Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina
Year 9: June 1, 2008 – May 31, 2009

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Acronyms Used in this Report

ANOSIM	Analysis of Similarity
ANOVA	Analysis of Variance
DCP	Data Collection Platform
ECSU	Elizabeth City State University
M	Methanogenic
MPSR	Methanogenic with evidence of past sulfate reduction
MSL	Mean Sea Level
NA	Insufficient Data
ND	No Data Recorded
NS	No Significant Difference
PPT	Parts Per Thousand
SR	Sulfate Reducing
SRNS	Sulfate reducing with non-seawater source of sulfate
UNCW	University of North Carolina Wilmington
UNF	University of North Florida
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
XXX	Data Loss
--	Species absent

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ABSTRACT

Data from all twelve stations was similar between years 07-08 and 08-09 with a slight increase in data loss due to under-ranging events and aging equipment. The station with the greatest loss of tidal range data was P2 (Town Creek), which lost 20.1% of tides due to under-ranging events and equipment failures. This was an increase from last years 6.8% of total tides lost, most likely a result of under-ranging events due to local ship traffic and large wakes associated with this traffic. Further, there have been issues with data recording and transfer due to aging equipment. This DCP has recently received a major overhaul with a new cap, cable and data logger which should alleviate a large percentage of these issues in the future. Data loss at P8 (Dollisons Landing) was relatively high at 9.8%. The major problem during this reporting period occurred when the unit was impacted by a floating tree during a high water/flood event. The tree was wedged into the DCP and the platform was knocked over. The platform has been repaired with little data lost. Overall, there were more than 1,400 tide ranges measured between June 1, 2008 and May 31, 2009.

Tidal ranges within the estuary were fairly constant, including the lowermost of the upstream stations, and were higher than tidal ranges measured at most upstream stations. A good correlation between measured tidal range from the base station at Ft Caswell and the predicted tidal range for this station continues to exist. Water levels in the most upstream sites and the inner Town Creek station continued to be affected by precipitation and discharge rates in the river, but to a lesser degree than in 2007-2008. Half of the sites exhibited a significant difference in yearly mean tidal ranges between this reporting period and 2007-2008. The mean tidal range at P1 was significantly higher than the mean reported in the previous monitoring period, but was not significantly different from the range reported in year 1. Comparisons of the regression slopes when tidal range at each site was regressed against P1 tidal range yielded no significant differences between this reporting period and the previous reporting period. This result contrasts with the previous reporting period when significant differences were detected for all of the stations. When the slopes from this reporting period were compared to slopes calculated for Year 1 (2000-2001), all sites exhibited a significantly different slope except for station P13.

Periods of lower, drought-induced water levels and extreme flooding in the system over the last 5 years have contributed to differing tidal conditions in the Cape Fear and Northeast Cape Fear Rivers between monitoring years. During this reporting period, the mean discharge in the Cape Fear mainstem was higher than during year 8 (2007-2008), but still below the 30 year average. The mean discharge for this reporting period is almost twice the discharge measured for 2007-2008 and approximately one-half of the discharge measured in 2006-2007. This intermediate discharge may explain why some of this year's results are more similar to those reported in 2006-2007 while others are more similar to those reported in 2007-2008. For example, this year the highest salinity reported at site P11 subsite 1 on the Northeast Cape Fear

River was 13 ppt. In 2006-2007, the highest measured salinity at this same site and subsite was 12 ppt, similar to the measured salinity from this reporting year. However, in a low flow year, 2007-2008, the salinity at this same site and subsite reached a maximum of 24 ppt.

During the annual reporting period seven cruises upstream to Lock & Dam 1 (1 June 2008 through 30 December 2008) were conducted to monitor the water column salinity. Average stream flow on the Cape Fear River at Lock and Dam 1 ranged from 632 cfs to 22,600 cfs during the collection season. The highest flow rate during a cruise averaged 19,300 cfs recorded in September. Salinity was not detected during this data collection. The lowest average flow rate over Lock and Dam 1, 994 cfs, occurred during a river cruise in July. Ocean derived saline water was detected at Site 1 ranging from 1.3 ppt at the surface increasing to 2.0 ppt at maximum depth. The maximum salinity measured near shore from the DCP at Site 1 during this same time period was 13.8 ppt and the minimum was 0.1 ppt. No salinity was observed at or beyond Site 2 during the cruise. Thus, saline water did not reach farther than 40 miles upstream (lat/long: 34.20187, -78.02900)

The flooding frequency within swamps and marshes at approximately half the DCP stations was lower this year when compared to last year. This effect was more pronounced in the fall during drought conditions when the river discharge rates were below average. However, during spring 2008, flooding conditions had returned to levels comparable to previous years. Salinity levels in the fall also reflected the drought and low flow regime. In fall 2007, salinity was detected at all stations except P9. Also similar to flood patterns, salinity measurements in spring 2008 returned to levels comparable to previous years.

In general, the current year was slightly saltier compared to the average year, but not as salty as the low flow year. The lower salinity conditions were evident at Indian Creek (P7), Black River (P9), Rat Island (P12), Town Creek (P3), and Eagle Island (P6). Fishing Creek (P13) and Prince George (P14) had conditions that were similar to the low flow year. Dollisons Landing (P8) and Smith Creek (P11) did not show any trends towards either saltier or fresher conditions. Monthly sampling at Eagle Island (P6) indicated that classifications at this site are consistent with an average year where the majority of the classifications were methanogenic with evidence of past sulfate reduction (MPSR). During the low flow year, classifications were evenly divided between sulfate reducing and MPSR.

Bentic infaunal species richness, diversity, and mean abundance were reduced in summer 2008 compared to the previous summer and the initial summer sampling. These trends were consistent among major taxonomic groups, numerically dominant taxa, and functional groupings. However, among sites and years, most comparisons were not significantly different. As was observed in the 2007 report, oligochaetes dominated most sites representing between 10% and 90% of the total number of individuals overall. Summer 2008 represented a change in patterns for several key community characteristics.

While benthic infauna respond more slowly to changes in physical factors, the epibenthic community responds quickly to physical changes due to their highly motile nature and need for refuge and forage habitat. Breder traps (a passive sampling device) deployed at multiple tidal positions within the marsh and Drop traps (an active density-based sampling method) used along the shallow subtidal marsh edge habitat, measured the presence of the epibenthos in various portions of the estuary. Evaluations of total abundance among years show that more fish utilized the fringing marshes in fall 2007 compared to the fall 2008 and the initial fall 1999 collections. For the spring collections, 2008 total abundances were higher than the 2009 and 2000 collections. With a few exceptions, the fall and spring richness and diversity data displayed similar patterns with the fall 2007 period, exhibiting higher levels than the fall 2008 and 1999 periods and the spring 2008 period being higher than the 2009 and 2000 periods.

Sensitive herbaceous vegetation at seven sites varied widely in response to river flow rate and also by direct human manipulation. The effects of ocean-derived salts on sensitive herbaceous vegetation have been documented for an unusual second consecutive year at two sampling stations in the Cape Fear River estuary monitoring area. A third sampling station experienced its first salinity event. These events coincided with a minimal or seasonal reduction in flow along the Black, Cape Fear, and Northeast Cape Fear Rivers.

Salinity incursions at the Inner Town Creek site have now resulted in loss of most sensitive herbaceous vegetation, most shrubs and all trees in or near the monitoring polygon. Soil subsidence has also been noted. The Fishing Creek site on the Northeast Cape Fear River has experienced its second consecutive salinity event. Last year sensitive vegetation was impacted by brackish water. This year, the most common species of sensitive vegetation, *Pontederia cordata* and *Saururus cernuus*, were largely dead above the surface. This event followed the first observation of substrate subsidence in the area. Furthermore, it occurred coincidentally with death of tree and shrub species at the site and with documented low flow periods in the Northeast Cape Fear River.

The Indian Creek sampling station was recently disturbed by partial clearing of natural vegetation. It experienced a minor ocean-derived tidal salt incursion that occurred coincidentally with a seasonal period of low discharge during June and July of 2008. Disturbance at the site may have helped to modify the full effects of the event. The monitoring polygon was relocated to a different area within the existing belt transect.

This report includes data from project year June 1, 2008 – May 31, 2009. Previous year's data may be obtained from USACE or the project webpage (http://people.uncw.edu/culbertsonj). Comparisons will be made among and between data from all project years following project construction.

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1.0 STATION OPERATION

1.1 Summary

Measurement of water levels in the main channel of the Cape Fear River, the Northeast Cape Fear River, and Town Creek continue to provide the data necessary to determine the impact associated with the widening and deepening project. Differences between the high and low points of each tide, referred to as ranges in this report, can be followed upstream from the base station at Ft Caswell (P1) to any individual station. Differences between stations with respect to tidal range, time to high or low tide, length of low and high tides were also determined. Comparisons of these variables before and after channel modifications will provide the statistical testing mechanism to examine whether the project has impacted adjacent wetlands. In addition, the absolute elevation of floodwater when related to measurements of water levels at marsh/swamp substations allows the determination of both flood duration and flood depth for any tide. This report includes data collected from June 2008 through May 2009. During this period, problems of communication with instruments or minor instrument malfunction were solved as they occurred. Mechanical errors were slightly higher at some sites this year than during previous reporting periods, and this may reflect the age of some of the equipment. As was the case in previous monitoring years, each tide has been examined for each station and a determination made as to whether data collected were reliable.

Table 1.1-1 provides a general summary of data loss that affects statistical analysis for present and future comparisons

Table 1.1-1. Percentages of tides unavailable for analysis and reasons for loss. Detailed descriptions of "loss" categories are listed in Section 1.2 above.

Station	% Loss At Station P1	% QA/QC	% Under-ranging Events	% Absence of Data	% Freezing	% Mechanical Errors	Total % Lost Tides
P1	N/A	0.3	0	0	0	7.9	8.2
P2	8.2	0.4	3.1	7.0	0	1.4	20.1
P3	8.2	0.1	0	0	0	0.6	8.9
P4	8.2	0	0	0	0	0	8.2
P6	8.2	0.3	0	0	0	4.6	13.1
P7	8.2	0.1	8.6	0	0	0.6	17.5
P8	8.2	0.2	0	9.8	0	1	19.2
P9	8.2	1.2	0	1.1	0	4.0	14.5
P11	8.2	1	0	1.2	0	1.9	12.3
P12	8.2	0	0	0	0	0	8.2
P13	8.2	0	0	0	0	0.6	8.8
P14	8.2	0.1	0	0.0	0	3.2	11.5

1.2 Methodology

Water level is sampled by a UNIDATA shaft-encoded water level recorder housed in an aluminum stilling well at 1-second intervals. A UNIDATA Starlogger logs the average, maximum and minimum values every 3 minutes at stations P1 and P2 and every 6 minutes at all other stations. Conductivity and temperature are also sampled by a UNIDATA conductivity instrument and recorded by the Starlogger every 3 or 6 minutes. Data are downloaded to a PC housed in the laboratory every 2 weeks via modem. In instances when the modem has not functioned properly, technicians on site download data loggers using a laptop. Preliminary data quality review consists of visually reviewing data for major problems (e.g. float hang-ups in the stilling well, data transmission errors, large jumps/shifts in water level, loss of data) within 2-3 days of download. This process is done so that any major problems identified can be rectified immediately. Data are then compiled into files each of which contains 1 month of data for each station. Data files are next sorted at 6 minutes intervals and the resulting data set stored for subsequent data analysis. As in previous reporting periods, the terms used to describe general mechanisms through which data are lost or compromised are defined below:

Loss at Station P1: Because the response of each variable upstream (Figure 1.2-1) is related to the base station at Ft Caswell (P1), the loss of a variable from P1 during a particular tide means that there is no means of comparison with other stations. Reasons for data loss at P1 as well as other stations are: 1) QA/QC Procedure, which refers to tides that were removed from the data set when measurements coincided with QA/QC and equipment maintenance procedures. In these instances, recorded water levels were inaccurate due to cleaning the water level float, removing/replacing the water level recorder, replacing the beaded cable, or performing a field reset when in-situ observations of water level were inconsistent with water levels reported by the data logger. 2) Under ranging events refers to tides that were removed from the data set when the actual water level fell below the elevation of the stilling well cap. In these instances, the instruments were unable to detect the minimum water level. 3) Absence of Data refers to tides that were lost when the data were not recorded by the data logger or were not transmitted properly via the modem or PC download process. 4) Freezing of surface water in the stilling well prohibited the float from following the rise and fall of the tides and these tides were removed. 5) Mechanical Errors refer to tides removed from the data set during the data review process because of likely mechanical malfunction. Mechanical malfunctions were suspected when the plotted data exhibited misshapen curves, large jumps, and flat lines (i.e. hang-ups).

1.3 Ft Caswell (P1)

Ft Caswell is the most important station because this station experiences amplitude changes that are essentially oceanic tides. All upstream water levels are related to this station. During this reporting period, the total percentage of lost tides at this station (8.2 %) was higher than during the 2007-2008 reporting period (4.0%). The lost tide percentage was more in line with the three reporting periods (6.9, 10.2% and 8.0 %) prior to the 2007-2008 reporting period. Data collected at this station still show occasional irregularities in the shape of the water level curves but these variations do not affect the reported minimum and maximum water level values (i.e. reported tidal range). The greatest loss of data at this station was associated with high wind and wave action that disrupted data collection. Monthly QA/QC checks and cleaning of probes and the well interior prevent most minor problems before they occur. Corrosion of the beaded cable also affects data quality; therefore, cable integrity is assessed each month and the cable replaced when necessary.

1.4 Town Creek Mouth (P2)

Water level curves at this station can be noisy due to periods of what appear to be high frequency variations in water level. These episodes do not occur with any regular periodicity and are believed to be associated with nearby ship traffic. Nonetheless, data are of sufficient quality to regularly identify maximum and minimum water levels and these data correspond well with the data from P1. The total percentage of lost tides at this station (20.1%) was a large increase over the 2007-2008 reporting period (6.8%). Under-ranging problems have continued to be an issue at this site, and were one cause of the increase in lost tides. There has been ongoing work to cap this station in hopes of solving the under-ranging issue. Lost data (7.0%) from under-ranging events was also a major contibutor to the number of lost tides having increased from the 2007-2008 reporting period. P2 experienced only a few mechanical errors this reporting period. Minor data loss also occurred during QA/QC resets. Water relatively high in salinity at this site continues to affect the beaded cables, necessitating their replacement on occasion.

1.5 Inner Town Creek (P3)

This station generally experiences few problems and continues to generate smooth tidal curves. Data loss during this reporting was less than the 2007-2008 period. Mechanical problems the primary cause of data loss at P3 comprising 0.6% of total tides. This was an improvement from the previous year's loss of 3.1% of tides.

1.6 Corps Yard (P4)

NOAA operates the tidal gauge at this site and data are available at their website after curve-smoothing procedures are applied. The UNCW conductivity/salinity gauges located at this site have operated with only a few problems over the reporting period.

1.7 Eagle Island (P6)

During this reporting period, data loss at this station increased slightly (2.0%) over the 2007-2008 reporting period. The primary cause of failure during this reporting period was tides lost due to mechanical failures. This year P6 experienced a 4.6% loss compared to 1.0% loss for the previous year. QA/QC water level resets resulted in minor data loss (0.3%).

1.8 Indian Creek (P7)

Under-ranging has continued to be problematic at this site. The percentage of 2008-2009 under-ranging events (8.6%) was comparable to the previous reporting year (9.6%). The last two years had the highest rates of under-ranging at this site since monitoring began. One possible explanation for this trend is recent clear cutting that has occurred on the uplands adjacent to this site. This site continues to experience infrequent mechanical errors and QA/QC water level resets which resulted in a loss of less than 1% of total tides.

1.9 Dollisons Landing (P8)

This station experienced a high percentage of total tides lost. Only one other station (P2) lost more tides than this station (19.2%). The major problem during the reporting period occurred when the unit was impacted during a high water/flood event that wedged a tree into the DCP and the platform was knocked over. Approximately 9.8% of tides were lost during this event. This site also experienced infrequent mechanical errors and QA/QC water level resets which resulted in a loss of 1.2% of total tides.

1.10 Black River (P9)

Site P9 experienced a loss of 14.5% of total tides for the 2008-2009 reporting period. Total tides lost were similar when compared to the previous data period. Consistent with previous years, data loss at the station was primarily associated with mechanical errors (4.0%) resulting from periodic river flooding that interrupted operation of the water level recorder. Data absences also occurred following some flooding events (1.1%). During this reporting period (like all previous years), this station required many water level resets due to a gradual drift in the water level recorder (1.2%).

