



URI Watershed Watch Program
Block Island Monitoring Results 2001-2010

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Elizabeth Herron and Linda Green, URI Watershed Watch

Summary: To date both the field monitoring and laboratory analyses indicate that Block Island's premier resource, the Great Salt Pond, is in good health. However, during the ten years of monitoring increases in nutrients have been detected, and a number of tributary streams have high levels of both nutrients and bacteria, particularly following rain events. Tributary monitoring has shown a great deal of variability in water quality conditions, and therefore is especially important to maintain. Continued monitoring of both Great Salt Pond and its tributary streams is essential in order to determine whether apparent nutrient increases are an actual trend in water quality, or due to natural variability in response to weather patterns and the degree of associated uses of this well-used and beloved ecosystem. Monitoring enables us to more accurately pinpoint if and when problems begin to develop, and how the ecosystem responds to changes in the watershed. Scientists recommend that ten years of monitoring is needed to fully assess the health of a water body. During that time there will be drought and deluge, warm and cool weather, maybe even a hurricane - a full span of natural conditions. With ten years of data available for the Great Salt Pond and the original three tributary stream sites, overall water quality status as well as some trends are becoming discernable, but not yet definitive.

Table 1: Block Island Watershed Watch Monitoring Site Information

| Great Salt Pond Locations | | |
|---|--|-----------------|
| (at 1 meter from the surface and 1.0 meter from the bottom, or at mid-depth): | | |
| GSP #1 | mid-harbor @ Green can #5 | |
| GSP #2 | Narragansett Inn cove | |
| GSP #3 | Off Champlin's dock | |
| GSP #4 | Trim's Pond | |
| Outside - North | Outside GSP to the north of the breachway | (added in 2008) |
| Outside - South | Outside GSP to the south of the breachway | (added in 2009) |
| Tributary Locations: | | |
| BI Trib #1 | Mill Tail Pond, Ocean Ave. culvert | |
| BI Trib #2 | Bridgeway Square culvert - "colored side pipe" | |
| BI Trib #3 | Cormorant Cove salt marsh culvert | |
| BI Trib #4 | Beach Avenue | (added in 2003) |
| BI Trib #5 | Harris Pt | (added in 2003) |
| BI Trib #6 | Scott's | (added in 2004) |



Figure 1. Map showing CGSP Monitoring Sites



Introduction: The 2010 monitoring season marked the tenth year that dedicated volunteer water quality monitors from the Committee for the Great Salt Pond (CGSP) monitored four sites on the Great Salt Pond (GSP), two sites outside the pond in Block Island Sound and up to six tributary stream sites as a part of the URI Watershed Watch Program (URIWW) (see Table and Figure 1 for site information). These sites were selected by members of the Committee for the Great Salt Pond in consultation with URIWW staff at a site visit in 2001. Three additional tributary streams were added in 2003 and 2004 in order to investigate additional potential inland pollution sources. Additional sites were later added outside of the GSP, north and south of the breachway in order to determine potential impacts from Block Island Sound waters.

Monitoring was initially funded through the Block Island and Green Hill Pond National Decentralized Wastewater Demonstration Project to establish a baseline of conditions in the pond and its watershed. The CGSP has continued funding the monitoring in order to track trends in water quality, and to try to identify potential bacterial and nutrient sources.

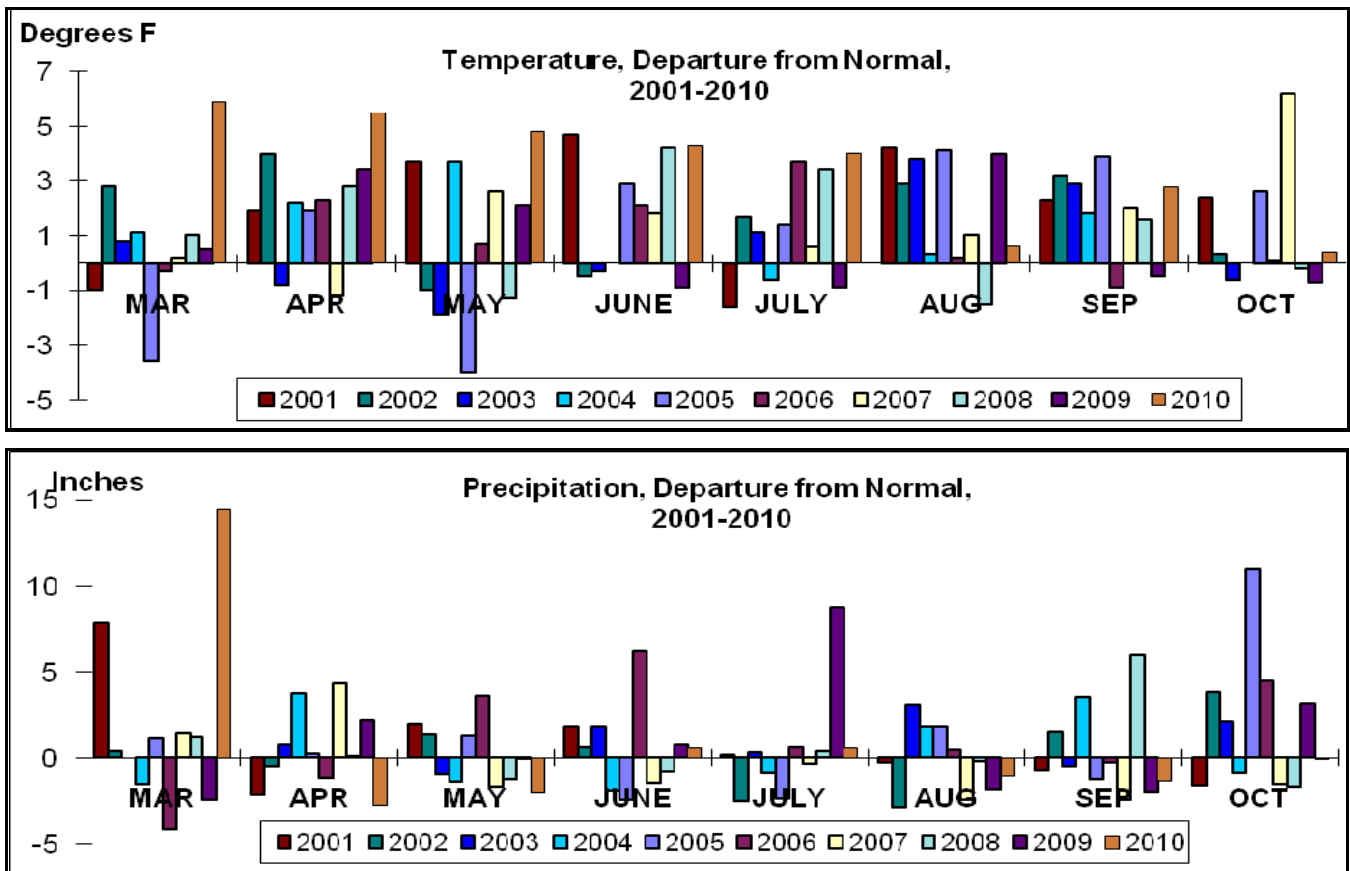
URI Watershed Watch staff trained CGSP volunteers to conduct the water quality monitoring, and provided annual refreshers after the initial training. These water quality monitors were provided with all the necessary monitoring equipment and supplies as well as a written monitoring manual that detailed all the procedures. Their regular monitoring followed a schedule developed by URIWW designed to cover the period of peak activity on the island - from mid-June through mid-October each year. (Unfortunately late season storms that disrupted ferry service shortened the monitoring season in several years.) The monitoring included biweekly on-site monitoring of water clarity, water temperature, dissolved oxygen content, salinity, and algae level. (Please see URIWW monitoring manuals and quality assurance project plans available on the website at <http://www.uri.edu/ce/wq/ww/> for more specific information.) In 2003 the CGSP purchased a multi-parameter field meter to measure dissolved oxygen, temperature and salinity, replacing the URIWW owned and maintained kits. However the basic field monitoring procedures (monitoring depth, time of day - late morning, etc.) remained the same. The on-site monitoring data was submitted to URIWW on monitoring postcards.

In addition to the bi-weekly on-site monitoring, once a month the volunteers also collected a suite of samples, packed them on ice in a cooler and shipped them via ferry to Point Judith. The water collection schedule was set to ensure that samples were collected near low tide in order to better assess the impact of land based sources versus in-pond sources, while also making sure that the samples would reach the URIWW laboratory within acceptable hold times. URIWW staff picked the water samples up from Point Judith and delivered them to the URIWW Analytical Laboratory in URI's College of the Environment and Life Sciences in Kingston. These samples were analyzed for bacteria, pH, nitrogen, phosphorus and chlorophyll according to standard URIWW laboratory procedures (please see Quality Assurance Project Plan: University of Rhode Island Watershed Watch Analytical Laboratory <http://www.uri.edu/ce/wq/ww/Publications/LabSOPs.pdf> for additional information). The analytical laboratory is Rhode Island Department of Health certified (#LAI00294). Brief summaries and discussion of the results of the nine years of water quality monitoring follow.

Weather summary: Weather can significantly affect water quality, and can confound the assessment of water quality findings. This summary (figure 2) is based on weather data from the URI Weather Station in Kingston, RI which reflects weather conditions on Block Island reasonably well. Departures from normal were in relation to the average temperature and precipitation values over the past thirty years. Monthly temperature was above normal for the vast majority of months during the nine monitoring seasons, particularly August through October. Rainfall has been more evenly distributed between above and below normal over this same time span, although the amount (inches above normal per month) of above normal precipitation has exceeded deficits. Droughts during much of the summers of 2002, 2004, 2005 and 2007 brought long periods of sunny days and warmer than average temperatures, and potentially increased impacts from good boating seasons. But despite dry summers, the annual precipitation was above average in 2003, 2005 and 2006, meaning that there were periods when rainfall, and the resulting runoff, was higher than usual. In 2004 the remnants of two hurricanes in September produced nearly six inches of rain over two weekends, ending a summer long drought. In 2005 a wet winter preceded a record dry summer, which ended with week long rains including an October record setting rain event. More than 6" above normal

rain in June 2006, and more than 4" above normal in 2006 contributed to the 9+" above normal rain for that year. In 2007 the drought continued right through into winter, but was broken in 2008 with above average rainfall that continued through 2009, with near record rainfall in July. 2010 will be remembered for the historic floods in March, which brought weeks of rainfall, including 9" over two day. This resulted in more than 14" above average precipitation for that one month. However, the remainder of the year was generally dry, with below average rainfall most months bringing the annual departure from normal to less than 8.5". These types of extreme weather patterns create significant short-term variations in conditions making assessment of the water quality data, particularly trends, challenging. This weather instability argues for continued long-term monitoring in order to help differentiate between true water quality trends and weather related impacts.

Figure 2. Weather Summary (Kingston RI Weather Station)



Great Salt Pond field monitoring summaries: Volunteers measured a number of key water quality indicators using field instruments and/or kits at four sites on the Great Salt Pond. These included water clarity (Secchi depth transparency), temperature, dissolved oxygen, salinity and processing samples for chlorophyll, and were typically done at either mid-depth at sites less than two meters deep, or at half a meter from the surface and within one meter from the bottom at deeper sites.

With the exception of the Mid Harbor site (GSP #1), which is the deepest site, the Secchi depth transparency measurement was typically also the bottom depth, as the Secchi disk was usually visible on the bottom (figures 3 – 6). At GSP #1 water clarity has been excellent, or in the oligotrophic range (greater than 4 meters or 13 feet) most of each monitoring season (figure 3). However the average water clarity has decreased somewhat over the past few years. But no increase in algae as measured by chlorophyll, the usual cause of reduced water

clarity, has been recorded at GSP #1, or any of the GSP sites. In fact algae levels have consistently been well within levels considered “Good” by the United States Environmental Protection Agency’s (USEPA) National Coastal Assessment (NCA) program at GSP #1 - #3 (figures 3 – 5). Occasional spikes in algae levels were noted at GSP #4, but they were typically very brief and do not seem to be part of an overall trend (figure 6).

