493	0.598	4.18	2.91	0.59	7.09
CHILMARK POND	CHP1	1.14	74%	5.02	63%	12.1	0.002	0.041	0.022	0.063	0.345	0.408	1.360	0.234	0.579	0.642	9.19	1.84	0.77	11.04
OAK BLUFFS HARBOR/SUNSET LAKE	MV14	0.72	100%	4.63	63%	29.3	0.010	0.024	0.043	0.067	0.260	0.328	0.605	0.103	0.364	0.431	3.75	1.81	0.67	5.56
OAK BLUFFS HARBOR/SUNSET LAKE	MV15	1.57	100%	5.10	71%	30.6	0.012	0.017	0.011	0.028	0.260	0.288	0.625	0.120	0.380	0.408	5.86	1.95	0.73	7.81
OAK BLUFFS HARBOR/SUNSET LAKE	MV16	2.91	81%	5.16	71%	30.8	0.011	0.017	0.005	0.022	0.232	0.254	0.505	0.088	0.320	0.342	4.83	1.54	0.71	6.37
FARM POND	FRM1	0.85	100%	4.31	60%	29.7	0.008	0.014	0.008	0.021	0.355	0.377	0.686	0.120	0.475	0.496	6.12	1.78	0.68	7.90
FARM POND	FRM2	0.87	100%	4.05	58%	29.8	0.008	0.020	0.004	0.024	0.301	0.325	0.626	0.104	0.405	0.430	3.78	1.09	0.69	4.87
FARM POND	FRM3	1.11	100%	3.30	47%	29.5	0.013	0.022	0.002	0.024	0.383	0.407	1.126	0.202	0.585	0.610	8.69	1.64	0.80	10.32
SENGEKONTACKET POND	SKT2	1.69	100%	4.96	69%	30.7	0.012	0.006	0.003	0.010	0.221	0.231	0.474	0.082	0.303	0.313	2.85	0.99	0.74	3.84
SENGEKONTACKET POND	SKT3	2.09	76%	4.64	64%	30.2	0.012	0.003	0.003	0.006	0.266	0.272	0.981	0.164	0.430	0.437	8.22	1.84	0.87	10.06
SENGEKONTACKET POND	SKT4	1.22	97%	5.19	73%	29.9	0.013	0.004	0.002	0.006	0.265	0.271	1.450	0.247	0.512	0.518	16.21	1.40	0.89	17.62
SENGEKONTACKET POND	SKT5	2.38	94%	5.44	75%	30.9	0.012	0.011	0.002	0.013	0.217	0.230	0.365	0.061	0.278	0.291	3.01	0.88	0.73	3.88
SENGEKONTACKET POND	SKT6	2.28	100%	4.84	67%	30.9	0.012	0.005	0.003	0.008	0.173	0.181	0.410	0.075	0.248	0.256	2.63	0.73	0.75	3.36
SENGEKONTACKET POND	SKT8	1.76	99%	4.59	65%	30.5	0.007	0.008	0.004	0.012	0.222	0.234	1.123	0.179	0.400	0.412	13.46	0.46	0.91	13.92
SENGEKONTACKET POND	SKT9	0.86	100%	4.28	61%	29.1	0.009	0.006	0.002	0.008	0.367	0.375	0.977	0.146	0.513	0.521	9.04	0.88	0.80	9.93
LOOKS POND	LOOK4	0.50	100%	10.22	112%	0.2	0.040	0.003	0.013	0.016	0.305	0.321	0.808	0.078	0.328	0.338	2.29	3.84	0.36	6.13
LAGOON POND	LGP11	1.42	100%	4.50	62%	23.7	0.007	0.034	0.443	0.477	0.304	0.781	1.338	0.249	0.553	1.030	11.16	2.47	0.76	13.63
LAGOON POND	LGP2	2.94	35%	3.24	43%	30.2	0.011	0.004	0.004	0.009	0.226	0.235	0.657	0.111	0.337	0.346	5.00	1.48	0.79	6.48
LAGOON POND	LGP4	2.78	55%	2.57	35%	29.3	0.015	0.010	0.006	0.016	0.225	0.241	0.707	0.119	0.344	0.360	5.29	1.74	0.76	7.03
LAGOON POND	LGP8	2.86	49%	5.27	69%	30.1	0.007	0.007	0.003	0.010	0.227	0.237	0.518	0.092	0.319	0.329	3.56	0.79	0.82	4.34
LAGOON POND	LGP9	3.52	63%	5.39	71%	30.9	0.006	0.010	0.004	0.013	0.200	0.214	0.466	0.081	0.281	0.295	3.40	0.81	0.81	4.21
LAKE TASHMOO	MV21	0.96	100%	5.56	76%	30.8	0.012	0.002	0.003	0.005	0.190	0.195	0.358	0.063	0.253	0.258	2.09	0.67	0.72	2.75
LAKE TASHMOO	MV2	3.01	94%	4.82	65%	30.8	0.011	0.002	0.005	0.007	0.187	0.194	0.401	0.070	0.257	0.264	2.45	0.72	0.69	3.16
LAKE TASHMOO	MV3	2.56	84%	4.80	66%	30.8	0.013	0.001	0.005	0.005	0.197	0.203	0.637	0.119	0.316	0.321	3.34	1.17	0.63	4.51
LAKE TASHMOO	MV4	2.36	81%	4.85	67%	30.7	0.013	0.000	0.004	0.004	0.203	0.207	0.793	0.141	0.345	0.349	5.29	1.09	0.67	6.38
LAKE TASHMOO	MV SEN	2.20	60%	4.27	59%	30.6	0.018	0.002	0.003	0.005	0.223	0.228	0.761	0.133	0.357	0.362	7.50	1.56	0.64	9.05

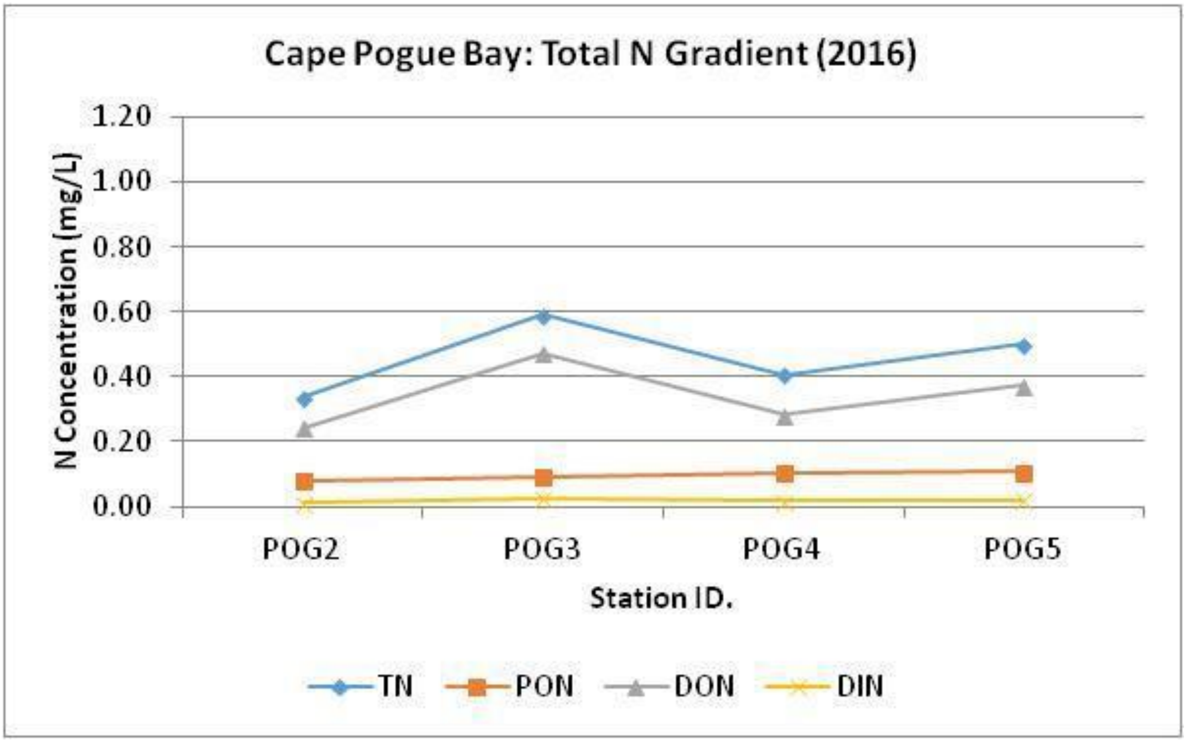
Table 2a. Summary of Water Quality Parameters, 2017 Martha's Vineyard Island-wide Water Quality Monitoring Program. Values are Station Averages of all sampling events, July-Sept. for estuarine and salt pond sites. Looks Pond received 1 sampling event in June, July August and September.

Embayment	Sample ID	Secchi average (meters)	Secchi Depth % of WC	20% Low DO (mg/L)	20% Low DO (% Sat.)	Salinity (ppt)	Avg. PO4 (mg/L)	Avg. NH4 (mg/L)	Avg. Nox (mg/L)	Avg. DIN (mg/L)	Avg. DON (mg/L)	Avg. TDN (mg/L)	Avg. POC (mg/L)	Avg. PON (mg/L)	Avg. TON (mg/L)	Avg. TN (mg/L)	Avg. Chla (ug/L)	Avg. Phaeo (ug/L)	Chla/Phaeo Ratio	Avg. Total Pig (ug/L)
TISBURY GREAT POND	TGP1	0.71	85%	4.22	59%	15.8	0.102	0.005	0.020	0.026	0.453	0.478	2.817	0.472	0.924	0.950	33.16	3.48	0.83	36.64
TISBURY GREAT POND	TGP3A	0.63	100%	4.85	61%	18.4	0.130	0.010	0.003	0.013	0.380	0.393	2.742	0.419	0.799	0.812	25.35	2.09	0.83	27.44
TISBURY GREAT POND	TGP4	1.31	54%	4.70	60%	20.5	0.141	0.005	0.003	0.008	0.303	0.311	2.409	0.395	0.698	0.706	16.00	2.52	0.80	18.52
TISBURY GREAT POND	TGP5	0.96	43%	6.08	82%	13.7	0.098	0.004	0.006	0.010	0.343	0.352	2.441	0.382	0.725	0.735	18.91	0.34	0.97	19.24
TISBURY GREAT POND	TGP6	0.98	37%	3.22	44%	18.5	0.118	0.006	0.003	0.009	0.351	0.360	2.881	0.456	0.807	0.816	22.88	1.33	0.89	24.22
TISBURY GREAT POND	TGP7	1.31	68%	5.80	75%	19.8	0.131	0.005	0.001	0.006	0.321	0.327	2.589	0.385	0.705	0.712	12.99	2.19	0.77	15.19
TISBURY GREAT POND	TGP8	0.96	82%	5.76	77%	18.4	0.138	0.007	0.004	0.011	0.362	0.374	2.151	0.357	0.719	0.730	21.10	1.52	0.79	22.63
MENEMSHA POND	MEN2	3.61	88%	6.05	79%	31.0	0.011	0.013	0.003	0.016	0.189	0.205	0.513	0.082	0.272	0.288	2.77	0.98	0.76	3.76
MENEMSHA POND	MEN3	3.49	63%	5.42	72%	30.9	0.008	0.006	0.003	0.008	0.197	0.206	0.549	0.095	0.292	0.301	3.19	1.27	0.74	4.46
MENEMSHA POND	MEN5	2.24	93%	4.90	81%	30.9	0.010	0.006	0.005	0.011	0.207	0.218	0.517	0.092	0.300	0.311	3.17	0.86	0.78	4.02
MENEMSHA POND	MEN6	1.86	86%	5.40	73%	30.7	0.011	0.008	0.004	0.012	0.283	0.294	0.617	0.111	0.393	0.405	4.18	0.76	0.80	4.93
MENEMSHA POND	MEN7	1.59	100%	4.58	63%	30.4	0.020	0.020	0.004	0.024	0.281	0.305	0.751	0.129	0.410	0.434	4.66	0.79	0.82	5.45
SQUIBNOCKET POND	SQB1	2.79	79%	5.82	76%	12.2	0.008	0.005	0.004	0.009	0.525	0.534	1.394	0.249	0.774	0.783	6.79	2.49	0.72	9.28
SQUIBNOCKET POND	SQB3	2.00	51%	6.85	89%	12.1	0.007	0.009	0.006	0.015	0.516	0.531	1.233	0.222	0.738	0.754	7.01	1.22	0.81	8.23
JAMES POND	JMS1	0.25	100%	4.52	64%	27.3	0.033	0.047	0.004	0.052	0.476	0.527	1.165	0.202	0.678	0.729	5.14	2.23	0.69	7.37
JAMES POND	JMS3	1.28	95%	5.54	80%	26.8	0.023	0.017	0.008	0.025	0.356	0.381	1.170	0.203	0.546	0.570	7.23	3.32	0.74	10.55
JAMES POND	JMS4	0.90	100%	4.51	65%	27.2	0.030	0.003	0.005	0.008	0.340	0.347	1.219	0.208	0.548	0.556	7.26	2.37	0.72	9.63

Table 2a cont'd. Summary of Water Quality Parameters, 2017 Martha's Vineyard Island-wide Water Quality Monitoring Program. Values are Station Averages of all sampling events, July-Sept. for estuarine and salt pond sites.

Embayment	Sample ID	Secchi average (meters)	Secchi Depth % of WC	20% Low DO (mg/L)	20% Low DO (% Sat.)	Salinity (ppt)	Avg. PO4 (mg/L)	Avg. NH4 (mg/L)	Avg. Nox (mg/L)	Avg. DIN (mg/L)	Avg. DON (mg/L)	Avg. TDN (mg/L)	Avg. POC (mg/L)	Avg. PON (mg/L)	Avg. TON (mg/L)	Avg. TN (mg/L)	Avg. Chla (ug/L)	Avg. Phaeo (ug/L)	Chla/Phaeo Ratio	Avg. Total Pig (ug/L)
CAPE POGUE BAY	POG2	2.68	49%	5.04	72%	32.48	0.0108	0.0106	0.0012	0.0119	0.2433	0.2552	0.5023	0.0814	0.3247	0.3366	1.35	0.42	0.75	1.77
	POG3	2.25	45%	4.17	60%	32.63	0.0130	0.0220	0.0027	0.0247	0.4733	0.4980	0.5358	0.0929	0.5662	0.5908	1.00	0.74	0.56	1.74
	POG4	2.44	66%	4.66	68%	32.73	0.0119	0.0158	0.0015	0.0173	0.2834	0.3007	0.6006	0.1044	0.3879	0.4051	1.42	0.76	0.63	2.18
	POG5	1.82	93%	4.25	62%	32.65	0.0110	0.0160	0.0030	0.0190	0.3723	0.3913	0.6062	0.1078	0.4801	0.4991	1.05	0.91	0.53	1.96
POCHA POND	PCA1	1.07	100%	4.25	63%	32.58	0.0113	0.0200	0.0040	0.0239	0.3099	0.3338	0.6890	0.1170	0.4269	0.4509	1.30	0.94	0.58	2.24
	PCA2	1.80	72%	4.97	72%	33.50	0.0111	0.0040	0.0020	0.0059	0.2338	0.2397	0.9450	0.1444	0.3782	0.3841	2.15	0.76	0.74	2.91
	PCA3	1.48	87%	4.09	61%	32.58	0.0100	0.0205	0.0040	0.0245	0.3462	0.3707	0.8561	0.1405	0.4868	0.5112	1.56	0.94	0.61	2.50
KATAMA BAY	KAT1	3.03	35%	4.86	69%	32.43	0.0165	0.0132	0.0033	0.0164	0.2520	0.2684	0.4454	0.0828	0.3348	0.3513	1.23	0.49	0.73	1.72
	KAT2	2.81	60%	4.78	68%	32.43	0.0184	0.0145	0.0029	0.0174	0.2849	0.3023	0.4782	0.0834	0.3682	0.3857	1.33	0.74	0.64	2.07
	KAT3	1.16	100%	4.57	66%	32.08	0.0210	0.0127	0.0024	0.0151	0.2363	0.2514	0.6866	0.1247	0.3610	0.3761	2.16	0.76	0.72	2.93
	KAT4	2.00	18%	4.79	69%	32.33	0.0228	0.0195	0.0045	0.0240	0.2914	0.3155	0.6498	0.1165	0.4079	0.4319	2.07	1.20	0.63	3.28
	KAT5	1.80	63%	4.71	68%	32.15	0.0288	0.0150	0.0031	0.0181	0.2629	0.2809	0.7049	0.1402	0.4031	0.4211	2.38	1.20	0.66	3.57
	KAT7	1.28	94%	4.56	65%	32.08	0.0263	0.0118	0.0017	0.0135	0.2903	0.3038	0.8422	0.1553	0.4456	0.4591	3.03	1.20	0.71	4.23
EDGARTOWN GREAT POND	EGP2	2.38	92%	3.63	68%	21.63	0.0012	0.0338	0.0024	0.0362	0.3938	0.4300	0.6454	0.1223	0.5160	0.5522	1.64	0.27	0.83	1.91
	EGP3	2.63	78%	4.75	66%	21.50	0.0009	0.0222	0.0019	0.0242	0.3791	0.4033	0.6010	0.1118	0.4909	0.5151	2.03	0.17	0.91	2.19
	EGP4	1.75	100%	4.59	65%	21.50	0.0011	0.0390	0.0062	0.0453	0.3479	0.3931	0.6677	0.1028	0.4506	0.4959	1.23	0.24	0.80	1.47
	EGP5	2.23	100%	4.83	68%	22.85	0.0005	0.0274	0.0022	0.0295	0.3897	0.4192	0.7599	0.1249	0.5146	0.5441	2.09	0.24	0.84	2.33
	EGP6	2.28	100%	4.65	65%	22.43	0.0005	0.0206	0.0014	0.0220	0.3816	0.4036	0.7398	0.1311	0.5128	0.5347	2.66	0.19	0.87	2.85
	EGP7	2.66	100%	4.56	64%	22.78	0.0009	0.0329	0.0016	0.0345	0.3934	0.4279	0.6456	0.1126	0.5061	0.5406	1.60	0.19	0.86	1.80
	EGP9	1.88	100%	4.60	65%	20.78	0.0009	0.0203	0.0027	0.0230	0.3090	0.3319	0.8229	0.1366	0.4456	0.4686	1.85	0.34	0.84	2.19
	EGP10	1.80	100%	4.33	62%	21.08	0.0013	0.0231	0.0021	0.0253	0.3580	0.3833	0.7030	0.1152	0.4732	0.4984	1.73	0.22	0.87	1.95
	EGP11	1.60	100%	4.16	59%	21.40	0.0009	0.0494	0.0029	0.0523	0.3969	0.4492	0.5736	0.0994	0.4963	0.5486	1.10	0.23	0.82	1.33
CHILMARK POND	CHP UP	0.78	56%	6.46	79%	0.13	0.0326	0.0030	0.0024	0.0055	0.4145	0.4200	3.7003	0.6761	1.0907	1.0961	23.19	0.96	0.97	24.16
	CHP7	0.72	100%	2.78	36%	5.77	0.0174	0.0207	0.0042	0.0249	0.5248	0.5497	2.3354	0.4127	0.9375	0.9624	13.16	1.64	0.80	14.80
	CHP6	0.85	89%	4.98	65%	9.20	0.0168	0.0190	0.0032	0.0222	0.5525	0.5747	1.9863	0.3488	0.9013	0.9235	6.81	0.72	0.88	7.53
	CHP5	1.18	61%	5.28	69%	9.50	0.0064	0.0061	0.0019	0.0081	0.5672	0.5753	1.7618	0.2570	0.8223	0.8320	4.98	0.43	0.88	5.41
	CHP4	1.09	80%	5.50	71%	9.75	0.0108	0.0041	0.0020	0.0061	0.5918	0.5979	1.1489	0.1995	0.7913	0.7974	3.59	0.69	0.84	4.27
	CHP2	1.16	54%	5.13	67%	9.88	0.0215	0.0034	0.0023	0.0056	0.5609	0.5665	1.7785	0.2893	0.8502	0.8558	6.04	0.62	0.87	6.66
	CHP1	0.90	61%	4.91	64%	9.58	0.0059	0.0038	0.0024	0.0062	0.6427	0.6489	2.6034	0.3750	1.0178	1.0240	9.32	0.48	0.92	9.80
OAK BLUFFS HARBOR	MV14	0.90	100%	3.73	52%	30.50	0.0142	0.0096	0.0262	0.0358	0.2533	0.2891	0.9596	0.1742	0.4275	0.4633	2.48	1.14	0.69	3.62
	MV15	1.79	100%	4.56	63%	31.60	0.0176	0.0095	0.0126	0.0221	0.2713	0.2934	0.8708	0.1273	0.3987	0.4207	2.43	0.77	0.74	3.20
	MV16	2.81	78%	4.80	67%	31.81	0.0129	0.0132	0.0035	0.0167	0.2082	0.2249	0.5120	0.0810	0.2892	0.3059	1.45	0.62	0.69	2.08
FARM POND	FRM1	0.79	100%	4.30	62%	31.58	0.0153	0.0106	0.0060	0.0165	0.3033	0.3199	0.6457	0.1074	0.4108	0.4273	1.48	0.59	0.71	2.07
	FRM2	0.97	100%	3.42	48%	31.55	0.0149	0.0073	0.0038	0.0110	0.3407	0.3517	0.6054	0.1111	0.4518	0.4628	1.20	0.73	0.64	1.93
	FRM3	1.20	100%	2.84	42%	30.65	0.0613	0.0070	0.0036	0.0106	0.3615	0.3721	0.9738	0.1720	0.5334	0.5440	2.38	0.97	0.74	3.35
SENGEKONTACKET POND	SKT2	1.88	100%	4.25	61%	31.88	0.0135	0.0143	0.0022	0.0165	0.3474	0.3639	0.6014	0.0951	0.4425	0.4590	1.15	0.48	0.70	1.62
	SKT3	2.37	89%	3.93	57%	31.50	0.0115	0.0141	0.0027	0.0167	0.3804	0.3971	0.7691	0.1481	0.5285	0.5452	2.72	0.67	0.74	3.39
	SKT4	1.41	98%	3.82	55%	30.85	0.0151	0.0142	0.0041	0.0184	0.2883	0.3066	0.7281	0.1305	0.4188	0.4372	1.50	1.06	0.58	2.56
	SKT5	1.23	100%	4.59	65%	31.95	0.0112	0.0101	0.0016	0.0117	0.2286	0.2403	0.4614	0.0753	0.3039	0.3156	0.88	0.54	0.59	1.41
	SKT6	2.27	100%	4.44	63%	31.95	0.0135	0.0134	0.0022	0.0157	0.2150	0.2306	0.3810	0.0679	0.2828	0.2985	0.82	0.36	0.69	1.18
	SKT8	1.93	100%	4.28	62%	31.48	0.0040	0.0121	0.0017	0.0138	0.3192	0.3330	0.5876	0.1124	0.4316	0.4454	1.31	0.35	0.77	1.66
	SKT9	0.30	100%	3.48	51%	30.45	0.0085	0.0250	0.0045	0.0295	0.3899	0.4195	0.5468	0.0890	0.4789	0.5085	0.93	0.74	0.57	1.67
FRESH POND	FRS1	1.93	59%	5.44	68%	0.05	0.0016	0.0020	0.0041	0.0061	0.4076	0.4137	0.8022	0.1103	0.5179	0.5240	1.50	0.71	0.64	2.22
	FRS2	1.78	88%	5.48	69%	0.03	0.0026	0.0030	0.0033	0.0063	0.4127	0.4190	0.7497	0.1201	0.5328	0.5391	1.15	0.67	0.63	1.82
	FRS3	1.98	89%	5.50	69%	0.03	0.0049	0.0072	0.0049	0.0121	0.3999	0.4120	0.6857	0.0906	0.4905	0.5026	1.17	0.70	0.62	1.87
LAGOON POND	LGP11	0.93	78%	2.75	35%	26.48	0.0088	0.0280	0.3447	0.3727	0.4802	0.8528	5.6625	0.9640	1.4553	1.8279	8.16	7.46	0.64	15.61
	LGP12	0.23	89%	2.96	39%	23.58	0.0190	0.0344	0.2872	0.3216	0.5719	0.8935	5.8302	1.0202	1.5921	1.9136	11.00	5.96	0.66	16.97
	LGP2	2.73	31%	1.94	27%	31.75	0.0213	0.0119	0.0021	0.0141	0.2654	0.2795	0.9164	0.1526	0.4180	0.4320	3.28	0.72	0.79	4.00
	LGP4	2.69	36%	0.49	7%	31.48	0.0268	0.0111	0.0020	0.0131	0.2568	0.2698	1.2330	0.1904	0.4471	0.4602	3.07	0.98	0.73	4.05
	LGP6	2.19	42%	2.94	42%	31.20	0.0332	0.0196	0.0042	0.0238	0.3892	0.4130	0.5614	0.1060	0.3587	0.3858	1.27	0.49	0.72	1.75
	LGP8	2.88	48%	4.31	60%	31.38	0.0151	0.0117	0.0017	0.0134	0.2376	0.2510	0.9078	0.1360	0.3736	0.3870	3.02	0.45	0.81	3.47
	LGP9	3.20	59%	3.99	57%	31.65	0.0143	0.0097	0.0021	0.0119	0.2050	0.2169	0.6397	0.1005	0.3055	0.3174	2.29	0.70	0.70	2.99
LAKE TASHMOO	MV21	0.81	100%	5.13	71%	31.63	0.0126	0.0114	0.0028	0.0142	0.1910	0.2052	0.4163	0.0676	0.2586	0.2728	1.07	0.44	0.72	1.51
	MV2	2.80	93%	4.82	66%	31.60	0.0320	0.0125	0.0018	0.0142	0.2374	0.2516	0.4819	0.0844	0.3217	0.3360	1.47	0.46	0.77	1.94
	MV3	2.46	88%	4.66	65%	31.53	0.0153	0.0097	0.0021	0.0118	0.2308	0.2425	0.6889	0.1088	0.3396	0.3514	1.33	0.58	0.72	1.91
	MV4	2.60	84%	4.70	65%	31.68	0.0146	0.0125	0.0016	0.0140	0.2268	0.2408	0.7036	0.1138	0.3406	0.3546	1.97	0.79	0.71	2.75
	MVSEN	2.00	70%	4.38	62%	30.89	0.0173	0.0138	0.0046	0.0184	0.2386	0.2570	1.4494	0.2249	0.4636	0.4820	4.10	0.92	0.80	5.02

Table 2b. Summary of Water Quality Parameters, 2016 Martha's Vineyard Island-wide Water Quality Monitoring Program. Values are Station Averages of all sampling events, July-Aug for estuarine and salt pond sites. Farm Pond and Oak Bluffs Harbor received 1 sampling event in August and 1 in September. All other systems were sampled twice in both July and August.