1.11 Smith Creek (P11)

This site experienced more problems during the 2008-2009 reporting period than during the previous reporting period. P11 experienced several mechanical losses (1.9%) during this period, which may be related to the influx of sediments from Smith Creek. Several additional QA/QC visits were needed to correct this issue and these contibuted to 1.0% of lost tides. The stilling well also was capped during this reporting period, which seems to have alleviated the problem.

1.12 Rat Island (P12)

No tides were lost at this station during the reporting period.

1.13 Fishing Creek (P13)

The percentage of lost tides at this site was comparable to the previous reporting period. As was the case during the previous reporting period, this site operated exceedingly well with a 0.6% loss of tides due to mechanical or other problems.

1.14 Prince George Creek (P14)

As with the other stations on the Northeast Cape Fear River, the performance of P14 was similar to the previous reporting period. Similar to P9, this site is prone to water level equipment failures during major flooding events causing mechanical errors. Mechanical errors during this reporting period (3.2%) were similar to the previous years (2.8%). QA/QC visits at this site resulted in only a 0.1% loss of tides.

2.0 MONUMENT AND STATION SURVEY VERIFICATION

2.1 Summary

All of the elevation monuments are intact and stable. The subsite elevation monuments and primary monument at P7 appear to be intact following last year's extensive vegetation clearing by adjacent development. All of the sites, including P7, require future resurveying at the end of the project by professional surveyors to ensure we are relying on accurate NAVD88 elevations determined at the beginning of the study.

3.0 PART A - RIVER WATER LEVEL/SALINITY MONITORING

3.1A Summary

More than 1400 tide ranges measured between 1 June 2008 and 31 May 2009 (Appendix A) were used to conduct analyses of changes in tidal amplitude as well as changes of ebb and flood duration. A good correlation between measured tidal range from the base station at Ft Caswell and the predicted tidal range for this station continues to exist. The mean tidal range at P1 was significantly higher than the mean reported in the previous monitoring period, but was not significantly different from the range reported in year 1. Tidal ranges within the estuary were fairly constant and were higher than tidal ranges measured at most upstream stations. Water levels in the most upstream sites and the inner Town Creek station continued to be affected by precipitation and discharge rates in the river, but to a lesser degree than in 2007-2008. Half of the sites exhibited a significant difference in yearly mean tidal ranges between this reporting period and 2007-2008. Mean tidal range at five of the monitoring stations was significantly different from the mean tidal range reported in year one of monitoring. Mean monthly maximum water levels for this reporting period were significantly different from the values reported for the previous monitoring period only at station P8. Mean monthly minimum water level at P8 also was significantly different between this reporting period and the value reported last year. Comparisons of the regression slopes when tidal range at each site was regressed against P1 tidal range yielded no significant differences between this reporting period and the previous reporting period. This result contrasts with the previous reporting period when significant differences were detected for all of the stations. When the slopes from this reporting period were compared to slopes calculated for Year 1 (2000-2001), all sites exhibited a significantly different slope except for station P13.

Changes in tidal lag showed no consistent pattern during this reporting period. There were about as many increases in high or low tide lag as decreases. In most cases, the noted changes were quite small (<0.1 hr) and overall, showed a return to values reported in 2006-2007. The largest differences were noted at stations P2, P7, and P9. During this reporting period, mean flood duration decreased by less than 0.2% at all stations. Mean ebb duration also varied little from those values reported in the last monitoring period, showing an increase of <2% at all stations.

Periods of lower, drought-induced water levels and extreme flooding in the system have contributed to differing tidal conditions in the Cape Fear and Northeast Cape Fear Rivers between monitoring years. As reported by Hackney et al. (2002-2008), these effects are confounded by the shortened data set for Year 1 which included data collected from October to June, only, and covered a period when monthly river discharge was below the long-term average. During this reporting period, the mean discharge in the Cape Fear mainstem was higher than during year 7 (2007-2008), but still below the 30 year average. The mean discharge for this reporting period is almost twice the discharge measured for 2007-2008 and approximately one-half of the discharge measured in 2006-2007. This intermediate discharge may account for why some of this year's results are more similar to those reported in 2006-2007, while others are more similar to those reported in 2007-2008.

Harmonic analysis of tidal constituents has continued during this reporting period. For all of the stations, the M2 component is the dominant constituent. A longer water level time series exists at station P4, allowing for examination of tidal harmonics for several years prior to the initiation of dredging. Over the period between 1994 and 2009, however, neither the amplitude nor the phase of the M2 constituent has changed appreciably. For the most part, the amplitude of the M2 constituent at P4 has varied between 2.03 and 2.11 with this year's value being 2.09. As expected, the M2 amplitude at sites just upstream and downstream of P4 (e.g. P2, P6, and P11) are more similar to P4 than to other sites in the river. Like mean water level, changes in harmonic amplitude appear to be linked to variations in discharge. It will be necessary to parse the discharge and tidal data differently so that a direct comparison between discharge and harmonic amplitude can be undertaken.

For part of this reporting period, drought conditions existed in the region and upstream releases in the Cape Fear River were reduced. Salinities as high as 13.8 ppt were measured at site P7 in July 2008, this same site exhibited salinities as high as 10.5 ppt in October 2007 when river discharge was very low. At site P13 on the Northeast Cape Fear River, salinities as high 14 ppt were reported in July and again in October 2008. Nonetheless, salinities were lower than those reported during the previous years for the upstream stations. Although discharge data are not available for the Northeast Cape Fear to enable a direct comparison of salinity to discharge, salinity patterns measured in this branch are consistent with discharge and salinity patterns reported in the Cape Fear mainstem.

3.2A Database

Water level, conductivity, and temperature data collected at DCP stations from June 2008 through May 2009 are incorporated in this report. This year's database includes approximately 1410 tides of sufficient quality to be used in the analyses of each of the DCP stations. Specific problems associated with each station have been described in Section 1 of this report. Table 1.1-1 summarizes the percentage of tides unavailable for analysis due to the various reasons cited above.

3.3A Data Analyses Methods

Because of changes in software for the DCP, the sampling schema was changed at all of the stations except P1 and P2 this year. At stations P1 and P2, water level and conductivity/

temperature data were measured once per second and averaged over a 3 minute interval every 6 minutes. At all other stations, water level and conductivity/temperature were collected once per second and then averaged over a 6 minute interval. The 6-minute means for all stations were plotted after each two-week interval and the resulting curves visually inspected by a senior analyst for quality control purposes. Suspect data, such as outliers or data points that deviate from a smooth curve, were discarded. Unreliable data, such as those collected during periods of mechanical malfunction, equipment maintenance, under-ranging events, and freezing events, were also removed. The remaining data were then filtered to extract the maximum and minimum water levels associated with each tidal event. For this report, a tidal event consists of one high water/low water pair.

The high and low water values contained in the final data set were used to determine the mean tidal range and to compute tidal lags between sites. The mean tidal range was computed from the difference in water level between each high and low tide event for each station (Figure 3.3A-1). The mean tidal ranges measured during this reporting period were significantly different ($P<0.05$) than the means reported during the first year of monitoring (2000-2001), or pre-dredging, at 5 out of 12 of the stations (Table 3.3A-2). These differences were evident at all estuary stations and the two lower most upstream stations. At one-half of the stations, the mean tidal range measured during this reporting period also was significantly different ($P<0.05$) than the means reported during the previous reporting period. This result differs from the 2007-2008 reporting period when ten out of 12 stations showed such differences. However, this result is comparable to those reported for the 2006-2007 period (Hackney et al., 2008).

Yearly comparisons of mean monthly maximum and minimum water levels collected at the DCP stations are shown in Table 3.3A-3. Significant differences in mean monthly maximum water level between this reporting period and year 1 only were observed at stations P2, P8, P9, and P13. However, when mean monthly maximum water levels from this reporting period were compared to the 2007-2008 reporting period, a significant difference existed only at station P8. When mean monthly minimum water levels for this reporting period were compared to year 1, the means were significantly different at stations P2, P7, P8, and P9. These results are very similar to those reported in 2008-2009 where four stations also exhibited significant differences. During this reporting period, only station P8 showed a significant difference (lower) in mean monthly minimum water level when this reporting period was compared to 2007-2008.

Table 3.3A-1. Monthly maximum, minimum, and range of salinity values for each station. Monthly maximum, minimum, and range of water level for each station are also given. All water levels are relative to NAVD88 with the exception of P4 (USACE yard), which is relative to MSL.

		Salinity (ppt)			Water Level (ft)		
Site	**Month**	**Maximum**	**Minimum**	**Range**	**Maximum**	**Minimum**	**Range**
P1	Jun-08	34.2	5.3	28.9	2.35	-4.42	6.77
	Jul-08	35.4	5.5	29.9	2.63	-4.30	6.93
	Aug-08	35.1	0.1	35.0	2.56	-3.89	6.45
	Sep-08	33.0	15.8	17.2	3.44	-3.30	6.74
	Oct-08	39.9	20.7	19.2	3.58	-3.40	6.98
	Nov-08	34.2	2.4	31.8	3.56	-4.11	7.67
	Dec-08	33.5	7.5	26.0	2.61	-4.77	7.38

		Salinity (ppt)			Water Level (ft)		
Site	**Month**	**Maximum**	**Minimum**	**Range**	**Maximum**	**Minimum**	**Range**
	Jan-09	32.8	8.3	24.5	2.44	-5.05	7.49
	Feb-09	33.5	14.0	19.5	1.99	-4.48	6.47
	Mar-09	35.1	13.0	22.1	2.83	-4.24	7.07
	Apr-09	32.3	5.9	26.4	2.11	-4.54	6.65
	May-09	32.7	8.3	24.4	2.25	-3.77	6.02
P2	Jun-08	30.8	0.0	30.8	3.54	-2.73	6.27
	Jul-08	39.4	0.0	39.4	3.69	-2.73	6.42
	Aug-08	42.8	0.1	42.7	3.79	-2.20	5.99
	Sep-08	39.0	0.5	38.5	4.00	-2.42	6.42
	Oct-08	20.1	3.9	16.2	3.16	-2.94	6.10
	Nov-08	20.0	0.1	19.9	3.94	-3.35	7.29
	Dec-08	11.1	0.0	11.1	5.58	-1.69	7.27
	Jan-09	9.7	0.0	9.7	2.86	-4.21	7.07
	Feb-09	10.4	0.9	9.5	2.94	-2.57	5.51
	Mar-09	9.5	0.1	9.4	3.89	-2.46	6.35
	Apr-09	7.4	0.6	6.8	3.94	-2.45	6.39
	May-09	11.6	0.1	11.5	3.77	-2.38	6.15
P3	Jun-08	16.5	0.6	15.9	1.74	-2.52	4.26
	Jul-08	11.9	7.5	4.4	1.89	-2.50	4.39
	Aug-08	18.5	6.7	11.8	1.98	-1.79	3.77
	Sep-08	14.7	0.0	14.7	2.73	-1.29	4.02
	Oct-08	15.6	0.3	15.3	2.42	-1.85	4.27
	Nov-08	10.9	0.0	10.9	2.26	-1.92	4.18
	Dec-08	2.3	0.0	2.3	1.77	-2.72	4.49
	Jan-09	0.7	0.0	0.7	1.65	-2.89	4.54
	Feb-09	2.5	0.2	2.3	1.40	-2.98	4.38
	Mar-09	1.5	0.1	1.4	1.95	-2.49	4.44
	Apr-09	1.4	0.0	1.4	2.12	-2.64	4.76
	May-09	7.5	0.1	7.4	1.84	-2.28	4.12
P4	Jun-08	23.1	0.0	23.1	2.96	-3.67	6.63
	Jul-08	21.3	0.0	21.3	3.06	-3.55	6.61
	Aug-08	18.5	2.3	16.2	3.20	-2.90	6.10
	Sep-08	31.9	0.1	31.8	4.24	-2.23	6.47
	Oct-08	26.6	0.6	26.0	3.80	-2.86	6.66
	Nov-08	35.8	0.0	35.8	3.69	-3.46	7.15
	Dec-08	9.2	0.1	9.1	2.90	-4.10	7.00
	Jan-09	7.3	0.1	7.2	2.77	-4.28	7.05
	Feb-09	12.3	0.0	12.3	2.24	-4.12	6.36
	Mar-09	7.3	0.0	7.3	3.09	-3.47	6.56
	Apr-09	7.4	0.1	7.3	3.24	-3.77	7.01
	May-09	13.1	1.0	12.1	2.98	-3.17	6.15
P6	Jun-08	25.8	0.2	25.6	3.28	-3.11	6.39
	Jul-08	18.9	0.0	18.9	3.42	-3.03	6.45
	Aug-08	18.7	0.1	18.6	3.64	-2.25	5.89
	Sep-08	16.0	0.0	16.0	4.65	-1.57	6.22
	Oct-08	17.6	0.0	17.6	3.48	-2.02	5.50
	Nov-08	17.4	0.0	17.4	3.73	-3.19	6.92
	Dec-08	8.9	0.0	8.9	3.00	-3.85	6.85
	Jan-09	6.4	0.0	6.4	2.77	-4.07	6.84
	Feb-09	9.8	0.0	9.8	2.22	-4.12	6.34
	Mar-09	6.9	0.0	6.9	2.95	-3.24	6.19
	Apr-09	6.0	0.0	6.0	3.10	-3.81	6.91
	May-09	13.1	0.1	13.0	2.44	-3.45	5.89
P7	Jun-08	10.9	0.1	10.8	2.61	-2.69	5.30
	Jul-08	13.8	0.1	13.7	2.58	-2.69	5.27
	Aug-08	5.2	0.1	5.1	2.93	-2.5	5.43
	Sep-08	6.2	0.0	6.2	4.19	-1.49	5.68
	Oct-08	10.2	0.1	10.1	3.65	-2.25	5.90
	Nov-08	10.3	0.0	10.3	3.45	-2.36	5.81
	Dec-08	0.1	0.0	0.1	3.06	-2.38	5.44
	Jan-09	0.1	0.0	0.1	2.89	-2.40	5.29
	Feb-09	0.1	0.0	0.1	2.27	-2.40	4.67

Site	Month	Salinity (ppt) Maximum	Minimum	Range	Water Level (ft) Maximum	Minimum	Range
	Apr-09	0.1	0.0	0.1	3.42	-2.27	5.69
	May-09	0.2	0.1	0.1	2.99	-2.36	5.35
P8							
	Jun-08	1.6	0.1	1.5	2.68	-2.71	5.39
	Jul-08	2.2	0.1	2.1	2.96	-2.63	5.59
	Aug-08	0.2	0.1	0.1	3.4	-1.62	5.02
	Sep-08	0.9	0.0	0.9	4.11	-0.58	4.69
	Oct-08	0.1	0.1	0.0	3.94	-1.50	5.44
	Nov-08	0.1	0.1	0.0	3.82	-1.67	5.49
	Dec-08	0.1	0.0	0.1	3.51	-1.94	5.45
	Jan-09	0.1	0.0	0.1	3.58	-2.10	5.68
	Feb-09	0.1	0.0	0.1	2.86	-2.50	5.36
	Mar-09	0.1	0.0	0.1	4.14	-1.15	5.29
	Apr-09	0.1	0.0	0.1	4.42	-2.16	6.58
	May-09	0.2	0.1	0.1	3.29	-1.84	5.13
P9							
	Jun-08	0.1	0.1	0.0	3.06	-1.67	4.73
	Jul-08	0.2	0.1	0.1	3.75	-1.11	4.86
	Aug-08	0.1	0.1	0.0	2.99	-1.26	4.25
	Sep-08	0.1	0.0	0.1	4.20	-0.30	4.50
	Oct-08	0.1	0.1	0.0	3.39	-1.70	5.09
	Nov-08	0.1	0.0	0.1	3.55	-1.58	5.13
	Dec-08	0.1	0.0	0.1	3.57	-1.69	5.26
	Jan-09	0.1	0.0	0.1	3.42	-1.97	5.39
	Feb-09	0.1	0.0	0.1	2.44	-2.71	5.15
	Mar-09	0.1	0.0	0.1	3.22	-1.34	4.56
	Apr-09	0.1	0.0	0.1	3.51	-1.89	5.40
	May-09	0.1	0.0	0.1	3.16	-1.60	4.76
P11							
	Jun-08	38.7	2.8	35.9	2.51	-4.29	6.80
	Jul-08	38.6	7.9	30.7	2.64	-3.87	6.51
	Aug-08	37.0	8.7	28.3	3.08	-2.52	5.60
	Sep-08	15.8	0.3	15.5	4.17	-1.95	6.12
	Oct-08	16.8	0.2	16.6	3.61	-2.69	6.30
	Nov-08	18.4	0.2	18.2	3.81	-2.91	6.72
	Dec-08	8.0	0.1	7.9	3.39	-2.85	6.24
	Jan-09	4.7	0.1	4.5	2.82	-3.27	6.09
	Feb-09	9.4	0.0	9.4	2.40	-3.39	5.79
	Mar-09	3.9	0.1	3.8	3.12	-2.75	5.87
	Apr-09	3.0	0.0	3.0	3.26	-3.63	6.89
	May-09	5.6	0.2	5.4	2.57	-3.17	5.74
P12							
	Jun-08	16.9	0.2	16.7	2.67	-2.99	5.66
	Jul-08	18.5	1.5	17.0	2.77	-2.96	5.73
	Aug-08	15.5	4.0	11.5	2.91	-2.14	5.05
	Sep-08	13.7	0.0	13.7	3.93	-1.53	5.46
	Oct-08	14.8	0.1	14.7	3.43	-2.27	5.70
	Nov-08	15.1	0.1	15.0	3.29	-2.69	5.98
	Dec-08	5.1	0.1	5.0	2.67	-3.25	5.92
	Jan-09	4.8	0.1	4.7	2.49	-3.54	6.03
	Feb-09	9.2	0.1	9.1	2.13	-3.53	5.66
	Mar-09	4.2	0.1	4.1	2.82	-2.75	5.57
	Apr-09	1.0	0.1	0.9	3.00	-3.11	6.11
	May-09	11.0	0.0	11.0	2.72	-2.57	5.29
P13							
	Jun-08	13.7	0.1	13.6	2.24	-2.69	4.93
	Jul-08	14.4	1.0	13.4	2.36	-2.66	5.02
	Aug-08	11.7	1.9	9.8	2.5	-1.82	4.32
	Sep-08	12.1	0.1	12.0	3.36	-1.25	4.61
	Oct-08	14.3	0.1	14.2	2.99	-1.98	4.97
	Nov-08	11.2	0.1	11.1	2.81	-2.26	5.07
	Jan-09	0.4	0.1	0.3	2.15	-2.91	5.06
	Feb-09	1.5	0.1	1.4	1.85	-2.90	4.75
	Mar-09	0.7	0.1	0.6	2.49	-2.33	4.82