Figure 3. Great Salt Pond #1 – Mid-harbor Site Field Data Charts

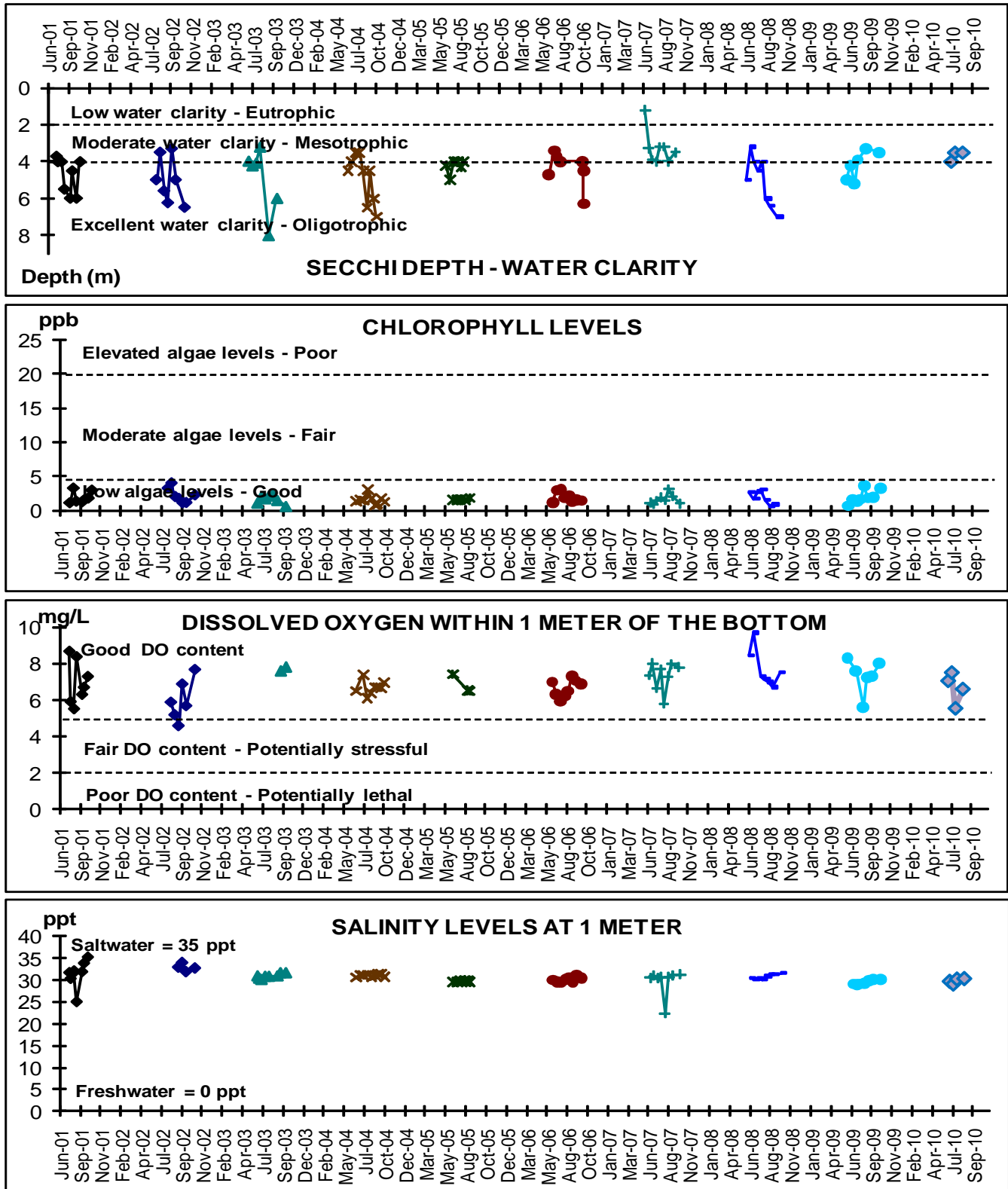


Figure 4. Great Salt Pond #2 – Narragansett Inn Cove Site Field Data Charts

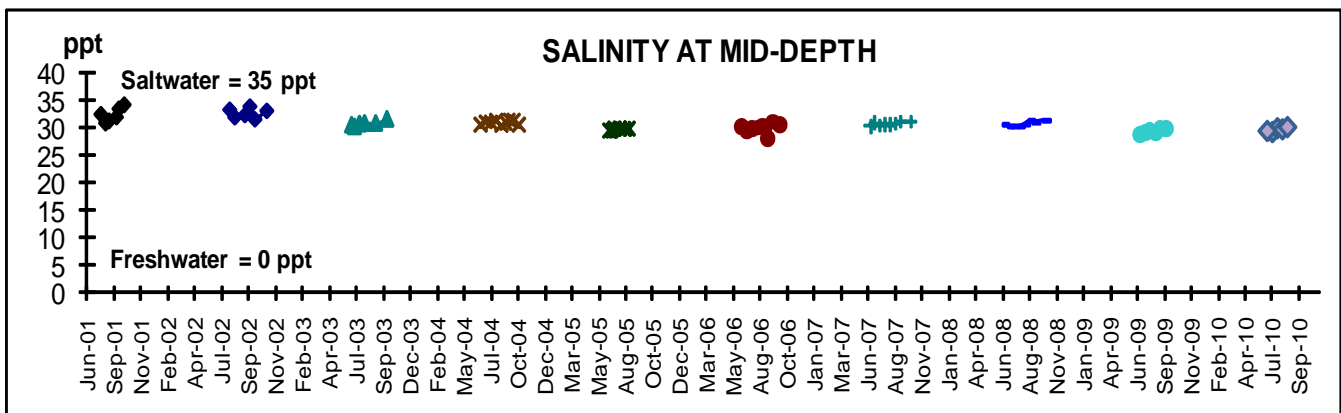
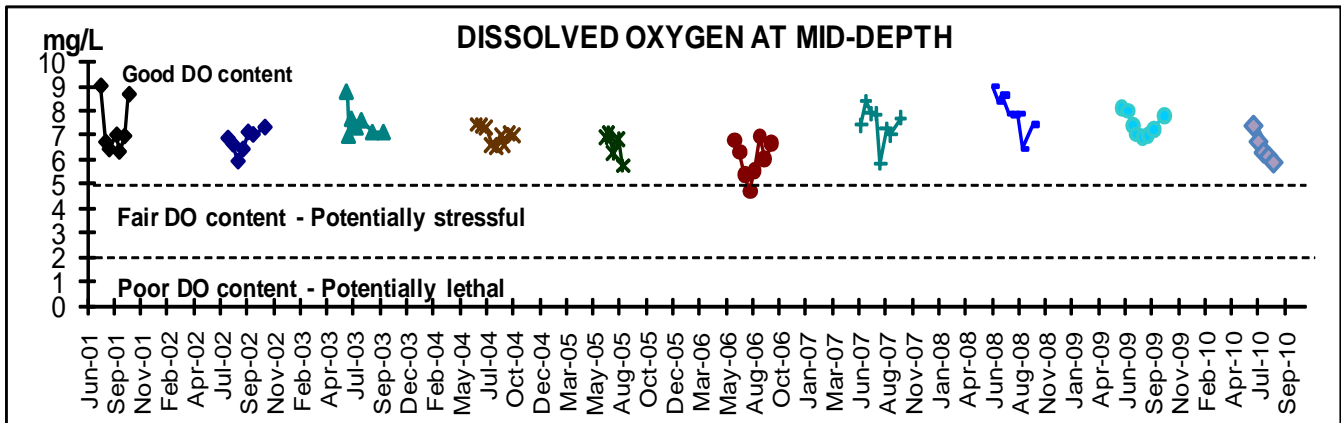
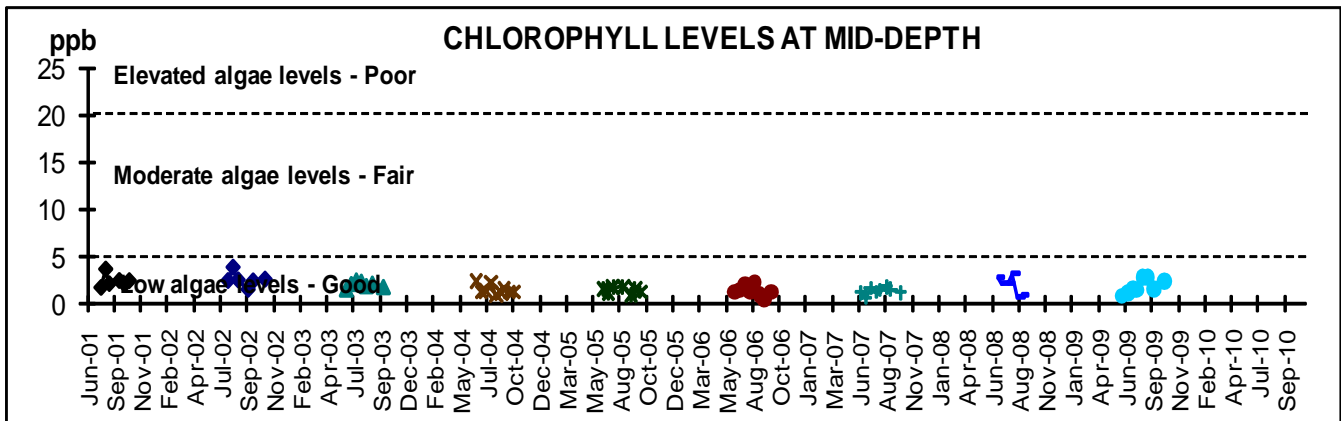
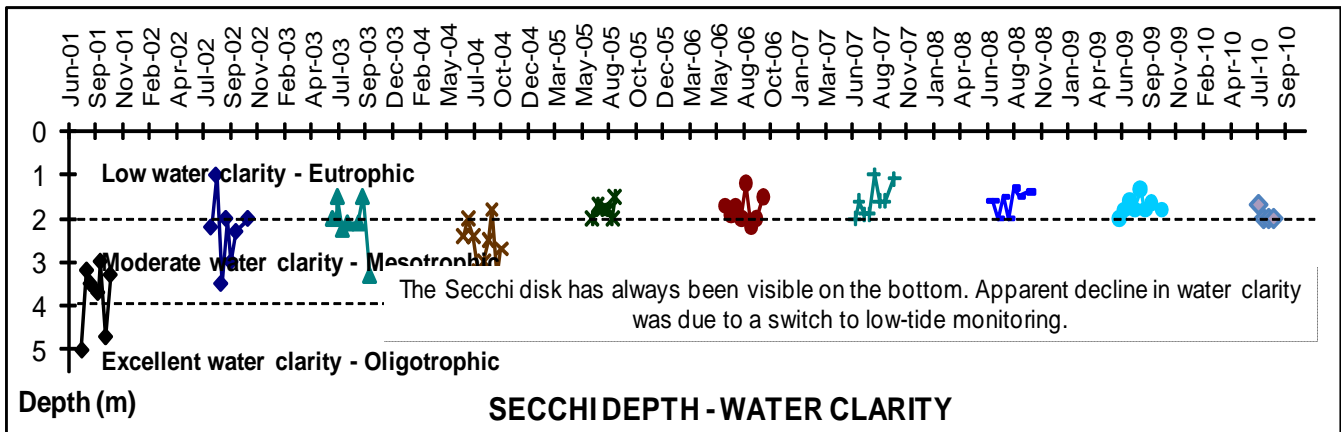