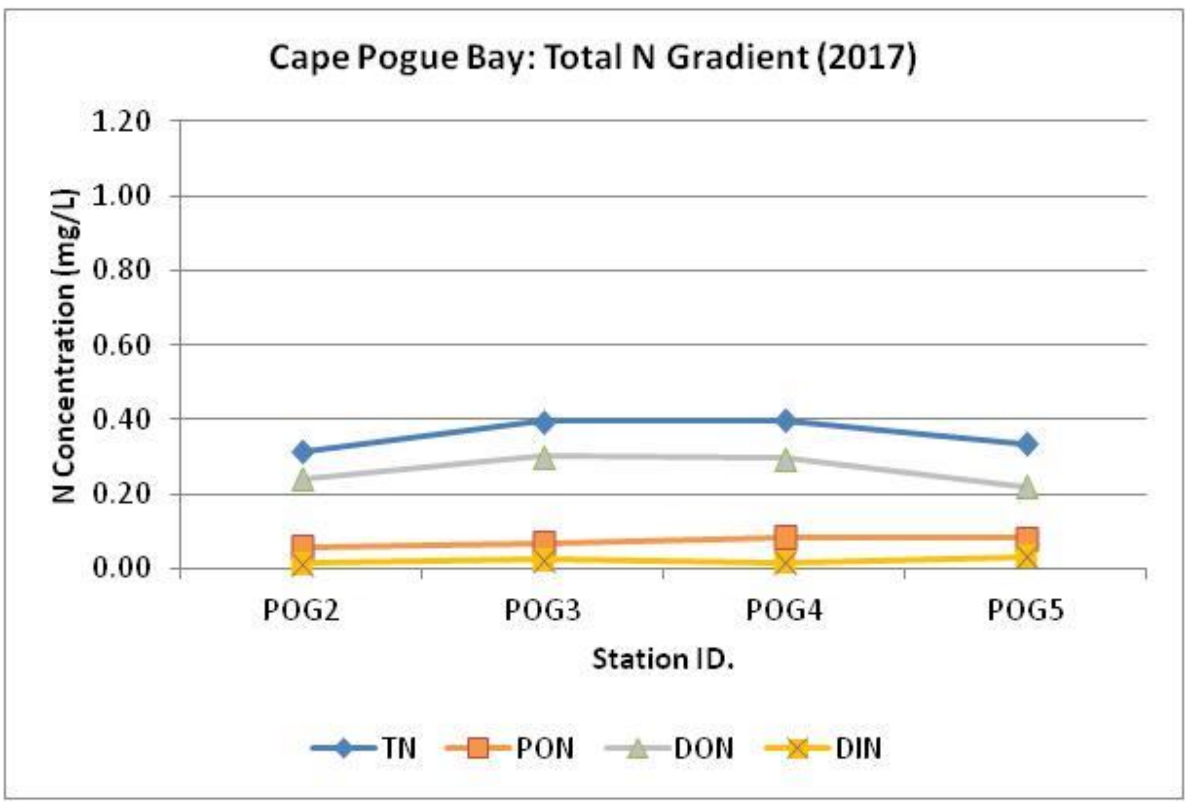
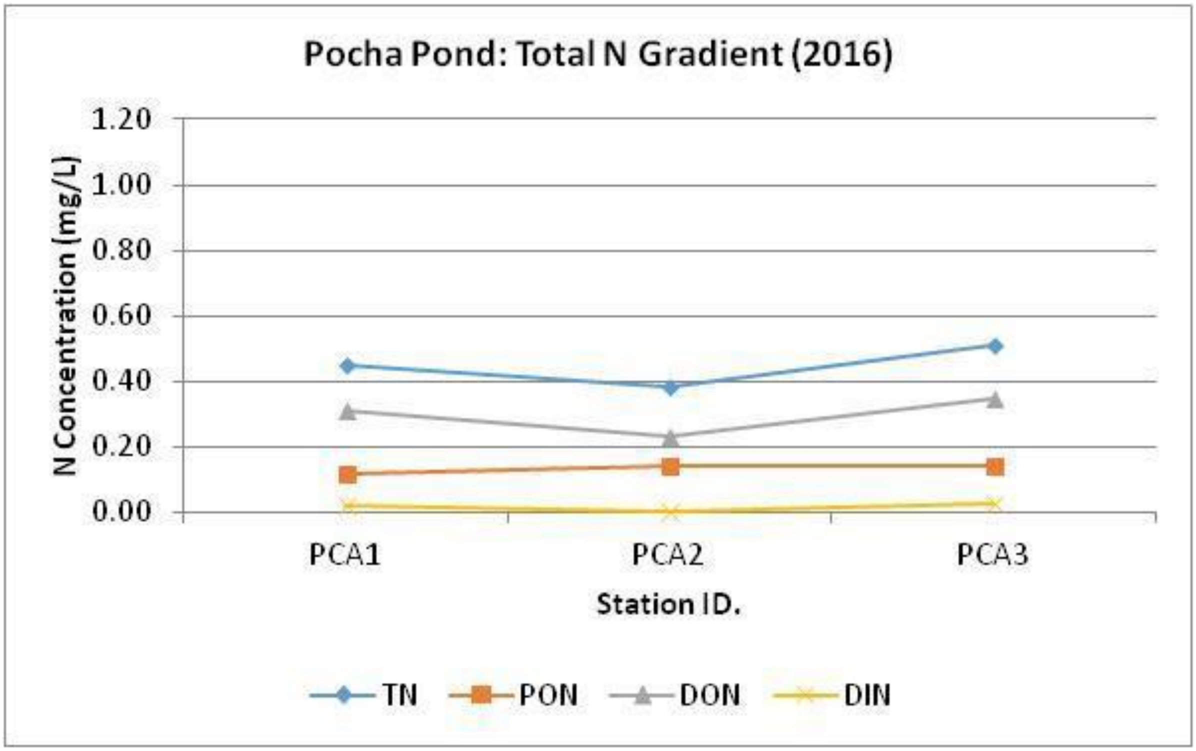


Figure 17. Comparison of nitrogen species in the Martha's Vineyard estuaries and salt ponds (Summer 2016 and 2017 sampling season). Presently, no MEP Threshold set for Cape Pogue Bay.



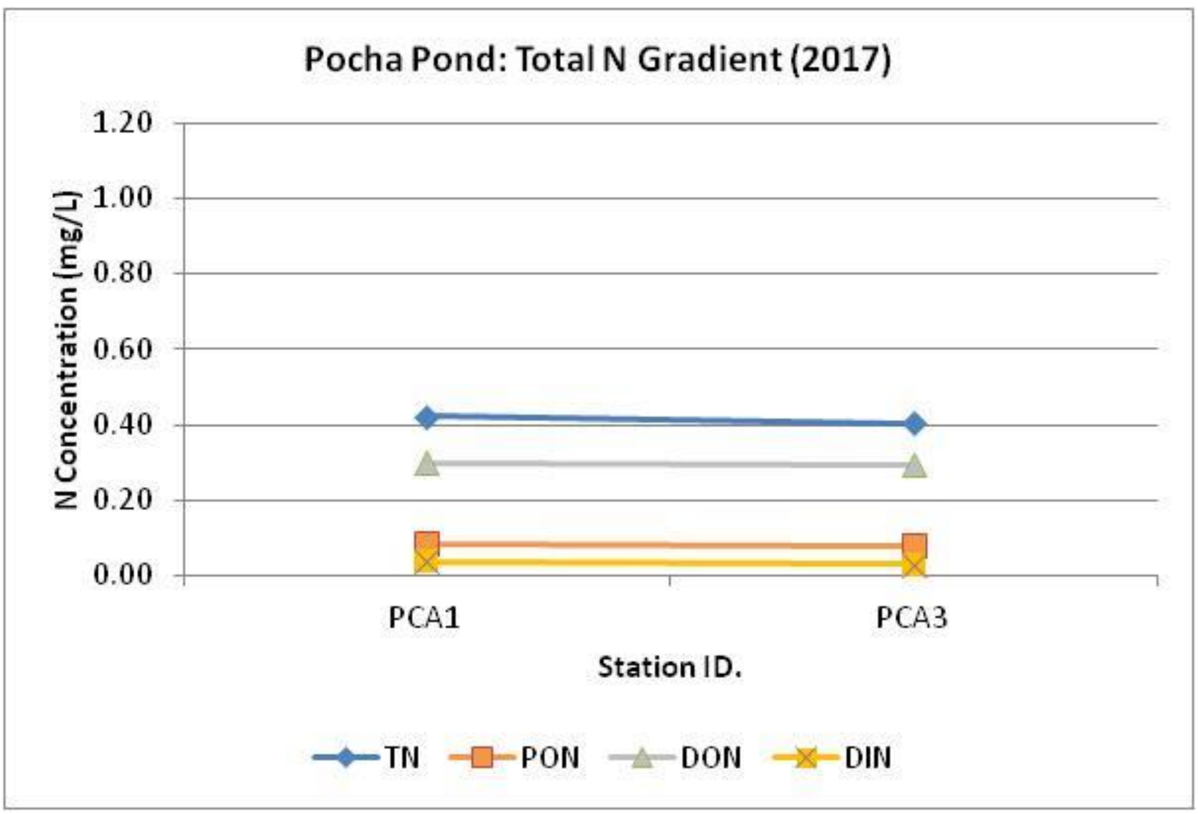
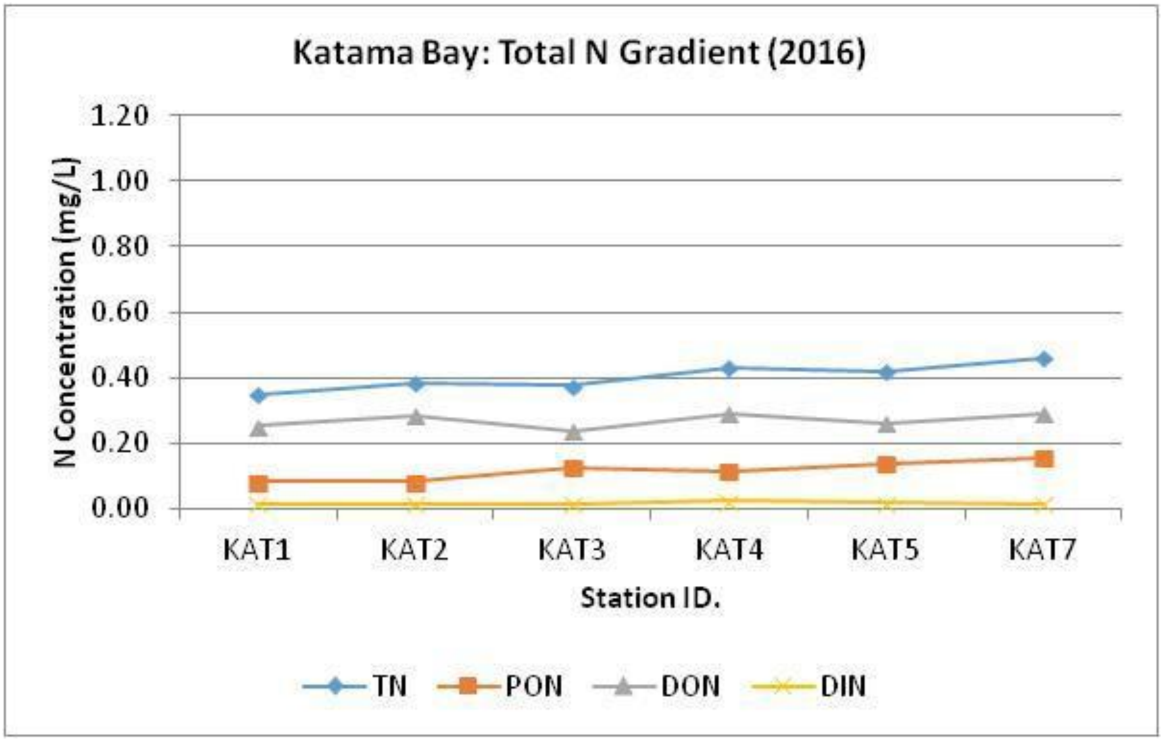


Figure 17 cont'd. Comparison of nitrogen species in the Martha's Vineyard estuaries and salt ponds (Summer 2016 and 2017 sampling season). Presently, no MEP Threshold set for Pocha Pond.



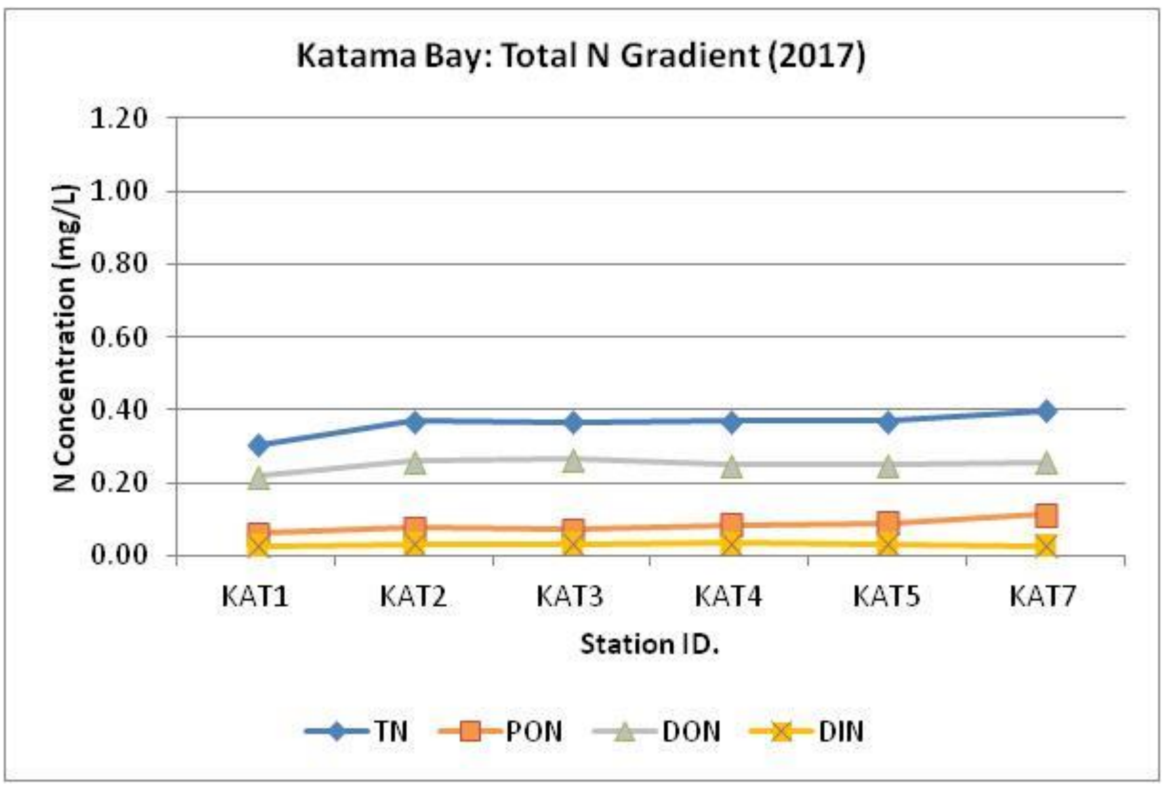
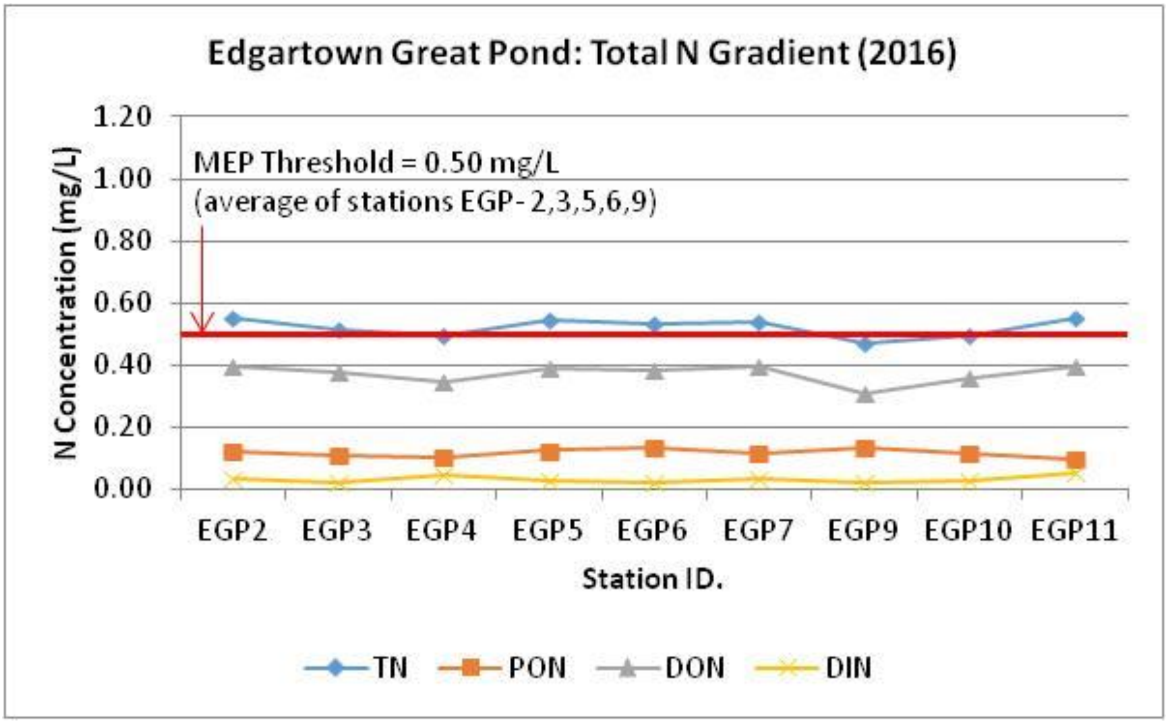


Figure 17 cont'd. Comparison of nitrogen species in the Martha's Vineyard estuaries and salt ponds (Summer 2016 and 2017 sampling season). Presently, no MEP Threshold set for Katama Bay.



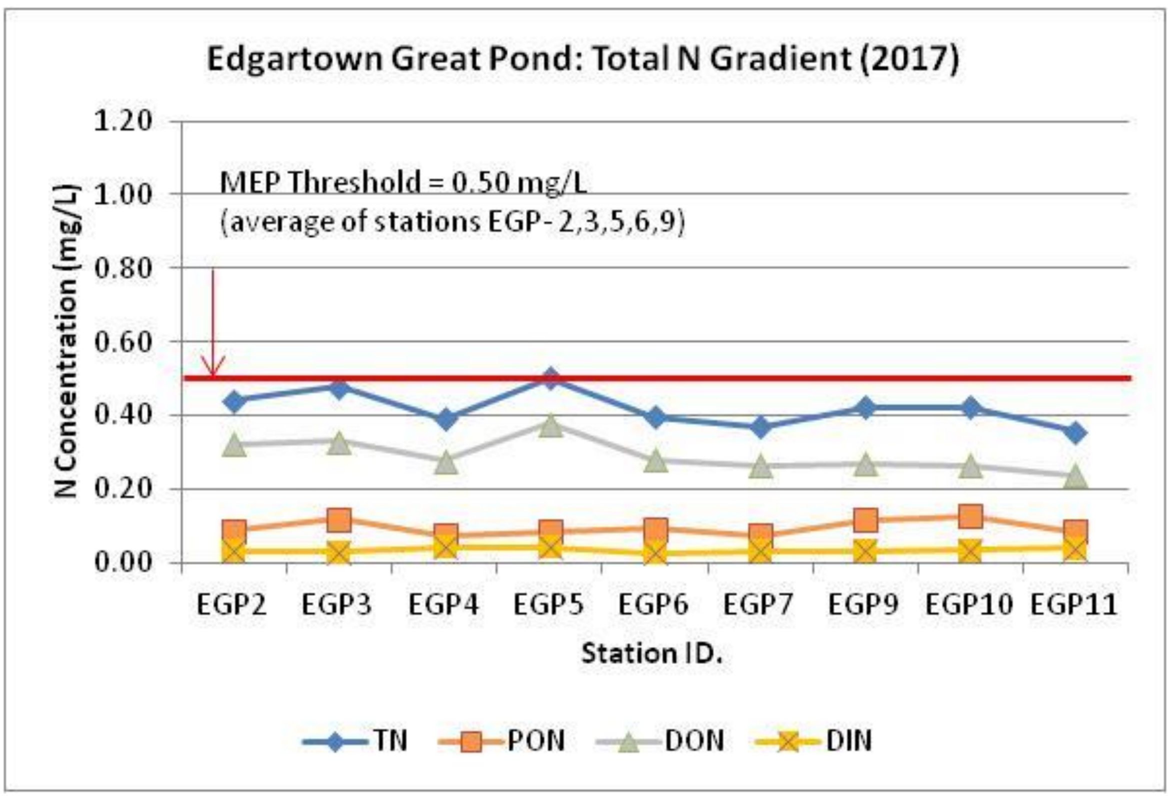
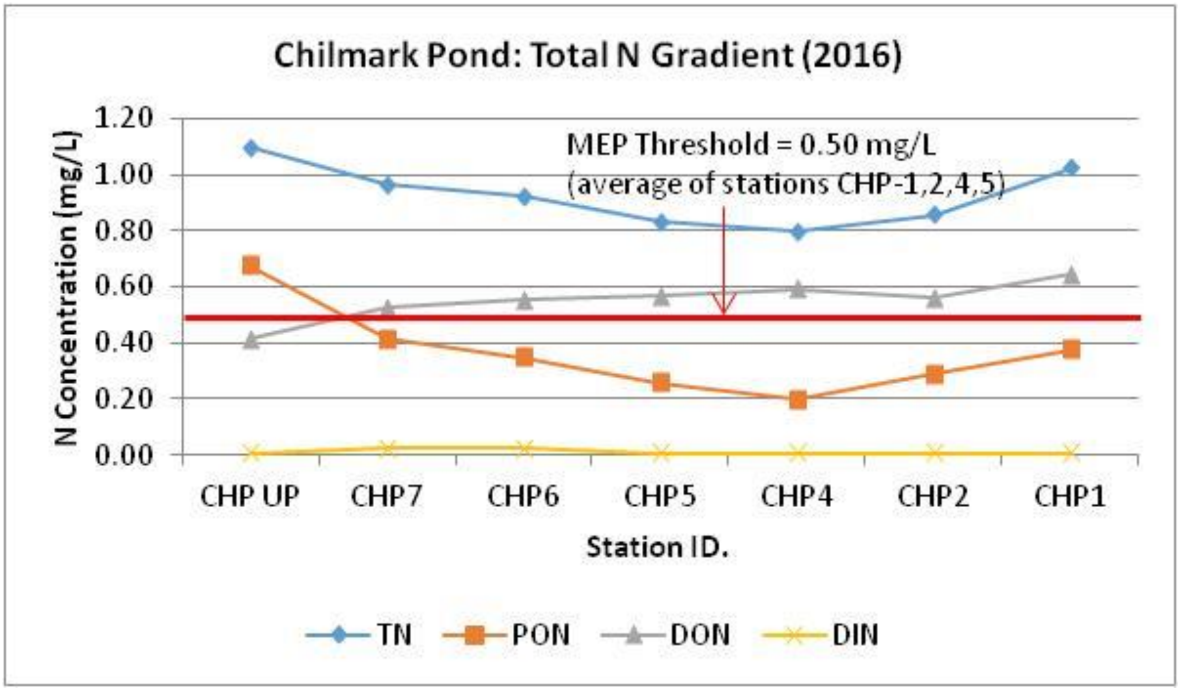


Figure 17 cont'd. Comparison of nitrogen species in the Edgartown Great Pond system (Summer 2016 and 2017 sampling season).



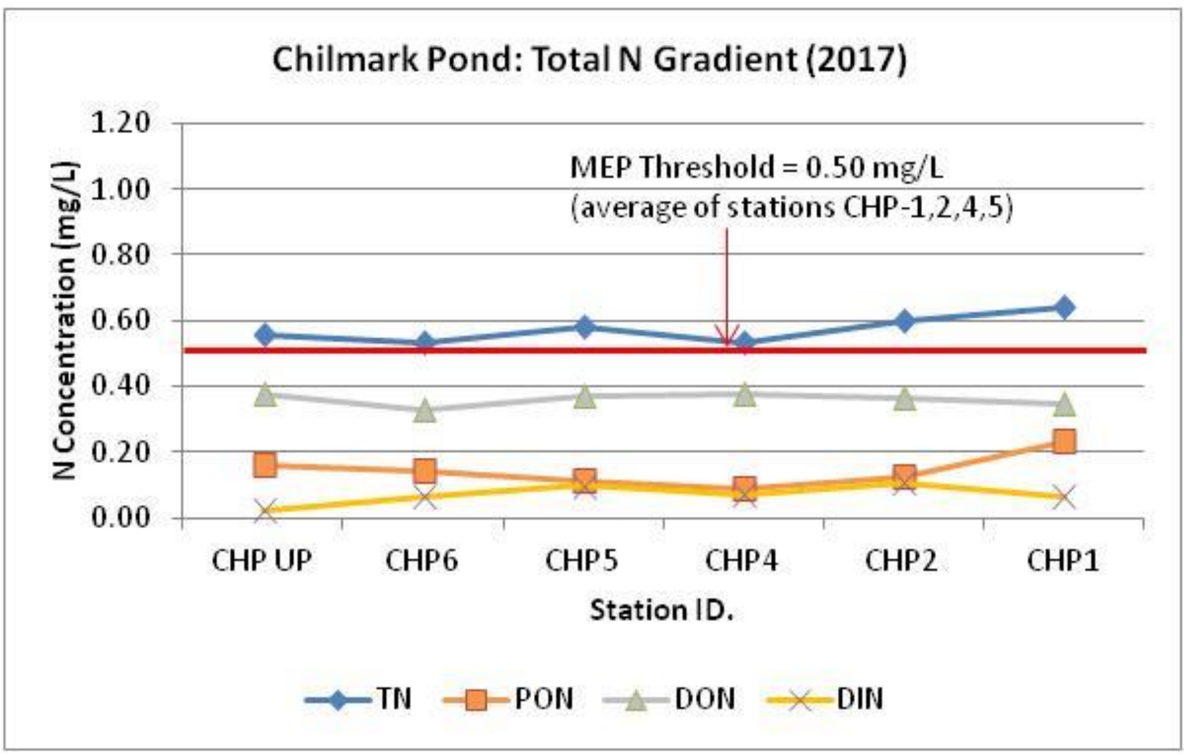
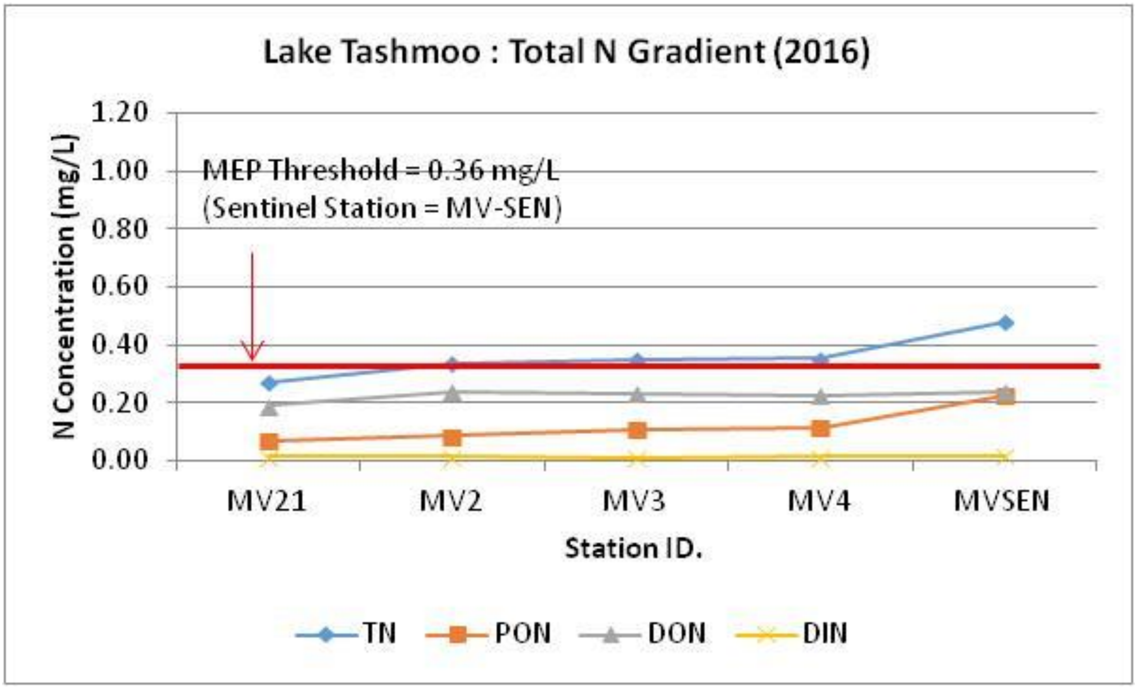


Figure 17 cont'd. Comparison of nitrogen species in the Chilmark Pond system (Summer 2016 and 2017 sampling season).