Site	Month	Salinity (ppt) Maximum	Minimum	Range	Water Level (ft) Maximum	Minimum	Range
	Apr-09	0.2	0.1	0.1	2.66	-2.74	5.40
	May-09	1.1	0.1	1.0	2.38	-2.28	4.66
P14	Jun-08	2.3	0.1	2.2	1.48	-2.29	3.77
	Jul-08	3.8	0.3	3.5	1.55	-2.33	3.88
	Aug-08	3.0	0.1	2.9	1.66	-1.58	3.24
	Sep-08	4.8	0.1	4.7	2.38	-1.10	3.48
	Oct-08	1.1	0.1	1.0	2.39	-1.35	3.74
	Nov-08	0.3	0.1	0.2	2.22	-1.35	3.57
	Dec-08	0.1	0.1	0.0	1.94	-2.25	4.19
	Jan-09	0.1	0.1	0.0	1.77	-2.38	4.15
	Feb-09	0.1	0.0	0.1	1.50	-2.54	4.04
	Mar-09	0.1	0.1	0.0	2.04	-1.46	3.50
	Apr-09	0.1	0.1	0.0	2.20	-2.07	4.27
	May-09	0.1	0.0	0.1	1.96	-1.68	3.64

Table 3.3A-2. Summary of statistical analyses of mean annual water level comparisons for each of the DCP stations. Yearly mean tidal ranges were compared using Tukey-Kramer highest significant difference (p<0.05). Years with different letter superscripts were significantly different. Asterisks denote where significant differences occurred between this reporting period (2008-2009) and year 1 (2000-2001). Ampersands denote where significant differences exist between this reporting period and the previous reporting period (2007-2008). Note that the year 1 reporting period only included the period of October to May and allssubsequent periods have included a complete calendar year. No data (ND) were available for year 1 for station P12.

Station	Significant	Effect (Year)
P1	@	1^{a} 8^{b} 9^{a}
P2	*@	1^{a} 8^{a} 9^{b}
P3	*	1^{a} 8^{b} 9^{b}
P4	*@	1^{a} 8^{a} 9^{b}
P6	*@	1^{a} 8^{a} 9^{b}
P7		1^{a} 8^{b} 9^{ab}
P8		1^{a} 8^{b} 9^{ab}
P9	@	1^{ab} 8^{a} 9^{b}
P11	*@	1^{a} 8^{a} 9^{b}
P12		ND 8^{a} 9^{a}
P13		1^{a} 8^{a} 9^{a}
P14		1^{a} 8^{a} 9^{a}

Table 3.3A-3. Yearly comparisons of mean monthly maximum and minimum water levels collected at the DCP stations. Significant differences were identified using a Wilcoxon Rank Sum test. NS indicates no significant difference at P <0.05. Asterisks denote significant differences between years and p values are given. NA indicates insufficient data to complete analyses. Additional yearly comparisons are available in previous reports (e.g. Culbertson et al., 2009; Hackney et al., 2008, 2007 etc.).

Station	Yr1/Yr9 Mean Monthly Maximum WL	Yr8/Yr9 Mean Monthly Maximum WL	Yr1/Yr9 Mean Monthly Minimum WL	Yr8/Yr9 Mean Monthly Minimum WL
P1	NS	NS	NS	NS
P2	*(0.0206)	NS	*(0.0447)	NS
P3	NS	NS	NS	NS
P4	NS	NS	NS	NS
P6	NS	NS	NS	NS
P7	NS	NS	*(0.0037)	NS

Station	Yr1/Yr9 Mean Monthly Maximum WL	Yr8/Yr9 Mean Monthly Maximum WL	Yr1/Yr9 Mean Monthly Minimum WL	Yr8/Yr9 Mean Monthly Minimum WL
P8	*(0.0167)	*(0.0326)	*(0.0308)	*(0.0463)
P9	*(0.0136)	NS	*(0.0012)	NS
P11	NS	NS	NS	NS
P12	N/A	NS	N/A	NS
P13	*(0.0372)	NS	NS	NS
P14	NS	NS	NS	NS

Tidal lags were determined by measuring the difference in time for high (or low) tide at 2 different stations as described in Hackney et al., (2002). All tidal lags were calculated relative to station P1 and used to evaluate the impact of dredging on the propagation of the tidal wave upriver. Mean tidal range, flood duration, ebb duration, and tidal lags for each station are given in Table 3.3A-4. Although most stations showed a slight change (<0.1 hr) in either high tide or low tide lag, most values were comparable to those reported in 2007-2008. The greatest difference between years occurred at stations P2, P7, and P9 where the mean high tide lag increased by 0.12, 0.17, and 0.11 hrs, respectively. These values, however, are comparable to the values reported in 2006-2007 (Hackney et al., 2008). During this reporting period, the mean flood duration and the mean ebb duration varied little (<0.16 %) from the previous reporting period (Table 3.3A-4). For the changes that were observed, flood durations decreased at almost all stations whereas ebb duration tended to increase. These results are the opposite of those observed in 2006-2007 and may suggest conditions more similar to those in the 2007-2008 reporting period, but are consistent with those reported in years characterized by a similar magnitude in river discharge (see Culbertson et al., 2009, Hackney et al., 2008, and Hackney et al., 2007).

Table 3.3A-4. Summary of tidal data generated from data collection platforms (DCP) at eleven stations along the Cape Fear River and tributaries. Values in italicized parens are the percent change between the current monitoring interval and the previous reporting period. Positive values indicate an increase and negative values a decrease. NA indicates that data were insufficient to measure change. Mean lag times for the previous reporting period are also given in parentheses for both high and low tide.

Station Number	Mean Tidal Range (ft)	Mean Flood Duration (hr) *(% change)*	Mean Ebb Duration (hr) *(%change)*	Mean High Tide Lag From P1 (hr) ('07-'08 lag time)	Mean Low Tide Lag From P1 (hr) ('07-'08 lag time)
P1	4.24 ± 21.27%	6.26 (-0.06)	6.16 (+0.15)	NA	NA
P2	4.35 ± 15.94%	5.71 (0.00)	6.68 (+0.02)	1.38 (1.50)	1.93 (1.88)
P3	2.91 ± 15.29%	6.40 (-0.01)	6.00 (+0.02)	3.04 (2.98)	2.95 (2.85)
P4	4.49 ± 15.65%	5.73 (-0.02)	6.66 (+0.01)	1.65 (1.65)	2.02 (2.20)
P6	4.38 ± 14.84%	5.91 (-0.05)	6.50 (+0.07)	2.21 (2.18)	2.53 (2.52)
P7	3.81 ± 14.03%	5.81 (-0.07)	6.55 (+0.07)	2.60 (2.77)	3.03 (3.15)
P8	3.50 ± 15.98%	5.83 (-0.10)	6.56 (+0.08)	3.00 (3.05)	3.45 (3.41)
P9	3.13 ± 20.83%	5.81 (-0.09)	6.58 (+0.08)	3.35 (3.46)	3.81 (3.87)
P11	4.28 ± 14.63%	5.85 (-0.15)	6.55 (+0.15)	2.21 (2.18)	2.65 (2.61)
P12	3.82 ± 14.80%	5.90 (-0.02)	6.50 (+0.02)	2.57 (2.55)	2.95 (2.95)
P13	3.24 ± 15.05%	5.91 (-0.02)	6.48 (+0.01)	3.01 (3.07)	3.46 (3.43)
P14	2.33 ± 19.26%	5.93 (-0.05)	6.46 (+0.03)	4.18 (4.15)	4.53 (4.47)

Statistical differences between tidal range values for upstream stations, before versus after channel deepening for specified tidal changes at the river mouth (P1) comprise one key approach to determining if the project has resulted in detectable changes in tidal range upstream. One assumption of this approach is that the tidal range at the base station at Ft Caswell (P1) is in equilibrium with open ocean tides and not subject to changes associated with dredging activities. To verify this condition, the observed tidal range at P1 for each reporting period is regressed against the predicted (astronomical) range. Analysis of Covariance (ANCOVA) is then used to determine if significant differences exist between the each yearly regression (i.e. slope). The tidal ranges observed at each upstream station are then regressed on the corresponding tidal range for P1. Comparisons of the resultant regression slopes are then conducted between subsequent reporting periods using ANCOVA ($p<0.05$). These results are shown in Table 3.3A-5.

Table 3.3A-5. Summary of statistical tests for yearly data collected at the DCP stations. Yearly means of tidal ranges were compared. Also shown are yearly differences in the slopes of the best-fit lines generated by regressing each tidal range for each station on the corresponding tidal range for P1. These were compared using analysis of covariance. NS indicates no significant difference at $P <0.05$. Asterisks denote significant differences between years and p values are given. NA indicates insufficient data to complete analyses.

Station	Y1/Y9 Regression Slope	Y8/Y9 Regression Slope

P2	* (<0.0001)	NS
P3	*(0.0074)	NS
P4	* (<0.0001)	NS
P6	* (<0.0001)	NS
P7	* (<0.0001)	NS
P8	* (<0.0001)	NS
P9	* (0.0022)	NS
P11	* (<0.0001)	NS
P12	NA	NS
P13	* (<0.0001)	NS
P14	NS	NS

3.4A Upstream Tidal Effects

Stations upstream of Point Peter are increasingly influenced by river flow in both branches of the Cape Fear Estuary and are considered separately from estuarine stations P1, P2, and P4, and from each other.

3.41A Ft Caswell (P1) and Outer Town Creek (P2)

The tidal ranges observed at the Ft Caswell base station show good agreement with the predicted tides for the area (Figure 3.41A-1). When observed tidal ranges are regressed against the predicted tidal ranges, the r^2 value is similar to those documented in previous reports. The mean tidal range at P1 was significantly higher than the mean reported in the previous monitoring period, but was not significantly different from the range reported in year 1 (Table 3.3A-2). There was no significant difference in either the mean monthly maximum and minimum water levels relative to last year's reporting period or relative to year 1 (Table3.3A-5). The mean tidal range at the Outer Town Creek (P2) site was significantly higher than the mean reported in 2007-2008. The mean tidal range at P2 also was significantly different from the mean reported in year 1. As seen in Figure 3.41A-2, the tidal range at P2 is strongly and positively correlated with observed tidal ranges at P1. The slope of the P1 versus P2 regression for this monitoring period was not significantly different from the slope reported during the 2007-2008 reporting period (Table 3.3A-5), but was significantly different ($p<0.0001$) from the slope measured in the first monitoring period. Although tidal fluctuations at this station are impacted by factors such as drought and flooding, P2 was not appreciably affected by climatological events this year as evidenced by the low range in water level variability ($r^2 = 0.93$).

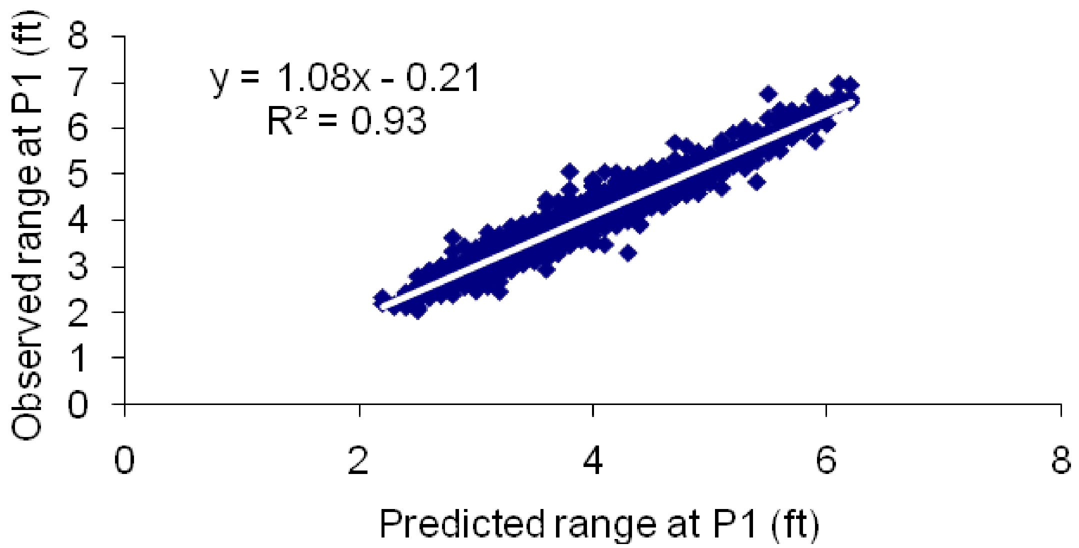


Figure 3.41A-1. Plot of predicted tidal range at P1 relative to measured tidal range at P1 for June 2008 to May 2009.

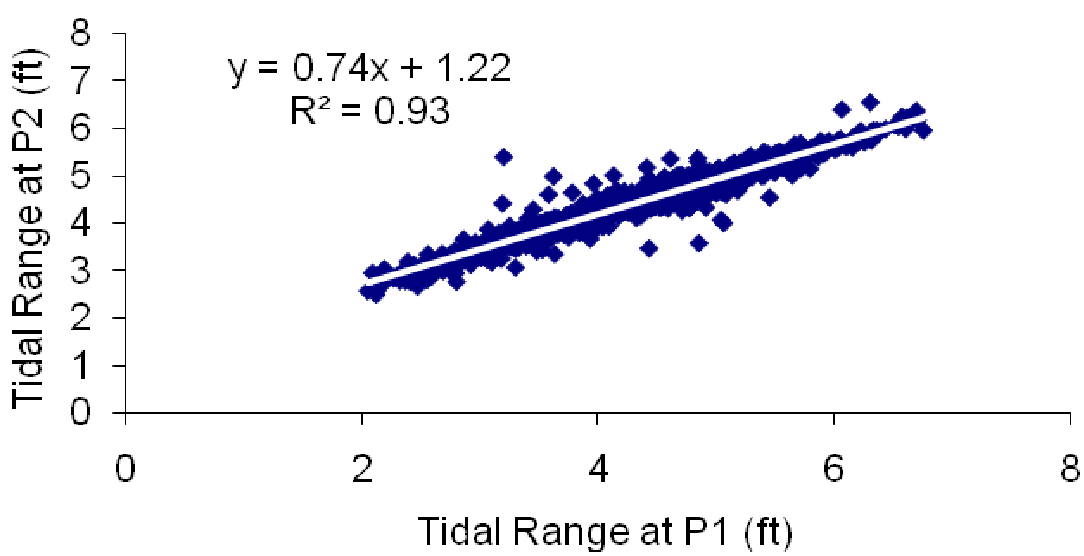


Figure 3.41A-2. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Outer Town Creek (P2).