Figure 5. Great Salt Pond #3 Champlin's Site Field Data Charts

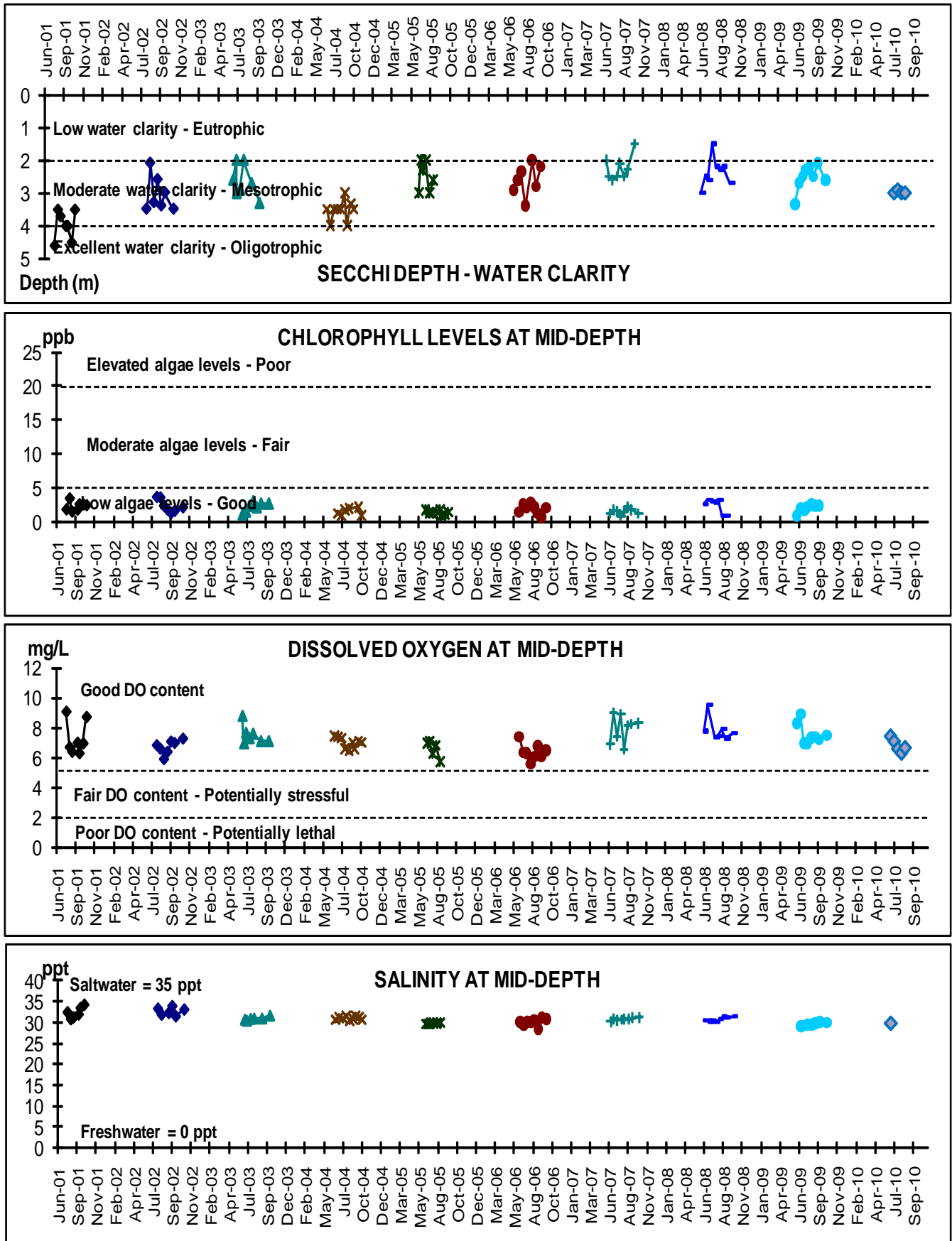
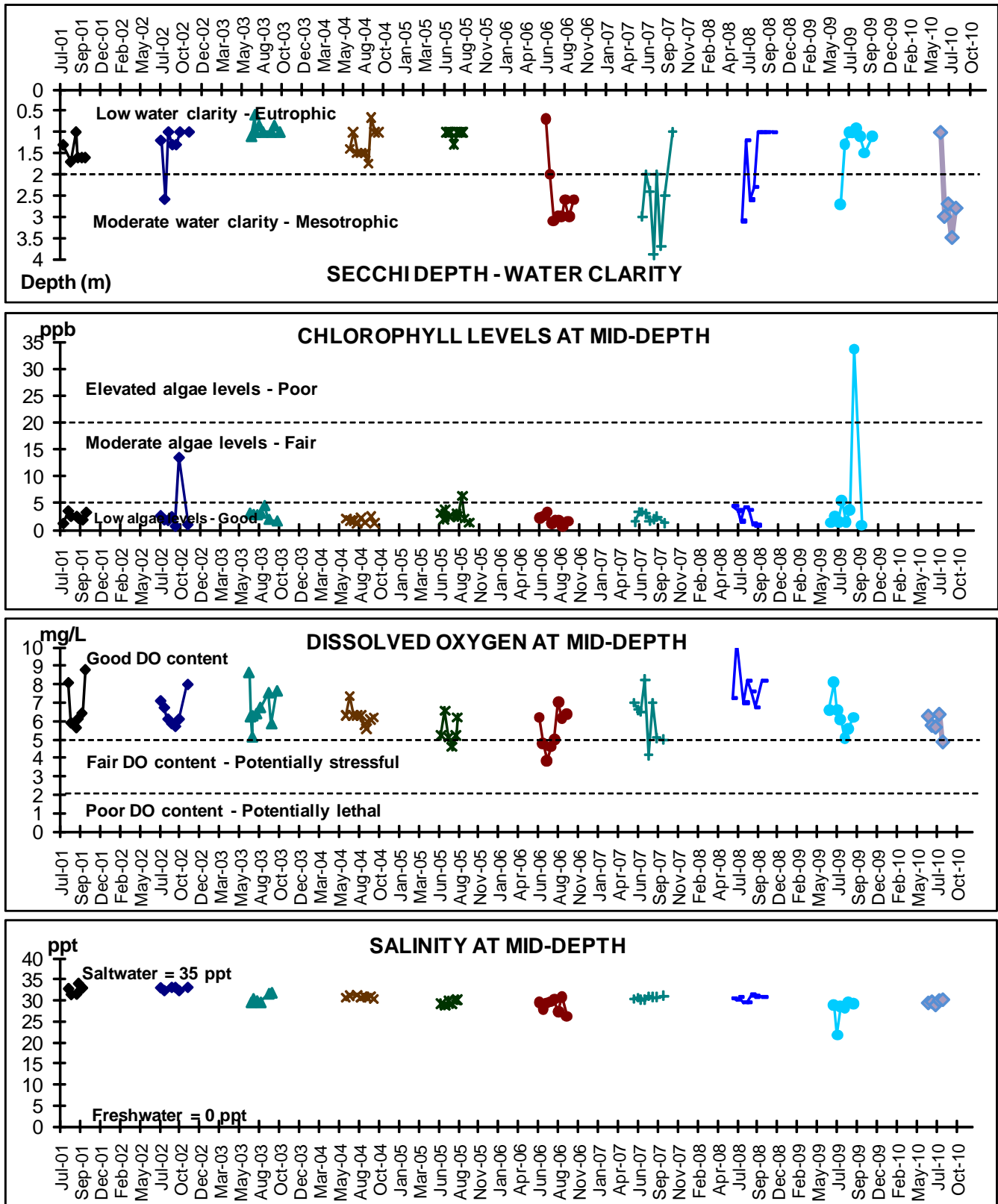


Figure 6. Great Salt Pond #4 Trim's Pond Site Field Data Charts



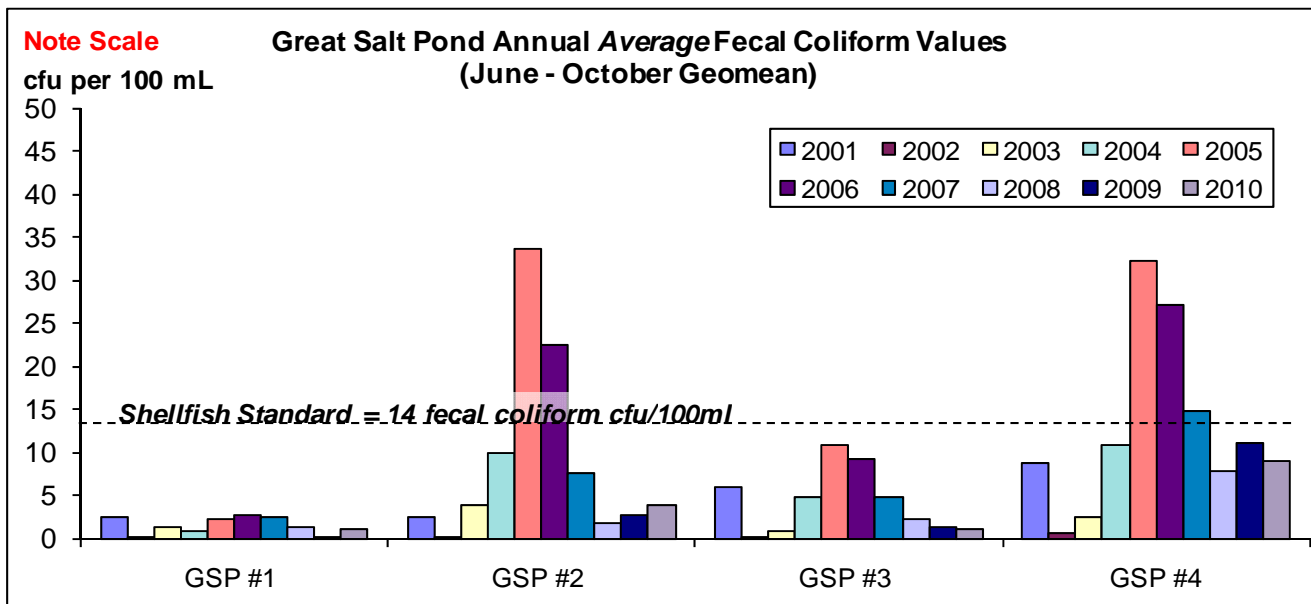
Dissolved oxygen remained consistently high throughout all ten seasons at all four pond sites with the exception of very brief periods in Trim's Pond (GSP #4) during several years (figure 6). Salinity measurements showed a slight fresh water influence at all the pond sites monitored (figures 3 - 6). Salt water typically has 35 parts per thousand (ppt) salinity, fresh

water has 0 ppt. Salinity values have typically ranged from 30 – 33 ppt salinity in the pond sites. However salinity values in 2005, 2005 and 2009 averaged approximately 29 ppt, reflecting the higher than average precipitation during those season. Interestingly, the 2007 salinity range was quite broad (22 – 31 ppt) despite low seasonal rainfall. Salinity levels in general and Trim’s Pond (GSP #4) in particular appeared to be declining very slightly overall.

These water quality indicators were generally quite stable and pointed to overall excellent water quality in the Great Salt Pond for all four sites. Water clarity at all sites was good, with generally low algae levels. These both indicate low nutrient, or oligotrophic conditions. The good dissolved oxygen levels combined with generally stable salinity values indicates good tidal flushing, as well as excellent overall water quality.

Fecal coliform bacteria monitoring: Fecal coliform bacteria are an indicator of fecal contamination and potentially disease causing organisms or pathogens. The National Shellfish Sanitation Program (NSSP) has established acceptable fecal coliform levels (14 colony forming units (cfu)/100 mL) for waters from which shellfish can be harvested. The standard was designed to prevent human illness associated with the consumption of fresh and frozen shellfish, and thus is quite conservative. Because bacteria levels can fluctuate dramatically and be impacted by short-term sources affecting quite small areas such as by seagull or duck droppings, bacteria average concentrations are typically reported as the geometric mean. This statistical method transforms a set of highly variable data in order to better represent a central tendency, the middle or expected values. Thus a single very high sample will not overwhelm routine low or below detection values as might happen with simple arithmetic averaging.

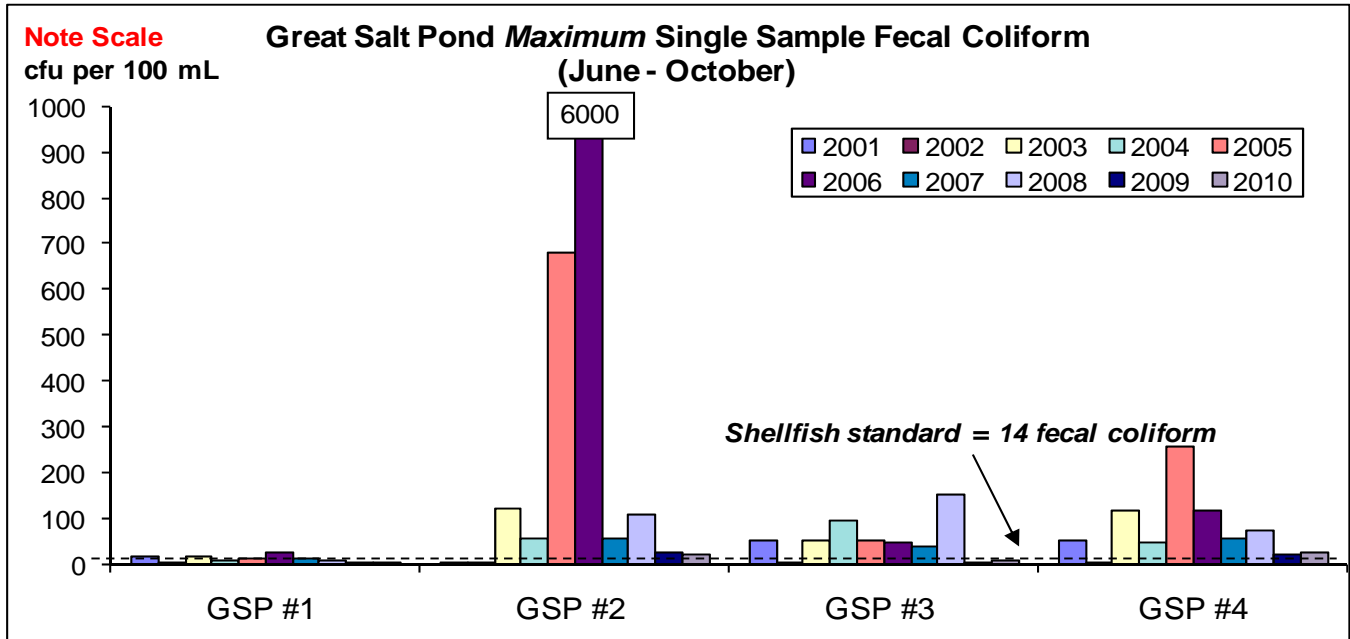
Figure 7. Annual Mean Fecal Coliform Bacteria at Great Salt Pond Sites



The monitoring sites outside of the Great Salt Pond (north and south of the breachway) have had consistently very low fecal coliform levels; in fact samples have been either at or below the 1 colony forming unit / 100 mL detection limit. Average fecal coliform values at the GSP sites were typically below the stringent 14 cfu/100 mL NSSP shellfishing standard, with the exception of a couple of seasons at GSP #2 and GSP #4 (figure 7). Maximum fecal coliform counts far exceeded the shellfishing criteria at all the GSP sites, except the Mid Harbor (GSP #1) site where exceedence of that criteria was rare (figure 8). Levels above the shellfishing standard were common, particularly at Trim’s Pond (GSP #4) and Narragansett Inn Cove

(GSP #2), as well as at Champlin's (GSP #3). In fact site #4 exceeded the standard at least once during eight of the ten monitoring seasons, while sites #2 and #3 exceeded at least once during seven of the ten seasons, and site #1 at least once during three seasons. Overall, GSP#4 consistently had higher values than the other three pond sites, which is likely a reflection of the more limited tidal flushing in that portion of the pond, the impact of tributaries with generally high levels of fecal coliform that discharge into the upper reaches of the pond, as well as development immediately adjacent to the area.

Figure 8. Annual Maximum Fecal Coliform Bacteria at Great Salt Pond Sites



Narragansett Inn Cove (GSP#2) typically had low levels of fecal coliform bacteria, but occasional spikes produced much higher maximum values (figure 8). The summer of 2006 was particularly bad at the Narragansett Inn Cove site, with counts of 6000 cfu/100ml on July 5, 520 cfu/100 mL on July 19, and 630 cfu/100 mL on August 17 (bacteria data available at <http://www.uri.edu/ce/wq/ww/data/DataTable.htm>). Fecal coliform levels measured at the Mid-Harbor site (GSP #1) have been consistently much lower, seldom exceeding the shellfish standard (figures 7 and 8).

Monitoring tributary inlet streams is important for determining water quality impacts including bacteria and nutrient loading. **Loading** is defined as the rate at which a substance such as bacteria or nitrogen is added to a system. The measurement of loading includes multiplying the concentration of bacteria or nutrient from a particular source by the volume of water from that source over a set time period (e.g. annually) (see <http://www.dnr.state.md.us/bay/monitoring/water/> for a discussion of the difference between concentration and loading.) Thus, while a particular tributary may have very high concentration of bacteria or nutrients, if there is very little flow from that source, its overall load or contribution, may be minimal. Since the flow of these tributary sites has not been measured, it is impossible to accurately assess the actual bacterial or nutrient loads to the Great Salt Pond. However the concentration results to date can help target areas for additional investigation and monitoring.