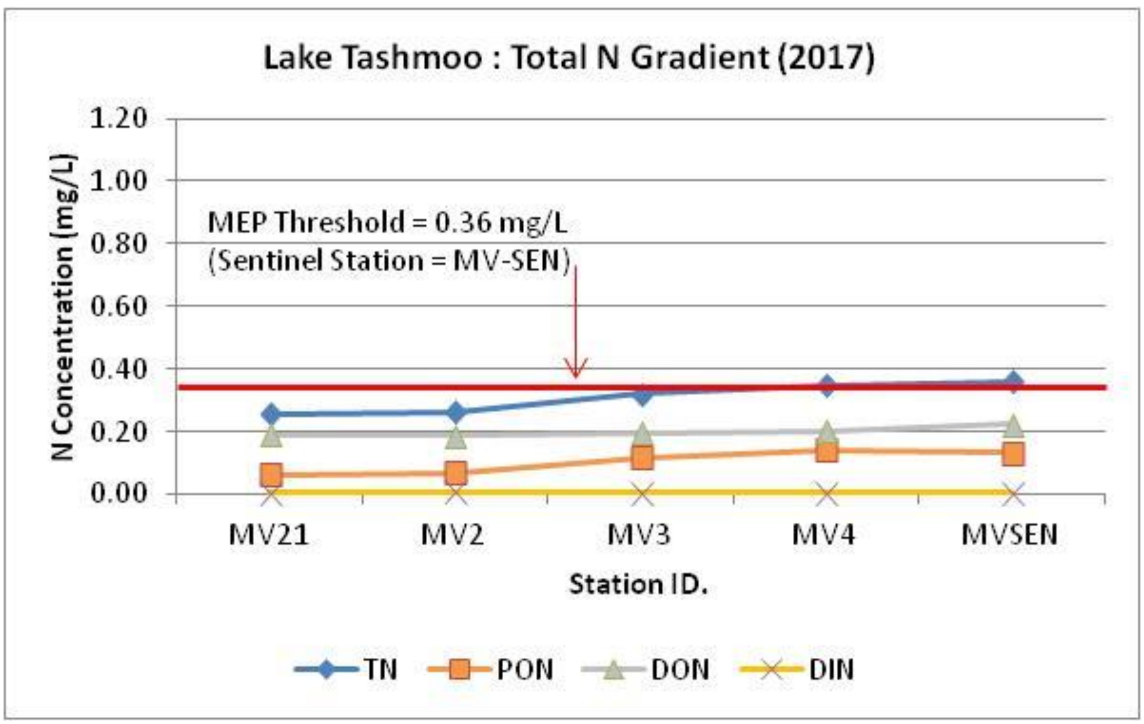
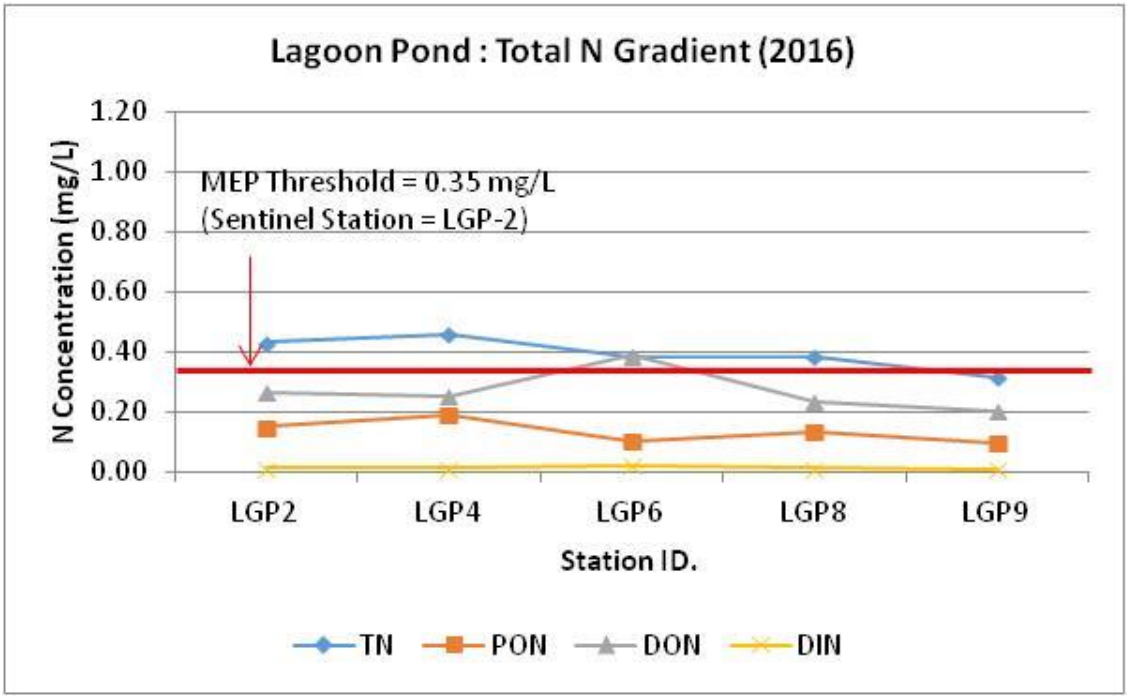


Figure 17 cont'd. Comparison of nitrogen species in the Lake Tashmoo system (Summer 2016 and 2017 sampling season).



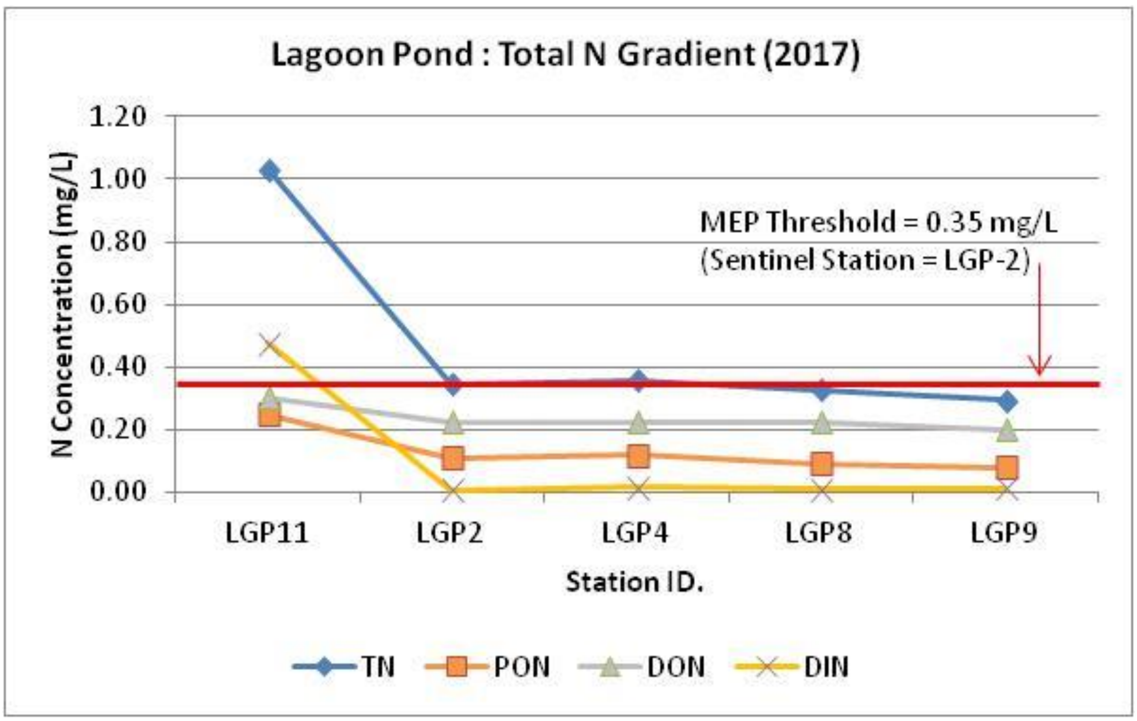
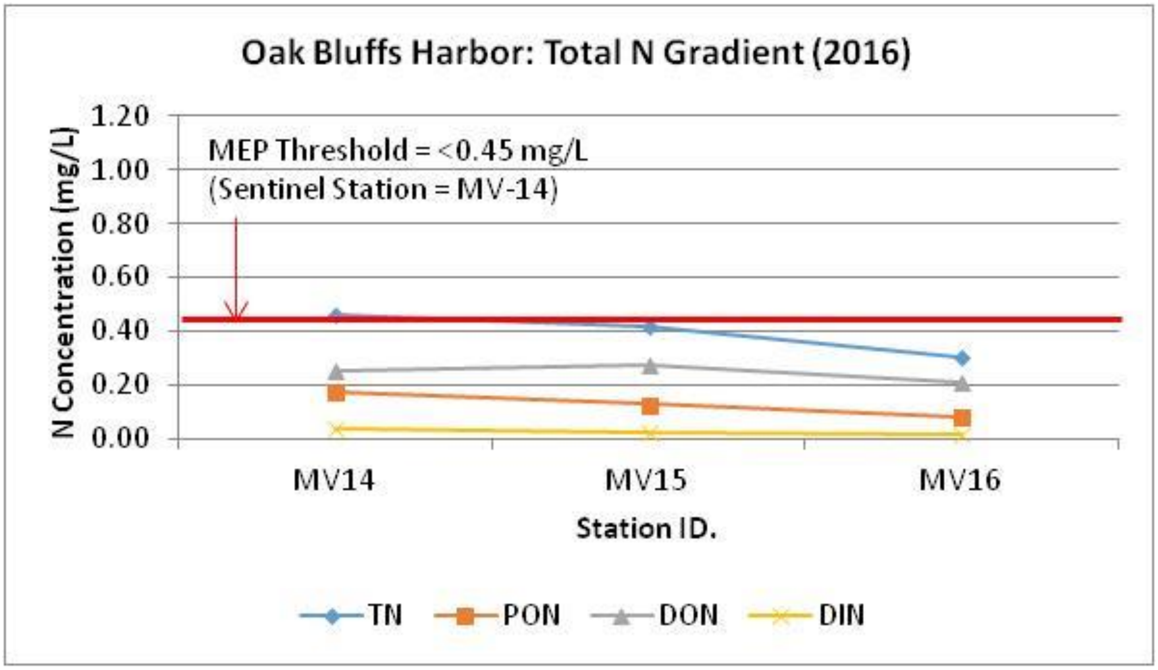


Figure 17 cont'd. Comparison of nitrogen species in the Lagoon Pond system (Summer 2016 and 2017 sampling season).



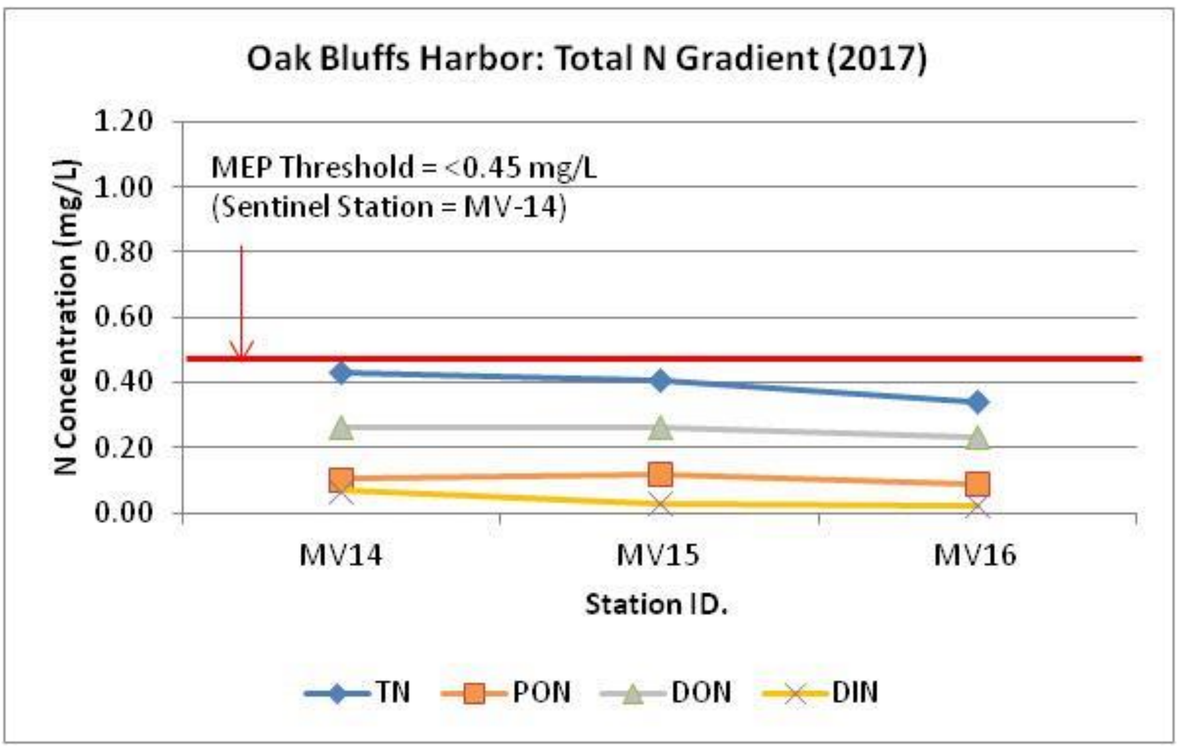
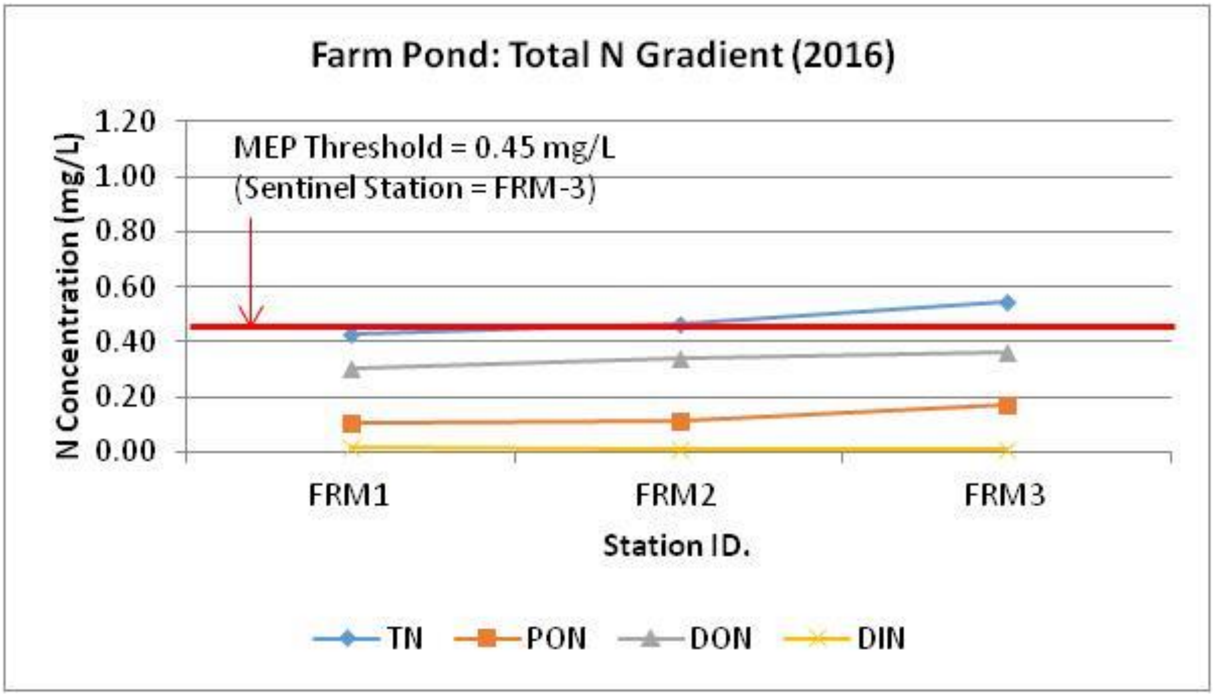


Figure 17 cont'd. Comparison of nitrogen species in the Oak Bluffs Harbor system (Summer 2016 and 2017 sampling season).



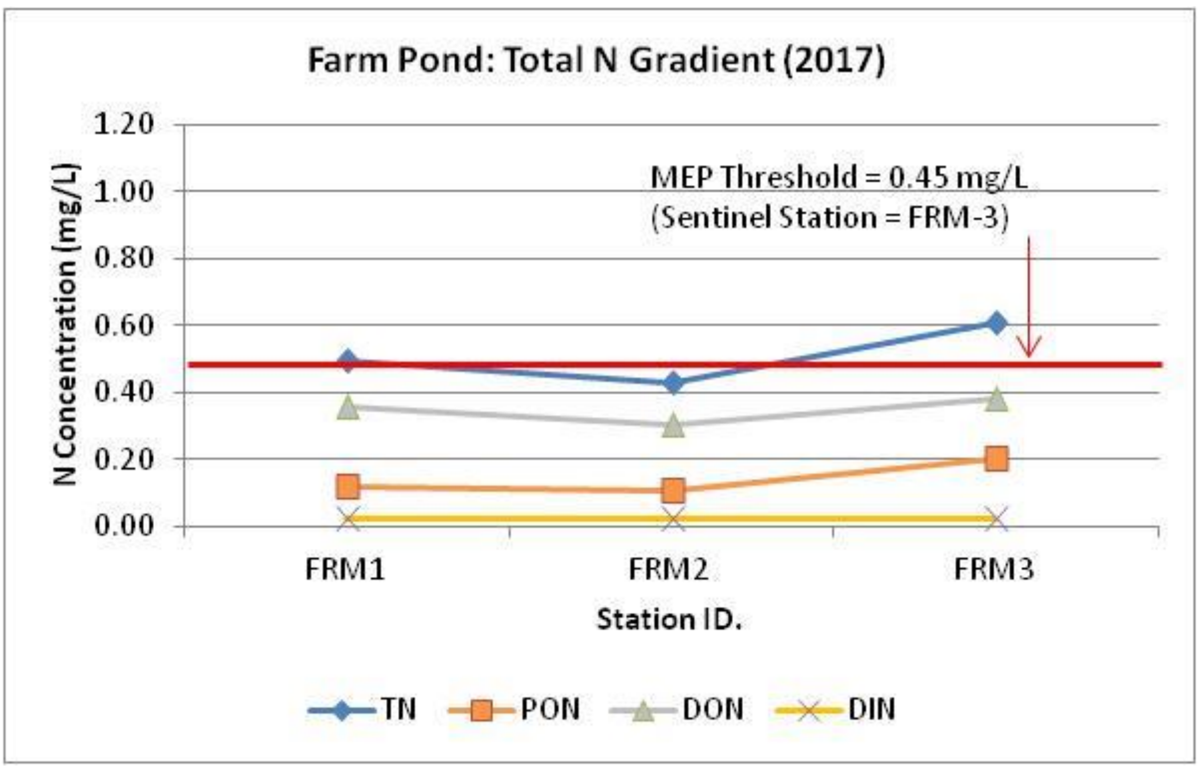
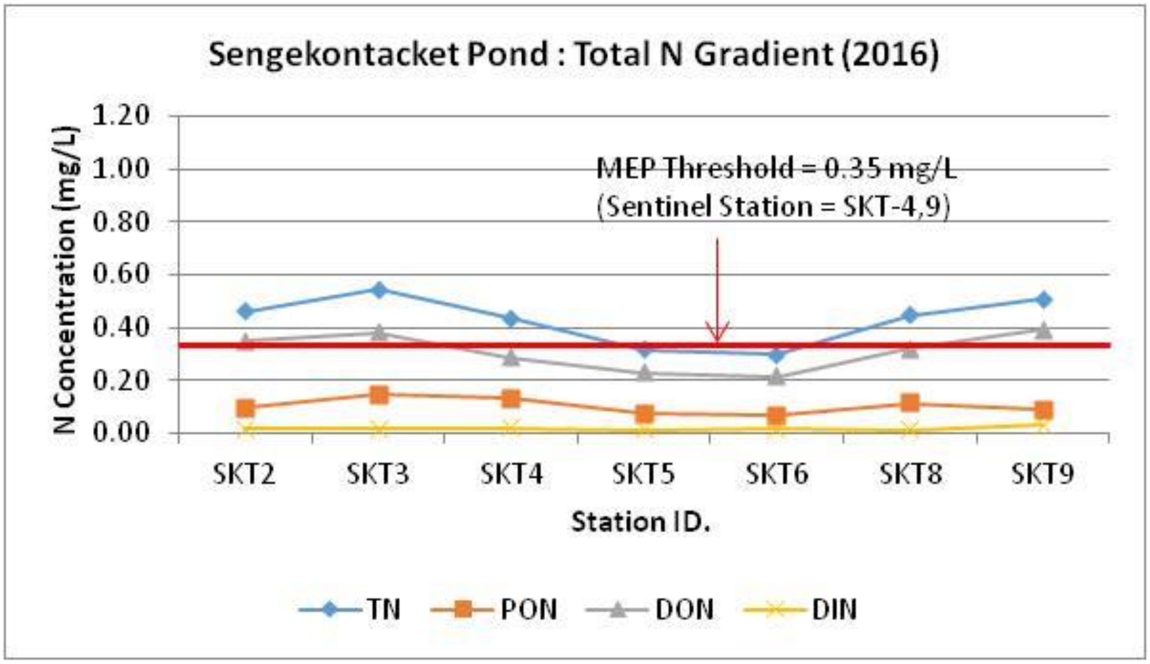


Figure 17 cont'd. Comparison of nitrogen species in the Farm Pond system (Summer 2016 and 2017 sampling season).



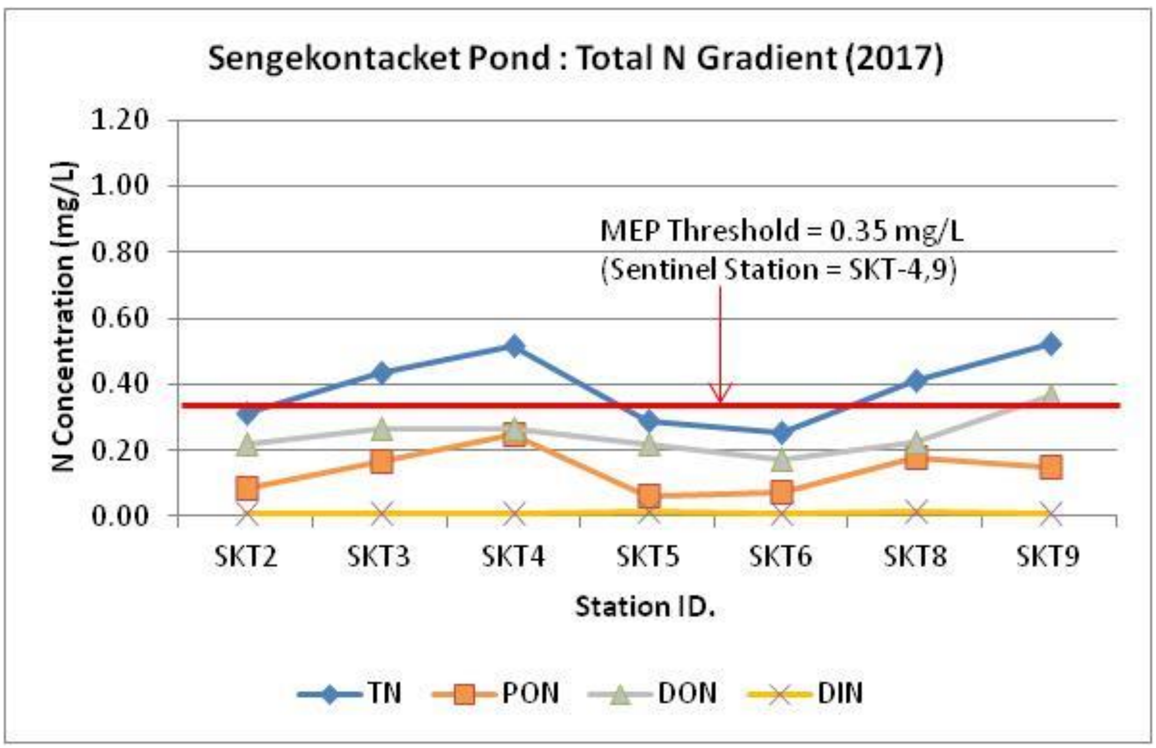


Figure 17 cont'd. Comparison of nitrogen species in the Sengekontacket Pond system (Summer 2016 and 2017sampling season).

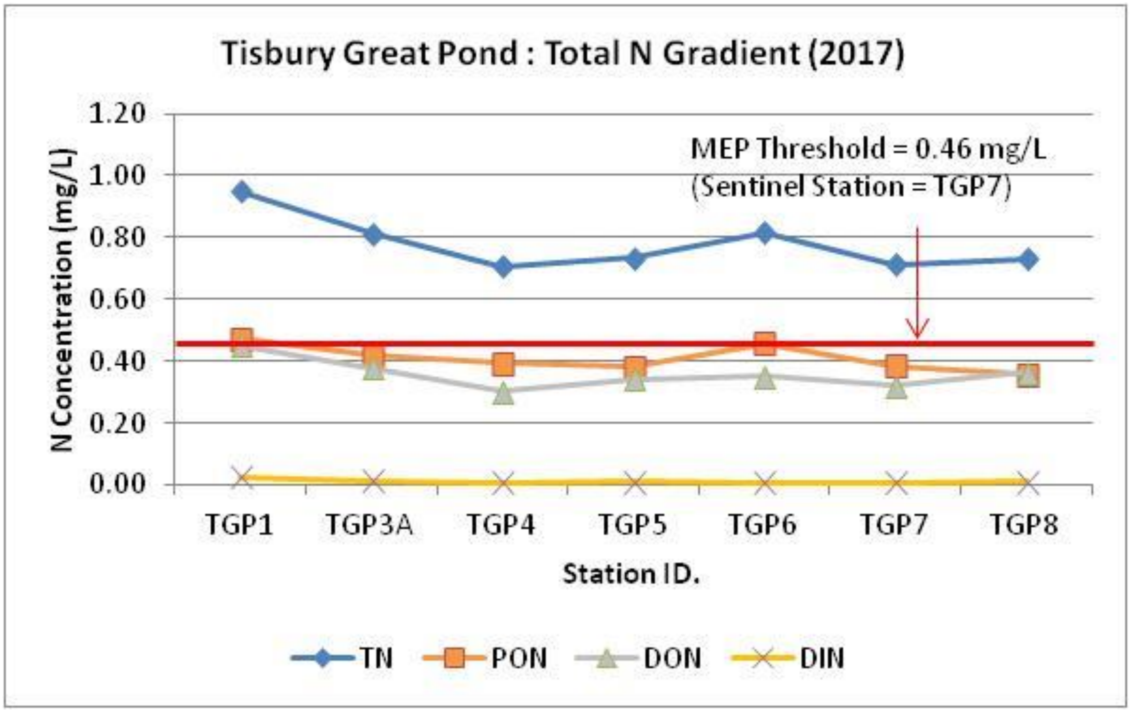


Figure 17 cont'd. Comparison of nitrogen species in the Tisbury Great Pond system (Summer 2017 sampling season).