The water level curve at P1 continues to show less evidence of the time asymmetries measured at other stations as evidenced by the unequal flood and ebb durations shown in Table 3.3A-3. These asymmetries begin at site P2 and continue up river to all monitoring sites. Neither the duration of flooding nor ebbing tide at P2 reported for this reporting period changed relative to the duration reported in 2007-2008. The mean high tide lag decreased slightly since the last reporting period and this year's value is comparable to that reported in 2006-2007 (Hackney et al., 2008). The mean low tide lag increased slightly during this reporting period.

3.42A Inner Town Creek (P3)

Consistent with the 2007-2008 reporting period, the mean tidal range observed at P3 was still approximately 1.4 feet less than the tidal range observed at the creek mouth (Table 3.3A-4). The P3 tidal range also remained lower than the mean tidal ranges of all other sites except P14. This result is consistent with the results of the previous 4 reporting periods. The mean tidal range from June 2008 to May 2009 did not significantly differ from the mean tidal range reported for 2007-2008. It was, however, significantly higher than year 1. The duration of mean flood decreased slightly this reporting period whereas the mean ebb duration increased slightly relative to the previous reporting period (Table 3.3A-4), but these changes do not reflect any consistent pattern between years. There was no significant difference in mean monthly maximum or minimum water level when compared to year 1 or the previous reporting period (Table 3.3A-3). The correlation between tides at P3 and P1 this year was lower than the values reported in 2007 – 2008 ($r^2 < 0.62$), but higher than the value reported in 2006-2007 (Hackney et al., 2008). The slope of the P1 versus P3 regression for this monitoring period was significantly different from the slope reported in the first year of monitoring, but not different from the slope reported for the previous monitoring period (Table 3.3A-5).

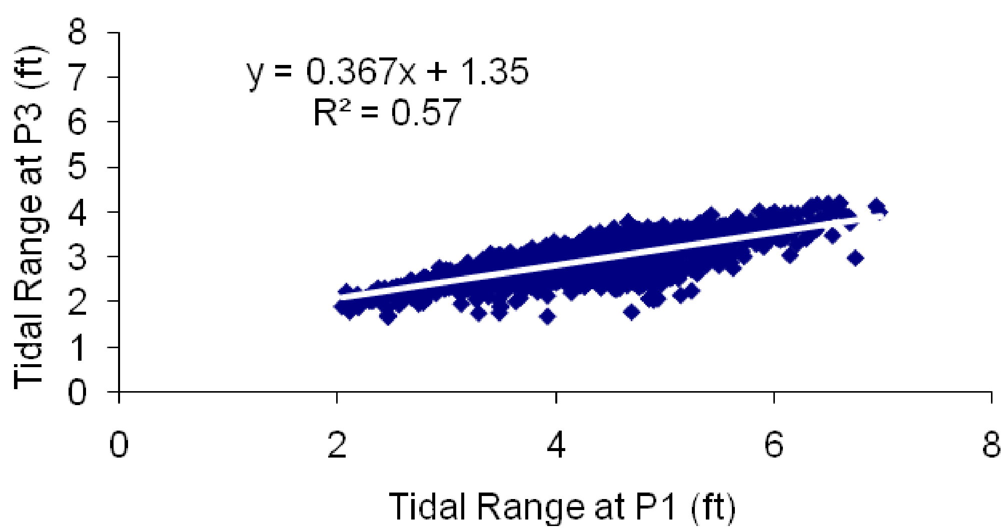


Figure 3.42A-1. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Inner Town Creek (P3).

3.43A Corps Yard (P4)

The mean tidal range observed at P4 continues to be greater than the mean tidal range measured at the P1 base station (Table 3.3A-4). The P4 mean tidal range for this reporting period is significantly higher than the means reported for 2007-2008 and the first year of monitoring (Hackney et al., 2002). The slope (0.75) of the P1/P4 regression was significantly greater than the slope reported for the first monitoring period (Table 3.3A-3), but not significantly different from the slope reported last year (0.73). Water level curves generated for P4 continue to show a slight time asymmetry that does not occur at P1. The mean ebb and flood durations, 6.66 and 5.73 hours, respectively, are comparable to those reported previously. These durations have changed by less than 0.1% since the previous reporting period. The mean low tide lag has decreased by about 12 minutes since the last reporting period while the mean high tide lag has remained constant (Table 3.3A-4). Mean maximum and minimum water levels at this station are not significantly different from those reported in 2007-2008 or year 1 (Table 3.3A-3). Water levels at the Corps yard appeared to be only minimally impacted by changes in river discharge during this reporting period.

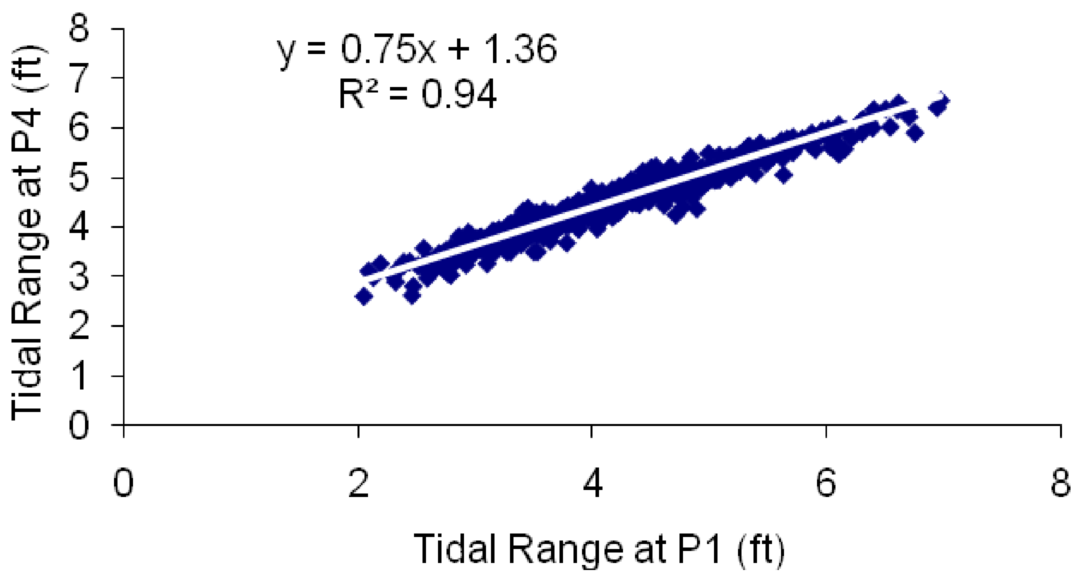


Figure 3.43A-1. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and the Corps Yard station (P4).

3.44A Cape Fear River: Eagle Island (P6), Indian Creek (P7), Dollisons Landing (P8), and Black River (P9)

With the exception of P6, mean tidal ranges for mainstem river sites were lower than the mean determined for P1. Consistent with previous years, tidal range decreased with distance upriver (Table 3.3A-4) with P9 exhibiting the lowest tidal range of these sites. During this reporting period, the mean tidal range at P6 was significantly higher than the mean reported in 2007-2008 and the mean tidal range at P9 was significantly lower than the mean reported in

2007-2008 (Table 3.3A-2). The mean tidal range at P6 also was significantly different from the mean reported during the first year of monitoring. None of the other mainstem stations showed significant differences in mean tidal range between this reporting period and 2007-2008 or year 1 (Table 3.3A-2). The results were highly variable when mean monthly maximum or minimum water levels were compared between years among stations (Table 3.3A-3). For example, mean monthly maximum water levels were significantly higher than the corresponding 2007-2008 value at site P8, while the P8 mean monthly minimum water level was significantly lower that the 2007-2008 value. At P6, no significant differences in either mean monthly maximum or minimum water level existed between this reporting period and 2007-2008 or the first year of monitoring. At P7, the only significant result was the comparison between mean monthly minimum water level during this reporting period and year 1. At site 9, there were no differences in the maximum and minimum water levels between this year and the previous reporting period. However, both the mean monthly maximum and minimum water levels were significantly different when compared to year 1 (Table 3.3A-3). This result is consistent with last year's findings (Culbertson et al., 2009).

Figures 3.44A-1, 3.44A-2, 3.44A-3, and 3.44A-4 illustrate the relationship between tidal range at these Cape Fear River sites and tidal range at Ft. Caswell (P1). In general, tidal range at each upriver site is positively correlated with tidal range at the mouth. During this reporting period, the r^2 values were lower than those reported in 2007-2008. This pattern likely reflects a combination of increased precipitation and higher discharge than during the previous reporting period (Figure 3.5A-1). Comparisons of the regression slopes between this reporting period and year 8 yielded no significant differences for any of the mainstem sites (Table 3.3A-5). Consistent with the 2007-2008 reporting period, all regression slopes for this reporting period were significantly different from year 1 (Table 3.3A-5).

The mainstem upriver sites continue to exhibit pronounced time asymmetries as described in previous reports (e.g. Hackney et al., 2002, 2003, etc) where mean flood duration is less than mean ebb duration. The duration of flooding tide at these stations has decreased very slightly (by less than 0.2 %), since the last reporting period (Table 3.3A-4). The duration of ebb tide also changed very little during this reporting period (also less than 0.2%), but reflected a slight increase. With the exception of site P6, the mean high tide lag from P1 decreased slightly at all stations relative to the 2007-2008 reporting period. In most cases, however, this year's values were comparable to those reported in 2006-2007 (Hackney et al., 2008). Changes in mean low tide lag relative to the previous reporting period also were minimal. The largest change was measured at site P7 where the low tide lag decreased by about 6 minutes, but where this year's value is again comparable to the value reported for P7 in 2006-2007 (Table 3.3A-4).

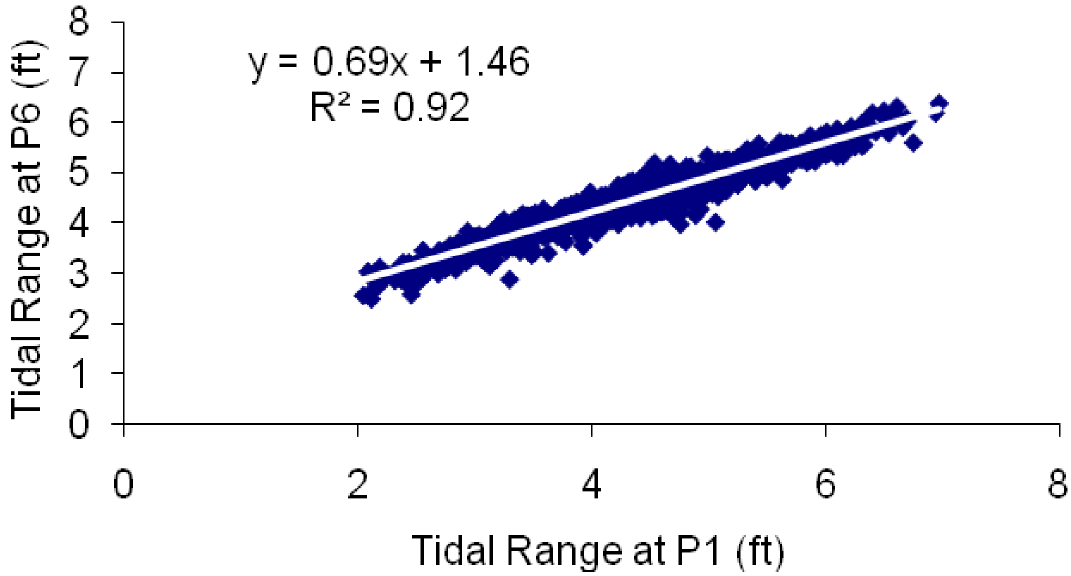


Figure 3.44A-1. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Eagle Island (P6).

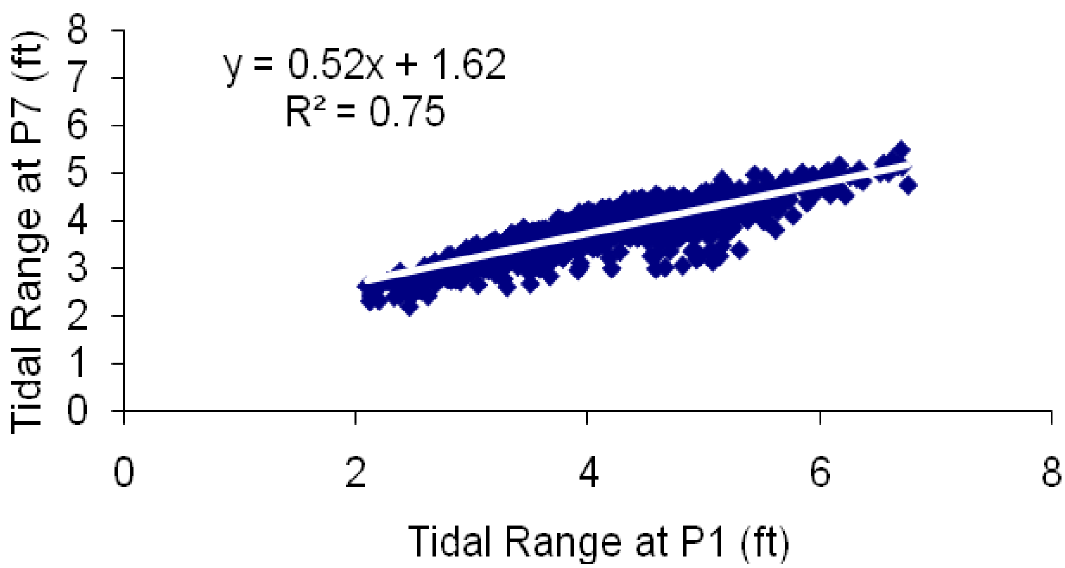


Figure 3.44A-2**.** Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Indian Creek (P7).

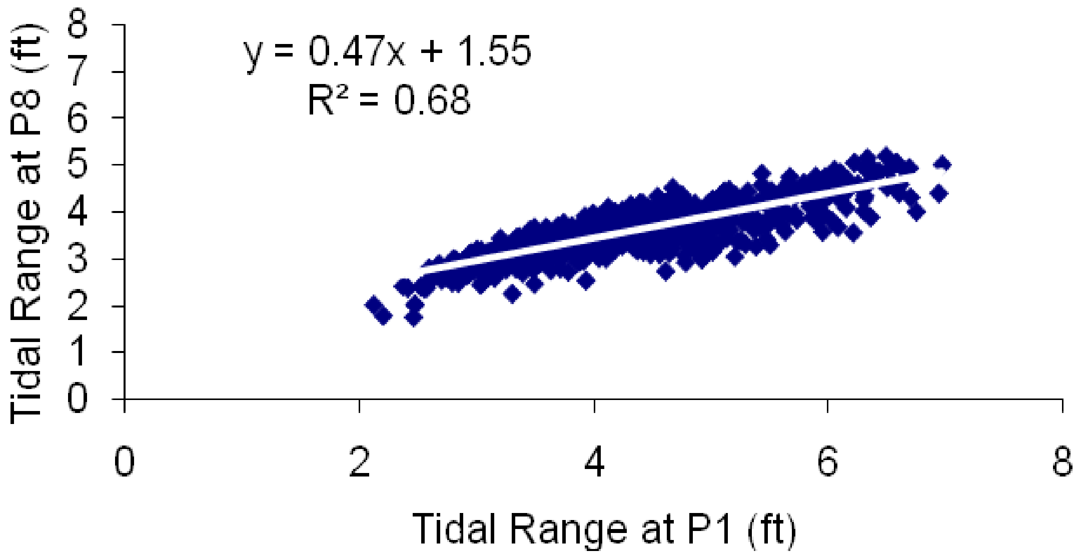


Figure 3.44A-3. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Dollisons Landing (P8).