Tributary stream sites typically had much higher fecal coliform counts than the Great Salt Pond sites, as shown in figure 9. Since several of these tributaries discharge directly into the shellfishing waters of the Great Salt Pond, identifying the source(s) and taking action to correct problems is an important goal. Tributaries at Ocean Ave (#1) and Bridgewater Square (#2) have had among the highest counts, often in excess of thousands per 100 mL of water,

resulting in mean values that exceed water quality standards. Tribes #1 and #2 have shown some improvement during recent seasons, despite wetter than average years, we may be seeing the benefit of efforts to identify and correct stormwater issues in the Bridgegate Square area. However, high fecal coliform levels at tributaries at Cormorant Cove (#3) and Beach Ave (#4) have become more common, and may warrant additional attention. Figure 10 shows the highest counts for the tributaries during each monitoring season. The scale of that chart is nearly ten times higher than for the average counts in the tributaries and six times as high as the maximum value recorded for a Great Salt Pond site.

Figure 9. Annual Mean Fecal Coliform Bacteria – Tributary Stream Sites

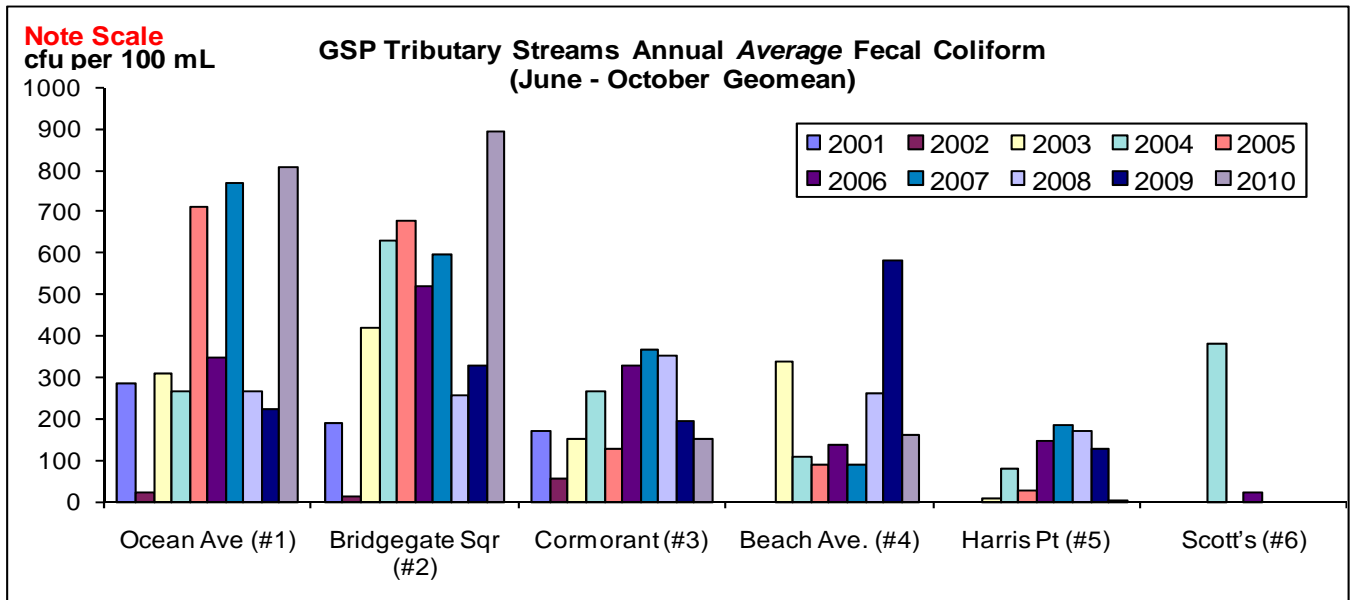
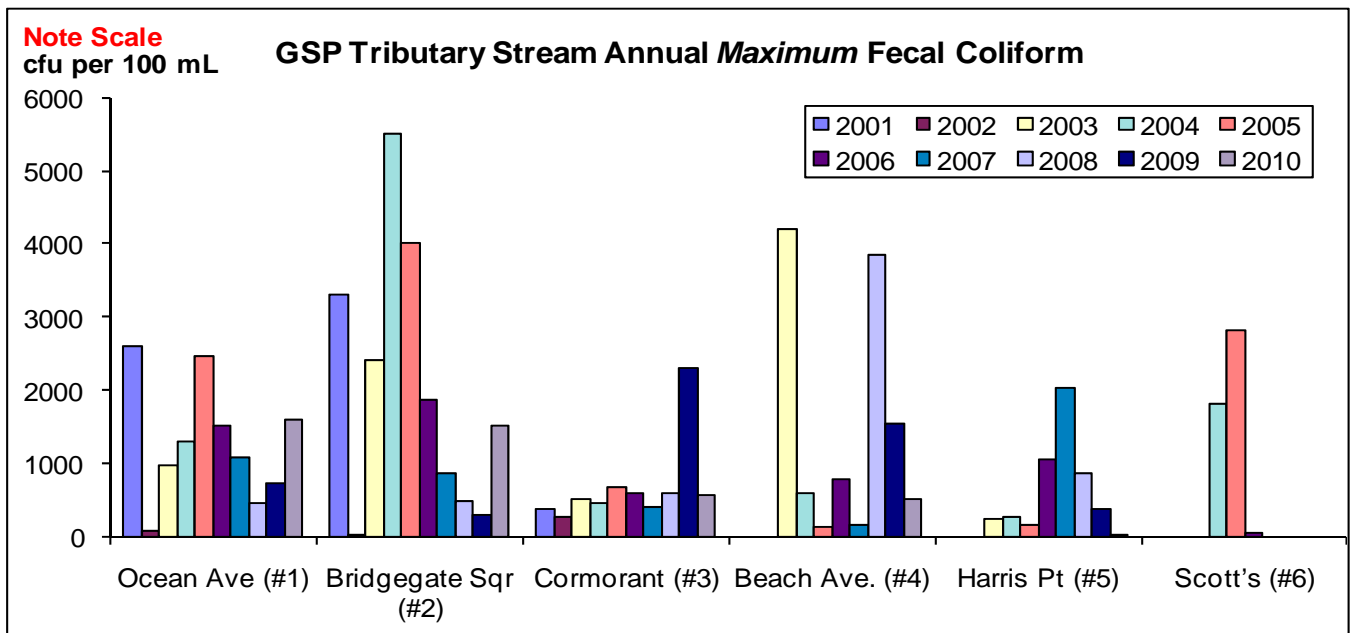


Figure 10. Annual Maximum Fecal Coliform Bacteria – Tributary Stream Sites

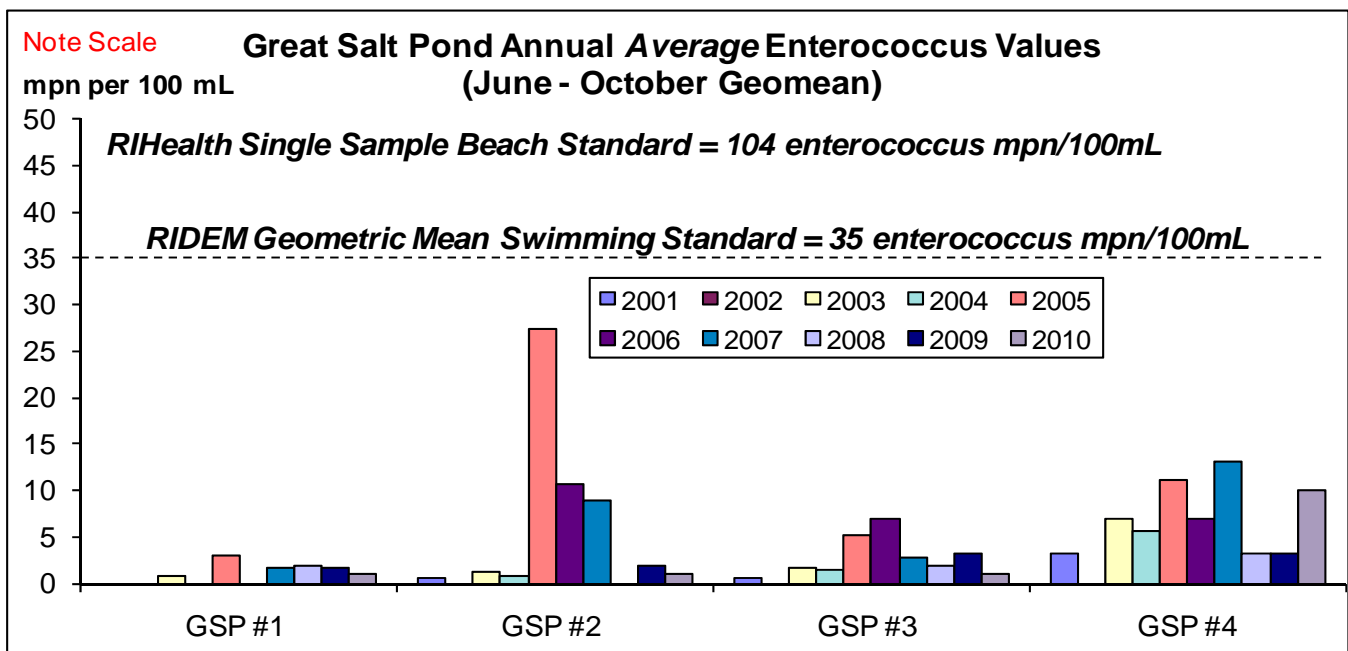


Typically the flow from tributaries #1 and #2 has been quite small. It should also be noted that during dry periods these sites have very low bacteria levels, with uniformly low values during the drought of 2002. With no rain there was no overland flow or runoff bringing wastes into the streams. Low bacteria counts during dry weather also suggest that there were no direct discharges of waste water to the streams, such as from a pipe or a failed septic system.

Average annual fecal coliform levels from Cormorant Cove (trib #3) seem to be increasing, although with the exception of 2009, the maximum values appear stable, and comparatively lower than most of the tributary maximums. This suggests that there is a consistent, although not particularly concentrated source in the cove. Wildlife and birds are one possible source. These tributary results confirm that land based sources of bacteria should be addressed in an overall management program for the GSP.

Enterococci bacteria monitoring: In 2004, *Enterococcus spp.* took the place of fecal coliform as the new federal standard for water quality at public beaches. Enterococci are believed to provide better correlation than fecal coliform with many human pathogens often found in sewage, particularly those associated with gastrointestinal illnesses. Based on federal recommendations the Rhode Island Department of Environmental Management (RIDEM) set the primary contact (swimming) water quality standard for salt waters at a geometric mean of 35 enterococcus/100 mL for five or more samples. To be more responsive to short term events, the Rhode Island Department of Health (RIHealth) adopted a *single sample standard* for swimming advisories at designated beaches. For salt waters, the RIHealth beach standard is 104 most probable number (mpn - a statistically based reporting method) enterococci /100 mL, and 61 mpn for fresh water. Anticipating this change of indicator for marine waters, URIWW began monitoring enterococci at select sites in 2001. In 2006 URIWW began using the RIHealth approved Enterolert method to analyze enterococci, and received certification for the method in 2007. In marine waters, Enterolert has a 10 mpn minimum detection limit, which results in many reported < 10 values reported. For the enterococci charts summarized here, a value of 1 has been used to calculate the geometric mean, and when no value exceeded 10, no result is recorded on the chart for that season.

Figure 11. Annual Mean Enterococci Bacteria at Great Salt Pond Sites



Enterococci levels in the pond were consistently at levels considered safe for swimming, with an annual geometric means well within the RIDEM water quality standard (figure 11). In fact very few sites exceeded the RIHealth single sample value throughout the monitoring period (figure 12). Exceptions were at GSP sites #2 and #4 during 2005, when each site exceeded the swimming value once - site #4 in June and site #2 in September. In 2007 GSP site #3 also

exceeded the enterococci swimming standard once in August. The mid-harbor site (GSP #1) has never exceeded the safe swimming value.