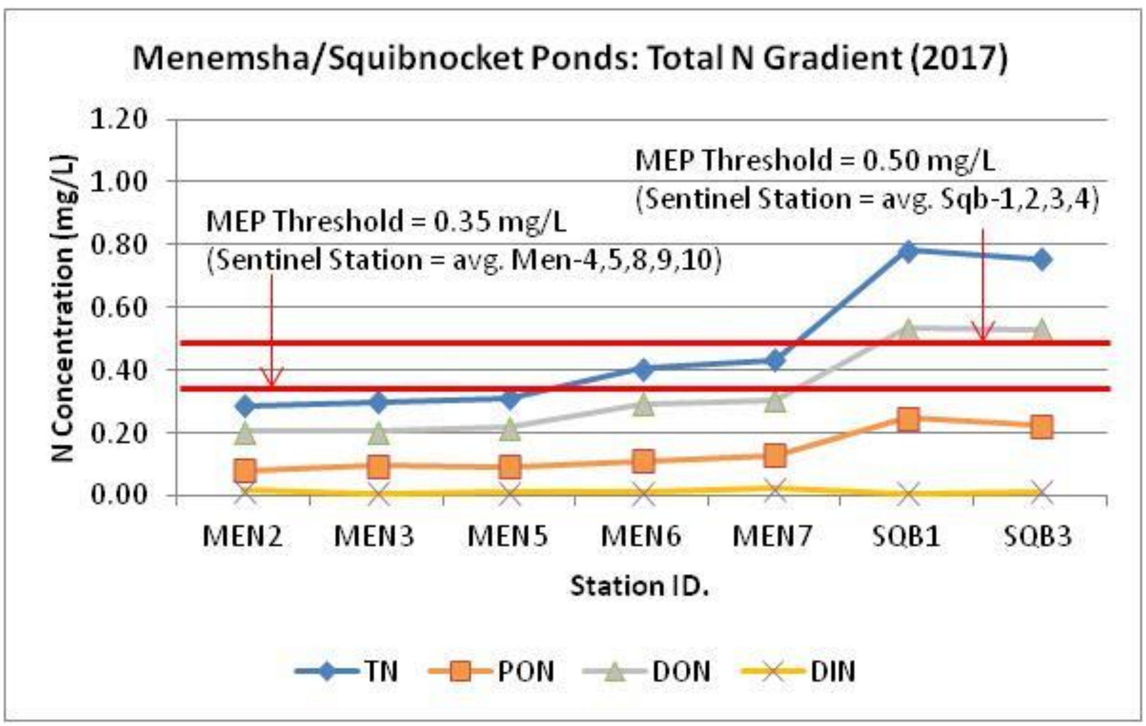


Figure 17 cont'd. Comparison of nitrogen species in the Menemsha Pond and Squibnocket Pond system (Summer 2017 sampling season).

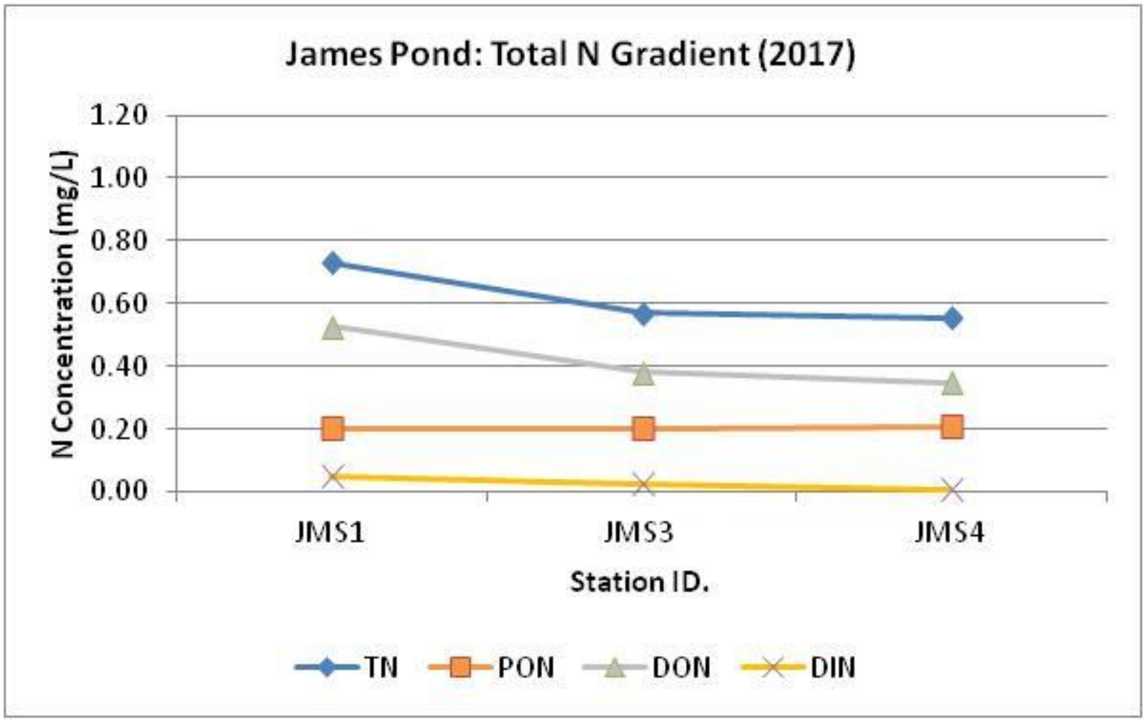


Figure 17 cont'd. Comparison of nitrogen species in the James Pond system (Summer 2017 sampling season).

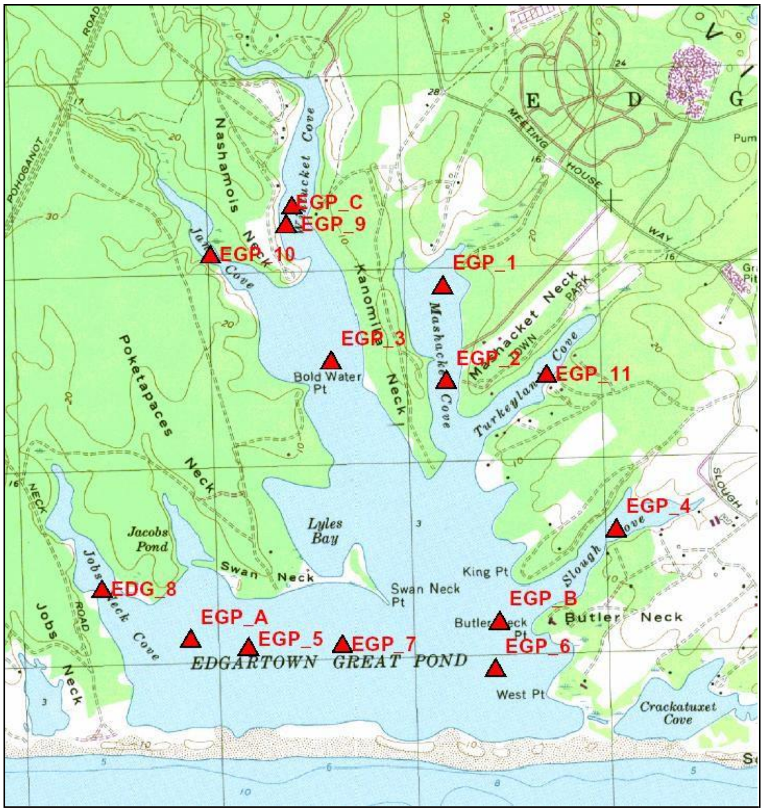


Figure 18. Estuarine water quality monitoring station locations in the Edgartown Great Pond estuary system. Station labels correspond to those provided in Table 3 below. Red diamonds indicate locations of MEP monitoring stations. Not all stations were included in the summer 2016 sampling effort. MEP "Sentinel station" (average of EGP 2,3,5,6,9). MEP TN threshold = 0.50 mg/L.

Station Location	MEP TN (mg/L)	MEP Salinity (ppt)	2016 TN (mg/L)	2017 TN (mg/L)
Jobs Neck Cove – EGP8	0.583	17.9		
Jane's Cove – EGP10	0.582	16.5	0.498	0.422
Wintucket Cove – EGP9	0.597	18	0.469	0.421
Upper Mash Cove – EGP1	0.65	18.9		
Lower Mash Cove – EGP2	0.613	18.2	0.552	0.441
Turkeyland Cove – EGP11	0.639	19.8	0.549	0.356
Upper Slough Cove – EGP4	0.711	16.2	0.496	0.39
Upper EGP Basin – EGP3	0.587	18.4	0.515	0.477
Lower EGP West – EGP5	0.595	20.9	0.544	0.502
Lower EGP East – EGP6	0.591	22.1	0.535	0.394
Lower EGP Mid - EGP7	--	--	--	0.368
Atlantic Ocean	0.232	32.3	--	--

Table 3. MEP mean values of TN and salinity used in the development of the nutrient threshold for Edgartown Great Pond. Measured nitrogen concentrations and salinities for Edgartown Great Pond. MEP values are calculated as the average of the separate yearly means. TN data represented in this table were collected in 2003 through 2006 in Great Pond and 2002 through 2004 for salinity. The offshore Atlantic Ocean data (offshore Pleasant Bay Inlet) are from the summer of 2005.

Figure 19. MEP monitoring station location in Chilmark Pond that was used in the water quality analysis for the Massachusetts Estuaries Project. MEP established "sentinel station" (average of CHP 1-5). MEP TN Threshold = 0.50 mg/L or less.

Station Location	**MEP TN (mg/L)**	MEP N	**2016 TN (mg/L)**	**2017 TN (mg/L)**
Wades Cove Upper (CHP-1)	**0.757**	20	**1.024**	0.642
Chilmark Pond (CHP-2)	**0.733**	20	**0.856**	0.598
Gilberts Cove (CHP-4)	**0.769**	9	**0.797**	0.533
Chilmark Pond (CHP-5)	**0.753**	15	**0.832**	0.578
Chilmark Pond (CHP-6)	**0.704**	12	**0.924**	0.534
Chilmark Pond (CHP-7)	**0.808**	7	**0.962**	
Chilmark Pond Upper (CHP-up)	--	--	**1.096**	0.556
Atlantic Ocean	**0.232**	17	--	--

Table 4. Comparison of MEP mean values of TN with summer 2016 and 2017 sampling effort (all values are mg/L) from Chilmark Pond. Measured nitrogen concentrations for Chilmark Pond. TN data represented in this table were collected from 2004 in Chilmark Pond. The offshore Atlantic Ocean data (offshore Pleasant Bay Inlet) are from the summer of 2005. MEP N represents sample size.

Figure 20. MEP monitoring station location in Lake Tashmoo that was used in the water quality analysis for the Massachusetts Estuaries Project. MEP established "sentinel station" between MV4 and MV5 (MV SEN, newly established station in 2016). MEP TN Threshold = 0.36 mg/L.

Sub-Embayment	Monitoring station	MEP Mean TN (mg/L)	MEP N	MEP Model average	2016 Mean TN (mg/L)	2017 Mean TN (mg/L)
Lower Basin	MV21	**0.314**	29	0.300	**0.273**	**0.258**
Lower Basin	MV1	**0.306**	28	0.311		--
Lower Basin	MV2	**0.301**	28	0.329	**0.336**	**0.264**
Mid-Upper Basin	MV3	**0.343**	38	0.369	**0.351**	**0.321**
Mid-Upper Basin	MV4	**0.36**	37	0.385	**0.355**	**0.349**
Upper Basin	MV5	**0.447**	37	0.423		--
MEP Sentinel Station	MV-SEN				**0.482**	**0.362**
Offshore	MV6	**0.27**	60	-		--

Table 5. MEP Measured data and modeled nitrogen concentrations for the Lake Tashmoo estuarine system. All concentrations are given in mg/L N. “MEP Mean TN” values are calculated as the average of all measurements. MEP Data represented in this table were collected in the summers of 2001 through 2007. MEP N represents sample size.

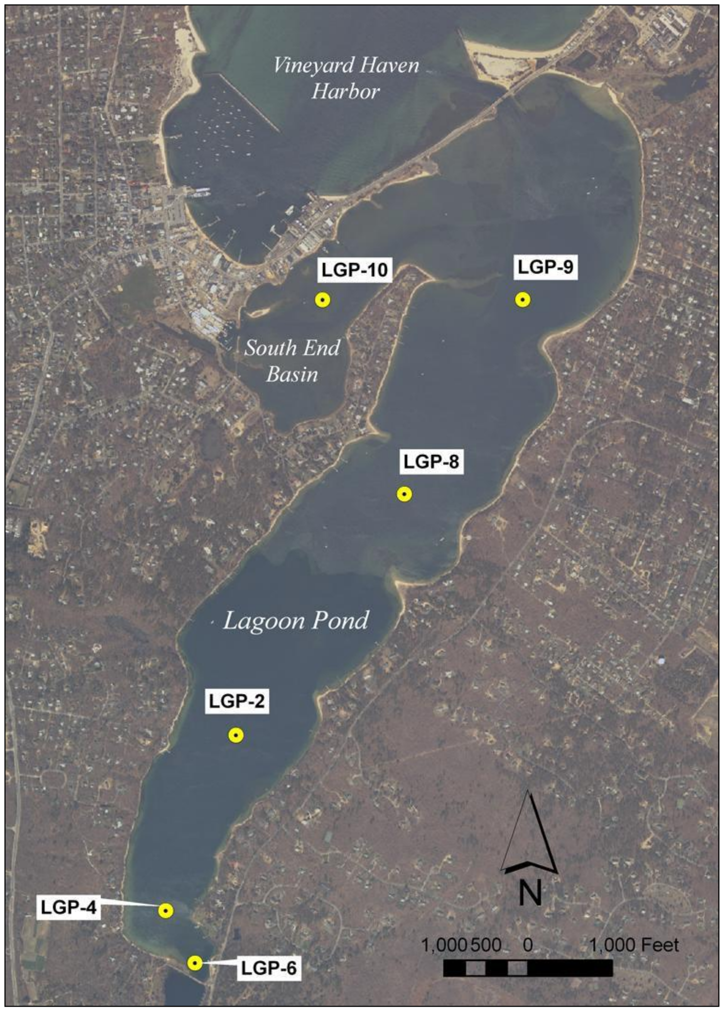


Figure 21. MEP monitoring station location in Lagoon Pond that was used in the water quality analysis for the Massachusetts Estuaries Project. MEP established "sentinel station" (LGP2). MEP TN Threshold = 0.35 mg/L.

Sub-Embayment	Monitoring station	**MEP Mean TN (mg/L)**	N	**MEP Model average**	**2016 Mean TN (mg/L)**	**2017 Mean TN (mg/L)**
Lagoon Pond head at dike	LGP-6	**0.418**	23	0.413	**0.386**	**--**
Lagoon Pond Head	LGP-4	**0.384**	100	0.385	**0.460**	**0.360**
Lagoon Pond upper Basin	LGP-2	**0.36**	135	0.371	**0.432**	**0.346**
Lagoon Pond mid Basin	LGP-8	**0.359**	66	0.338	**0.387**	**0.329**
Lagoon Pond lower Basin	LGP-9	**0.333**	60	0.328	**0.317**	**0.295**
West Arm (South End Basin)	LGP-10	**0.386**	35	0.378	**--**	**--**
Nantucket Sound	NTKS	**0.290**	48	--	**--**	**--**

Table 6. Measured data and modeled Nitrogen concentrations for the Lagoon Pond estuarine system used in the MEP modeling and threshold development. All concentrations are given in mg/L N. “MEP Mean TN” values are calculated as the average of the separate yearly means. MEP Data represented in this table were collected in the summers of 2002 through 2007.

Figure 22. Estuarine water quality monitoring station locations in the Oak Bluffs Harbor and Sunset Lake System used to establish the MEP water quality baseline. MEP TN threshold is <0.45 mg/L in Sunset Lake.

Monitoring station	2001 Mean (mg/L)	2002 Mean (mg/L)	2003 Mean (mg/L)	2004 Mean (mg/L)	2005 Mean (mg/L)	2006 Mean (mg/L)	2007 Mean (mg/L)	01-07 mean (mg/L)	N	MEP Model average	2016 Mean TN (mg/L)	2017 Mean TN (mg/L)
MV-14	0.382	--	0.39	0.411	0.386	0.413	0.35	**0.392**	35	0.392	**0.463**	**0.431**
MV-15	0.333	0.363	0.351	0.321	0.296	0.327	0.318	**0.329**	41	0.32	**0.421**	**0.408**
MV-16	0.338	0.363	0.32	0.389	0.273	0.324	0.302	**0.325**	63	0.313	**0.306**	**0.342**
MV-17	--	0.355	0.385	0.373	0.305	0.375	0.328	**0.351**	34	0.335	--	**--**

Table 7. Comparison of MEP mean values of TN with summer 2016 and 2017 data (all values are mg/L) from Oak Bluffs Harbor. Town of Oak Bluffs water quality monitoring data, and MEP modeled Nitrogen concentrations for the Oak Bluffs Harbor System. “01-07 mean” values are calculated as the average of the separate yearly means.

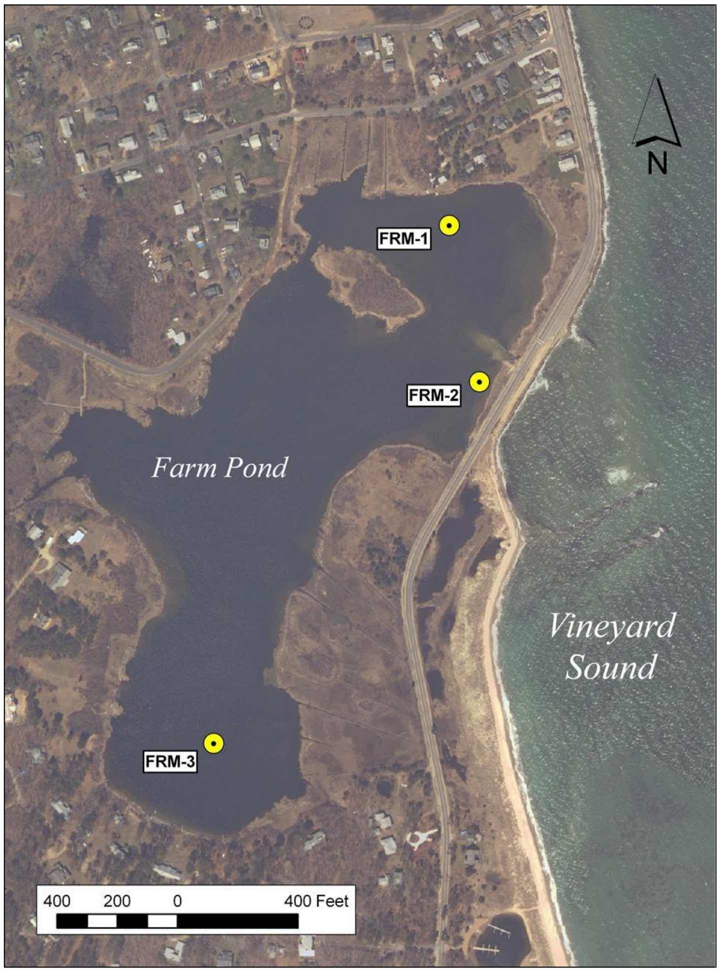


Figure 23. Estuarine water quality monitoring station locations in the Farm Pond System used to establish the MEP water quality baseline. MEP TN threshold is 0.45 mg/L at MEP "sentinel" station (FAM-3).

Sub-Embayment	Monitoring station	MEP Mean TN (mg/L)	N	MEP Model average	2016 Mean TN (mg/L)	2017 Mean TN (mg/L)
North Basin	FRM-1	**0.516**	18	0.496	**0.427**	**0.496**
Mid Pond	FRM-2	**0.505**	16	0.480	**0.463**	**0.430**
South Basin	FRM-3	**0.530**	17	0.508	**0.544**	**0.610**
Nantucket Sound	NTKS	**0.294**	4	--	--	--

Table 8. Comparison of MEP mean values of TN with summer 2016 and 2017 data (all values are mg/L) from Farm Pond. Measured data and modeled Nitrogen concentrations for the Farm Pond estuarine system used in the model calibration. All concentrations are given in mg/L N. “MEP Mean TN” values are calculated as the average of the separate yearly means. MEP Mean Data represented in this table were collected in the summers of 2002 through 2008.

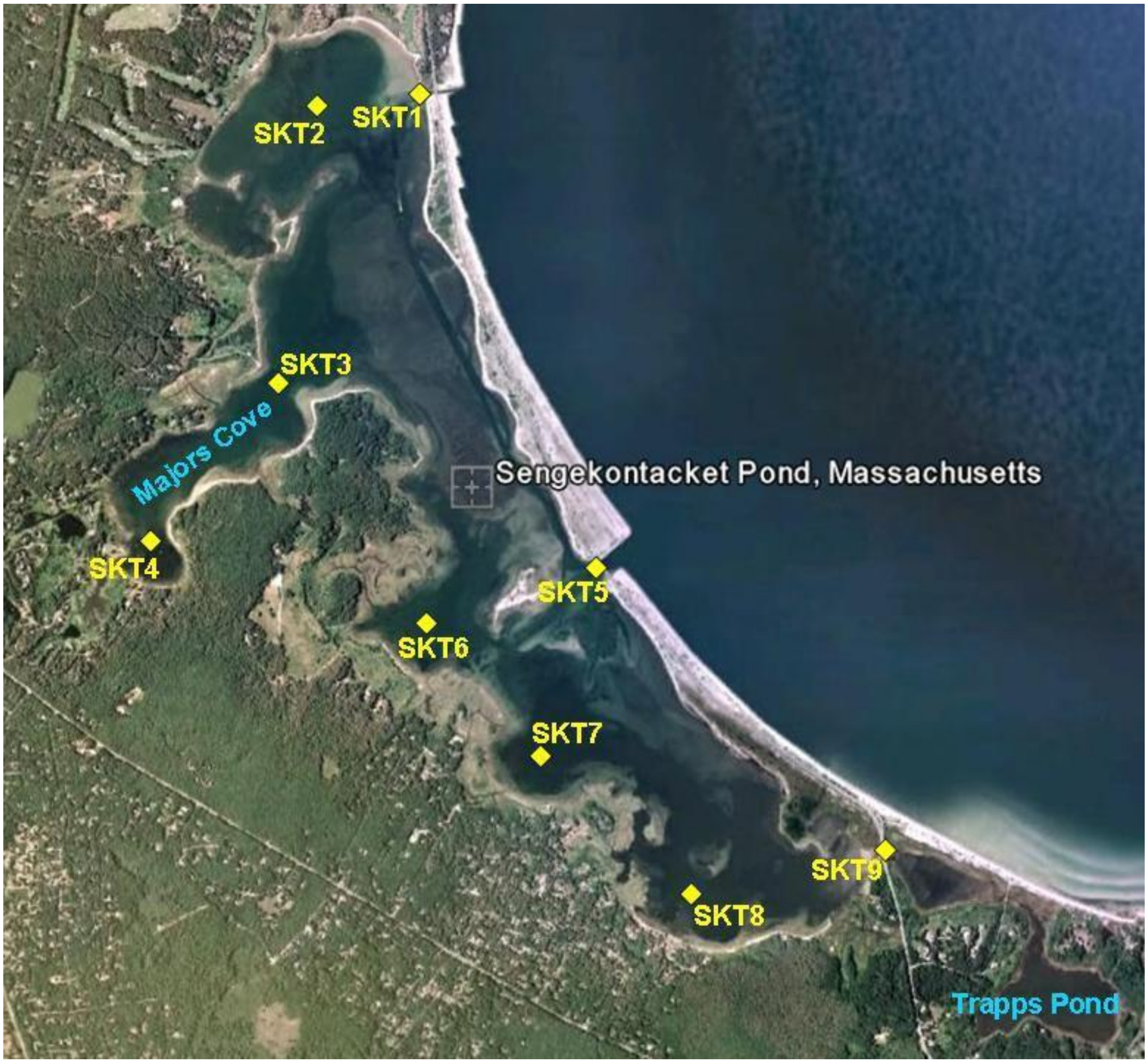


Figure 24. Estuarine water quality monitoring station locations in the Sengekontacket Pond System used to establish the MEP water quality baseline. MEP TN threshold is 0.35 mg/L at water quality monitoring stations SKT-4 and SKT-9, to restore eelgrass habitat within Majors Cove/Sengekontacket Pond and to improve eelgrass habitat within Trapps Pond. The approximate locations of the sentinel threshold stations for Sengekontacket Pond (SKT-4 and SKT-9) are shown. There is no baseline water quality station within Trapps Pond.

Sub-Embayment	Farm Neck Inlet	Farm Neck Basin	Majors Cove	Majors Cove	Main Inlet	Ocean Heights	Ocean Heights	Ocean Heights	Trapps Pond
Monitoring station	**Skt-1**	**Skt-2**	**Skt-3**	**Skt-4**	**Skt-5**	**Skt-6**	**Skt-7**	**Skt-8**	**Skt-9**
2003 mean	0.457	0.451	0.554	0.611	0.306	0.365	0.42	0.604	0.607
2004 mean	0.35	0.369	0.416	0.366	0.288	0.315	0.299	0.417	0.413
2005 mean	0.268	0.285	0.351	0.356	0.205	0.268	0.217	0.311	0.396
2006 mean	0.351	0.373	0.421	0.437	0.355	0.319	0.312	0.412	0.516
2007 mean	0.348	0.336	--	0.392	0.257	0.259	0.279	0.38	--
2008 mean	0.402	0.365	0.347	0.373	0.336	0.27	0.429	0.381	0.38
2009 mean	0.295	0.294	0.342	0.347	0.248	0.264	0.263	0.378	0.422
mean	**0.351**	**0.347**	**0.414**	**0.406**	**0.29**	**0.302**	**0.314**	**0.392**	**0.445**
N	24	24	25	25	25	25	27	24	20
model average	0.308	0.32	0.351	0.375	0.299	0.308	0.306	0.331	0.382
2016 mean		**0.459**	**0.545**	**0.437**	**0.316**	**0.299**		**0.445**	**0.509**
2017 mean		0.313	0.437	0.518	0.291	0.256		0.412	0.521

Table 9. Comparison of MEP mean values of TN with summer 2016 data (all values are mg/L) from Sengekontacket Pond. Measured data and modeled Nitrogen concentrations for the Sengekontacket Pond estuarine system used in the model calibration. All concentrations are given in mg/L N. “Data mean” values are calculated as the average of the separate yearly means. Data represented in this table were collected in the summers of 2003 through 2009.