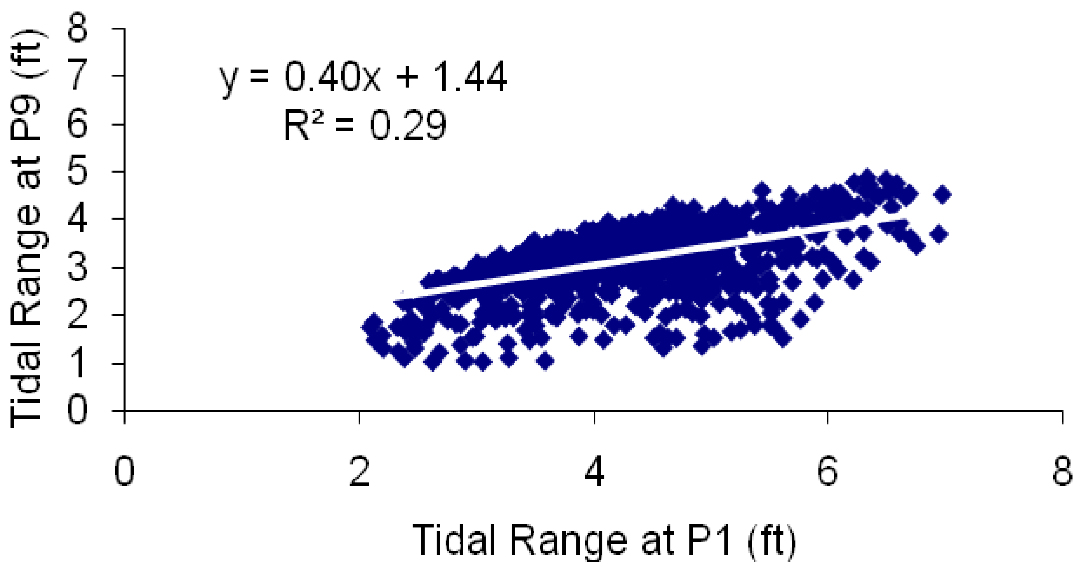


Figure 3.44A-4. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Black River (P9).

3.45A Northeast Cape Fear: Smith Creek (P11), Rat Island (P12), Fishing Creek (P13), and Prince George Creek (P14)

The mean tidal ranges computed for Northeast Cape Fear sites over the current reporting period were not significantly different from those reported in 2007-2008 at site P11 (Table 3.3A-2). At site P11, the mean tidal range for this reporting period was significantly greater than the range reported during the previous monitoring period. There also was no significant difference in mean tidal range between this reporting period and year 1 at sites P13 and P14. Again, at site P11, the mean tidal range for this reporting period was significantly greater than the range reported for year 1. As mentioned in previous reports, a similar comparison is unavailable for site P12 due to an incomplete data set at that station during the first year of monitoring (see Hackney et al., 2002). Mean tidal ranges for all of the Northeast Cape Fear River stations decrease upstream and continue to be lower than the mean determined for P1 with the exception of station P11 which was slightly higher (0.04 ft) than station P1 (Table 3.3A-4). There were no significant differences between this year's mean monthly maximum or minimum water levels and the 2007-2008 values reported for these stations (Table 3.3A-3). When compared to year 1 values, the only difference detected occurred at P13 (no year 1 data are available for such a comparison at P12; see Hackney et al., 2002). This result is consistent with the previous reporting period. All of the sites in the Northeast Cape Fear River continue to exhibit time asymmetries. Mean flood durations are shorter than ebb durations and show little variability among the sites (Table 3.3A-4). During this monitoring period, mean flood duration decreased slightly relative to the previous reporting period. Mean ebb durations increased slightly (<0.15%) at all stations during this reporting period (Table 3.3A-4). These patterns are consistent with those observed for the mainstem stations this year.

Tidal ranges at upstream stations in the Northeast Cape Fear are positively correlated with the tidal range at P1 (Figure 3.45A-1, Figure 3.45A-2, Figure 3.45A-3, and Figure 3.45A-4). The mean tidal range at P14 on the Northeast Cape Fear River continues to be less than the mean range measured at P9, the upper most mainstem station located 12 mi upstream of the convergence of the Cape Fear and Northeast Cape Fear rivers. Consistent with previous reports, tidal ranges at stations P11 and P12 are more strongly correlated to tidal ranges observed at P1 than the tidal ranges at P13 and P14. Water levels at these upriver stations continue to be impacted strongly by other types of events; especially increased rainfall and upriver discharge as suggested by the lower r^2 values for the most upstream stations (Figure 3.5A-1 and Figure 3.5A-2). Comparisons of regression slopes between this reporting period and last year (2007-2008) yielded no significant differences in regression slope at any of the sites. Comparisons of the regression slopes between this reporting period and the first year of monitoring identified significant differences at sites P11 and P13 (Table 3.3A-4). As noted earlier and in previous reports, no year 1 data were available for P12 with which to make a similar comparison.

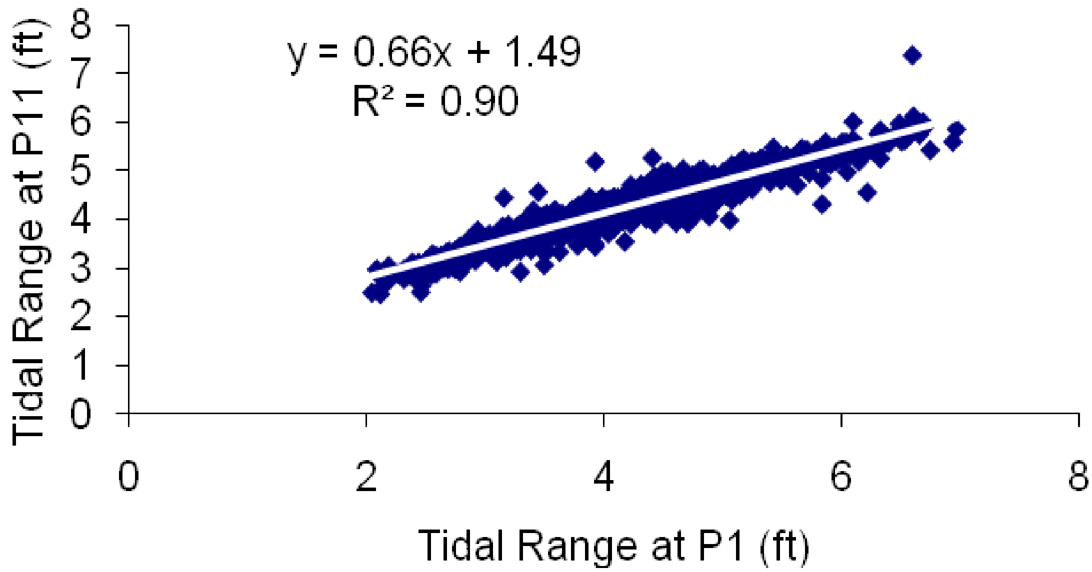


Figure 3.45A-1. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Smith Creek (P11).

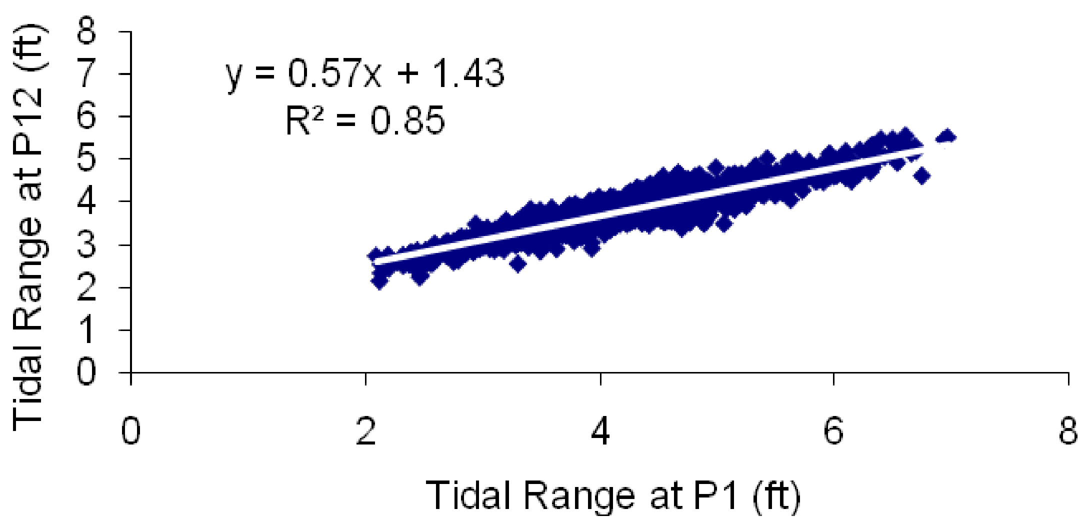


Figure 3.45A-2. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Rat Island (P12).

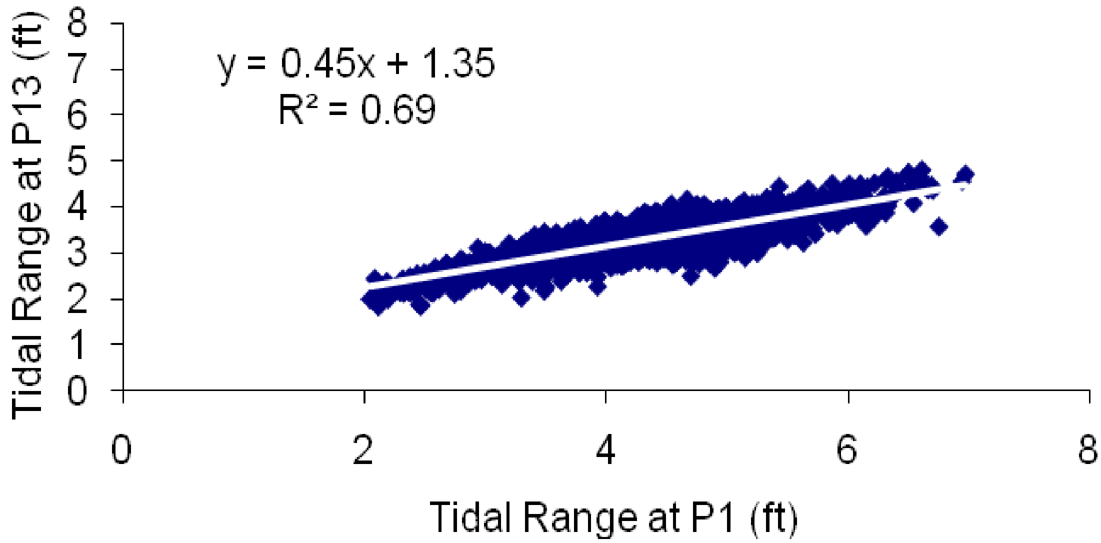


Figure 3.45A-3. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Fishing Creek (P13).

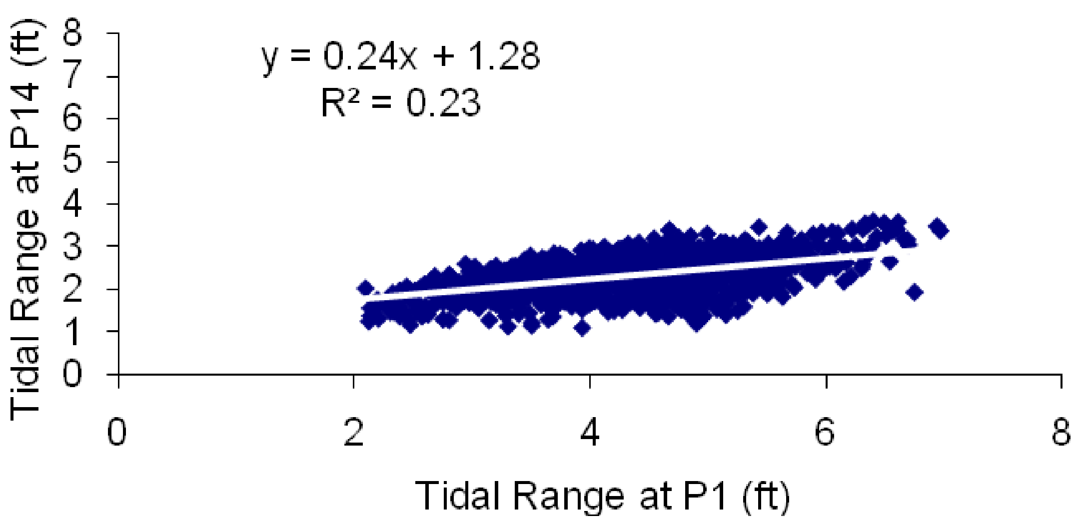


Figure 3.45A-4. Plot showing relationship between tidal ranges observed at Ft. Caswell (P1) and Prince George Creek (P14).

3.5A Influence of Upstream Flow

As mentioned in previous reports, periods of lower, drought-induced water levels and extreme flooding in the system strongly influence tidal characteristics in the Cape Fear and Northeast Cape Fear Rivers. Changes in hydrology and precipitation complicate interpretation of the tidal signal between monitoring years. Another key factor is the limited data set for Year 1 which included data collected from October to June, only, and covered a period when monthly river discharge was below the long-term average (~5531 ft^3/s) reported by the USGS at Lock and Dam 1 on the Cape Fear mainstem (Figure 3.5A-1). Interpretations related to discharge are also complicated by the fact that the discharge time series for the Northeast Cape Fear River is no longer available. As noted in Hackney et al., (2007), streamflow data collection at this station was only funded for a short term project and no longer supported by the Corps or USGS. Nonetheless, mainstem data are available and will be used as a proxy for discharge for the entire system.

During this reporting period, the mean discharge in the Cape Fear mainstem was higher than in the 2007-2008 reporting period, but still below the 30 year average. The mean discharge for this reporting period is almost twice the discharge measured for 2007-2008 and approximately one-half of the discharge measured in 2006-2007. This intermediate discharge may explain why some of this year's results are more similar to those reported in 2006-2007 (e.g. flood duration or tidal lag), while others are more similar to those reported in 2007-2008 (e.g. regression slopes).

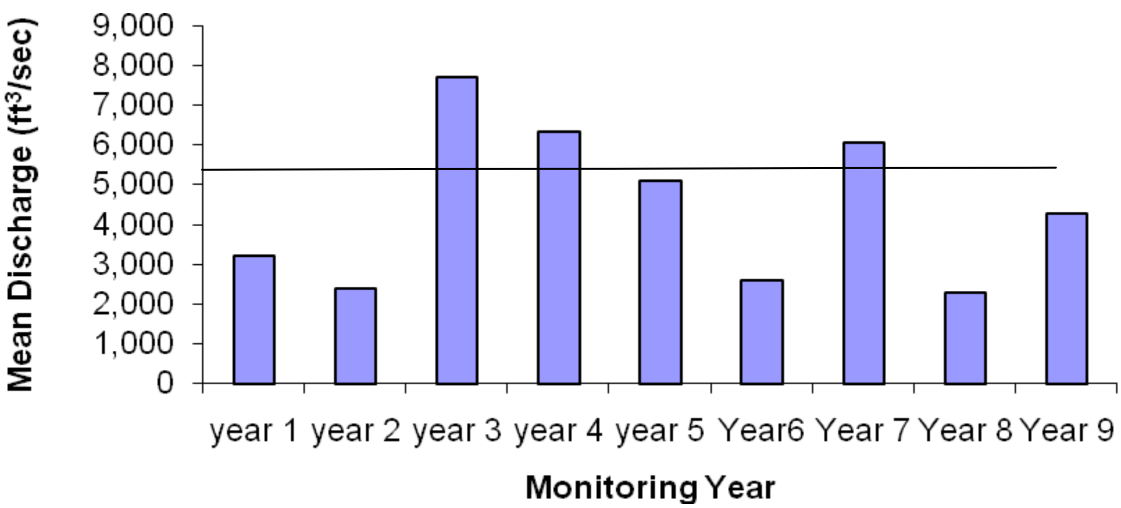


Figure 3.5A-1. Mean discharge for each monitoring period. Monitoring year 1 is October 2000 to May 2001; monitoring year 2 in June 2001 to May 2002; monitoring year 3 is June 2002 to May 2003; monitoring year 4 is June 2003 to May 2004; monitoring year 5 is June 2004 to May 2005; monitoring year 6 is June 2005 to May 2006; monitoring year 7 is June 2006 to May 2007, monitoring year 8 is June 2007 to May 2008and monitoring year 9 is June 2008 to May 2009. The line denotes the long-term mean discharge for the Cape Fear River as measured at Lock 1 by a USGS gauging station.