Figure 12. Annual Maximum Enterococci Bacteria at Great Salt Pond Sites

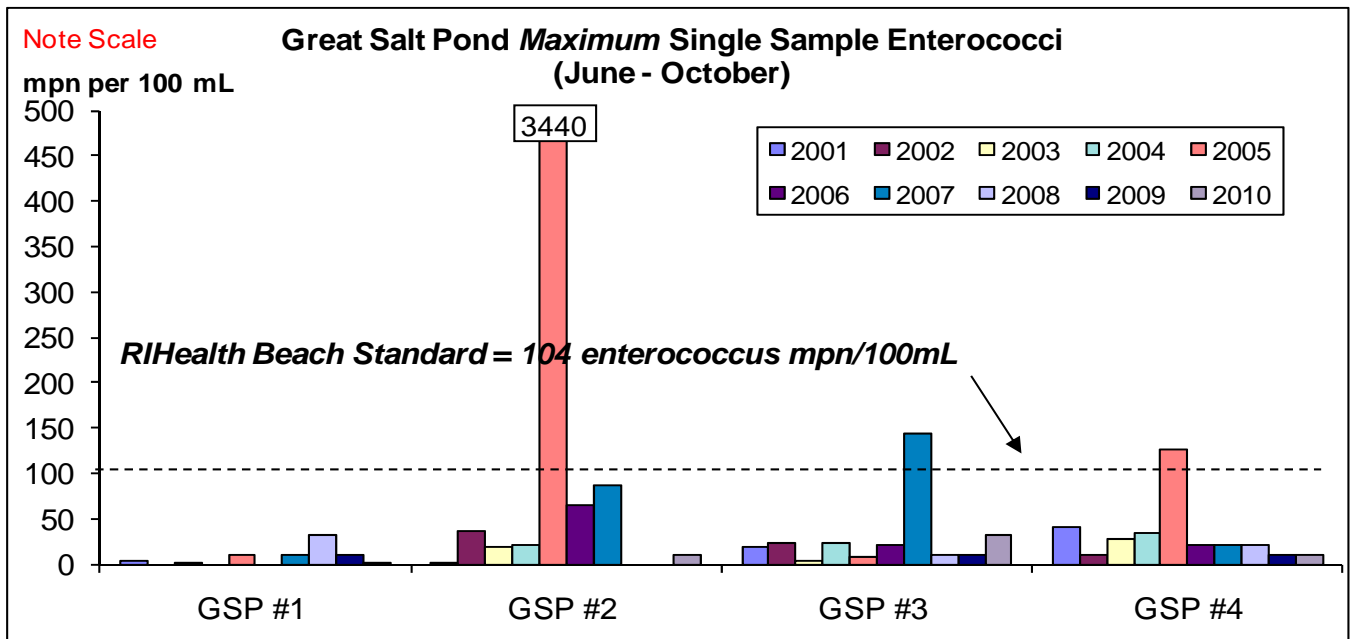
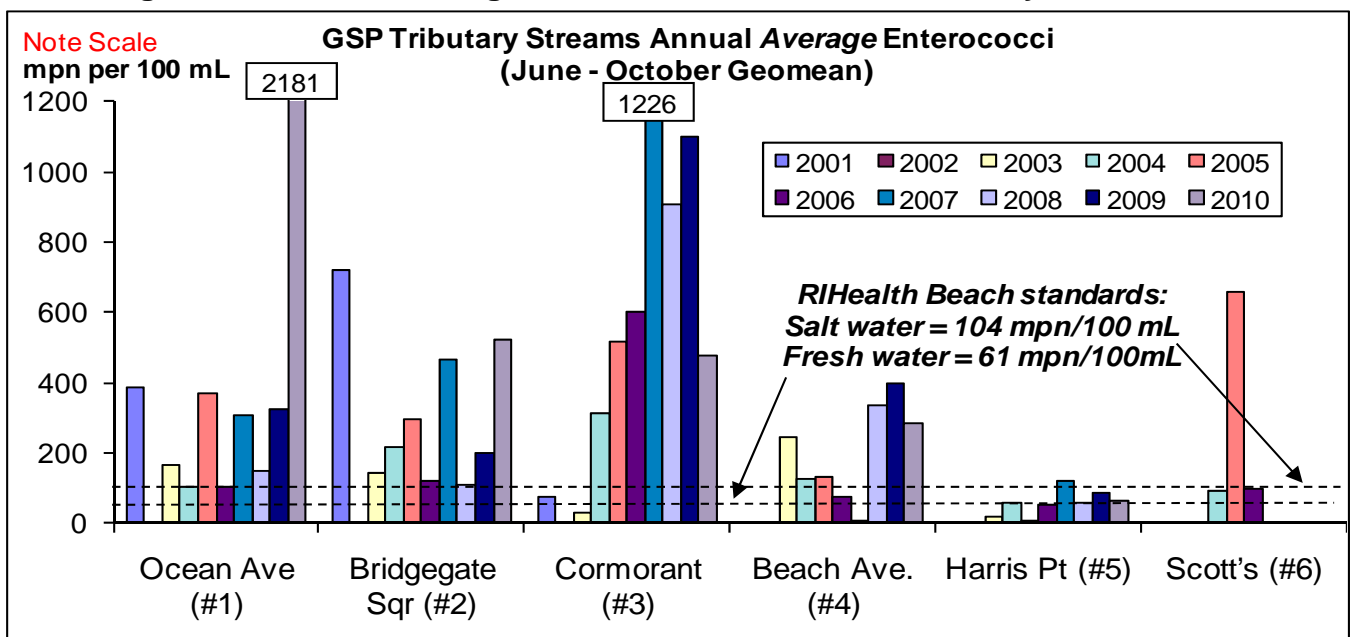
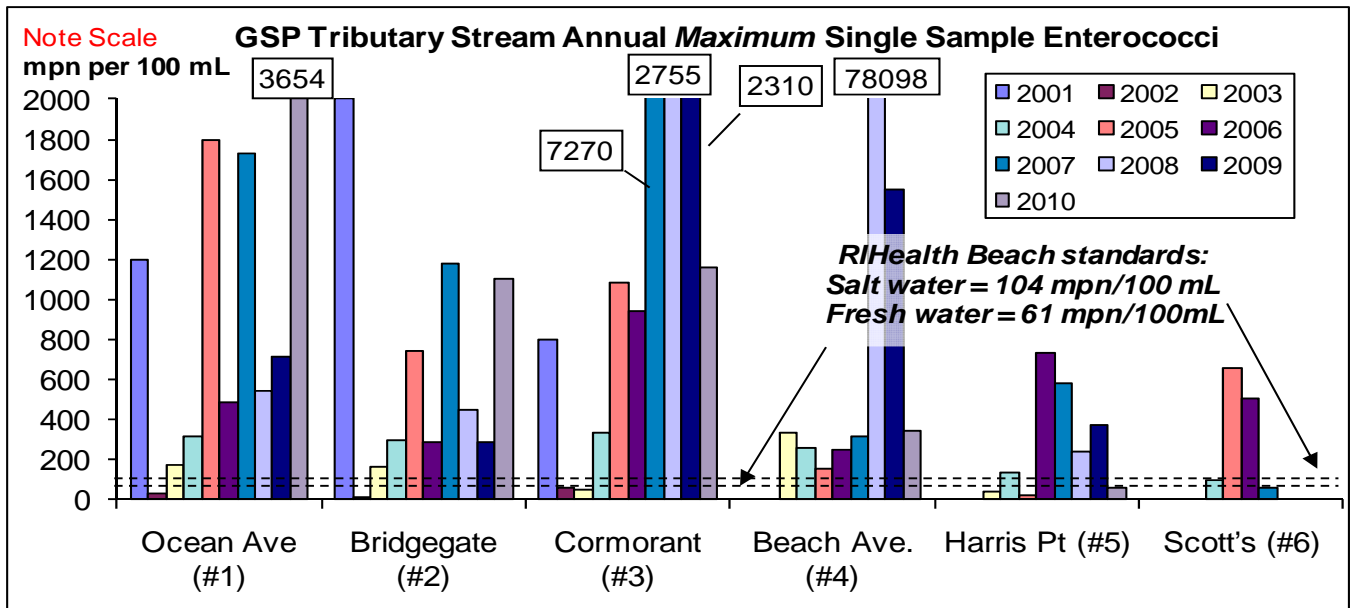


Figure 13. Annual Averages Enterococci Bacteria – Tributary Stream Sites



As with fecal coliform, enterococci values in the tributaries were orders of magnitude higher than in the pond itself (figures 13 and 14). In fact all of the tributaries exceeded the single sample value at least once during most of the seasons monitored, with tributary sites #1- #4 nearly always exceeding both the fresh and salt water values. Dilution of these relatively small but concentrated flows and tidal flushing result in acceptable levels in the pond. Nonetheless, identifying preventable sources should be a goal of tributary monitoring.

Figure 14. Annual Maximum Enterococci Bacteria – Tributary Stream Sites



Nutrients:

Nitrogen is a natural and essential part of all marine ecosystems, as it is required for the growth of phytoplankton or algae, the primary producers that form the base of the harbor’s food web (EPA 2008). It is considered the limiting nutrient in marine systems, controlling how much algae can grow. But excess nitrogen (N) adversely affects water quality and degrades habitat, ultimately impacting a wide range of marine organisms including fish and shellfish. Nutrient overloading in marine ecosystems over stimulates the growth of algae. Too much algae blocks sunlight to eelgrass, reducing the area of this valuable nursery habitat and feeding ground. In addition, living and dying algae consume oxygen, leading to anoxic (no oxygen) and hypoxic (low oxygen) conditions. This process of water quality decline creates a chain reaction of negative impacts known as eutrophication. Poor water clarity, bad odors, stressed marine organisms and even fish kills are all symptoms of eutrophic conditions marine organisms including fish and shellfish (Howes et al. 1999).

Total nitrogen, which includes both organic nitrogen (the N found in live, dead or decomposing plants and animals) as well as inorganic (the N that is dissolved into solution or bound to sediments, etc.) is widely used by scientists as an indicator of eutrophication or nutrient enrichment in marine waters. Levels below 350 parts per billion (ppb) are characteristic of low nutrient waters, while values above 600-700 ppb indicate nitrogen enrichment (Howes et al. 1999). Using those values for comparison, Great Salt Pond water samples have generally been in the low nutrient range since monitoring began (figure 15). However, that data shows a trend of increases in total nitrogen at Trim’s Pond (GSP#4). Monitoring the Great Salt Pond for total nitrogen should definitely be continued.

Total nitrogen values at the two Block Island Sound sites outside the Great Salt Pond were typically lower than those within the pond, with the exception of deep samples at the northern site in 2009 (figure 16). The unusually high average value reported in 2009 was due to a July concentration that was nearly four times as high as usual, and may have been the result of contamination from bottom sediments. Continued monitoring of these sites will be important to assess overall conditions at these sites as well as for providing background levels against which to compare GSP sites.

Figure 15. Annual Mean Total Nitrogen – Great Salt Pond Sites

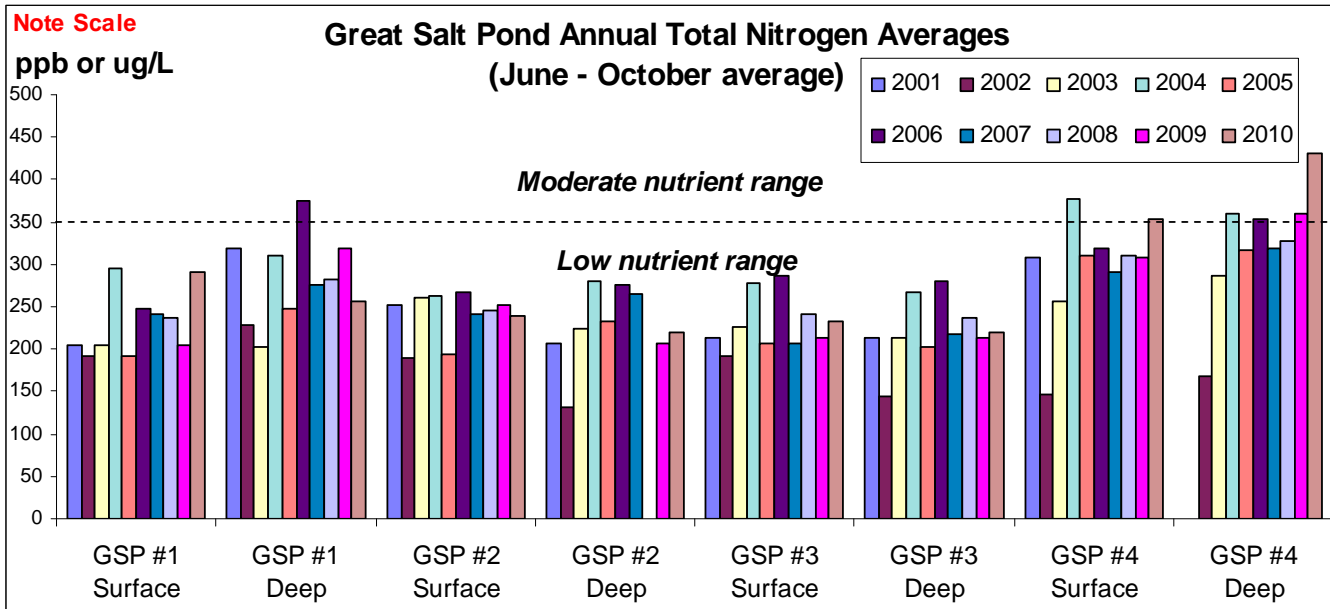
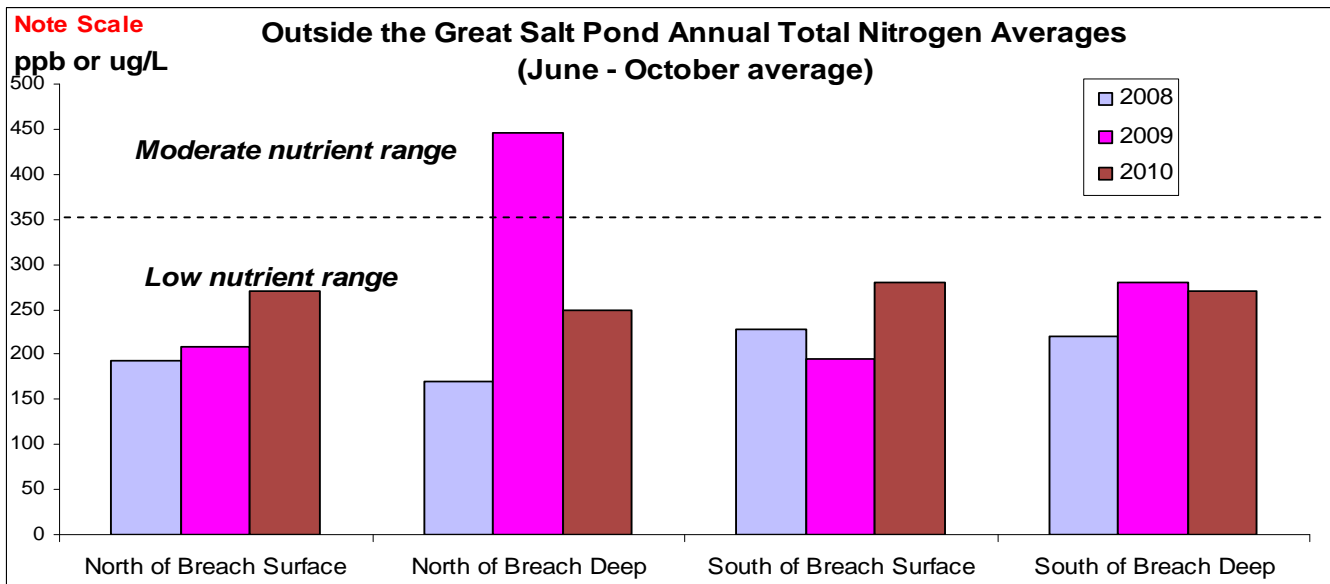
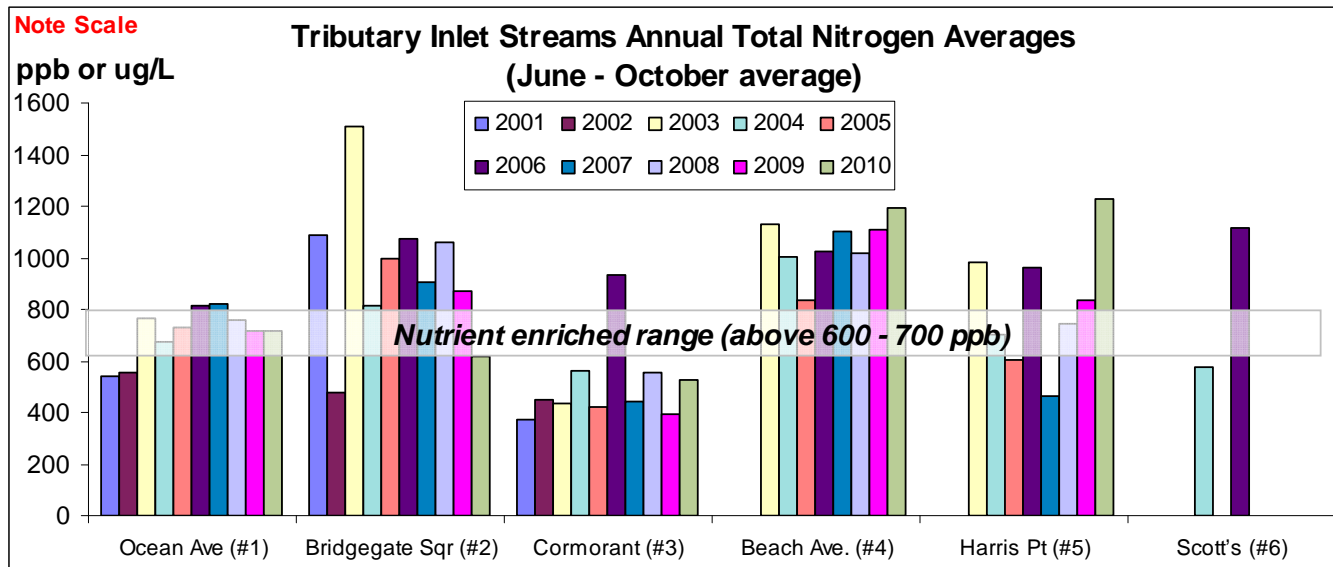