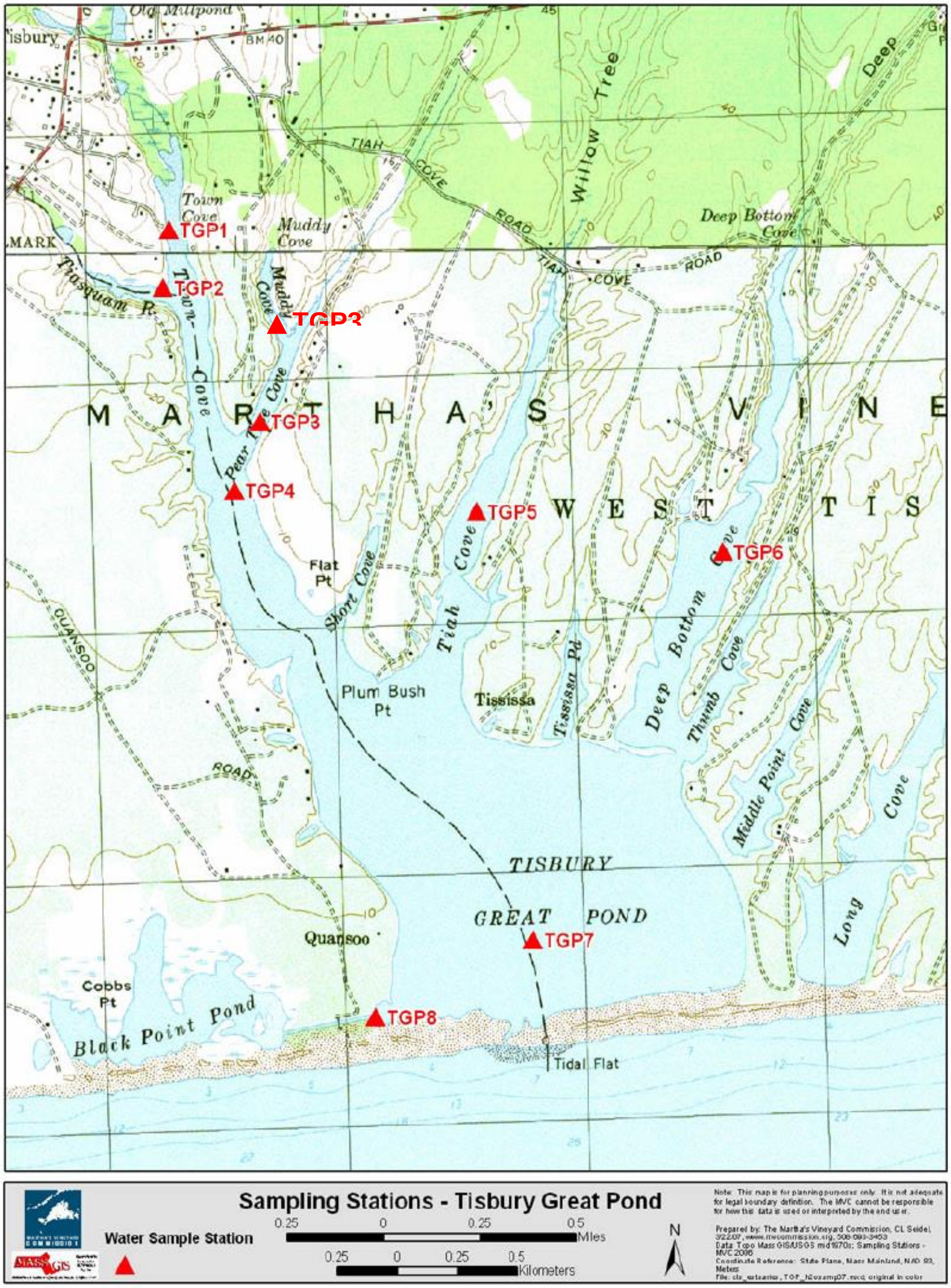


Figure 25. Estuarine water quality monitoring station locations in the Tisbury Great Pond System used to establish the MEP water quality baseline. MEP TN threshold is 0.46 mg/L at MEP "sentinel" station (average TGP-4,5,6) and 0.48 mg/L at TGP-7.

Station Location	Station ID	TN MEP mean (mg/L)	Salinity MEP mean (ppt)	2017 TN mean (mg/L)
Town Cove upper	TGP-1	0.643	9.9	0.950
Tiasquam River	TGP-2	0.563	10.5	--
Pear Tree Cove	TGP3	0.485	12.6	--
Muddy Cove	TGP-3A	0.785	14.7	0.812
Town Cove Mid	TGP-4	0.528	14.7	0.706
Tiah Cove	TGP-5	0.422	12.0	0.735
Deep Bottom Cove	TGP-6	0.536	14.3	0.816
Tisbury Great Pond low	TGP-7	0.509	17.0	0.712
Crab Creek	TGP-8	0.43	13.1	0.730
Tisbury Great Pond mid	TGP-9	0.413	13.2	--
Atlantic Ocean		0.232	32.3	--
NOTE: TN MEP mean data represented in this table were collected from 1995 through 2007 and 2011 in Tisbury Great Pond. The offshore Atlantic Ocean data (offshore Pleasant Bay Inlet) are from the summer of 2005. MEP established "sentinel station" (average of TGP 4,5,6 and TGP7).				

Table 10. Comparison of MEP mean values of TN with summer 2017 data from Tisbury Great Pond. TGP was not sampled in 2016. All values are mg/L for TN, ppt for salinity. “Data mean” values are calculated as the average of the separate yearly means. TN data represented in this table were collected from 1995 through 2007 and 2011 in Great Pond. The offshore Atlantic Ocean data (offshore Pleasant Bay Inlet) are from the summer of 2005.

Figure 26. Estuarine water quality monitoring station locations in the Menemsha and Squibnocket Ponds System used to establish the MEP water quality baseline. MEP TN threshold in Menemsha Pond is 0.35 mg/L at MEP "sentinel" station (avgerage of MEN-4,5,8,9,10) and the MEP TN threshold in Squibnocket Pond is 0.50 mg/L at MEP "sentinel" station (average of SQB-1,2,3,4).

Station Location	Station ID	TN MEP mean (mg/L)	N	MEP Model TN mean (mg/L)	2017 TN mean (mg/L)
Menemsha Creek Low	MEN 1	0.287	23	0.296	--
Menemsha Creek Low	MEN 2	0.341	24	0.304	0.288
Menemsha Main Basin	MEN 3	0.385	29	0.311	0.301
Menemsha Main Basin	MEN 4	0.399	25	0.404	--
Nashaquitsa Mouth	MEN 5	0.338	26	0.335	0.311
Nashaquitsa Basin	MEN 6	0.341	23	0.347	0.405
Stonewall Pond Basin	MEN 7	--	--	--	0.434
Menemsha Main Basin	MEN 8	0.379	23	0.368	--
Menemsha Main Basin	MEN 9	0.386	23	0.358	--
Menemsha Creek	MEN 10	0.351	22	0.308	--
Squibnocket Basin	SQ 1	0.763	20	0.761	0.783
Squibnocket Basin	SQ 2	0.798	22	0.793	--
Squibnocket Basin	SQ 3	0.769	18	0.786	0.754
Squibnocket Basin	SQ 4	0.853	15	0.817	--

NOTE: TN MEP mean data and modeled nitrogen concentrations for the Menemsha and Squibnocket Ponds system are given in mg/L N. “Data mean” values are calculated as the average of all measurements. Data represented in this table were collected in the summers of 2000 through 2012. MEP TN threshold in Menemsha Pond is 0.35 mg/L at MEP "sentinel" station (avgerage of MEN-4,5,8,9,10) and the MEP TN threshold in Squibnocket Pond is 0.50 mg/L at MEP "sentinel" station (average of SQB-1,2,3,4).

Table 11. Comparison of MEP mean values of TN with summer 2017 data from Menemsha Pond and Squibnocket Pond. These ponds were not sampled in 2016. “Data mean” values are calculated as the average of the separate yearly means. TN data represented in this table were collected from the summers of 2000 through 2012.

Table 12. 2017 Trophic Health Index Scores and status for water quality monitoring stations in Martha's Vineyard estuaries based upon open water embayment (not salt marsh) habitat quality scales. Index calculated ***with*** Dissolved Oxygen data (described in Howes et. al., 1999 at www.savebuzzardsbay.org).

EMBAYMENT STATION	YEAR	Secchi SCORE	Low20% Oxsat SCORE	DIN SCORE	TON SCORE	T-Pig SCORE	EUTRO Index	2017 EUTROPHICATION RANKING
CAPE POGUE BAY								
POG2	2017	100.0	79.2	98.9	90.5	83.6	90.4	High
POG3	2017	83.8	65.3	73.5	63.2	67.6	70.7	High
POG4	2017	89.1	69.7	91.2	59.4	45.8	71.0	High
POG5	2017	71.9	62.4	63.9	89.9	62.5	70.1	High
POCHA POND								
PCA1	2017	60.5	60.8	58.7	58.1	71.6	61.9	High-Mod
PCA2	2017	ND	ND	ND	ND	ND	ND	ND
PCA3	2017	59.7	53.4	67.7	62.1	68.7	62.3	High-Mod
KATAMA BAY								
KAT1	2017	93.2	72.8	73.0	100.0	63.4	80.5	High
KAT2	2017	88.2	64.9	64.3	75.8	50.2	68.7	High
KAT3	2017	82.2	68.3	64.9	76.3	60.3	70.4	High
KAT4	2017	89.6	65.5	61.0	76.9	48.9	68.4	High-Mod
KAT5	2017	71.8	76.5	64.4	75.4	37.7	65.2	High-Mod
KAT7	2017	41.9	65.7	72.6	62.7	25.6	53.7	Moderate
EDGARTOWN GREAT POND								
EGP2	2017	90.9	69.8	65.1	50.0	96.0	74.3	High
EGP3	2017	88.7	77.0	69.3	38.1	59.6	66.5	High-Mod
EGP4	2017	78.2	65.3	54.0	70.7	100.0	73.7	High
EGP5	2017	82.4	66.3	53.0	34.6	100.0	67.2	High-Mod
EGP6	2017	82.0	76.1	76.3	63.4	100.0	79.6	High
EGP7	2017	91.4	66.8	64.5	76.1	100.0	79.8	High
EGP9	2017	74.6	56.8	65.5	56.4	74.7	65.6	High-Mod
EGP10	2017	67.8	65.1	63.0	56.7	70.7	64.7	High-Mod
EGP11	2017	46.0	65.1	56.6	83.2	96.2	69.4	High
CHILMARK POND								
CHP UP	2017	44.5	92.5	85.3	14.6	0.0	47.4	Moderate
CHP7	2017	ND	ND	ND	ND	ND	ND	Moderate
CHP6	2017	7.3	44.0	33.6	32.2	15.5	26.5	Fair-Poor
CHP5	2017	64.6	66.9	15.8	29.1	46.0	44.5	Moderate
CHP4	2017	54.7	65.8	29.9	34.2	58.1	48.5	Moderate
CHP2	2017	59.4	75.3	12.2	25.9	28.6	40.3	Moderate
CHP1	2017	40.1	55.7	34.6	4.6	0.0	27.0	Fair-Poor
OAK BLUFFS HARBOR								
MV14	2017	10.9	55.9	31.9	65.7	48.7	42.6	Moderate
MV15	2017	59.8	70.7	70.2	59.9	20.5	56.2	Moderate
MV16	2017	98.0	70.9	80.1	82.6	37.5	73.8	High
FARM POND								
FRM1	2017	21.3	50.1	81.8	30.6	19.5	40.7	Moderate
FRM2	2017	23.3	45.1	75.7	51.5	59.7	51.1	Moderate
FRM3	2017	38.1	19.0	76.2	3.2	0.0	27.3	Fair-Poor

Table 12 cont'd. 2017 Trophic Health Index Scores and status for water quality monitoring stations in

Martha's Vineyard estuaries based upon open water embayment (not salt marsh) habitat quality scales. Index calculated ***with*** Dissolved Oxygen data (described in Howes et. al., 1999 at www.savebuzzardsbay.org).

EMBAYMENT STATION	YEAR	Secchi SCORE	Low20% Oxsat SCORE	DIN SCORE	TON SCORE	T-Pig SCORE	EUTRO Index	2017 EUTROPHICATION RANKING
SENGEKONTACKET POND								
SKT2	2017	64.3	66.8	100.0	89.6	79.6	80.1	High
SKT3	2017	77.5	58.0	100.0	43.6	0.0	55.8	Moderate
SKT4	2017	44.0	74.6	100.0	20.7	0.0	47.9	Moderate
SKT5	2017	85.5	77.4	100.0	100.0	78.6	88.3	High
SKT6	2017	82.9	62.9	100.0	100.0	90.6	87.3	High
SKT8	2017	66.7	59.4	100.0	53.1	0.0	55.9	Moderate
SKT9	2017	22.5	51.9	100.0	20.5	0.6	39.1	Moderate
FRESH POND								
FRS1	2017	ND	ND	ND	ND	ND	ND	ND
FRS2	2017	ND	ND	ND	ND	ND	ND	ND
FRS3	2017	ND	ND	ND	ND	ND	ND	ND
LOOKS POND								
LOOK4	2017	0.0	100.0	93.2	79.3	40.6	62.6	High-Mod
LAGOON POND								
LGP11	2017	53.3	54.6	0.0	10.7	0.0	23.7	Fair-Poor
LGP12	2017	ND	ND	ND	ND	ND	ND	ND
LGP2	2017	98.7	8.9	100.0	75.6	36.1	63.9	High-Mod
LGP4	2017	95.3	0.0	95.2	73.0	29.3	58.6	Moderate
LGP6	2017	ND	ND	ND	ND	ND	40.0	Moderate
LGP8	2017	97.1	67.9	100.0	82.8	69.3	83.4	High
LGP9	2017	100.0	71.4	100.0	99.4	71.9	88.5	High
LAKE TASHMOO								
MV21	2017	29.4	78.4	100.0	100.0	100.0	81.6	High
MV2	2017	100.0	60.8	100.0	100.0	95.7	91.3	High
MV3	2017	90.1	61.9	100.0	84.1	66.1	80.4	High
MV4	2017	85.0	63.6	100.0	72.7	37.3	71.7	High
MVSEN	2017	80.7	47.0	100.0	68.3	8.3	60.8	High-Mod
TISBURY GREAT POND								
TGP1	2017	10.3	47.2	73.8	0.0	0.0	26.3	Fair-Poor
TGP3A	2017	3.4	51.8	100.0	0.0	0.0	31.0	Mod-Fair
TGP4	2017	48.6	50.8	100.0	0.0	0.0	39.9	Moderate
TGP5	2017	29.1	88.2	100.0	0.0	0.0	43.5	Moderate
TGP6	2017	30.2	13.0	100.0	0.0	0.0	28.6	Fair-Poor
TGP7	2017	48.5	78.0	100.0	0.0	0.0	45.3	Moderate
TGP8	2017	29.1	80.5	100.0	0.0	0.0	41.9	Moderate
MENEMSHA POND								
MEN2	2017	100.0	84.0	94.2	100.0	81.3	91.9	High
MEN3	2017	100.0	71.8	100.0	94.4	67.0	86.6	High
MEN5	2017	82.0	86.3	100.0	91.1	75.6	87.0	High
MEN6	2017	70.2	74.3	100.0	55.4	58.7	71.7	High
MEN7	2017	60.5	56.4	76.4	49.9	50.5	58.7	Moderate
SQUIBNOCKET POND								
SQB1	2017	95.4	78.8	100.0	0.0	6.2	56.1	Moderate
SQB3	2017	74.8	99.0	96.0	0.0	16.2	57.2	Moderate
JAMES POND								
JMS1	2017	0.0	57.6	43.4	0.0	25.3	25.3	Fair-Poor
JMS3	2017	47.2	85.7	74.8	12.3	0.0	44.0	Moderate
JMS4	2017	25.2	59.9	100.0	11.9	3.1	40.0	Moderate

	YEAR	Secchi SCORE	Low20% Oxsat SCORE	DIN SCORE	TON SCORE	T-Pig SCORE	EUTRO Index	2016 EUTROPHICATION RATING
POG2	2016	93.0	72.6	100.0	80.6	100.0	89.2	High
POG3	2016	82.1	50.9	75.4	7.6	100.0	63.2	High-Moderate
POG4	2016	87.1	66.3	90.9	57.2	100.0	80.3	High
POG5	2016	68.8	53.3	86.8	29.2	100.0	67.6	High-Moderate
PCA1	2016	35.9	56.0	76.7	44.7	100.0	62.7	High-Moderate
PCA2	2016	68.3	72.4	100.0	60.5	100.0	80.2	High
PCA3	2016	55.9	52.2	75.8	27.4	100.0	62.3	High-Moderate
KAT1	2016	100.0	67.7	93.0	76.5	100.0	87.4	High
KAT2	2016	95.9	65.7	90.5	64.1	100.0	83.2	High
KAT3	2016	41.1	60.9	96.7	66.7	100.0	73.1	High
KAT4	2016	74.8	66.5	76.5	50.6	92.7	72.2	High
KAT5	2016	68.3	64.9	89.0	52.2	85.5	72.0	High
KAT7	2016	47.2	59.6	100.0	39.0	71.4	63.5	High-Moderate
EGP2	2016	85.6	64.5	58.7	19.8	100.0	65.7	High-Moderate
EGP3	2016	91.7	62.1	76.3	26.3	100.0	71.3	High
EGP4	2016	66.5	59.0	49.0	37.6	100.0	62.4	High-Moderate
EGP5	2016	81.4	65.4	67.6	20.2	100.0	66.9	High-Moderate
EGP6	2016	82.8	60.5	80.5	20.6	100.0	68.9	High-Moderate
EGP7	2016	92.6	58.0	60.8	22.3	100.0	66.8	High-Moderate
EGP9	2016	70.8	60.6	78.5	39.0	100.0	69.8	High
EGP10	2016	68.3	54.0	74.4	31.2	100.0	65.6	High-Moderate
EGP11	2016	60.9	47.6	42.8	24.9	100.0	55.2	Moderate
CHP UP	2016	15.9	83.6	100.0	0.0	0.0	39.9	Moderate
CHP7	2016	11.0	0.0	75.0	0.0	0.0	17.2	Fair/Poor
CHP6	2016	21.6	59.8	80.0	0.0	23.5	37.0	Mod-Fair
CHP5	2016	41.8	67.1	100.0	0.0	51.1	52.0	Moderate
CHP4	2016	37.0	71.2	100.0	0.0	70.6	55.7	Moderate
CHP2	2016	41.0	64.0	100.0	0.0	33.8	47.7	Moderate
CHP1	2016	25.2	58.1	100.0	0.0	1.7	37.0	Moderate-Fair
MV14	2016	24.9	31.7	59.2	44.5	84.3	48.9	Moderate
MV15	2016	67.8	56.4	80.3	53.6	94.6	70.5	High
MV16	2016	96.0	62.7	92.3	95.8	100.0	89.3	High
FRM1	2016	17.1	54.2	92.8	49.7	100.0	62.8	High-Moderate
FRM2	2016	29.7	23.6	100.0	37.2	100.0	58.1	Moderate
FRM3	2016	42.9	6.4	100.0	15.4	90.7	51.1	Moderate

Table 13. 2016 Trophic Health Index Scores and status for water quality monitoring stations in Martha's Vineyard estuaries based upon open water embayment (not salt marsh) habitat quality scales. Index calculated *with* Dissolved Oxygen data (described in Howes et. al., 1999 at www.savebuzzardsbay.org).

EMBAYMENT STATION	YEAR	Secchi SCORE	Low20% Oxsat SCORE	DIN SCORE	TON SCORE	T-Pig SCORE	EUTRO Index	2016 EUTROPHICATION RATING
SKT2	2016	70.8	51.4	92.9	39.9	100.0	71.0	High
SKT3	2016	85.3	42.8	92.3	16.7	89.7	65.4	High-Moderate
SKT4	2016	53.2	39.9	88.2	47.2	100.0	65.7	High-Moderate
SKT5	2016	44.8	60.4	100.0	89.2	100.0	78.9	High
SKT6	2016	82.6	55.7	95.1	98.7	100.0	86.4	High
SKT8	2016	72.7	54.2	100.0	43.2	100.0	74.0	High
SKT9	2016	0.0	29.3	67.6	29.6	100.0	45.3	Moderate
FRS1	2016	72.6	65.3	100.0	19.3	100.0	71.4	High
FRS2	2016	67.6	66.8	100.0	15.6	100.0	70.0	High
FRS3	2016	74.0	66.8	100.0	26.5	100.0	73.5	High
LGP11	2016	26.9	0.0	0.0	0.0	0.0	5.4	Fair/Poor
LGP12	2016	0.0	0.0	0.0	0.0	0.0	0.0	Fair/Poor
LGP2	2016	94.0	0.0	99.8	47.4	76.2	63.5	High-Moderate
LGP4	2016	93.2	0.0	100.0	38.6	75.0	61.4	High-Moderate
LGP6	2016	80.5	6.0	76.9	67.5	100.0	66.2	High-Moderate
LGP8	2016	97.5	50.8	100.0	62.2	88.0	79.7	High
LGP9	2016	100.0	43.5	100.0	88.6	100.0	86.4	High
MV21	2016	18.8	70.0	99.3	100.0	100.0	77.6	High
MV2	2016	95.7	62.6	99.3	81.8	100.0	87.9	High
MV3	2016	87.7	59.5	100.0	74.7	100.0	84.4	High
MV4	2016	91.1	60.4	99.9	74.3	100.0	85.2	High
MVSEN	2016	74.8	53.1	88.1	33.8	57.3	61.4	High-Moderate

Table 13 cont'd. 2016 Trophic Health Index Scores and status for water quality monitoring stations in Martha's Vineyard estuaries based upon open water embayment (not salt marsh) habitat quality scales. Index calculated *with* Dissolved Oxygen data (described in Howes et. al., 1999 at www.savebuzzardsbay.org).

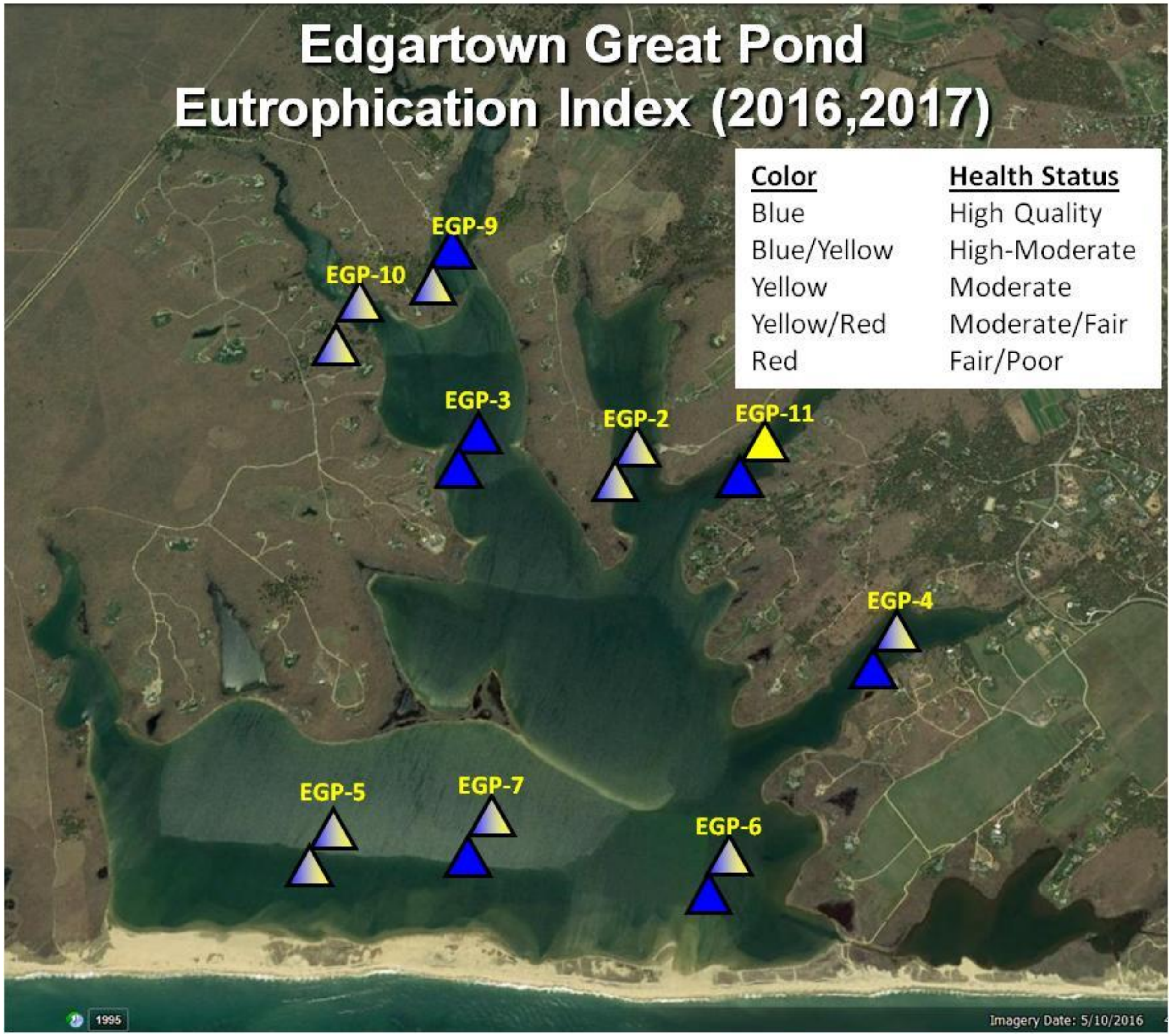


Figure 27. Edgartown Great Pond Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