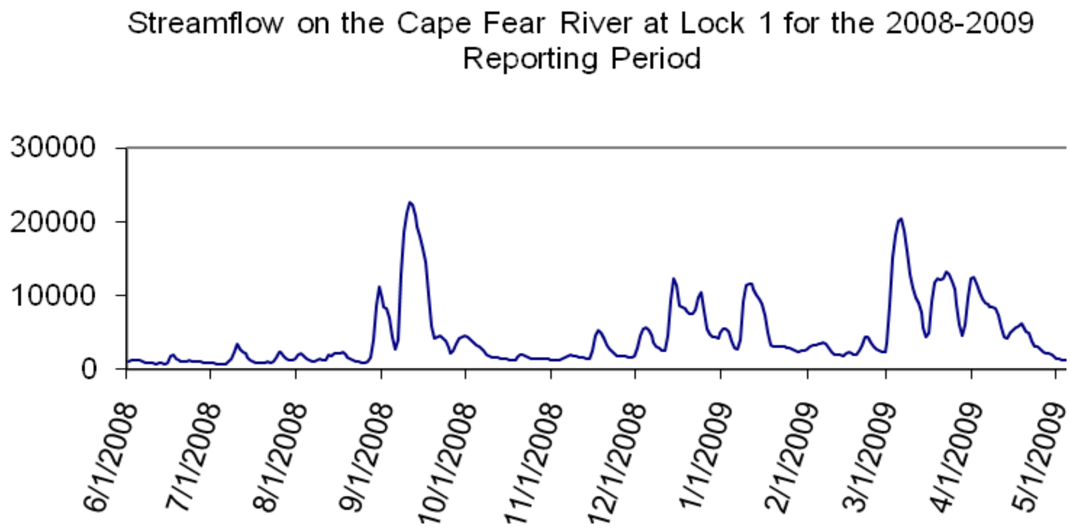


Figure 3.5A-2. Plot showing discharge in the Cape Fear River at Lock 1 for the current monitoring period. Data available at http://nwis.waterdata.usgs.gov/nc/nwis site number 02105769.

3.6A Tidal Harmonics

Because tides are resonance phenomena, any changes in cross sectional area will affect propagation frequency such that some harmonic components may be altered to a greater or lesser degree. In the CFR, it is anticipated that the tidal amplitudes and phases of the six primary harmonics, as monitored and defined by the National Ocean Service of the National Oceanic and Atmospheric Administration, will change after dredging. By focusing on the primary harmonics for the Lower Cape Fear, we are attempting to resolve differences in water levels resulting from tides versus upstream inputs.

As described in previous reports, a classical tidal harmonics analysis was performed on each of the individual stations of the Cape Fear River Project using the MATLAB version of T-Tide (Pawlowicz et al., 2002). The relative phase and amplitude of the major frequencies in the measured 6-minute water level data have been determined with error estimates and a 95% confidence level. Constituents were considered significant if the signal-to-noise ratio was greater than 1. As expected the M2 component is the dominant constituent at every station (Table 3.6A-1). This result is consistent with previous reporting periods. These phase/amplitude data provide a compression of the data in the complete time series and will eventually be used to identify differences in tidal dynamics between the stations along the river that have been impacted by channel modification activities once dredging is complete. Table 3.6A-2 shows tidal harmonics for station P4 in 2008 and Figure 3.6A-1 shows the tidal amplitude for years 1994 to present. Station P4 is used because water level time series data are available for several years prior to the initiation of dredging activities and because harmonic constituents have been well-established. T-tide was used to determine the phase and amplitude of the dominant tidal constituents. While the relative dominance of the lesser constituents continues to vary between years, the M2 component remains the dominant constituent. For the most part, the amplitude has been constant and varied between 2.03 and 2.11. As reported previously, higher amplitudes occurred in 1997 (pre-dredging) and in 2003 through 2008 (during dredging modifications). Lower amplitudes occurred in 1994, 1995 and 1998 (prior to dredging activities) and again in 2001 and 2002 after dredging had been initiated. A qualitative examination of the data set suggests that changes in harmonic amplitude may be responding more to variations in discharge than to dredging activities. For example, the period of low M2 amplitude in 1998 to 2002 also was a period of drought conditions in North Carolina. During the 2003-2004 reporting period, river discharge increased significantly and remained above the long-range mean for the next 3 years. This period (roughly 2002 to 2005) also exhibited higher M2 amplitudes. In 2007, M2 amplitude decreased slightly, but this also was a period of lower water flow in the river. It will be necessary to parse the discharge and tidal data differently so that a direct comparison between discharge and harmonic amplitude can be undertaken.

Table 3.6A-1 Summary of tidal harmonics for reporting period 2008-2009. Errors shown represent the standard error association with each respective data set.

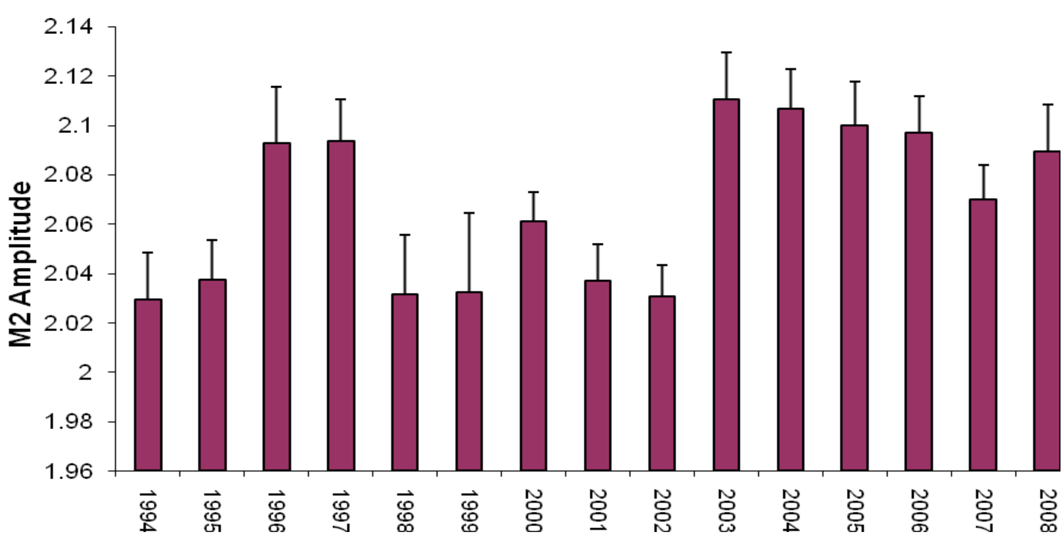
site	tide	amp	amp_err	pha	pha_err
P01	M2	1.4417	0.285	202.33	10.82
	K1	0.417	0.043	113.44	5.87
	N2	0.3371	0.304	174.4	51.89
	O1	0.2274	0.043	117.36	10.73
	S2	0.2062	0.265	261.67	72.56
P02	M2	1.967	0.124	256.88	3.63
	K1	0.4246	0.125	232.73	19.15
	N2	0.409	0.034	144.43	3.99
	O1	0.2574	0.031	156.44	8.06
	S2	0.2192	0.118	305.21	37.33
P03	M2	1.2151	0.165	278.62	8.76
	K1	0.2208	0.172	244.77	37.95
	O1	0.1227	0.152	331.62	75.89
	N2	0.0875	0.112	159.07	82.96
	M4	0.0534	0.083	224.76	131.75
P06	M2	1.8369	0.121	273.33	3.93
	K1	0.4339	0.123	227.07	17.94
	N2	0.3942	0.035	153.07	4.77
	O1	0.2486	0.038	168.72	7.85
	S2	0.2039	0.11	324.64	38.18
P07	M2	1.8015	0.034	287.02	1.29
	K1	0.3643	0.029	163.3	4.07
	N2	0.354	0.036	261.98	5.84
	O1	0.2471	0.029	178.51	7.44
	S2	0.1747	0.037	341.39	12.7
P08	M2	1.549	0.076	296.81	2.38
	K1	0.3449	0.028	172.42	5.11
	O1	0.3112	0.071	259.55	11.89
	N2	0.234	0.031	187.99	8.44
	S2	0.1446	0.07	352.83	28.54
P09	M2	1.3229	0.091	81.19	3.92
	K1	0.2692	0.039	26.79	6.26
	O1	0.2408	0.091	266.17	19.9
	N2	0.2048	0.036	121.32	9.93
	S2	0.0759	0.085	347.83	55.2
P11	M2	1.87	0.084	322.35	2.05
	K1	0.4366	0.072	29.08	9.75
	N2	0.2684	0.07	261.6	16.09
	O1	0.2549	0.043	120.9	7.98
	S2	0.2087	0.041	254.64	11.05

site	tide	amp	amp_err	pha	pha_err
P12	M2	1.7333	0.025	288.69	0.95
	K1	0.3519	0.027	164.55	4.35
	N2	0.3467	0.028	269.72	4.57
	O1	0.234	0.031	181.2	6.99
	S2	0.1617	0.03	340.05	8.87
P13	M2	1.4421	0.028	299.72	1.34
	K1	0.3031	0.026	175.03	4.64
	S2	0.2799	0.028	279.93	6.28
	O1	0.2094	0.028	193.51	7.82
	N2	0.1163	0.031	353.19	14.65
P14	M2	0.9268	0.067	326.89	4.18
	K1	0.2437	0.026	200.22	6.07
	O1	0.2061	0.068	294.59	18.33
	N2	0.1751	0.028	220.4	9.09
	S2	0.0345	0.054	27.85	108.09

Table 3.6A-2 Summary of yearly tidal harmonics for station P4 in 2008. Errors shown represent the standard error association with each respective data set. Data from previous years are available in Hackney et al., 2008.

year	Tide	amp	amp_err	pha	pha_err
2008	M2	2.0893	0.019	274.14	0.41
	N2	0.4161	0.017	264.53	1.92
	K1	0.3136	0.02	145.79	3.73
	S2	0.2867	0.017	306.71	2.61
	O1	0.2414	0.016	165.4	4.43

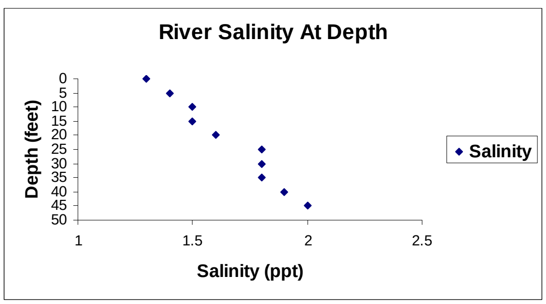
Figure 3.6A-1. Plot of the amplitude of the M2 tidal constituent at station P4 from 1994 to present. Error bars represent the amplitude error.



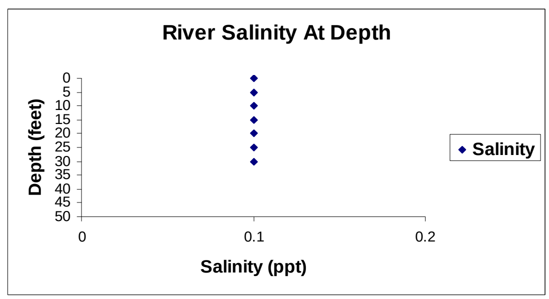
3.0 PART B – SALINITY PROFILES IN THE CAPE FEAR RIVER TO LOCK AND DAM 1

3.1B Summary

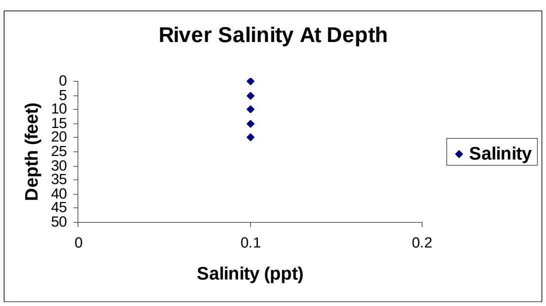
Seven data collection trips were conducted during the annual reporting period to monitor vertical salinity stratified throughout the water column. Collections started adjacent to DCP (P7) and continued upstream to Lock and Dam 1. The cruises monitored vertical salinity profiles from surface to maximum depth at twelve locations on the main stem Cape Fear River (Figure 3.2B-1). Average stream flow on the Cape Fear River at Lock and Dam 1 ranged from 632 cfs to 22,600 cfs during the annual collection period. The highest flow rate during a river cruise averaged 19,300 cfs recorded in September. Salinity was not detected during this data collection. The lowest average flow rate over Lock and Dam 1, 994 cfs, occurred during a river cruise in July. Ocean derived saline water was detected at Site 1 ranging from 1.3 ppt at the surface increasing to 2.0 ppt at maximum depth. No salinity was observed at or beyond Site 2 during the cruise (Figure 3.1B-1).



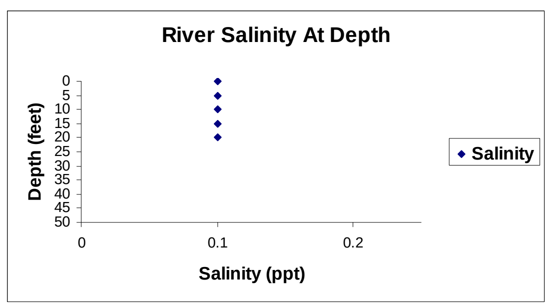
Site 1



Site 2



Site 3

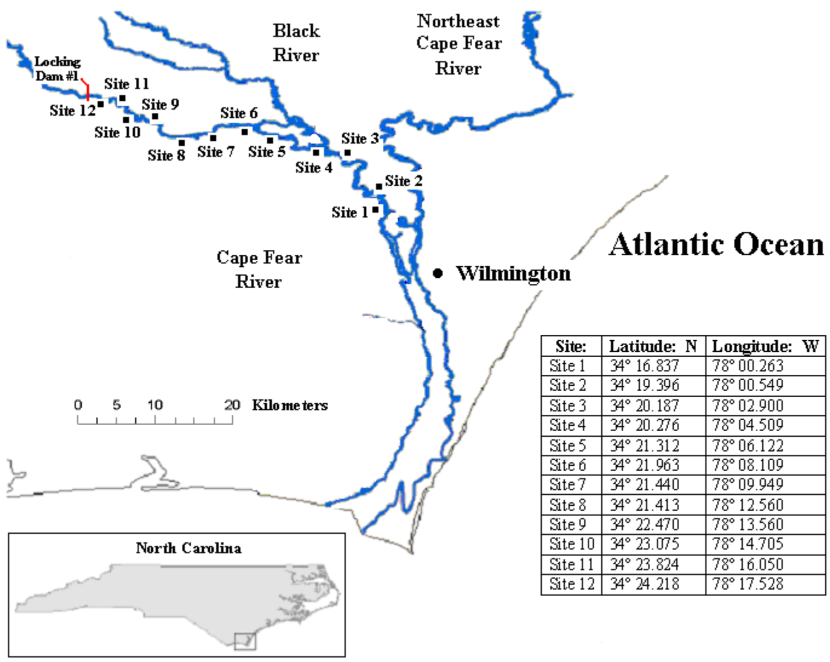


Site 4

Figure 3.1 B-1.River cruise salinity data at Sites 1 through 4 during average lowest stream flow over Lock and Dam 1. Data were collected July 2008.

3.2 B Methods

Each cruise began on- or- close to high tide and followed the high tide upstream. Water parameters were measured at twelve collection sites starting at the surface, continuing at 5- foot depth intervals until 45 ft or the bottom was reached (Figure 3.2B-1). Data were collected using an YSI 85 equipped with a 50ft cable and multi-parameter probe measuring dissolved oxygen, temperature, conductivity, and salinity. The multi-parameter instrument was calibrated prior to the beginning of each sampling day. Water samples were taken with a Van Dorn water bottle at the surface and lowest 5- foot increment possible, at site 1 and the last site sampled. If a change of conductivity was observed that might indicate ocean-derived salt water another collection was made. Immediately after collection, the samples were capped and placed on ice. In the lab, samples were added to a 20 ml serum vial (1:10 Milli Q water dilution). Samples were analyzed on a ICS – 1500 chromatograph for both chloride and sodium. Prior to analyzing the samples the ICS – 1500 was calibrated using a Dionex seven anion standard. Milli Q water was run through the chromatograph for a control. The ratio of chloride to sodium is constant and expected in samples where an increase in conductivity was caused by ocean derived salt water.