Figure 16. Annual Mean Total Nitrogen – Outside GSP - Block Island Sound Sites



Total nitrogen values in the inlet streams were generally at least twice as high as in the pond sites, and fluctuated quite a bit (figure 17). Clear trends in total nitrogen concentrations are not yet evident, and different tributaries seem to be responding differently. Ocean Ave (#1) has shown overall increases since monitoring began, but more recently levels have declined. With the exception of 2006, Cormorant Cove (#3) has been relatively stable at low levels. Harris Pt (#5) and the more limited Scott's (#6) data show moderate decreases. It should be noted that total nitrogen levels in these Block Island tributary streams were within the range of other tributaries monitored as a part of URIWW. However, Bridgegate Square (#2), and Beach Ave (#4) have been consistently higher, with N levels more similar to urban rivers and streams. In light of the impact that additional nitrogen loads could have on the pond, continued monitoring of these tributary inlet streams is strongly recommended.

Figure 17. Annual Mean Total Nitrogen – Tributary Sites



Ammonia-nitrogen is the most reactive form of N in aquatic systems. It is soluble, readily adheres to soils and sediments, and is converted to nitrate by microbes when oxygen is present through a process called nitrification. Nitrification requires a substantial amount of oxygen and carbonate, thus can reduce both DO levels and pH slightly. In excess, ammonia-nitrogen can be toxic, particularly at early life stages. The level at which it become lethal is dependent on water temperature, pH, and salinity so site specific criteria are applied (see <http://www.dem.ri.gov/pubs/regs/regs/water/h20q09a.pdf> for more information). In general, given the conditions in the Great Salt Pond, chronic exposure critical ammonia level would be approximately >411 ppb, and >2100 ppb in the tributaries. Ammonia-nitrogen values at all sites (pond and tributaries) were well below levels of concern for chronic exposure (figures 18 – 20).

Figure 18. Annual Mean Ammonia-Nitrogen – Great Salt Pond Sites

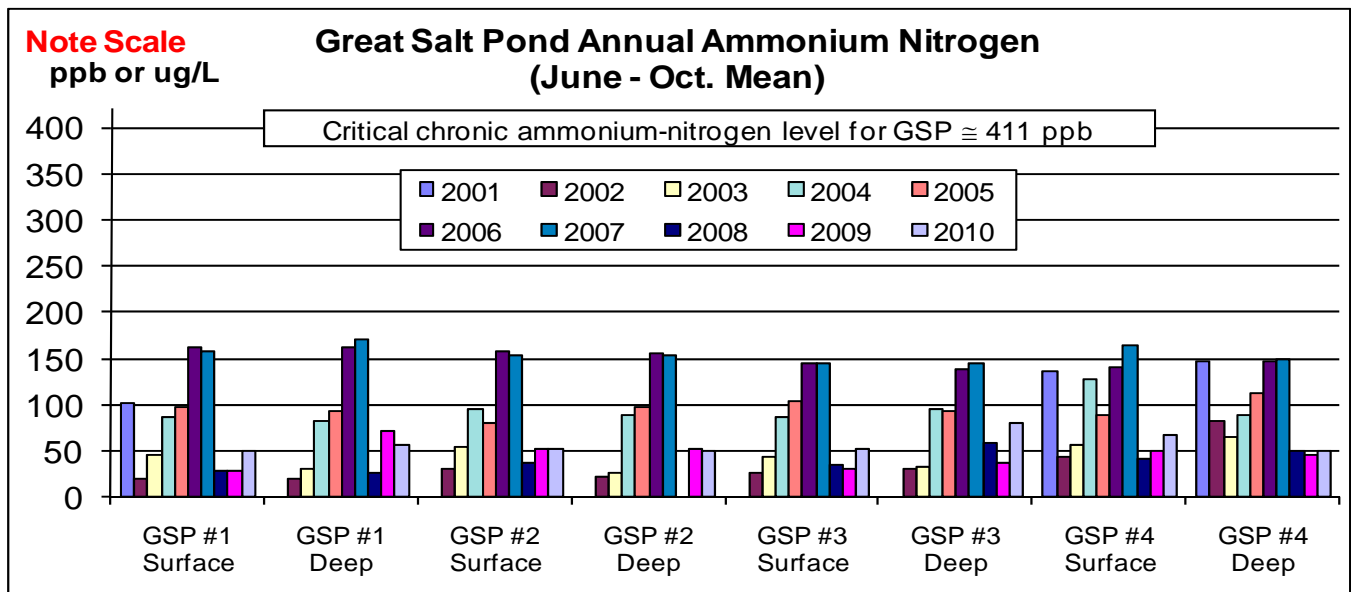


Figure 19. Annual Mean Ammonia-Nitrogen – Outside GSP - Block Island Sound Sites

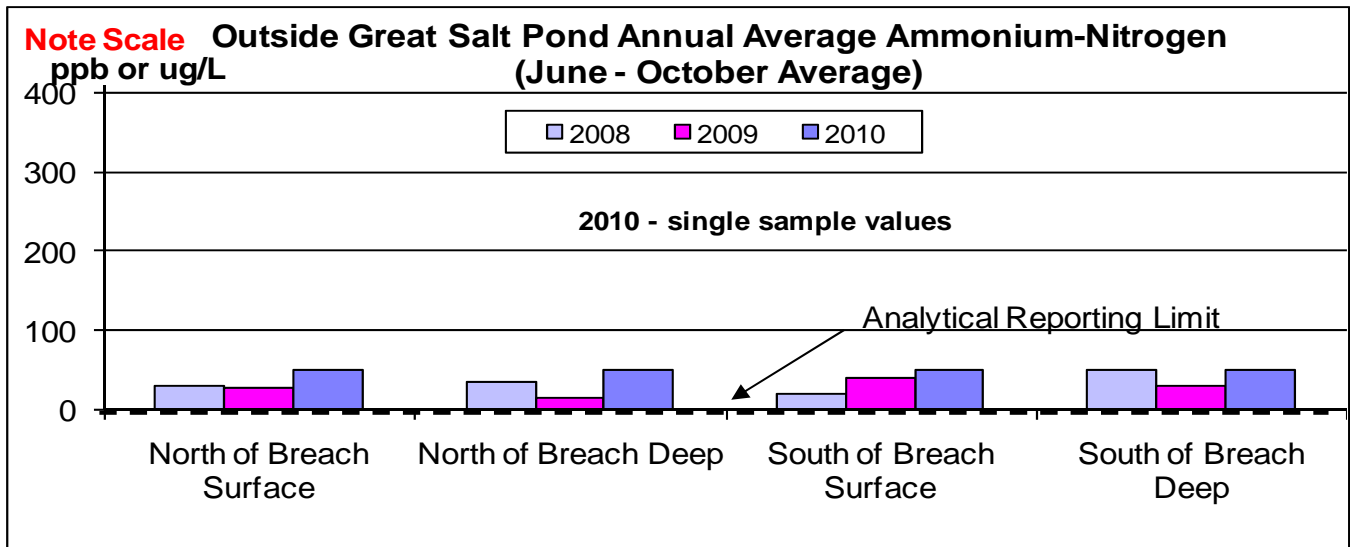
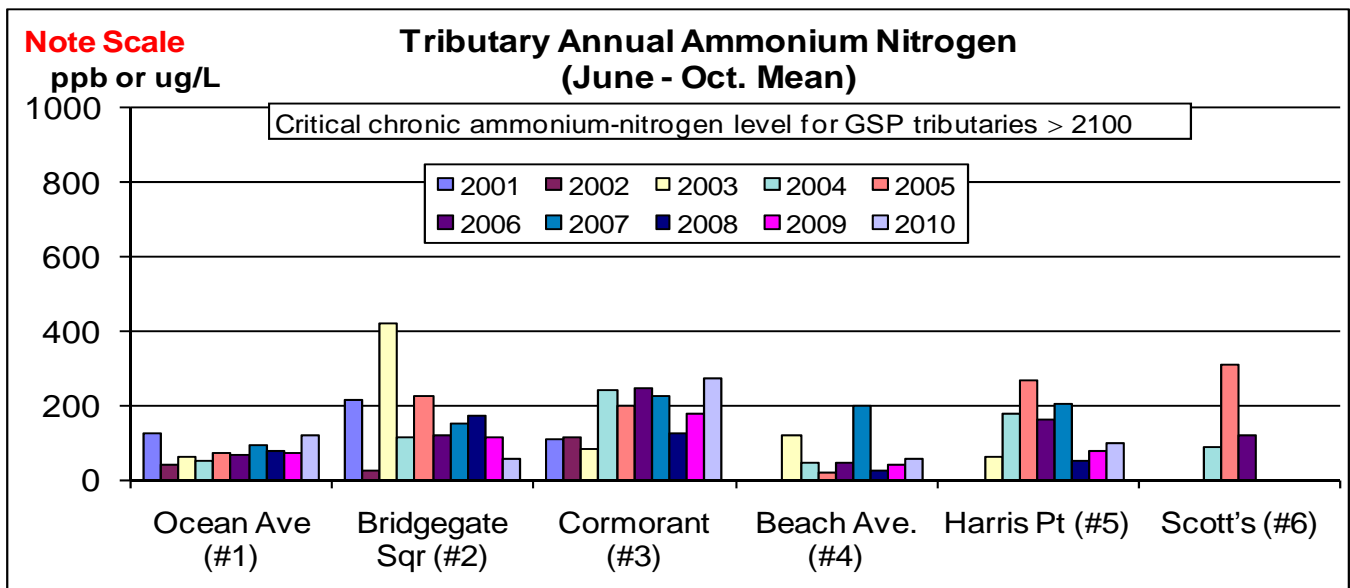


Figure 20. Annual Mean Ammonia-Nitrogen – Tributary Sites



Nitrate + nitrite-nitrogen (nitrate-nitrogen) is also a soluble form of N, and is readily taken up and used by algae and submerged vegetation during the summer growing season. When oxygen is absent (anoxic conditions), bacteria convert nitrate-N to gaseous N (N₂ or N₂O) through a process called denitrification, which removes N from the soil-water environment. Nitrate-nitrogen levels were very low, below the reporting limit for most of the sampling events in most years for the pond sites (figures 21 -23). As with total nitrogen, nitrate-nitrogen levels in the Ocean Ave. (#1) and Bridgegate Sq (#2) tributaries were also higher than in the pond sites (figure 23). These levels were within the range of other URIWW monitored tributaries, with Bridgegate Sq. (#2) similar to urban tributary streams. It should be noted that all levels were well below the 1000 ppb (1 ppm) nitrate-nitrogen levels that the US Geological Survey considers an indication of some type of groundwater contamination.