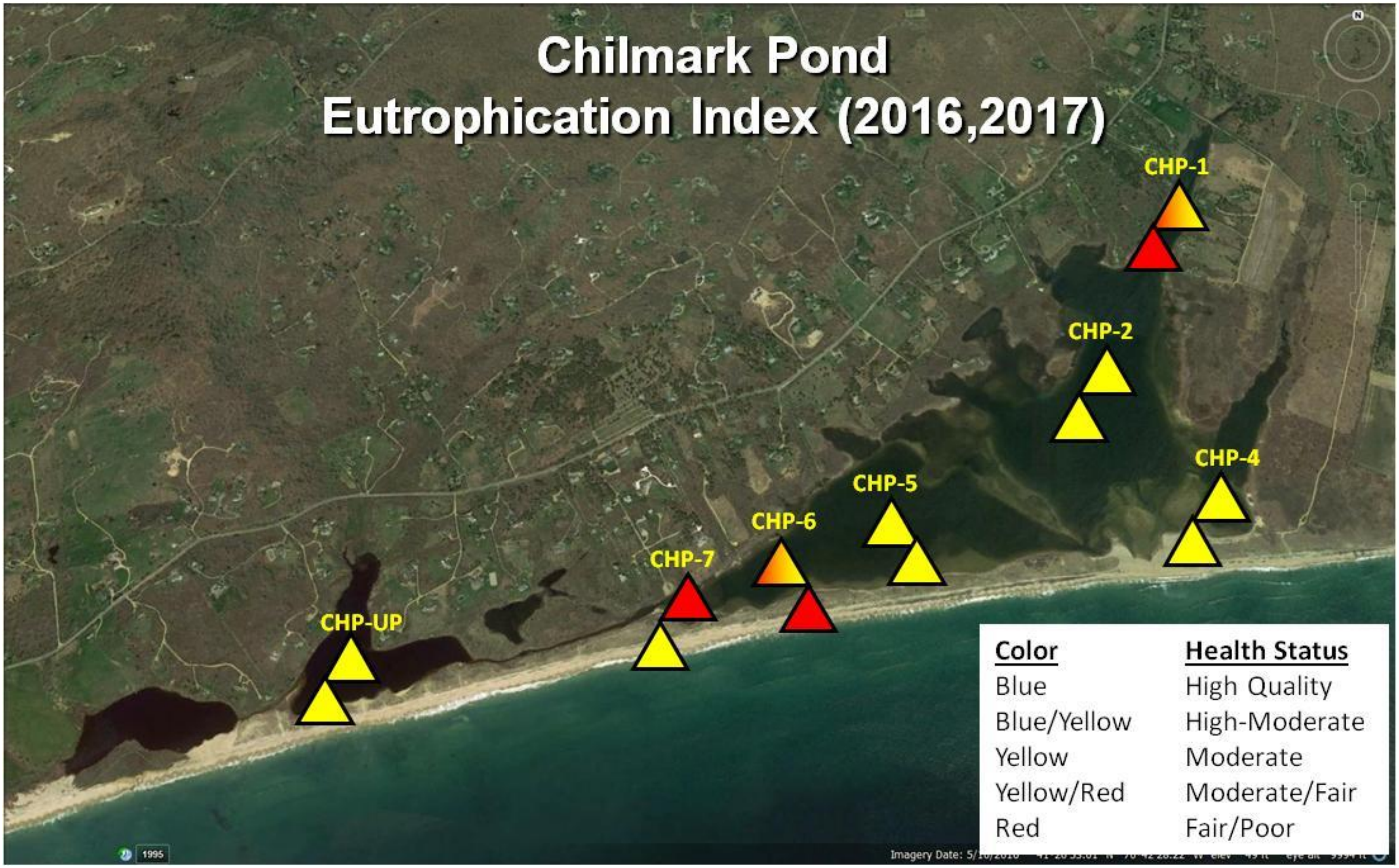


Figure 28. Chilmark Pond Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

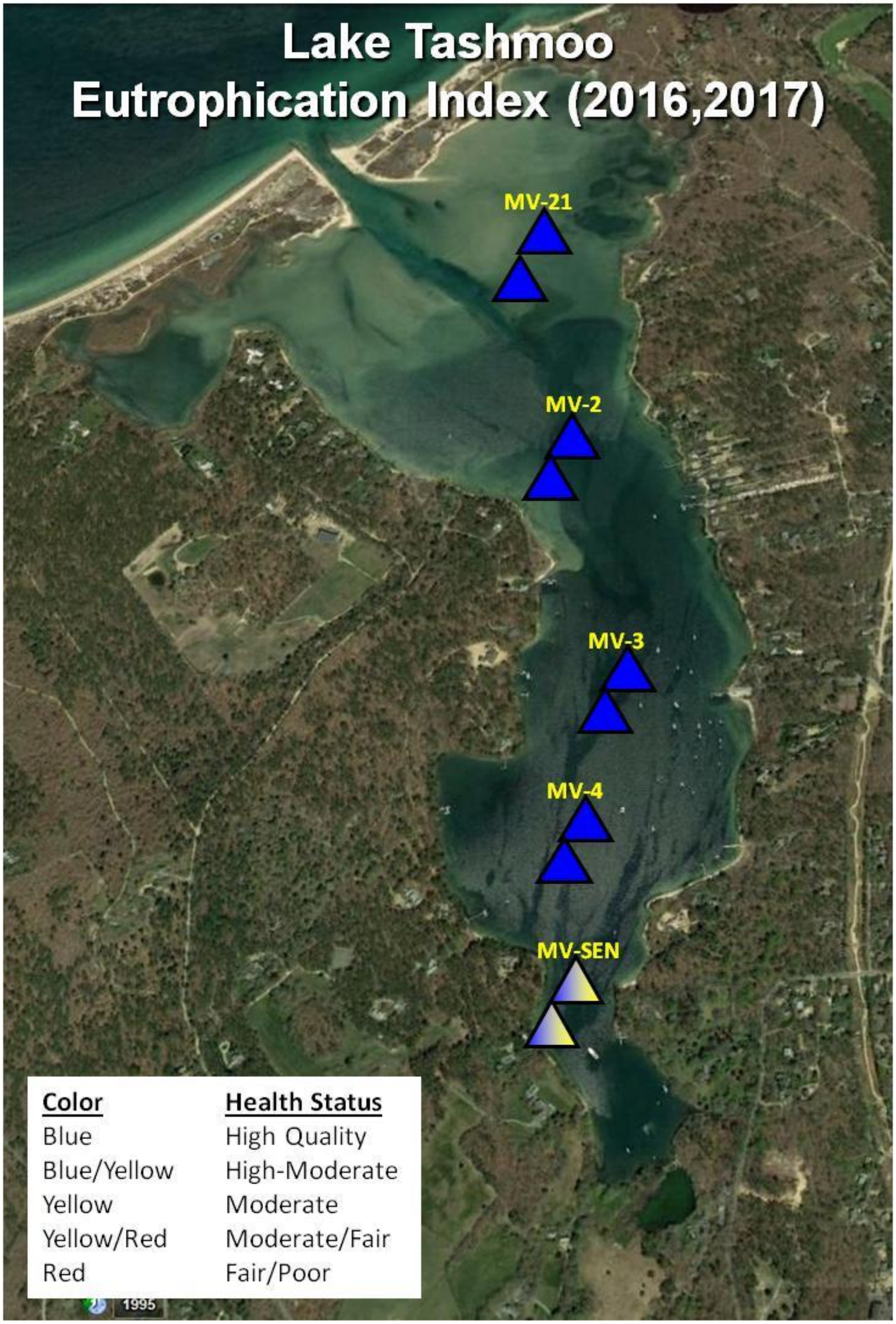


Figure 29. Lake Tashmoo Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality

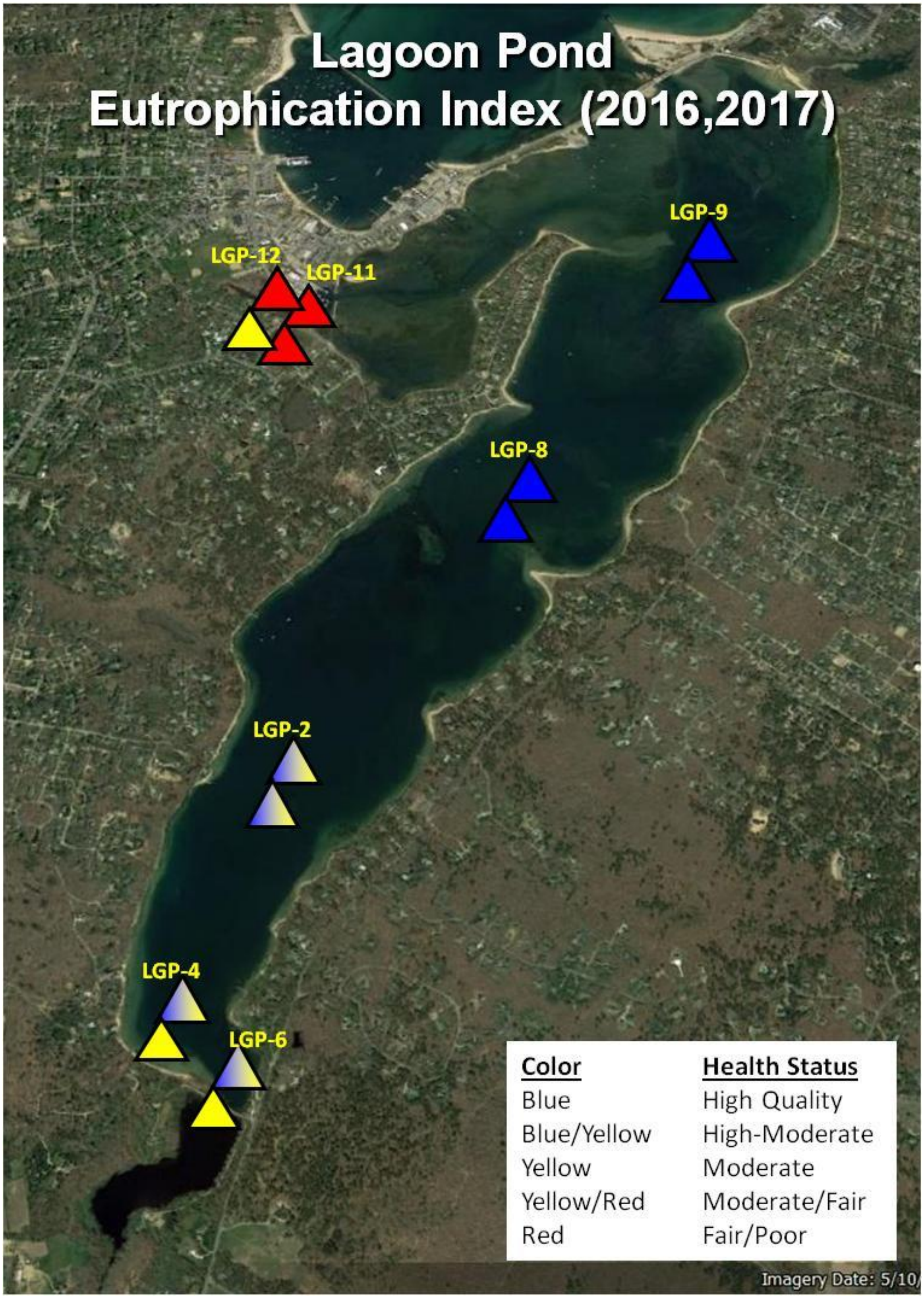


Figure 30. Lagoon Pond Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality

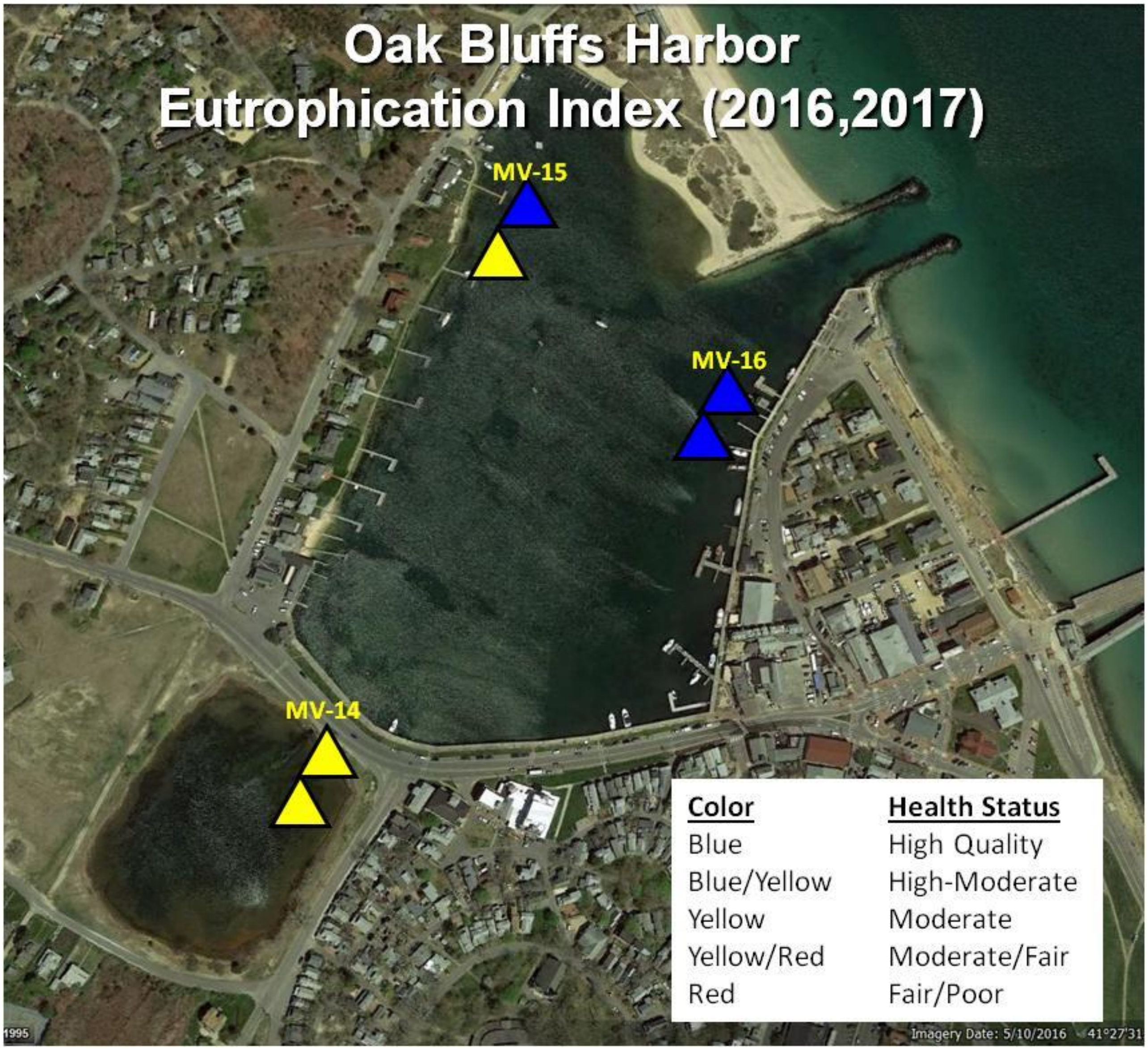


Figure 31. Oak Bluffs Harbor Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

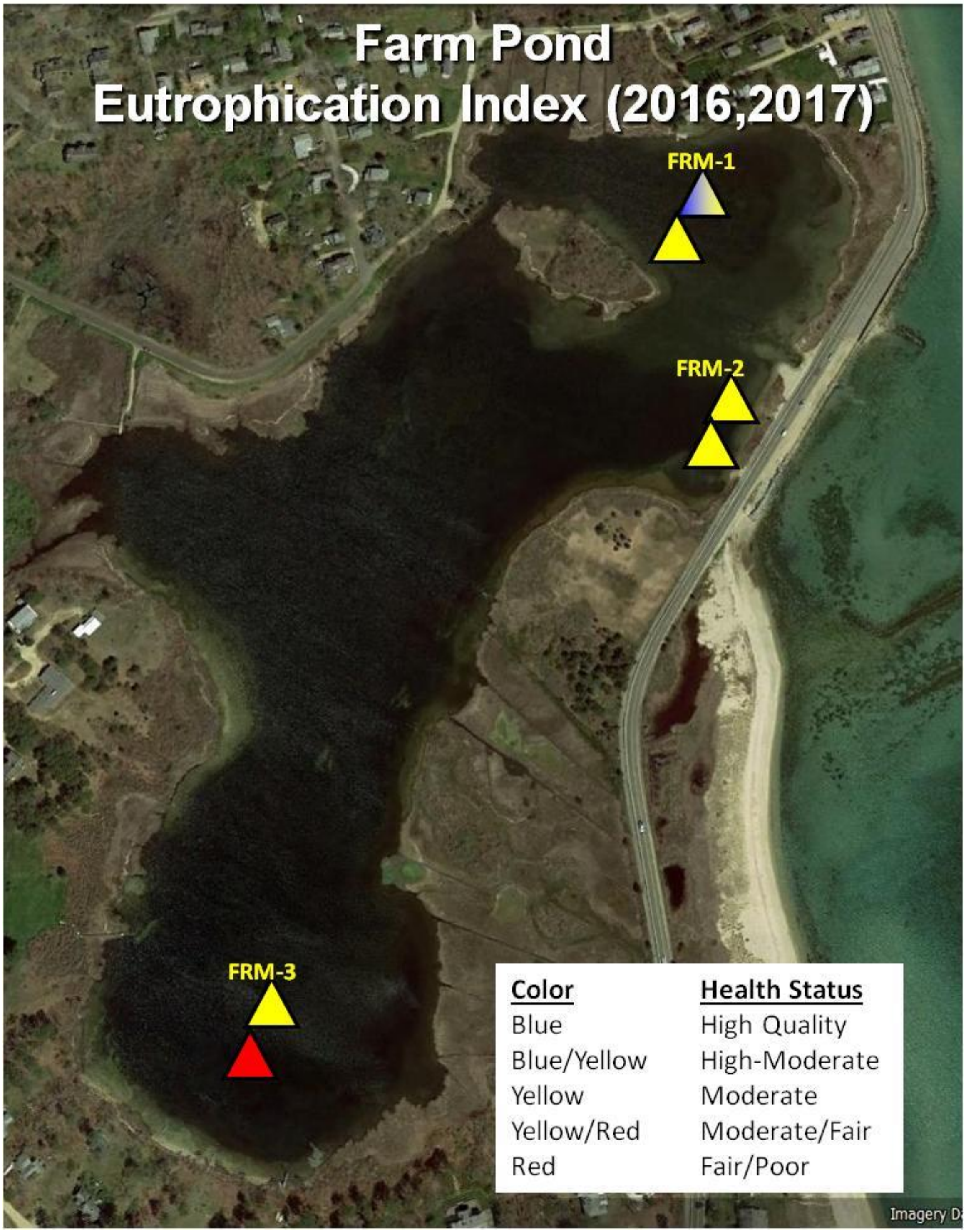


Figure 32. Farm Pond Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

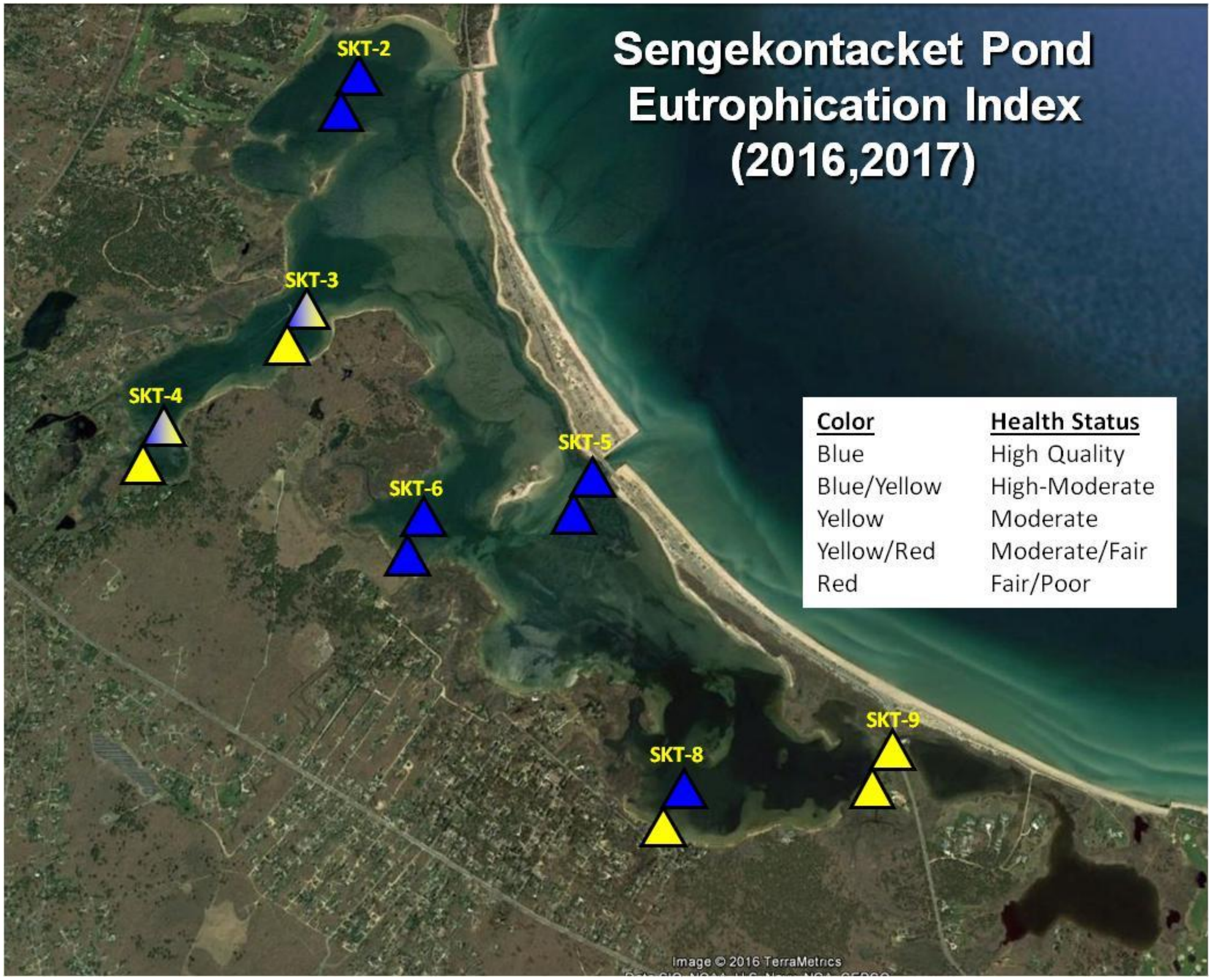


Figure 33. Sengekontacket Pond Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

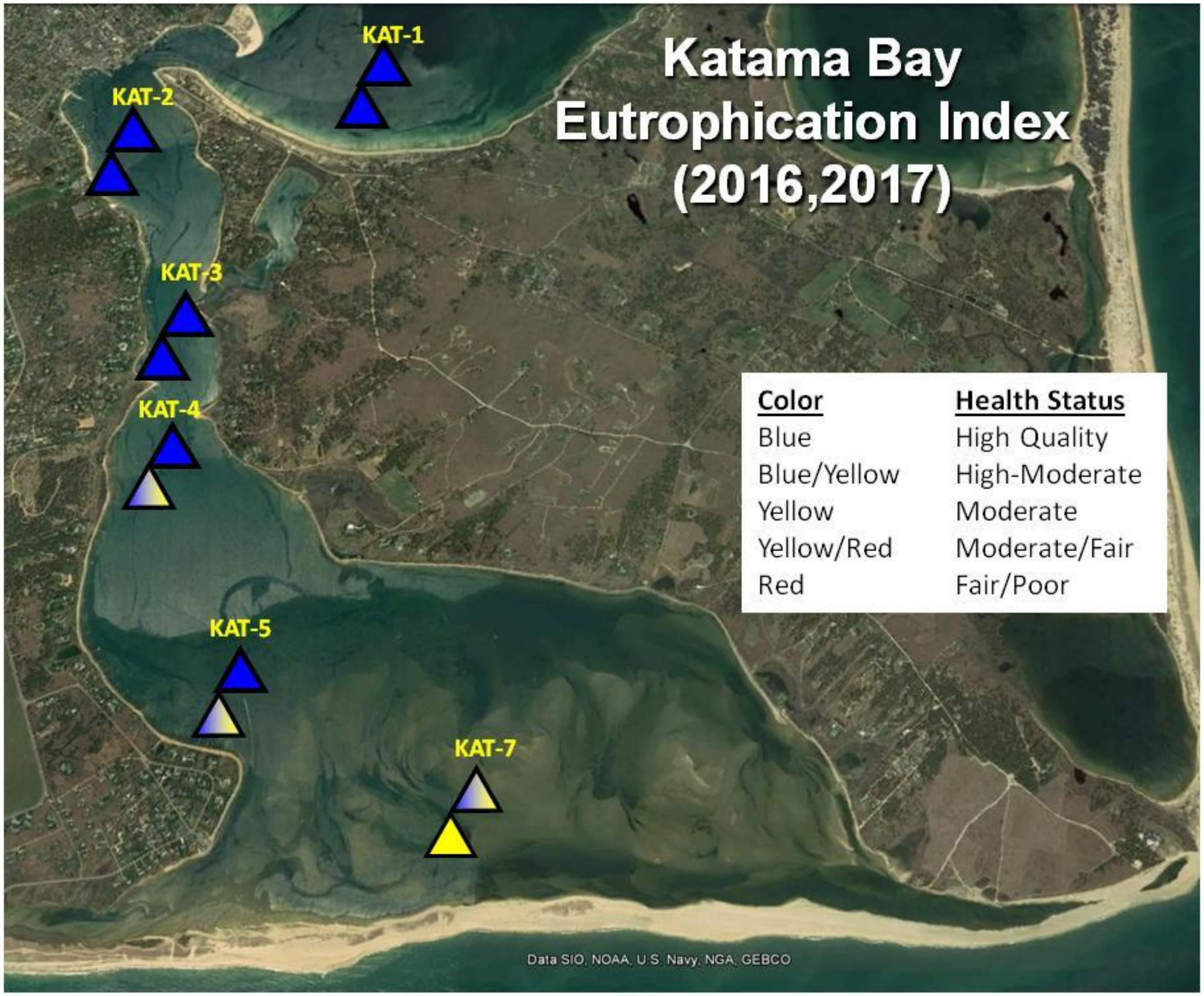


Figure 34. Katama Bay Eutrophication Index2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

Figure 35. Cape Pogue Bay Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

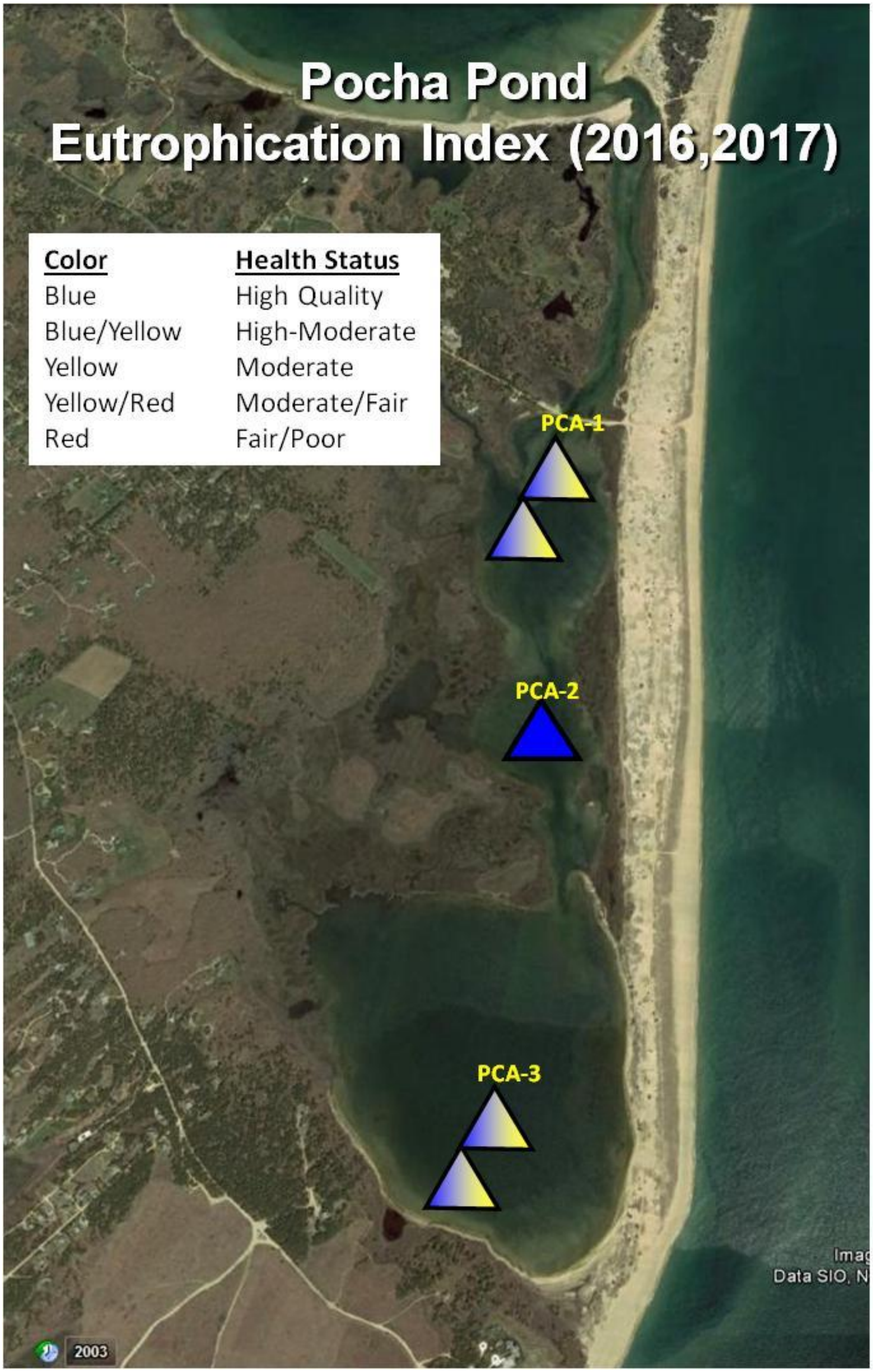


Figure 36. Pocha Pond Eutrophication Index 2016 (upper triangle) and 2017 (lower triangle). Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