Site:	Latitude: N	Longitude: W
Site 1	34° 16.837	78° 00.263
Site 2	34° 19.396	78° 00.549
Site 3	34° 20.187	78° 02.900
Site 4	34° 20.276	78° 04.509
Site 5	34° 21.312	78° 06.122
Site 6	34° 21.963	78° 08.109
Site 7	34° 21.440	78° 09.949
Site 8	34° 21.413	78° 12.560
Site 9	34° 22.470	78° 13.560
Site 10	34° 23.075	78° 14.705
Site 11	34° 23.824	78° 16.050
Site 12	34° 24.218	78° 17.528

Figure 3.2B-1 Location of salinity depth sampling stations

3.3B Results

During the annual reporting period a total of seven salinity profile detection cruises were conducted. Only one cruise during this time frame detected ocean derived saline water. This deployment was during the month of July and yielded a salinity of 1.3 parts per thousand at the surface and 2.0 parts per thousand at maximum depth at site 1. Salinity was not detected at Site 2. During this time of data collection the flow rates over Lock and Dam 1 averaged 994 cfs (Figure 3.3B-1). The highest flow rates during a collection averaged 19,300 cfs and occurred during the month of September. Ocean derived saline water was not detected during this cruise at all sites. During the rest of the river cruises, the flow rates over Lock and Dam 1 stayed above 1,000 cfs, resulting in normal flow regime of fresh water and no ocean derived salinity was detected. Additional data can be found in Appendices B and C.

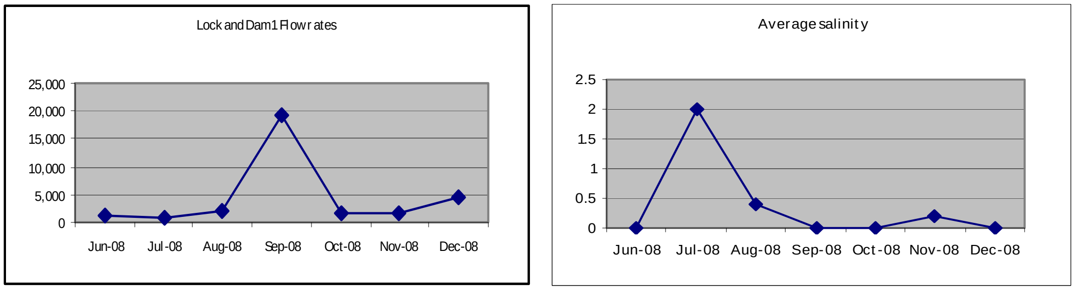


Figure 3.3B-1. Lock and Dam 1 average flow rates (cfs) and salinities (ppt) during cruise collections.

4.0 MARSH/SWAMP FLOOD AND SALINITY LEVELS

4.1 Summary

Tidal ranges within the estuary were fairly constant, including the lowermost of the upstream stations, and were higher than tidal ranges measured at most upstream stations. Half of the sites exhibited a significant difference in tidal ranges between this reporting period and 2007-2008. Mean tidal range at five of the monitoring stations was significantly different from the mean tidal range reported in year one of monitoring.

4.2 Data Base

Flood data collections went very smoothly this reporting year with only one exception, P6 (Eagle Island) (Tables 4.2-1 and 4.2-2). Historically, station P6 has experienced erosion due to increased boat traffic from a boat manufacturing operation in Leland, North Carolina, as noted in last year's report. Boats are tested at high speeds adjacent to P6. The placement of instruments at subsite 1 at P6 has been abandoned due to this erosion, therefore no data (flood or salinity) was collected from fall 2007 to the present. Aside from P6, a few subsites at other stations do not have salinity data (Tables 4.2-3 and 4.2-4) due to equipment failure, but these data losses were minor.

Table 4.2-1. Flooding frequency, duration, depth, and actual water level of marsh/swamp substations during fall 2008. Actual water level is calculated using the maximum depth and marsh/swamp surface elevation relative to the NAVD88 datum.

Station Number	Substation Number	Season	Start Date	End Date	# Flood Events	Mean Flood Duration (hr)	Maximum Depth (ft)	Marsh/Swamp Elevation (ft)	Actual water level (ft)
P3	1	Fall 08	12/17/2008	12/30/2008	23/27	5.7	1.5	0.66	0.9
	2	Fall 08	12/17/2008	12/30/2008	19/27	4.0	1.5	0.83	0.7
	3	Fall 08	12/17/2008	12/30/2008	21/27	4.8	1.7	0.52	1.2
	4	Fall 08	12/17/2008	12/30/2008	19/27	4.9	1.4	1.49	-0.1
	5	Fall 08	12/17/2008	12/30/2008	13/27	3.6	1.5	0.99	0.5
	6	Fall 08	12/17/2008	12/30/2008	9/27	4.8	3.8	3.31	0.4
P6	1	Fall 08	ND	ND	ND	ND	ND	ND	ND
	2	Fall 08	9/23/2008	10/7/2008	25/27	5.4	3.5	1.56	1.9
	3	Fall 08	9/23/2008	10/7/2008	27/27	6.6	3.5	0.85	2.6
	4	Fall 08	9/23/2008	10/7/2008	25/27	5.4	3.7	1.13	2.5
	5	Fall 08	9/23/2008	10/7/2008	22/27	4.8	3.7	1.92	1.8
	6	Fall 08	9/23/2008	10/7/2008	21/27	4.5	3.3	1.74	1.6
P7	1	Fall 08	10/7/2008	10/21/2008	27/27	5.0	3.1	1.76	1.3

Table 4.2-1 (continued)

Station Number	Substation Number	Season	Start Date	End Date	# Flood Events	Mean Flood Duration (hr)	Maximum Depth (ft)	Marsh/Swamp Elevation (ft)	Actual water level (ft)
	2	Fall 08	10/7/2008	10/21/2008	16/27	3.9	3.2	2.23	1.0
	3	Fall 08	10/7/2008	10/21/2008	16/27	4.0	3.2	2.26	0.9
	4	Fall 08	10/7/2008	10/21/2008	13/27	3.9	3.3	2.43	0.9
	5	Fall 08	10/7/2008	10/21/2008	7/27	4.1	3.1	2.31	0.8
	6	Fall 08	10/7/2008	10/21/2008	7/27	4.6	3.2	2.37	0.8
P8	1	Fall 08	10/21/2008	11/4/2008	18/27	3.8	3.5	2.14	1.4
	2	Fall 08	10/21/2008	11/4/2008	23/27	4.4	3.5	1.54	2.0
	3	Fall 08	10/21/2008	11/4/2008	26/27	4.9	3.6	1.46	2.2
	4	Fall 08	10/21/2008	11/4/2008	18/27	4.0	3.5	1.98	1.5
	5	Fall 08	10/21/2008	11/4/2008	12/27	4.1	3.4	2.24	1.1
	6	Fall 08	10/21/2008	11/4/2008	7/27	4.5	3.4	2.38	1.0
P9	1	Fall 08	11/4/2008	11/18/2008	27/27	6.9	3.0	0.58	2.5
	2	Fall 08	11/4/2008	11/18/2008	27/27	4.1	3.1	2.21	0.9
	3	Fall 08	11/4/2008	11/18/2008	12/27	4.3	2.7	1.22	1.4
	4	Fall 08	11/4/2008	11/18/2008	8/27	4.6	3.0	2.06	1.0
	5	Fall 08	11/4/2008	11/18/2008	4/27	6.4	3.1	2.20	0.9
	6	Fall 08	11/4/2008	11/18/2008	5/27	5.1	2.6	1.92	0.7
P11	1	Fall 08	9/30/2008	10/14/2008	24/27	4.9	3.4	1.44	1.9
	2	Fall 08	9/30/2008	10/14/2008	15/27	4.0	3.2	1.82	1.3
	3	Fall 08	9/30/2008	10/14/2008	18/27	3.9	3.3	1.76	1.6
	4	Fall 08	9/30/2008	10/14/2008	14/27	3.4	3.1	1.85	1.2
	5	Fall 08	9/30/2008	10/14/2008	15/27	4.0	2.9	1.91	1.0
	6	Fall 08	9/30/2008	10/14/2008	11/27	4.5	3.2	2.04	1.1
P12	1	Fall 08	10/14/2008	10/28/2008	26/27	6.2	3.3	0.90	2.4
	2	Fall 08	10/14/2008	10/28/2008	24/27	4.8	3.2	1.62	1.6
	3	Fall 08	10/14/2008	10/28/2008	20/27	5.8	3.3	2.00	1.3
	4	Fall 08	10/14/2008	10/28/2008	15/27	4.3	3.1	1.90	1.2
	5	Fall 08	10/14/2008	10/28/2008	12/27	4.7	3.3	2.08	1.2
	6	Fall 08	10/14/2008	10/28/2008	12/27	5.1	3.4	2.44	1.0
P13	1	Fall 08	12/4/2008	12/18/2008	18/27	6.0	2.2	1.43	0.8
	2	Fall 08	12/4/2008	12/18/2008	23/27	4.8	2.2	1.08	1.2
	3	Fall 08	12/4/2008	12/18/2008	26/27	5.4	2.3	0.75	1.5
	4	Fall 08	12/4/2008	12/18/2008	27/27	6.0	2.2	1.00	1.2
	5	Fall 08	12/4/2008	12/18/2008	24/27	4.6	2.2	1.21	0.9
	6	Fall 08	12/4/2008	12/18/2008	7/27	3.5	2.2	1.64	0.5
P14	1	Fall 08	10/30/2008	11/13/2008	27/27	6.7	2.0	0.70	1.3
	2	Fall 08	10/30/2008	11/13/2008	25/27	4.5	2.3	0.87	1.4
	3	Fall 08	10/30/2008	11/13/2008	23/27	5.5	2.0	1.08	1.0
	4	Fall 08	10/30/2008	11/13/2008	23/27	4.5	1.9	1.22	0.6
	5	Fall 08	10/30/2008	11/13/2008	22/27	4.4	1.9	1.28	0.6
	6	Fall 08	10/30/2008	11/13/2008	8/27	5.1	1.8	1.49	0.3

ND=No data available

Table 4.2-2. Flooding frequency, duration, depth, and actual water level of marsh/swamp substations during spring 2009. Actual water level is calculated using the maximum depth and marsh/swamp surface elevation relative to the NAVD88 datum. ND indicates no data

Station Number	Substation Number	Season	Start Date	End Date	# Flood Events	Mean Flood Duration (hr)	Maximum Depth (ft)	Marsh/Swamp Elevation (ft)	Actual water level (ft)
P3	1	Spr 09	3/4/2009	3/18/2009	27/27	5.9	1.7	0.66	1.1
	2	Spr 09	3/4/2009	3/18/2009	25/27	4.2	1.6	0.83	0.8
	3	Spr 09	3/4/2009	3/18/2009	27/27	4.7	1.6	0.52	1.1
	4	Spr 09	3/4/2009	3/18/2009	27/27	4.6	1.6	1.49	0.1
	5	Spr 09	3/4/2009	3/18/2009	21/27	4.1	1.6	0.99	0.6
	6	Spr 09	3/4/2009	3/18/2009	17/27	3.9	3.8	3.31	0.5
P6	1	Spr 09	ND	ND	ND	ND	ND	ND	ND
	2	Spr 09	3/27/2009	4/9/2009	24/27	4.0	3.3	1.56	1.7
	3	Spr 09	3/27/2009	4/9/2009	24/27	6.2	3.2	0.85	2.3
	4	Spr 09	3/27/2009	4/9/2009	24/27	5.0	3.4	1.13	2.3
	5	Spr 09	3/27/2009	4/9/2009	24/27	4.2	3.6	1.92	1.7
	6	Spr 09	3/27/2009	4/9/2009	23/27	4.2	3.0	1.74	1.3
P7	1	Spr 09	4/9/2009	4/23/2009	24/27	4.5	3.0	1.76	1.3
	2	Spr 09	4/9/2009	4/23/2009	6/27	5.0	3.0	2.23	0.8
	3	Spr 09	4/9/2009	4/23/2009	4/27	5.2	3.0	2.26	0.7
	4	Spr 09	4/9/2009	4/23/2009	4/27	5.7	3.1	2.43	0.7
	5	Spr 09	4/9/2009	4/23/2009	3/27	4.1	2.9	2.31	0.6
	6	Spr 09	4/9/2009	4/23/2009	3/27	5.3	2.9	2.37	0.6
P8	1	Spr 09	4/23/2009	5/7/2009	12/27	4.1	2.6	2.14	0.4
	2	Spr 09	4/23/2009	5/7/2009	22/27	4.2	2.5	1.54	1.0
	3	Spr 09	4/23/2009	5/7/2009	27/27	4.3	2.7	1.46	1.2
	4	Spr 09	4/23/2009	5/7/2009	12/27	3.8	2.4	1.98	0.5
	5	Spr 09	4/23/2009	5/7/2009	7/27	3.8	2.4	2.24	0.2
	6	Spr 09	4/23/2009	5/7/2009	12/27	6.1	2.8	2.38	0.4
P9	1	Spr 09	5/7/2009	5/21/2009	27/27	6.3	2.6	0.58	2.0
	2	Spr 09	5/7/2009	5/21/2009	23/27	3.2	2.6	2.21	0.4
	3	Spr 09	5/7/2009	5/21/2009	14/27	3.7	1.9	1.22	0.7
	4	Spr 09	5/7/2009	5/21/2009	7/27	4.1	2.5	2.06	0.4
	5	Spr 09	5/7/2009	5/21/2009	5/27	5.0	2.5	2.20	0.3
	6	Spr 09	5/7/2009	5/21/2009	7/27	5.3	2.4	1.92	0.5
P11	1	Spr 09	4/17/2009	5/1/2009	27/27	4.1	2.6	1.44	1.1
	2	Spr 09	4/17/2009	5/1/2009	22/27	4.0	2.5	1.82	0.7
	3	Spr 09	4/17/2009	5/1/2009	23/27	4.4	2.8	1.76	1.0
	4	Spr 09	4/17/2009	5/1/2009	18/27	4.2	2.5	1.85	0.6
	5	Spr 09	4/17/2009	5/1/2009	19/27	4.2	2.4	1.91	0.5
	6	Spr 09	4/17/2009	5/1/2009	15/27	4.7	2.6	2.04	0.5

Table 4.2-2. (continued)

Station Number	Substation Number	Season	Start Date	End Date	# Flood Events	Mean Flood Duration (hr)	Maximum Depth (ft)	Marsh/Swamp Elevation (ft)	Actual water level (ft)
P12	1	Spr 09	5/6/2009	5/20/2009	27/27	4.8	2.4	0.90	1.5
	2	Spr 09	5/6/2009	5/20/2009	18/27	4.5	2.3	1.62	0.7
	3	Spr 09	5/6/2009	5/20/2009	21/27	3.0	2.3	2.00	0.3
	4	Spr 09	5/6/2009	5/20/2009	13/27	4.3	2.3	1.90	0.4
	5	Spr 09	5/6/2009	5/20/2009	9/27	4.8	2.4	2.08	0.3
	6	Spr 09	5/6/2009	5/20/2009	2/27	4.6	2.5	2.44	0.1
P13	1	Spr 09	3/5/2009	319/2009	22/27	6.0	2.1	1.43	0.7
	2	Spr 09	3/5/2009	319/2009	25/27	5.1	2.1	1.08	1.0
	3	Spr 09	3/5/2009	319/2009	27/27	5.1	2.0	0.75	1.3
	4	Spr 09	3/5/2009	319/2009	27/27	6.2	2.1	1.00	1.1
	5	Spr 09	3/5/2009	319/2009	26/27	4.5	2.0	1.21	0.8
	6	Spr 09	3/5/2009	319/2009	11/27	4.0	2.0	1.64	0.3
P14	1	Spr 09	4/2/2009	4/16/2009	27/27	7.3	2.2	0.70	1.5
	2	Spr 09	4/2/2009	4/16/2009	27/27	5.6	2.0	0.87	1.2
	3	Spr 09	4/2/2009	4/16/2009	27/27	5.2	2.2	1.08	1.1
	4	Spr 09	4/2/2009	4/16/2009	25/27	4.0	2.2	1.22	1.0
	5	Spr 09	4/2/2009	4/16/2009	24/27	4.1	2.2	1.28	0.9
	6	Spr 09	4/2/2009	4/16/2009	15/27	4.5	2.0	1.49	0.5

ND=No data available

Table 4.2-3. Summary of salinity data from nine substations collected along the Cape Fear River and its tributaries in fall 2008. ND indicates no data

Station Number	Station Name	Substation Number	Fall 2008 Salinity Range (ppt)	Proportion of flood events containing > 1 ppt salinity
P3	Town Creek	1	<1 - 1	0/27
		2	ND	ND
		3	<1 - 1	0/27
		4	<1	0/27
		5	<1 - 1	0/27
		6	<1	0/27
P6	Eagle Island	1	ND	ND
		2	<1 - 14	16/27
		3	<1 - 14	19/27
		4	<1 - 14	18/19
		5	<1 - 5	3/27
		6	<1 - 6	3/27

Table 4.2-3 (continued)

Station Number	Station Name	Substation Number	Fall 2008 Salinity Range (ppt)	Proportion of flood events containing > 1 ppt salinity
P7	Indian Creek	1	<1 - 5	8/27
		2	<1 - 2	4/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P9	Black River	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P11	Smith Creek	1	<1 - 13	9/27
		2	<1 - 13	14/27
		3	ND	ND
		4	<1 - 11	14/27
		5	<1 - 11	14/27
		6	<1 - 10	14/27
P12	Rat Island	1	<1 - 15	27/27
		2	<1 - 15	25/27
		3	<1 - 14	21/27
		4	<1 - 12	20/27
		5	<1 - 12	15/27
		6	<1 - 8	11/27
P13	Fishing Creek	1	<1	0/27
		2	<1	0/27
		3	<1 - 1	0/27
		4	<1 - 1	0/27
		5	<1	0/27
		6	ND	ND
P14	Prince George	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	ND	ND

ND=No data available

Table 4.2-4. Summary of salinity data from nine substations collected along the Cape Fear River and its tributaries in spring 2009. ND indicates no data.