Figure 21. Annual Mean Nitrate + nitrite-Nitrogen – Great Salt Pond Sites

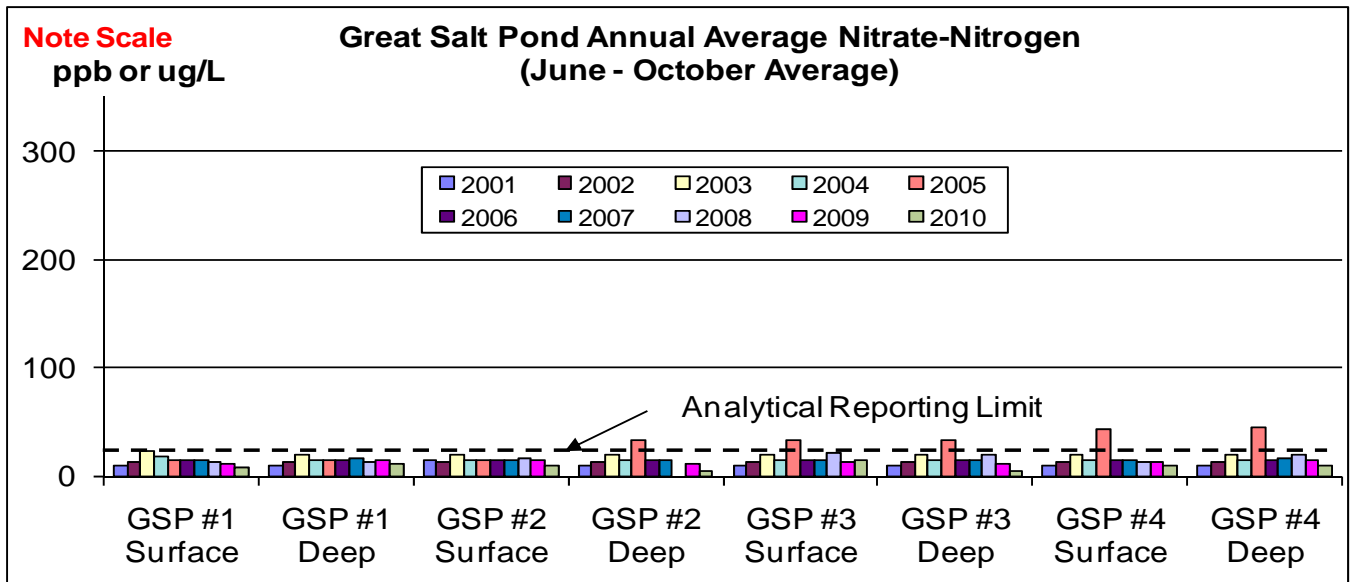


Figure 22. Annual Mean Nitrate + nitrite-Nitrogen – Outside GSP - Block Island Sound Sites

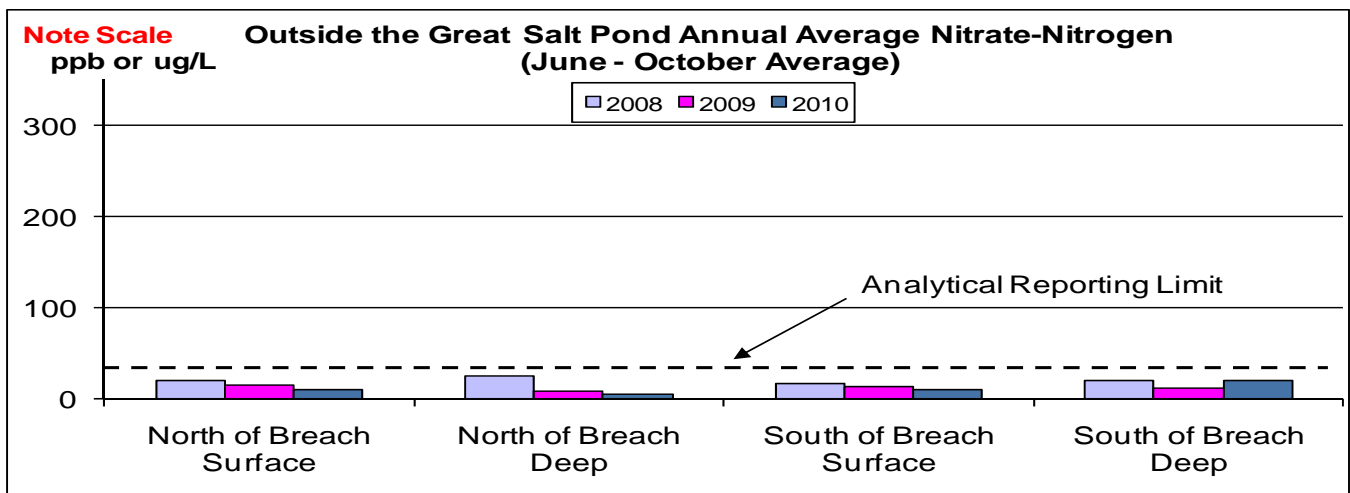
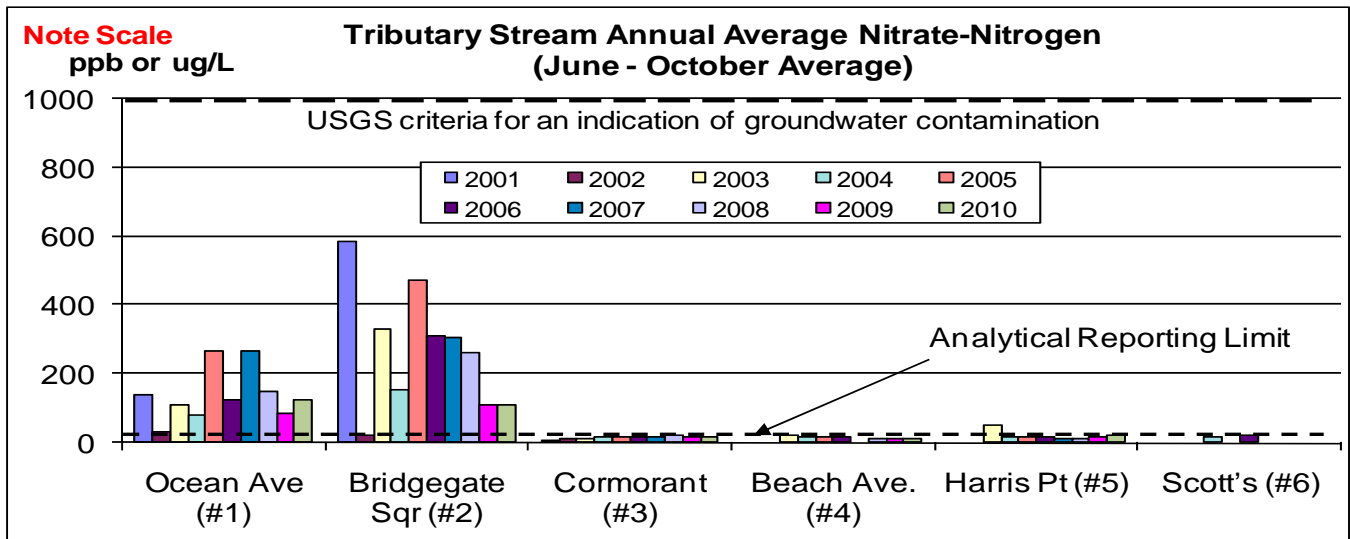


Figure 23. Annual Mean Nitrate + nitrite-Nitrogen – Tributary Sites



Dissolved Inorganic Nitrogen: Total nitrogen is comprised of nitrate-N, ammonia-N and organic-N, with nitrate-N and ammonia-N accounting for about half the total nitrogen at each of the Block Island sites. The National Coastal Assessment program uses the dissolved inorganic nitrogen (DIN) component, which includes both ammonia-N and nitrate + nitrite-N, in its coastal conditions assessment. For northeastern estuaries, DIN levels <100 ppb are considered good, 100 – 500 ppb considered fair, and > 500 ppb considered poor (EPA 2008).

Figure 24. Annual Dissolved Inorganic Nitrogen (DIN) – Great Salt Pond Sites

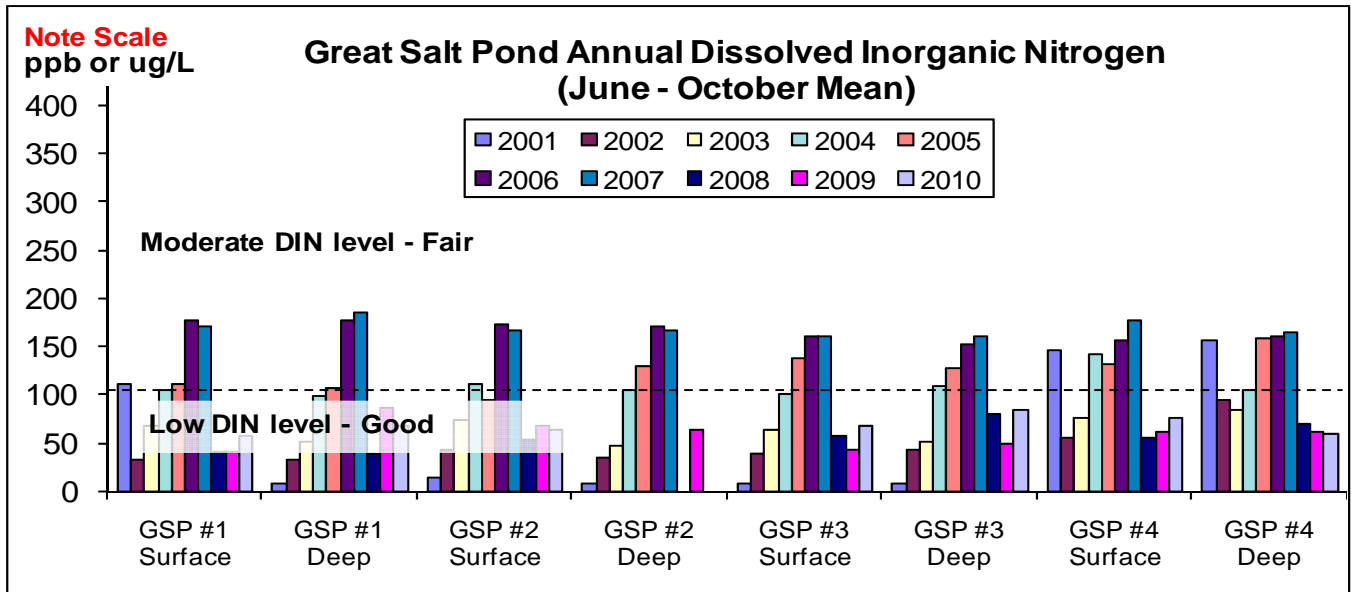
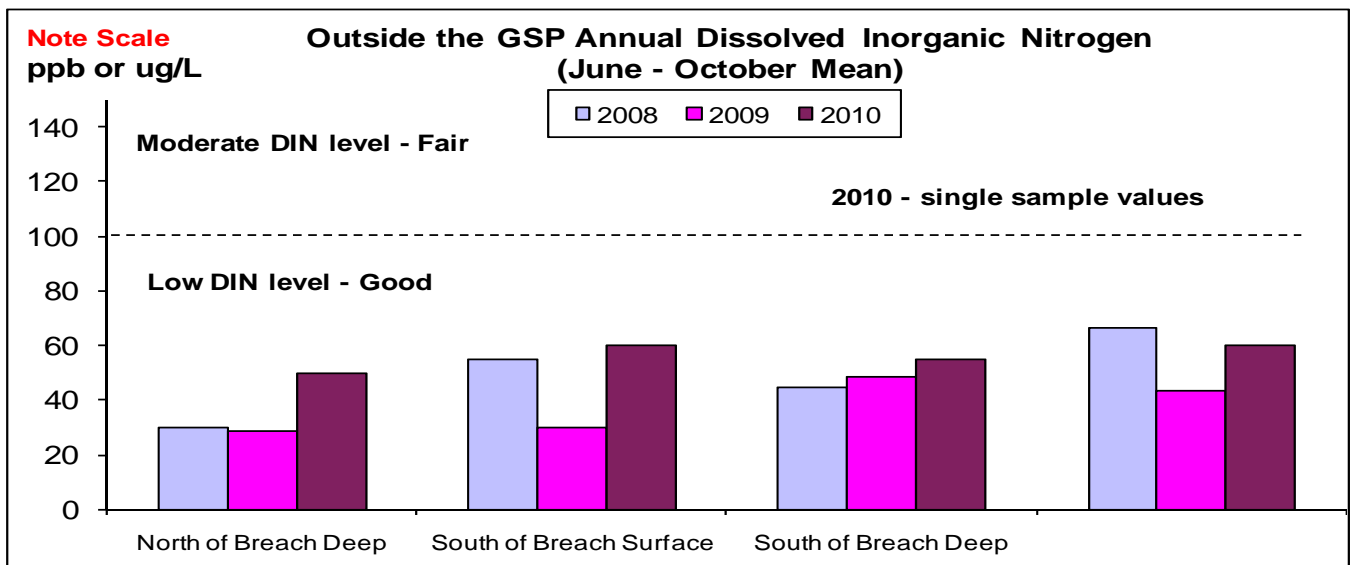
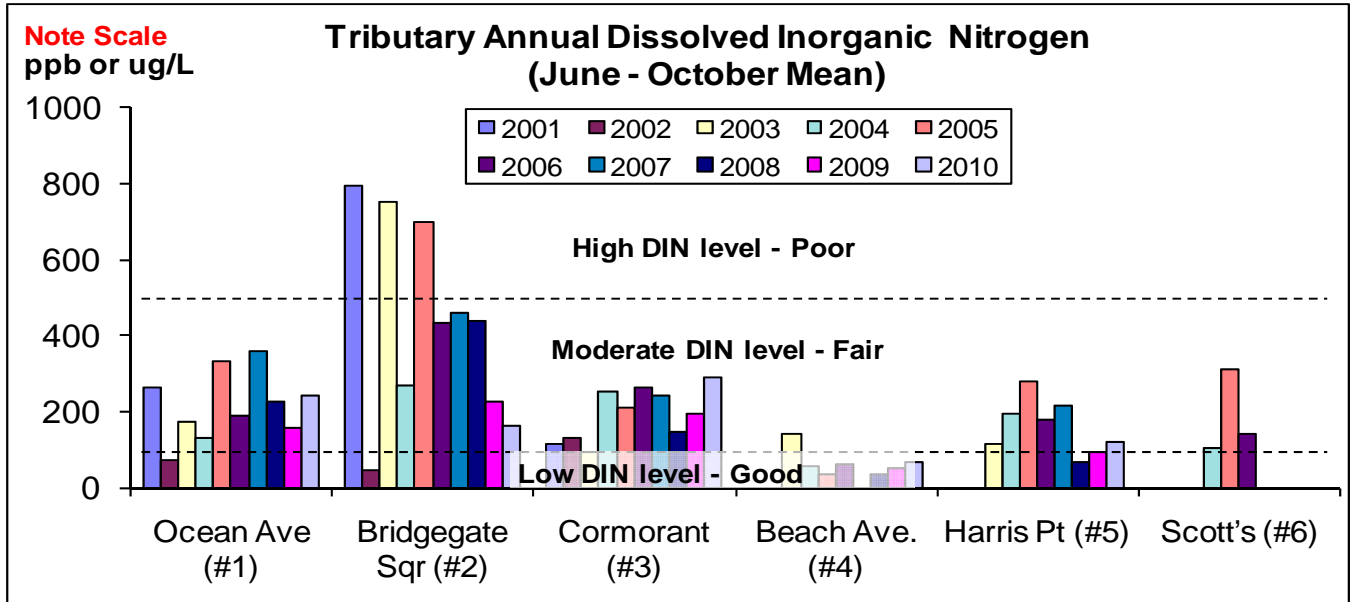