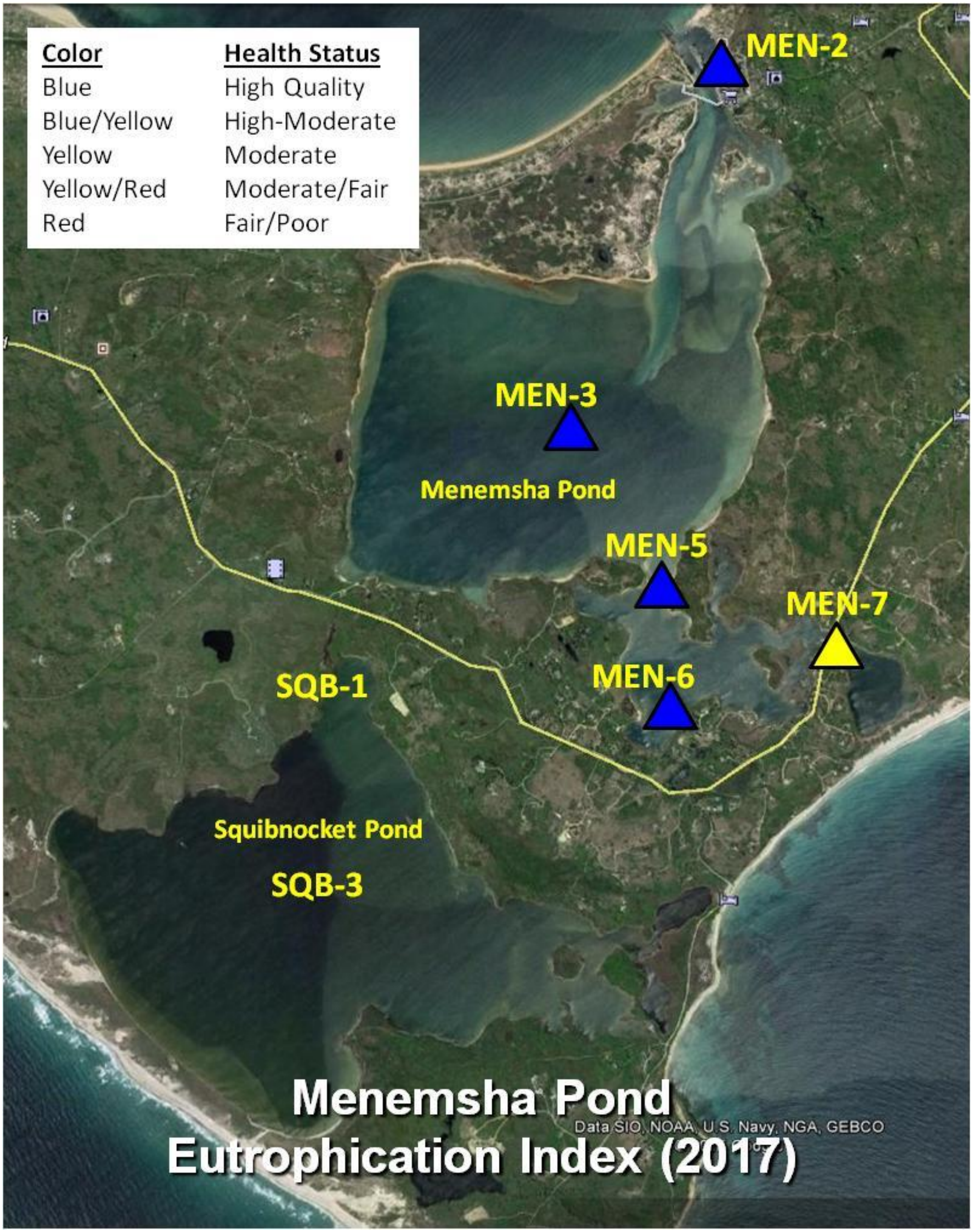


Figure 37a. Menemsha Pond Eutrophication Index 2017. Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

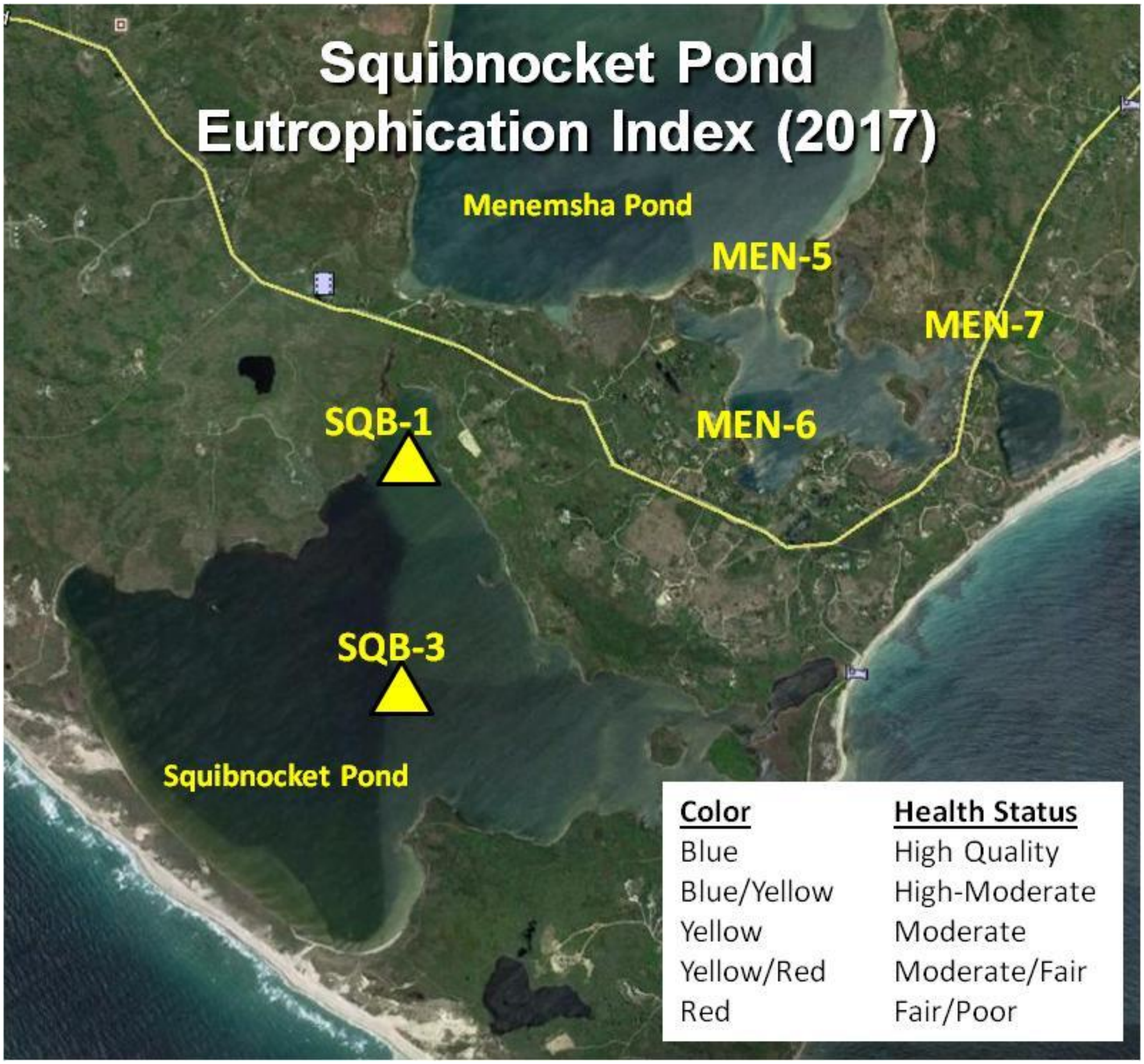


Figure 37b. Squibnocket Pond Eutrophication Index 2017. Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

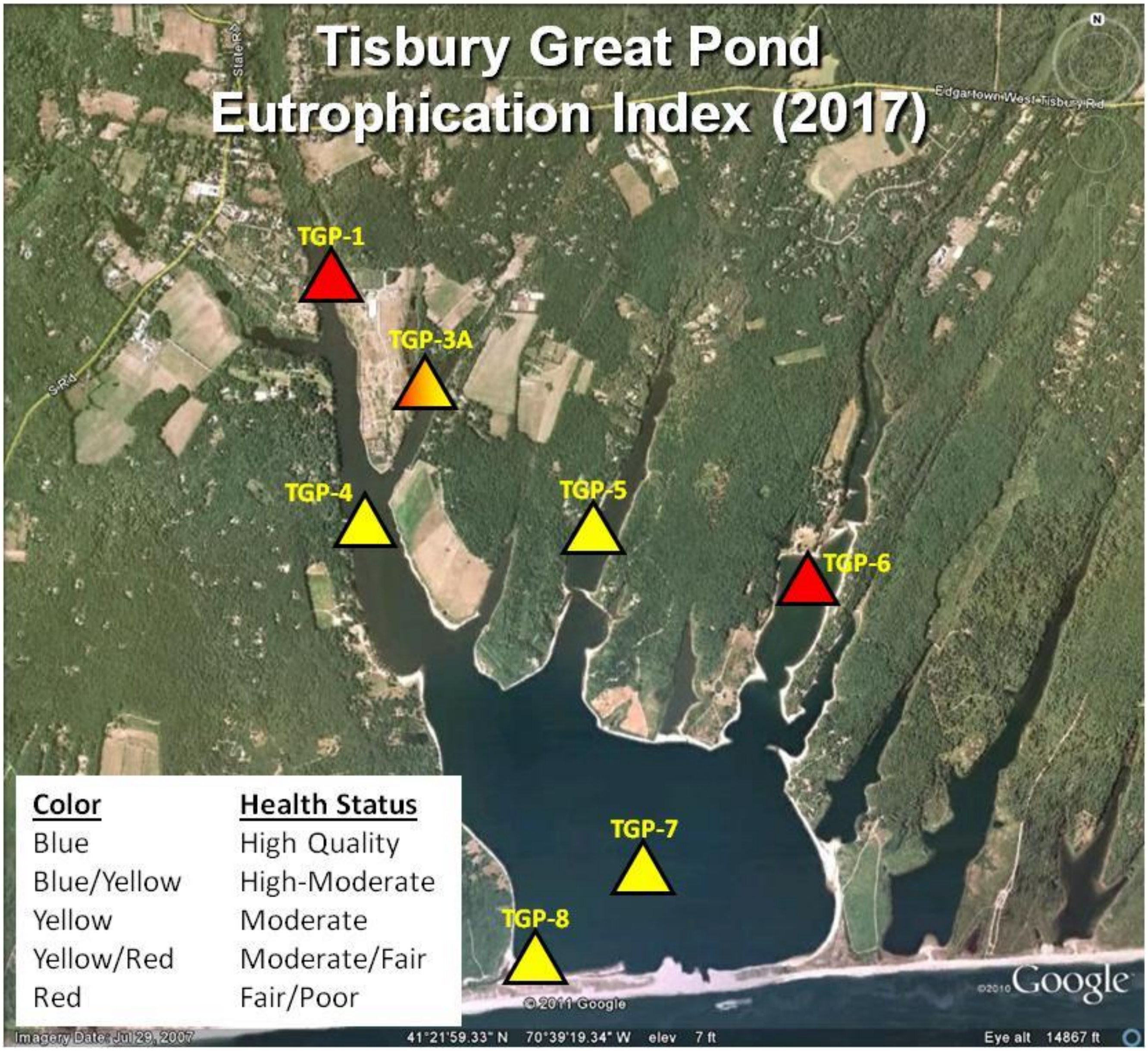


Figure 38. Tisbury Great Pond Eutrophication Index 2017. Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

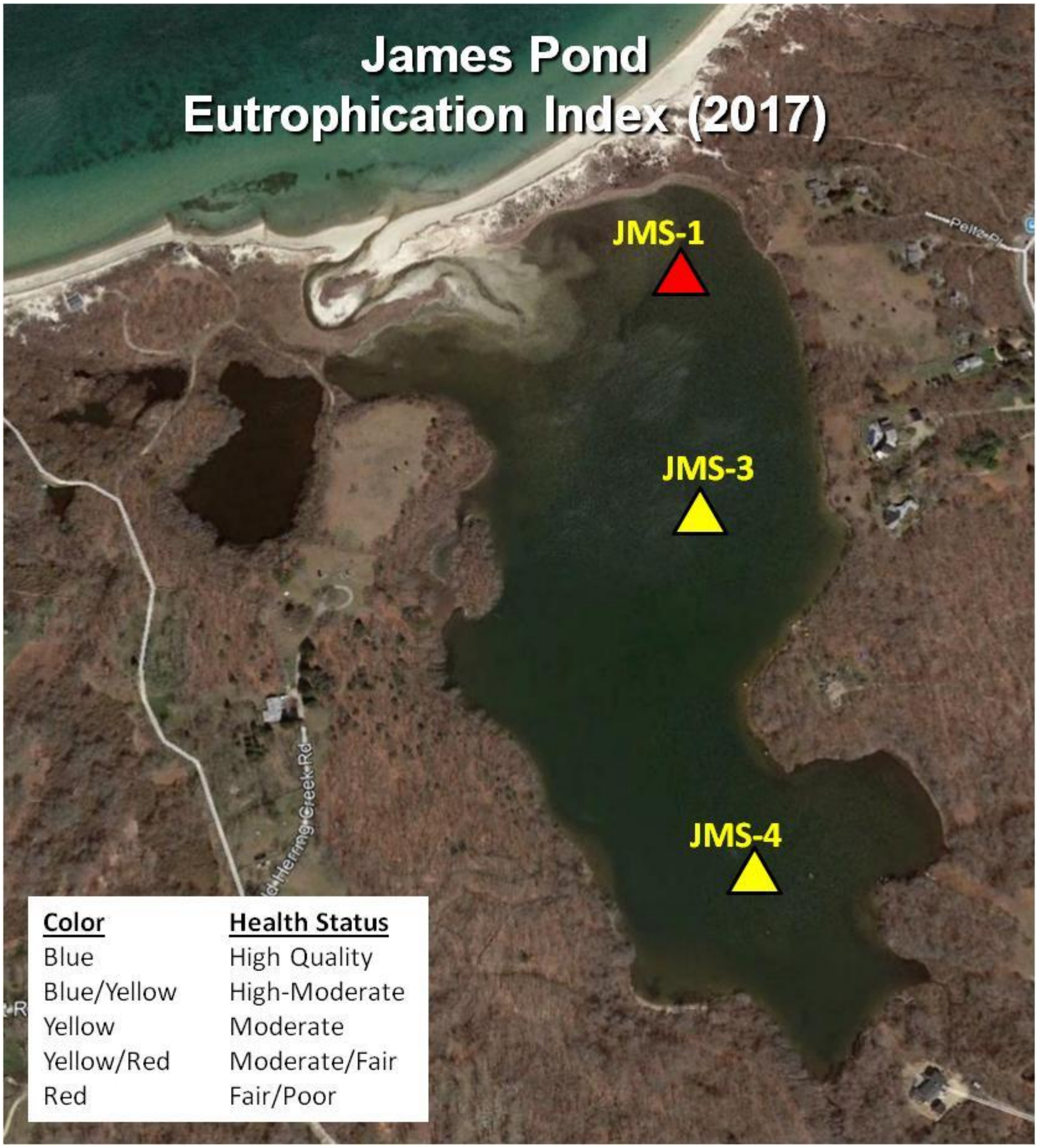
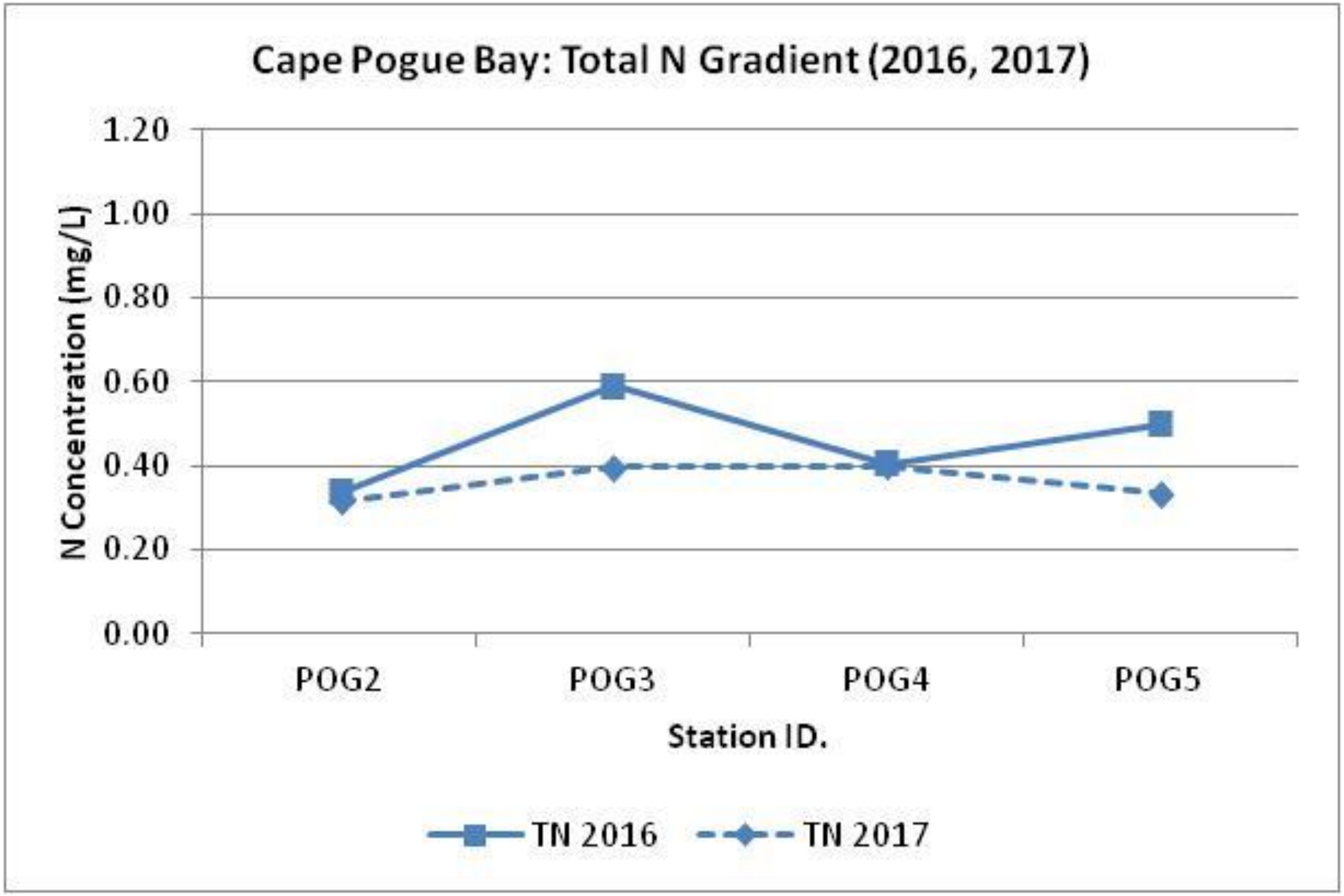
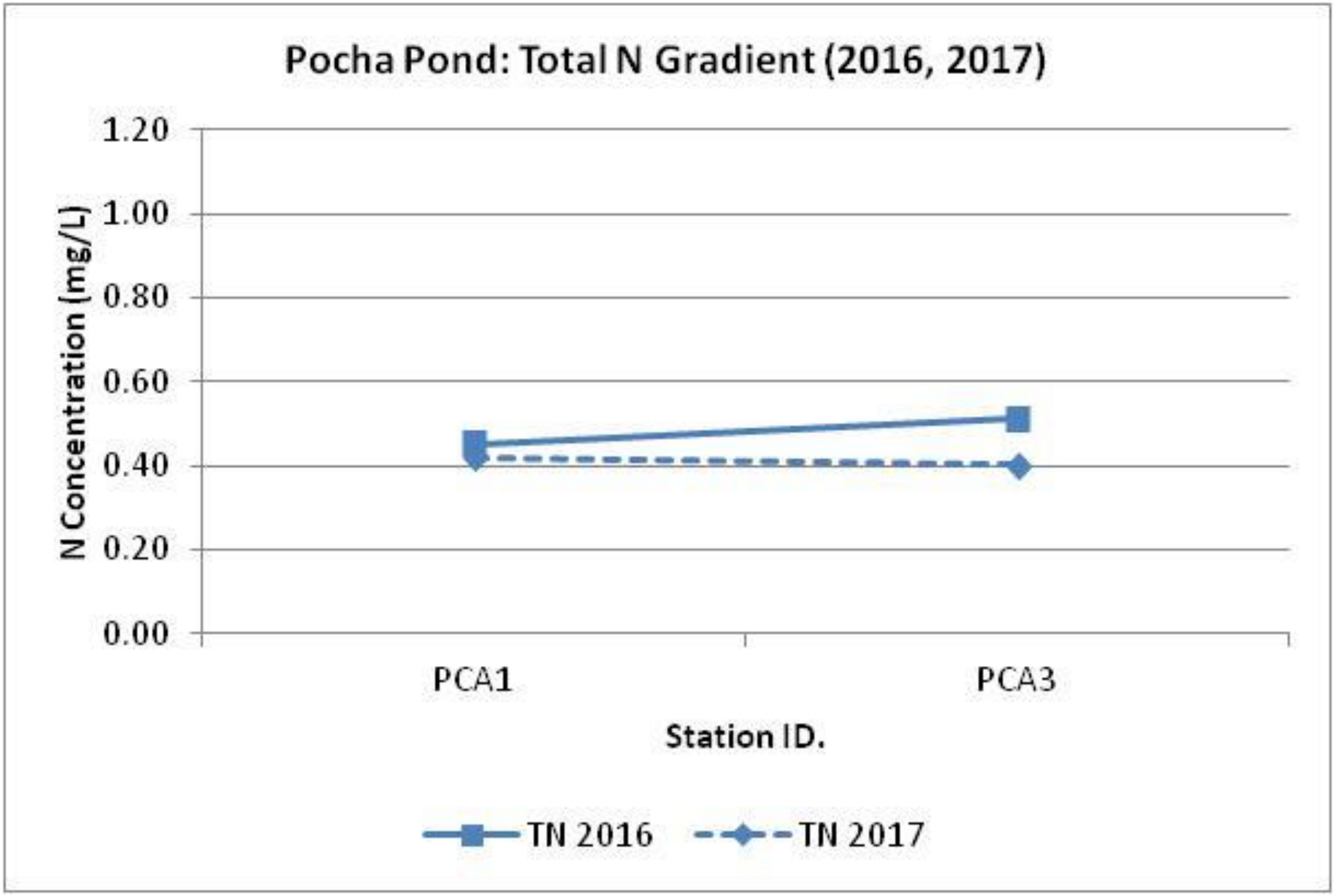


Figure 39. James Pond Eutrophication Index 2017. Colors indicate High (Blue), Moderate (Yellow), Fair/Poor (Red) nutrient related water quality.

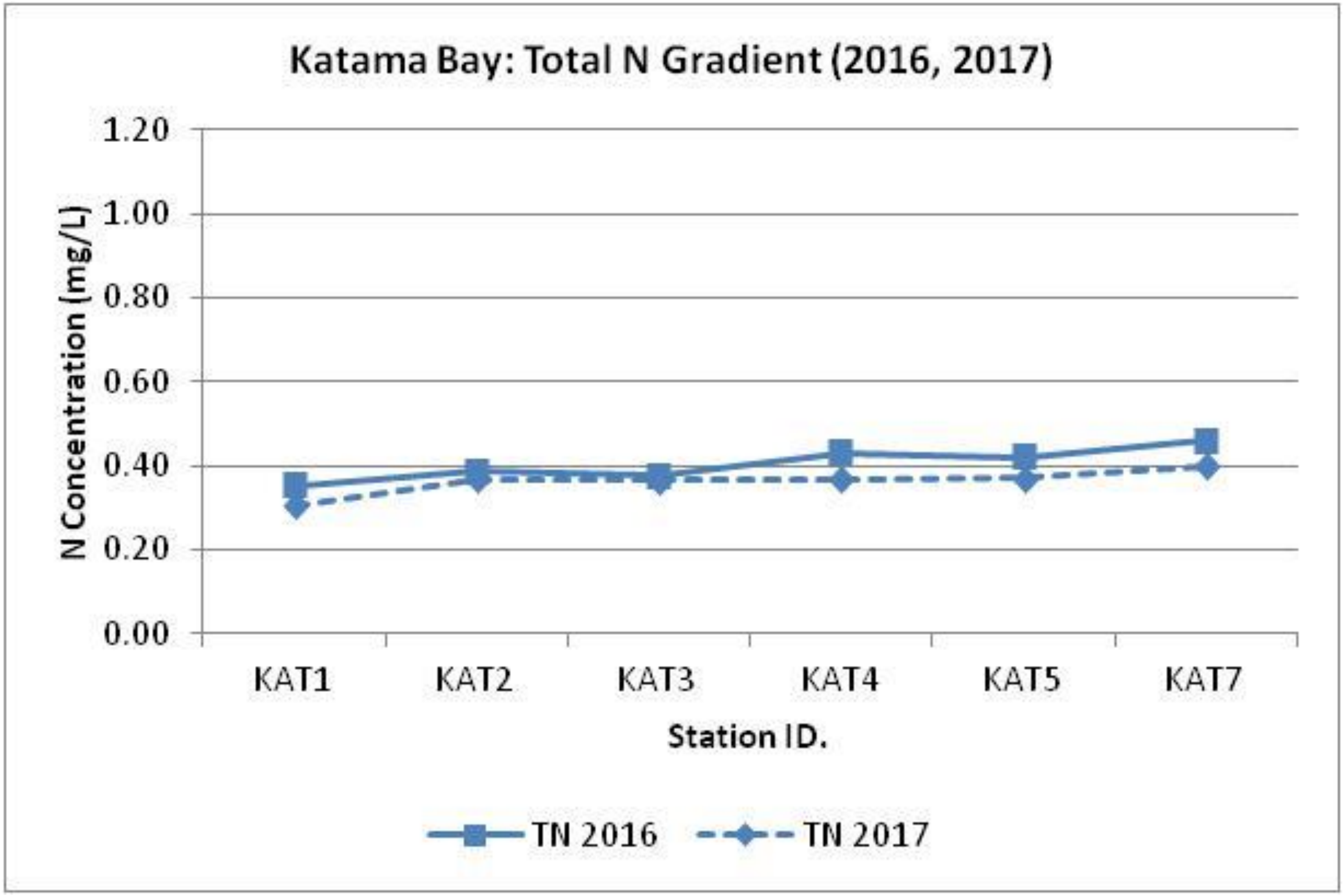
APPENDIX A

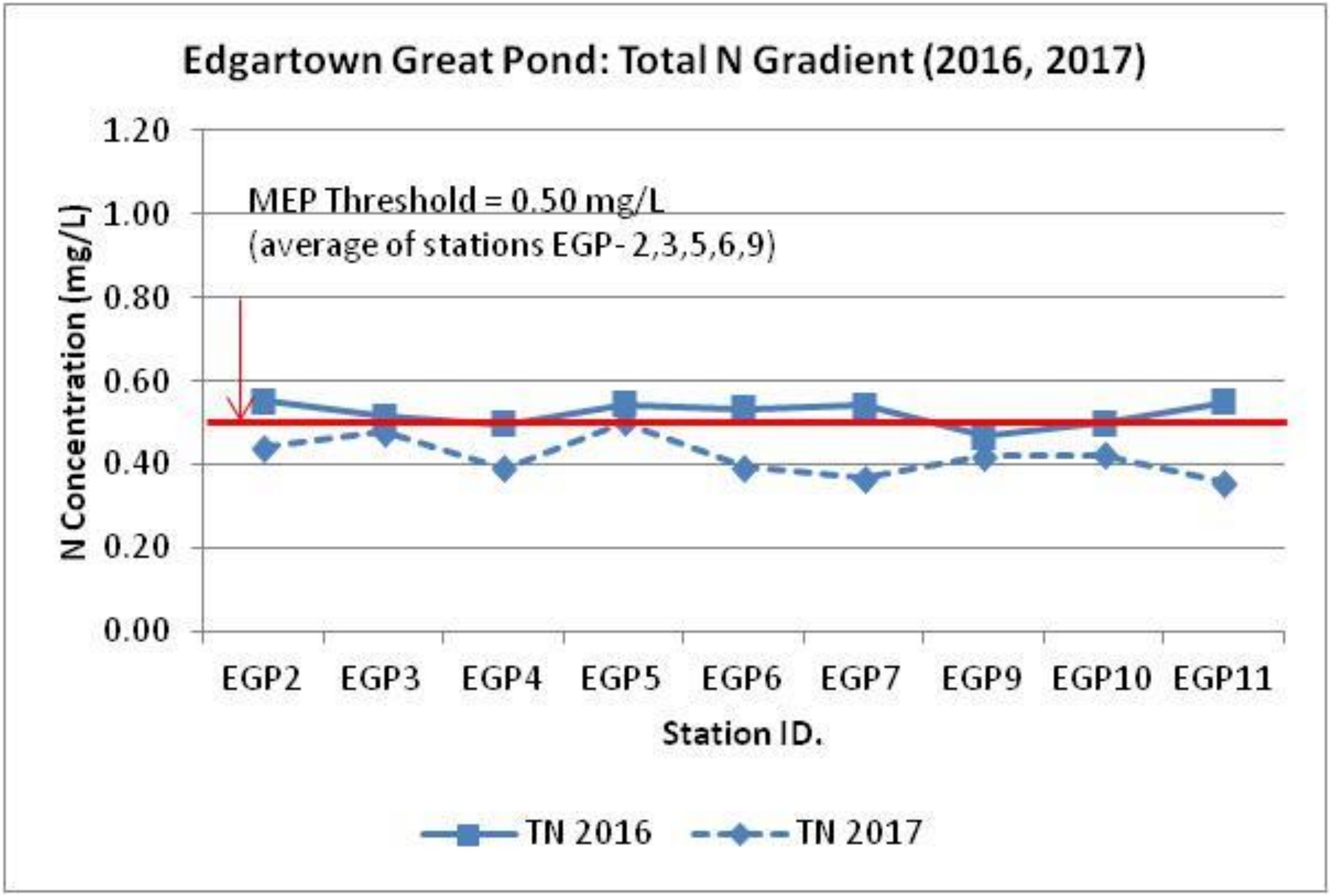
TN PLOTS (2016, 2017)

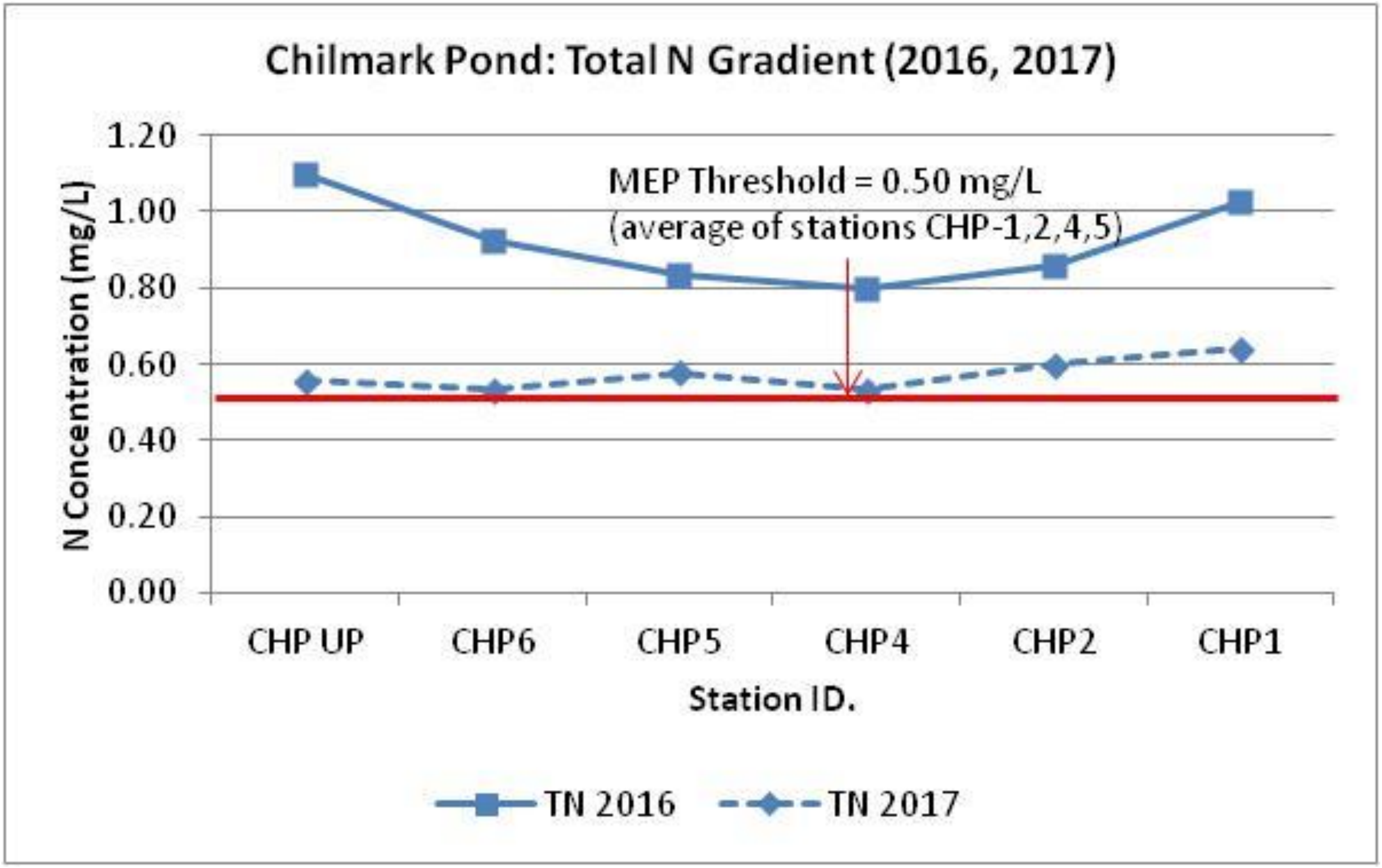

Cape Pogue Bay: Total N Gradient (2016, 2017)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
POG2
POG3
POG4
POG5
Station ID.
TN 2016
TN 2017

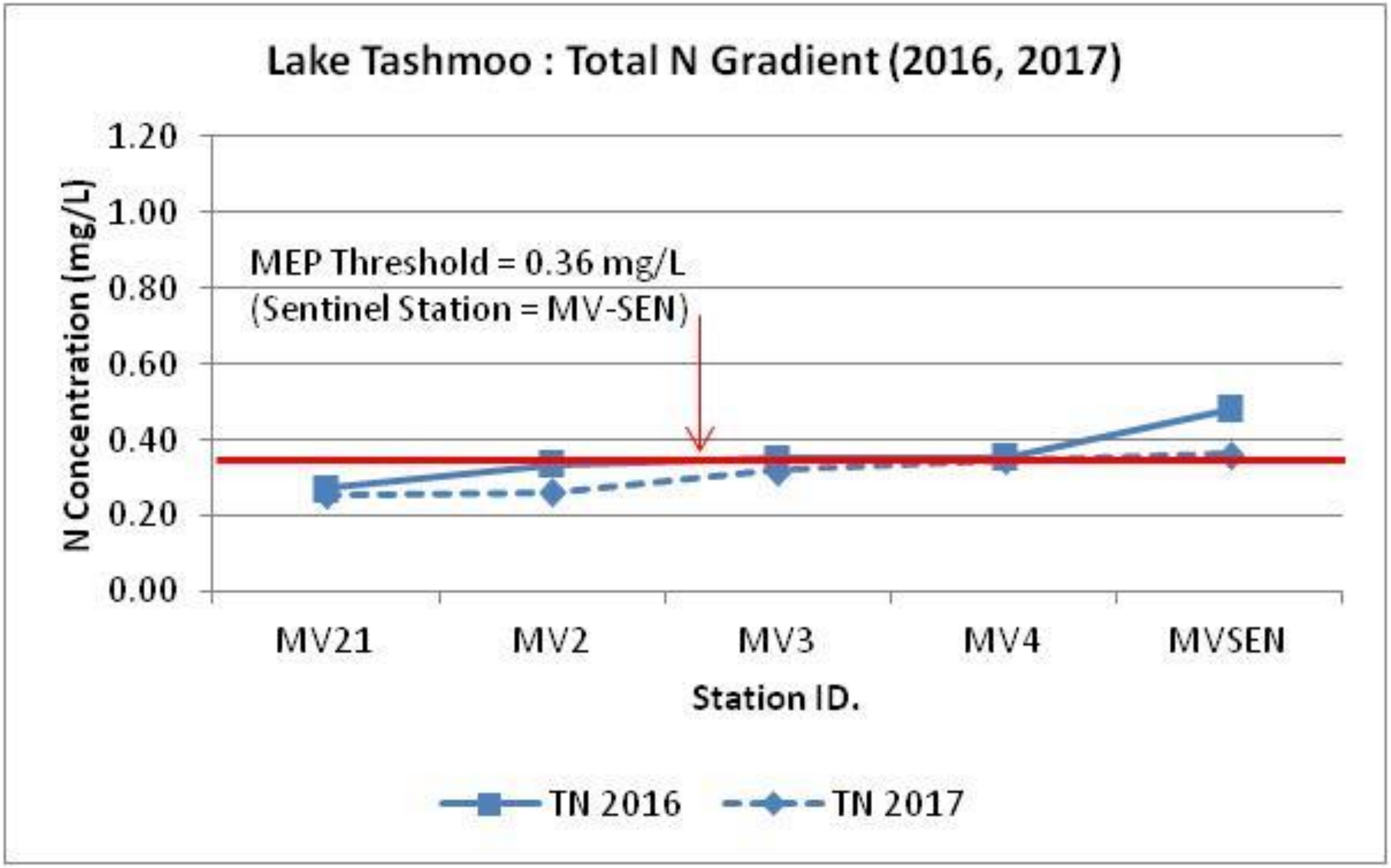


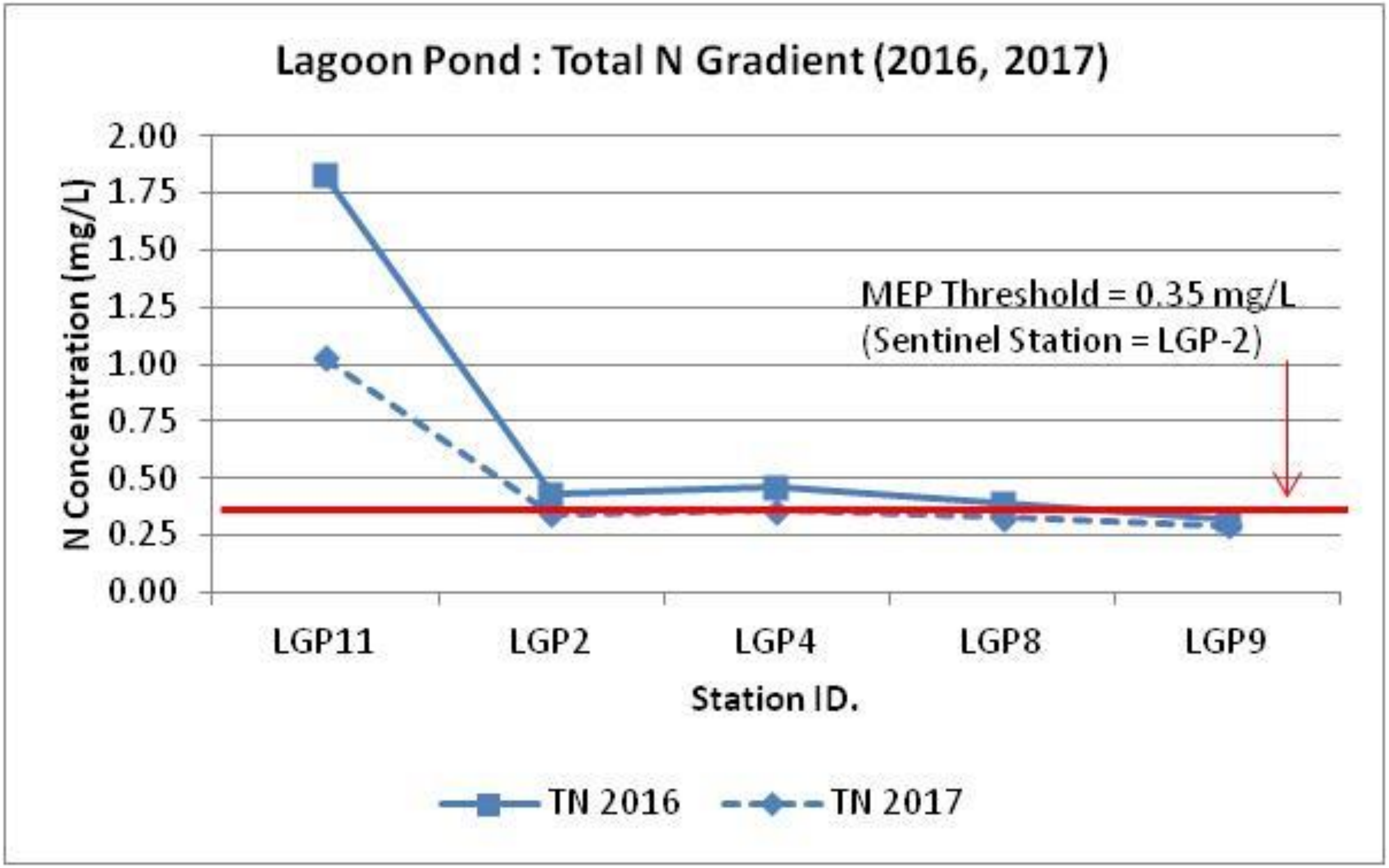
Pocha Pond: Total N Gradient (2016, 2017)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
N Concentration (mg/L)
PCA1
PCA3
Station ID.
TN 2016
TN 2017

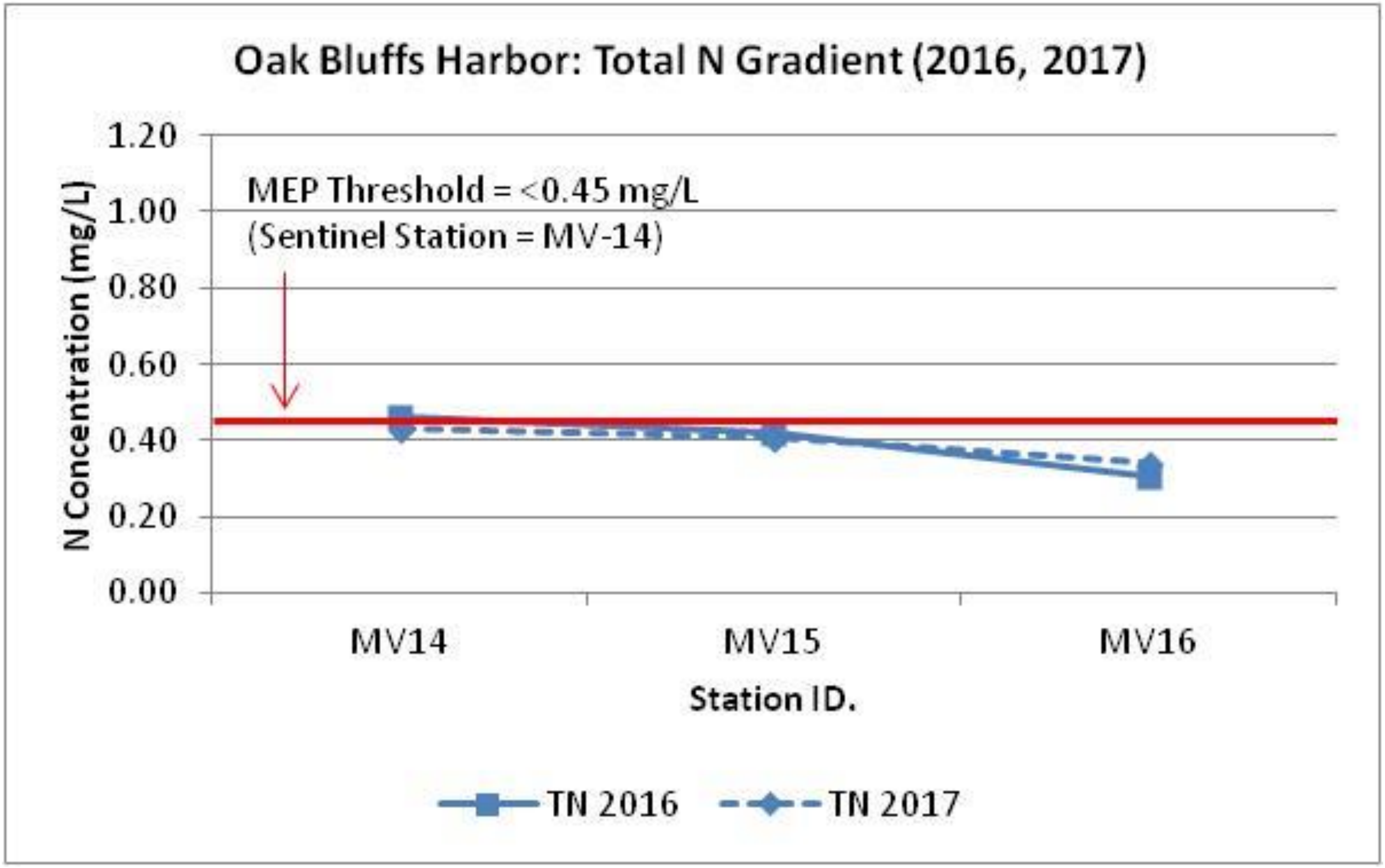

Katama Bay: Total N Gradient (2016, 2017)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
KAT1
KAT2
KAT3
KAT4
KAT5
KAT7
Station ID.
TN 2016
TN 2017

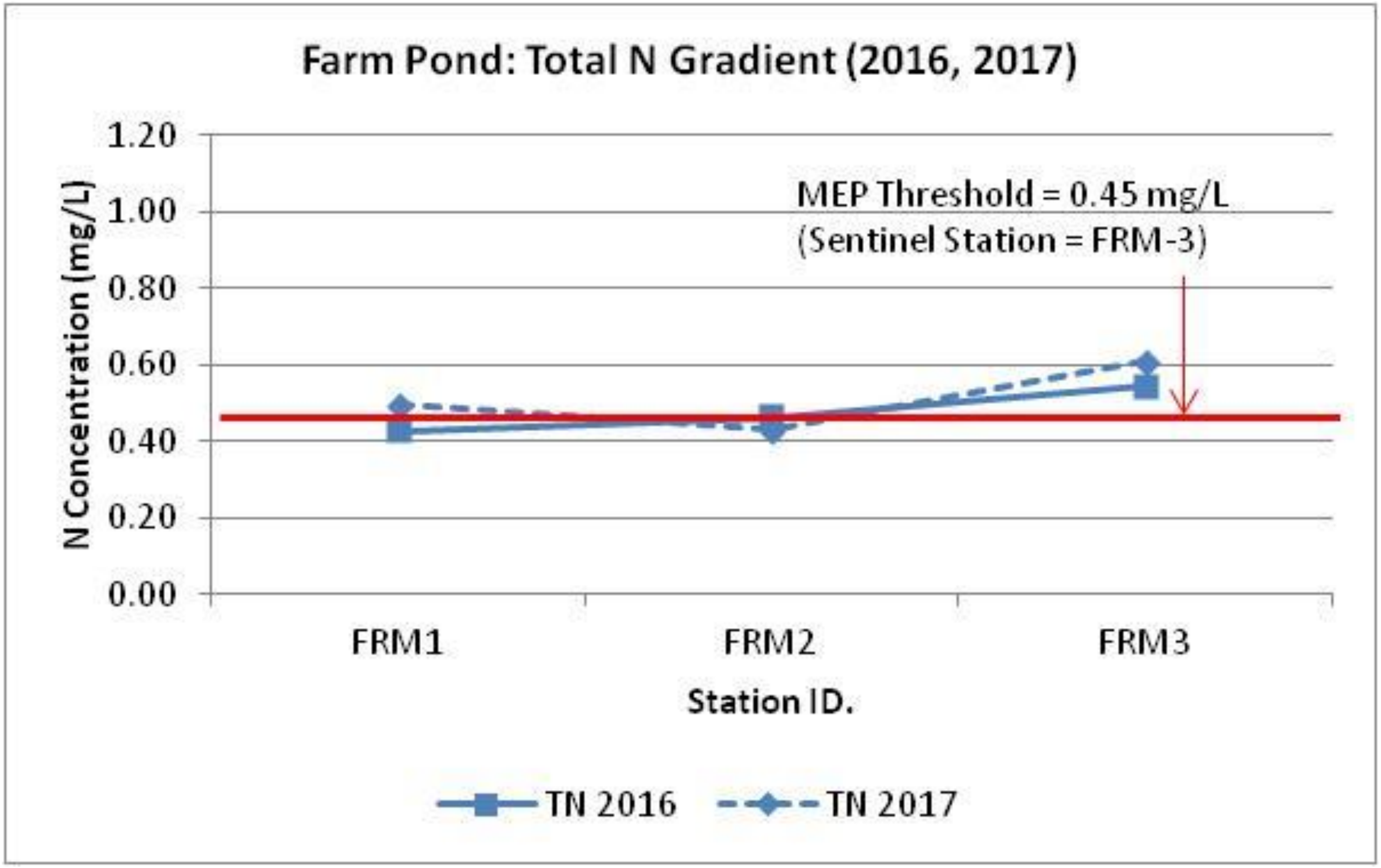

Edgartown Great Pond: Total N Gradient (2016, 2017)
MEP Threshold = 0.50 mg/L
(average of stations EGP- 2,3,5,6,9)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
EGP2
EGP3
EGP4
EGP5
EGP6
EGP7
EGP9
EGP10
EGP11
Station ID.
TN 2016
TN 2017

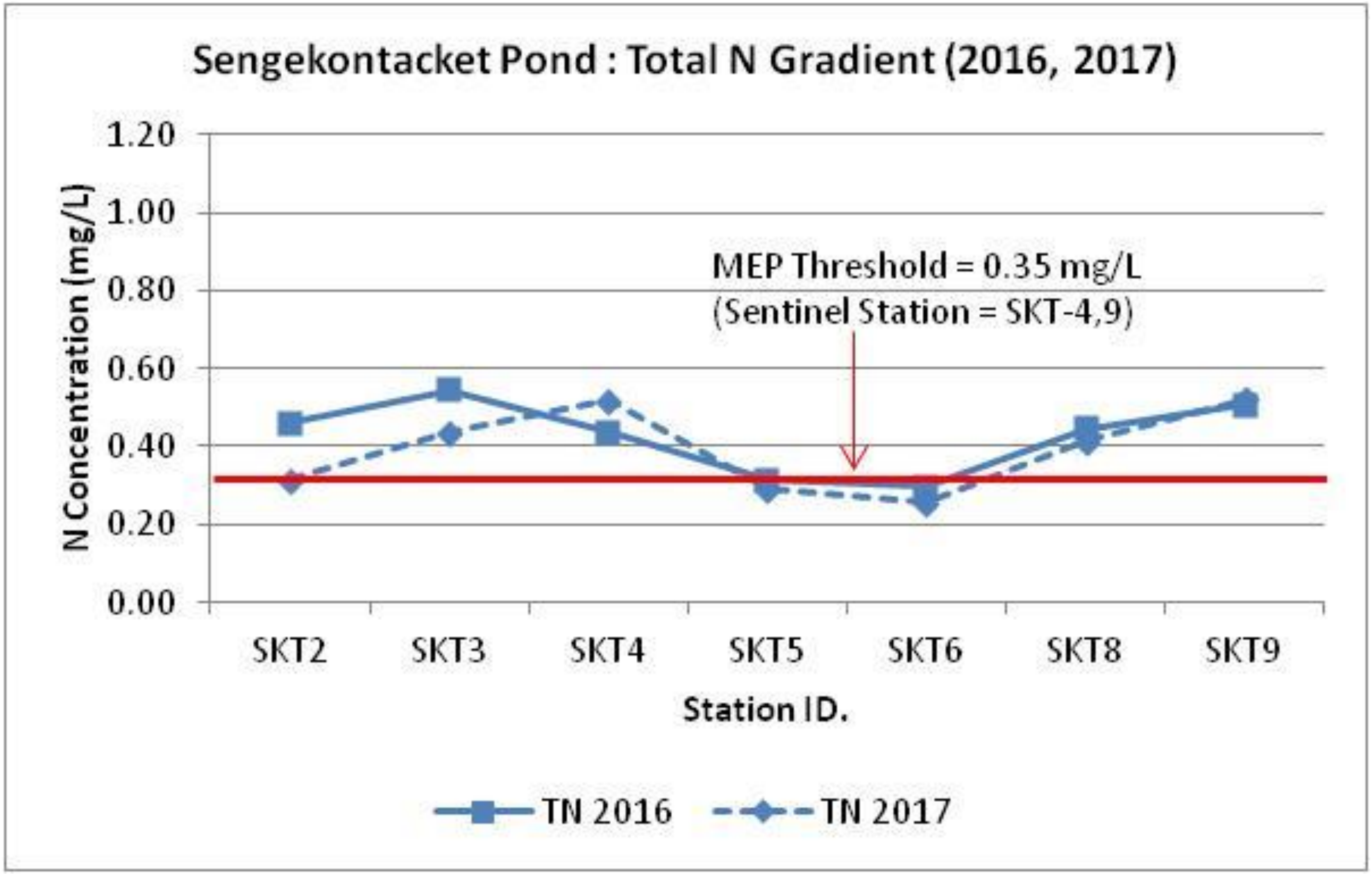

Chilmark Pond: Total N Gradient (2016, 2017)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
MEP Threshold = 0.50 mg/L
(average of stations CHP-1,2,4,5)
CHP UP
CHP6
CHP5
CHP4
CHP2
CHP1
Station ID.
TN 2016
TN 2017


Lake Tashmoo : Total N Gradient (2016, 2017)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
MEP Threshold = 0.36 mg/L
(Sentinel Station = MV-SEN)
MV21
MV2
MV3
MV4
MVSEN
Station ID.
TN 2016
TN 2017


Lagoon Pond : Total N Gradient (2016, 2017)
N Concentration (mg/L)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
MEP Threshold = 0.35 mg/L
(Sentinel Station = LGP-2)
LGP11
LGP2
LGP4
LGP8
LGP9
Station ID.
TN 2016
TN 2017


Oak Bluffs Harbor: Total N Gradient (2016, 2017)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
N Concentration (mg/L)
MEP Threshold = <0.45 mg/L
(Sentinel Station = MV-14)
MV14
MV15
MV16
Station ID.
TN 2016
TN 2017


Farm Pond: Total N Gradient (2016, 2017)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
MEP Threshold = 0.45 mg/L
(Sentinel Station = FRM-3)
FRM1
FRM2
FRM3
Station ID.
TN 2016
TN 2017


Sengekontacket Pond : Total N Gradient (2016, 2017)
N Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
MEP Threshold = 0.35 mg/L
(Sentinel Station = SKT-4,9)
SKT2
SKT3
SKT4
SKT5
SKT6
SKT8
SKT9
Station ID.
TN 2016
TN 2017