Figure 25. Annual Mean Dissolved Inorganic Nitrogen (DIN) – Outside GSP - Block Island Sound Sites



After several years of increasing DIN values, which reached the moderate or fair range for most of the sites between 2004 and 2007, all of the GSP sites have been in the low or good range in since 2008 (figure 24). The DIN decline between 2007 and 2008 was remarkably steep and consistent for all of the GSP sites, which suggests it was due to weather or other large scale changes. It will be interesting to see what, if any, future trends are evident in the dissolved inorganic nitrogen levels at the GSP sites. The Block Island Sound sites had consistently low DIN levels, well within the good category (figure 25).

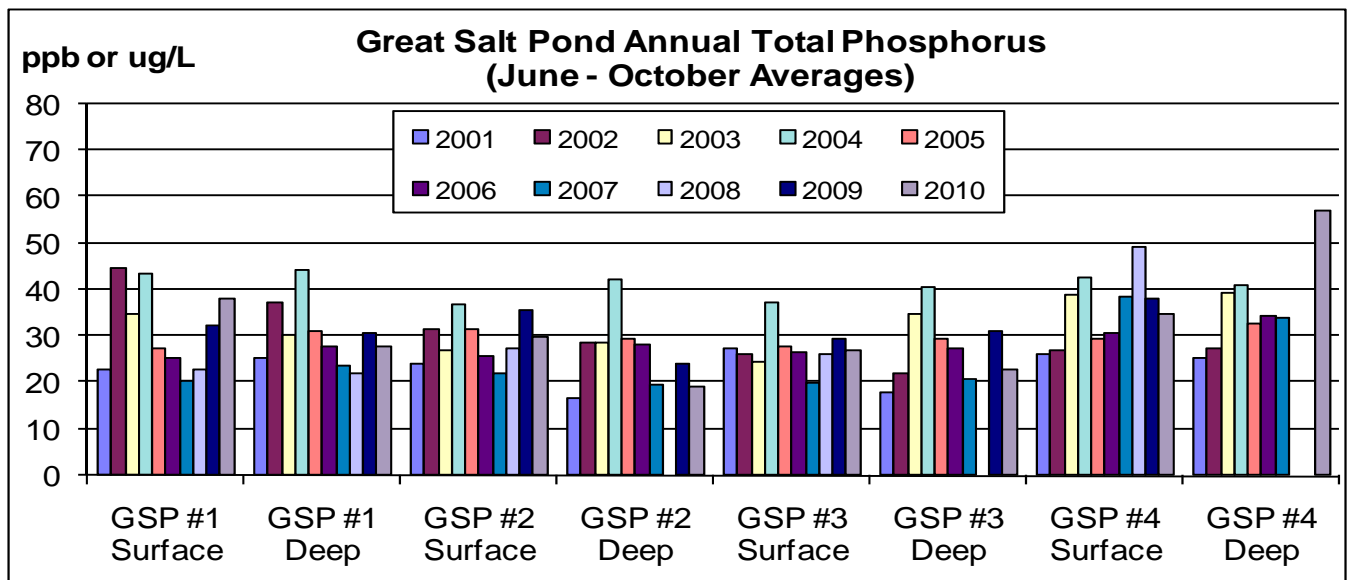
Figure 26. Annual Mean Dissolved Inorganic Nitrogen (DIN) – Tributary Sites



Consistent with total nitrogen values, DIN levels in the tributaries were generally much higher than the levels in the pond (figure 26). Most notable were the very high DIN levels often found at Bridgegate Square (trib #2), well within the high, or poor range. Encouragingly, DIN levels at that site have been declining, and have maintained in the moderate or fair range for the last five years.

Phosphorus. In most estuaries such as the Great Salt Pond, nitrogen is the primary nutrient that controls algal and plant growth. However like nitrogen, phosphorus is also essential for life, and in salt water environments phosphorus levels must be considered in relationship to nitrogen levels. Like nitrogen, phosphorus also occurs in the total form which includes phosphorus bound in particulate (organic and inorganic) matter and soluble or dissolved forms which are readily used by algae.

Figure 27. Annual Mean Total Phosphorus – Great Salt Pond Sites



Total phosphorus (TP) levels in the Great Salt Pond have been in the 20-40 ppb range (figure 27). Except for GSP #4, there hasn't been the same overall increase in TP seen with total

nitrogen. Phosphorus at all pond sites was mostly in the dissolved form (data not shown), indicating that it was biologically active. That means it was being absorbed and used by microscopic algae and aquatic plants, which were then being eaten and excreted by filter feeding zooplankton, shellfish and fish. Total phosphorus values for the sites outside of the Great Salt Pond were also consistently low (figure 28).

Figure 28. Annual Mean Total Phosphorus – Outside GSP- Block Island Sites

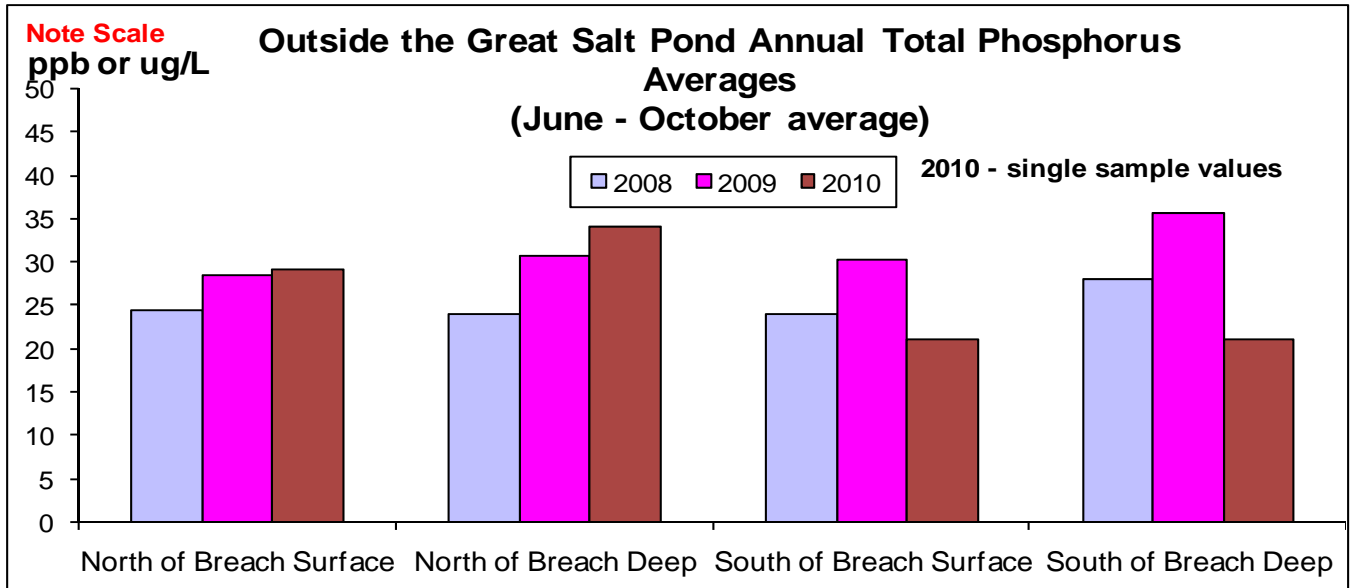
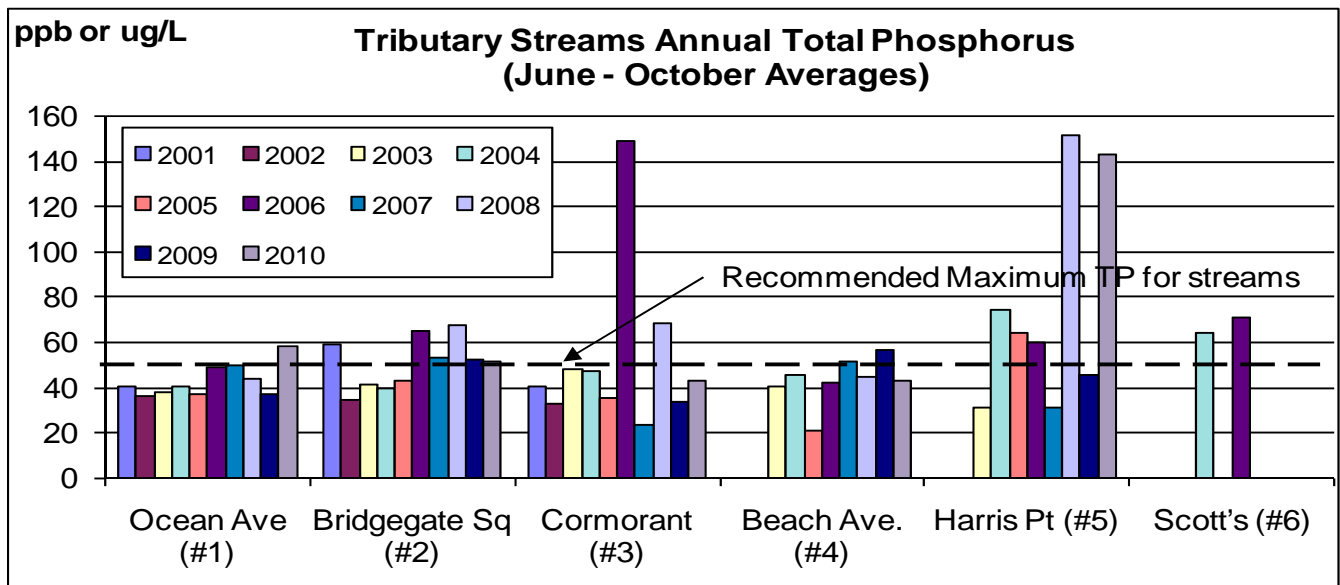


Figure 29. Annual Mean Total Phosphorus – Tributary Sites



For freshwater streams, a maximum concentration of 50 ppb total phosphorus is the advised limit for protection of downstream resources. Concentrations below 50 ppb were generally found in the tributary sites (figure 29). In 2006 Cormorant Cove (#3) had an extraordinarily high total phosphorus value of 724 ppb. This was the only time this happened during the ten years of monitoring at that site, and may have been due to sediment contamination in the sample. Bridgegate Square (#2), Harris Point (#5) and Scott's (#6), have all had water samples on multiple dates that exceeded 50 ppb. The regularity with which these sites have exceeded the recommended total phosphorus maximum in particular warrant continued monitoring of phosphorus. Ocean Ave. (#1) and Bridgegate Sq. (#2) both showed small but

steady increases in total phosphorus levels. The discussion of concentration versus loading in the section on bacteria also applies here.

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- University of Rhode Island Watershed Watch website (includes monitoring manual, data, fact sheets, and links to local, regional and national information)
<http://www.uri.edu/ce/wq/ww>