Station Number	Station Name	Substation Number	Spring 2009 Salinity Range (ppt)	Proportion of flood events containing > 1 ppt salinity
P3	Town Creek	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P6	Eagle Island	1	ND	ND
		2	<1 - 2	2/27
		3	<1 - 2	3/27
		4	<1 - 1	0/27
		5	<1	0/27
		6	<1	0/27
P7	Indian Creek	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P8	Dollison's Landing	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P9	Black River	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P11	Smith Creek	1	<1 - 6	10/27
		2	<1 - 6	11/27
		3	<1 - 6	11/27
		4	<1 - 6	11/27
		5	<1 - 2	5/27
		6	<1 - 3	3/27
P12	Rat Island	1	<1 - 5	11/27
		2	<1 - 2	3/27
		3	<1 - 2	2/27
		4	<1 - 1	0/27
		5	<1	0/27
		6	<1	0/27

Table 4.2-4 (continued)

Station Number	Station Name	Substation Number	Spring 2009 Salinity Range (ppt)	Proportion of flood events containing > 1 ppt salinity
P13	Fishing Creek	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27
P14	Prince George	1	<1	0/27
		2	<1	0/27
		3	<1	0/27
		4	<1	0/27
		5	<1	0/27
		6	<1	0/27

ND=No data available

4.3 Marsh/Swamp Flooding

About half the stations showed a decrease in flood events this year when compared to last year. The other half showed an increase in flood events during the sampling period, i.e. some subsites flooded more frequently than adjacent subsites (Tables 4.2-1 and 4.2-2). For example, at station P3 subsite 6 flood events decreased from 22/27 in fall 2007 to 9/27 in fall 2008. This effect is more pronounced in the fall when the river discharge rates were below average (Fig. 3.5-2). The discharge rate drastically increased by March 2009 when spring sampling at P3 was completed and P3 subsite 6 flood events increased to 17/27, an increase of one flood event out of 27 over spring 2008's data. During spring 2008, the number of flood events at most stations were comparable to previous years. This was not the case at station P7 which had fewer flood events at most of the subsites during fall 2008 and spring 2009. Flood events at Subsite 5 decreased from by 10 flood events from both spring 2007 and fall 2008 to spring 2008 and fall 2009. At this station (P7) mean flood durations were also lower in spring 2008. Each subsites mean was approximately 1.5 hours shorter than last year's duration. Note that when tides did flood the marsh/swamp surface the average depth and duration of flooding at all sites was not very different than previous years (Hackney et al,. 2002, 2003, 2004, 2005, 2006, 2007, 2008 and Culbertson et al., 2009). These data are collected for two-week periods, but all stations are not collected during the same two-week time frame. Typically, each two-week period includes either a new moon or full moon tide, which are usually higher than average. There is no attempt to schedule these two-week collection periods with high or low river flow so it is not unusual for any one station to have a lower frequency of flooding from chance alone.

4.4 Water Salinity in Marshes and Swamps

Salinity of surface water flooding swamps and marshes reflected the overall state of river flows relative to previous reporting periods. The mean discharge at Lock and Dam 1 for this reporting period is almost twice the discharge measured for 2007-2008 and approximately one-half of the discharge measured in 2006-2007. This mean discharge rate for this reporting year is most similar to the year 2004-2005 with the flow of water through Lock and Dam 1 slightly lower than the mean. This was reflected in the salinity measured on the marsh/swamp surface. Salinity was only detected at four stations (P6, P7, P11 and P12) and two in the spring (P11 and P12) (Table 4.2-3). This is similar to the reporting year of 2004-2005 when salinity was only detected at two stations (P11 and P12) in the fall and four (P3, P2, P11 and P12) in the spring when river flow had decreased. In fall 2008, the maximum salinity measured was at P12 at 15 ppt and in spring 2009 the maximum salinity was at P11 at 6 ppt (Table 4.2-3). This is a dramatic decrease in salinity maximums when compared to last year's fall maximum (P3) of 26 ppt during the severe regional drought.

5.0 MARSH/SWAMP BIOGEOCHEMISTRY

5.1 Summary

Geochemical data were collected at nine stations along the Cape Fear River Estuary beginning in winter of 2000. Data from the winters of 2000-2008 and the summers of 2000-2007 was presented in the previous annual reports for this project (CZR Incorporated 2001; Hackney et al., 2002, 2003, 2005, 2006, 2007; 2008 and Culbertson et al., 2009). Data presented in the current report includes winter 2009 and summer 2008. The microbial modes of organic matter remineralization of the study sites range from sulfate reducing to methanogenic. Analysis of porewater chloride, sulfate, and methane was performed at six substations per station and at 6 sub-depths per substation. Samples were collected during the winter and summer at eight sites and monthly at P6 (Eagle Island). These data were used to classify the geochemical setting of each substation at each station as methanogenic (M), sulfate reducing (SR), methanogenic with evidence of past sulfate reduction (MPSR), and sulfate reducing with a non-seawater source of sulfate (SRNS). Classifications were compared to the previous data for these sites.

The current year was generally slightly saltier compared to the average year but not as salty as the low flow year at Indian Creek (P7), Black River (P9), Rat Island (P12), Town Creek (P3), and Eagle Island (P6). Fishing Creek (P13) and Prince George (P14) had conditions that were similar to the low flow year. Dollisons Landing (P8) and Smith Creek (P11) did not show any trends towards either saltier of fresher conditions.

5.2 Geochemical Theory and Classification

Porewater sampling of the metabolic products of sulfate reducing and methanogenic bacteria help establish the frequency and duration of organic soil inundation by tidal water carrying ocean-derived salt versus inundation by fresh water. Changes in flooding frequency have a more significant impact if salts from seawater enter the pore space of wetland sediments. In the presence of sufficient seawater sulfate, organic matter is remineralized via sulfate reducing bacteria in anaerobic environments generating hydrogen sulfide. In freshwater environments, organic matter is usually remineralized via methanogens that generate methane as a byproduct. In the presence of high levels of sulfate from seawater, methanogens are replaced by sulfate reducing bacteria and methanogenesis is inhibited. Hydrogen sulfide is toxic and limits both plants and animal species that do not have a behavioral or physiological mechanism to tolerate this bacterial metabolite. Thus, a shift in remineralization pathway can lead to different communities of plants and animals.

Chloride concentrations are a direct measure of salinity as it occurs in a constant proportion in seawater and has no substantial sinks or sources in wetland sediments. Therefore, the term salinity used in the biogeochemistry section of this report will refer to salinity based on measured chloride concentrations.

Chloride and sulfate concentrations are in a constant ratio in seawater (approximately 20:1). Unlike sulfate, which can decrease due to sulfate reduction, there are no common removal mechanisms (biotic or abiotic) for chloride from seawater. Therefore, chloride concentrations can be used as an indicator of the amount of sulfate originally supplied to a site by seawater. Changes in the ratio of chloride to sulfate are an indicator of sulfate reduction. In the presence of sulfate reduction, methanogenic bacteria are out competed and methane production is inhibited. Therefore, low concentrations of methane are another indicator of sulfate reduction. When sulfate concentrations decrease sufficiently, sulfate-reducing bacteria are no longer able to function and methane production dominates. Thus, a sulfate reducing threshold concentration can be identified in sulfate concentration versus depth profiles, where sulfate concentrations no longer decrease with increasing depth and methane concentrations increase. Data from all nine marsh/swamp stations of the present study place the level where the shift occurs at approximately 300 μM sulfate. This corresponds to sulfate being supplied by salinities of approximately 0.4 parts per thousand.

Using this sulfate reducing threshold (300 μM sulfate) stations and substations were classified as sulfate reducing or methanogenic. Methanogenic substations that had a chloride to sulfate ratio significantly greater than seawater (>30:1) were classified as methanogenic sites with evidence of past sulfate reduction. Sulfate reducing sites with ratios less than seawater (5:1) were classified as sulfate reducing with a non-seawater source of sulfate which may also indicate oxidation of hydrogen sulfide in the porewaters. The four main classifications are: 1) sulfate reducing (SR), 2) methanogenic (M), 3) methanogenic with evidence of past sulfate reduction (MPSR) and 4) sulfate reducing with a non-seawater source of sulfate (SRNS). Changes in these classifications will be used to determine changes in biogeochemical setting associated with river dredging, drought, or other factors.

5.3 Geochemical Methodology

Biogeochemical monitoring was established in close proximity to shallow water well/conductivity/temperature substations. Six substations are distributed along the length of each of nine monitoring belt transects with number one near the river or channel and number 6 adjacent to uplands. Substations are roughly perpendicular to the segment of the stream along which they have been established. Sampling devices, peepers, are constructed of thick acrylic with wells (1-cm deep grooves) located at six different depths that sample 1, 6, 11, 16, 21, and 26 cm below the soil surface. Semipermeable membranes allow methane, sulfate, and chlorine to equilibrate with distilled water in wells. Peepers are inserted into the substrate and left for 1 week, which is ample time for equilibration. Peepers have been shown to be reliable collection devices for these types of dissolved substances (Hesslein 1976). The concentrations of all parameters are determined after removing samples from peeper cells with a syringe equipped with a needle. Sulfate and chloride concentrations are stable under oxic conditions and can be stored in serum vials until analysis. Sulfate and chloride concentrations are determined with an ion chromatograph (Hoehler et al., 1994). Salinity is calculated from the chloride concentrations of the equilibrated peeper chamber water based on the constant ratio of chloride to total dissolved salts in seawater. Samples for porewater methane analysis are prepared by extraction of porewater methane into an inert helium headspace within a gas-tight syringe. The headspace gas is then injected into a gas chromatograph equipped with a flame ionization detector (Kelley et al., 1995) for quantitative determination of methane concentration.

Porewater is collected and analyzed at all 54 substations in all nine transect stations during mid-summer and mid-winter, the coldest and warmest parts of the year. This provides data during periods of maximum and minimum bacterial metabolism. In addition, porewater is collected from the Eagle Island station (P6) every month using the same procedures. This station represents a transition between saline and fresh-dominated stations. In addition, the six substations represent the same transition along a different scale, well-flooded to less flooded.

The first seven reports of this monitoring project have provided enough information to establish an "average year". On the basis of the seven reports and river flow data, the authors have established the report year four (Hackney et al., 2005) as a year representing average conditions. This year will be referred to as the "average year" in this report. Year three (Hackney et al., 2004) has been identified as a low river flow year representing a year with high salinity intrusion into the monitoring sites. This year will be referred to as the "low river flow year" in the current report. The current year's data will be compared to the average year and the low river flow year to put the current year's data in context.

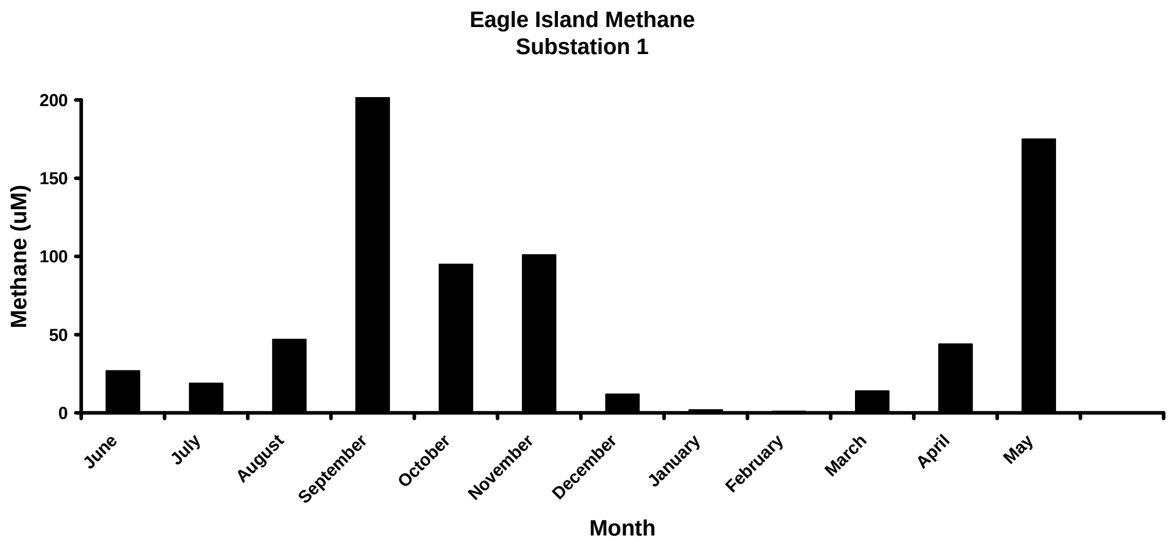
5.4 Eagle Island (P6) Annual Cycles of Sulfate, Chloride, and Methane

Eagle Island's previous and current general classifications are based on the following observations: 1) Methane is typically present at depth in all substations, but is often at very low concentrations at the surface during times of high sulfate input (Figure 5.4-1), 2) Sulfate concentrations range from below the sulfate reducing threshold of 300 μM indicating methane production, to as high as 1500 μM indicating sufficient sulfate to support sulfate reduction (Figure 5.4-2). The ratios of chloride to sulfate range from those found in seawater to ratios indicating a depletion of sulfate due to sulfate reduction (Figure 5.4-3). Some lower ratios also occur, possibly indicating oxidation of hydrogen sulfide from previous sulfate reduction.

Salinity values at Eagle Island for the average year (Hackney et al., 2005) were typically less than 1.5 ppt at the creekbank location S1 and less than 0.1 ppt at the upland site S6. The low river flow high salinity year (Hackney et al., 2004) had salinity values as high as 14 ppt at S1 and 8 ppt at S6. The salinity values observed during the current year were slightly elevated compared to the average year ranging from approximately 0.25-3 ppt at both S1 and S6 (Figure 5.4-4). Sulfate concentrations during the current year (approximately 50-1500 μM at both S1 and S6) were similar to those measured during the average year at S1 (200-1000 μM) and slightly elevated compared to values obtained for S6 during the average year (100-500 μM). The Chloride to sulfate ratios were at or above those expected for seawater for the majority of the months at both S1 and S6. Ratios near that of seawater indicate a recent resupply of sea salts while those above the chloride to sulfate ratio indicate active sulfate reduction.

Average year methane concentrations vary, but typically approach 400μM. During the low river flow year, methane concentrations were <70 μM. During the current year methane concentrations were approximately 10-200 μM at S1 and ranged between 100–200 μM at S6 (Figure 5.4-1). The lower methane concentrations at S1 reflect the higher supply of sulfate from the high salinity floodwaters. The sulfate reducers had a sufficient supply of sulfate that remained above the threshold concentration resulting in the sulfate reducer's outcompetting the methanogens. The higher levels of methane at S6 are consistent with less resupply of sulfate at the upland edge location. The sulfate was not resupplied often enough by subsequent floodwaters resulting in the shift to methanogenesis following depletion of sulfate to the threshold concentration.

The classifications of Eagle Island during the current year (Table 5.4-1) are consistent with an average year where the majority of classifications were methanogenic with evidence of past sulfate reduction (MPSR) (Hackney et al., 2005). This is consistent with an occasional pulse of relatively low salinity water followed by temporary sulfate reducing conditions until the sulfate is reduced to the threshold concentration. After the low levels of sulfate are depleted, the site returns to methanogenic conditions recording in the sediments evidence of the prior sulfate reduction in the chloride to sulfate ratios. During the low flow year, classifications were evenly divided between sulfate reducing and MPSR (Hackney et al., 2004).



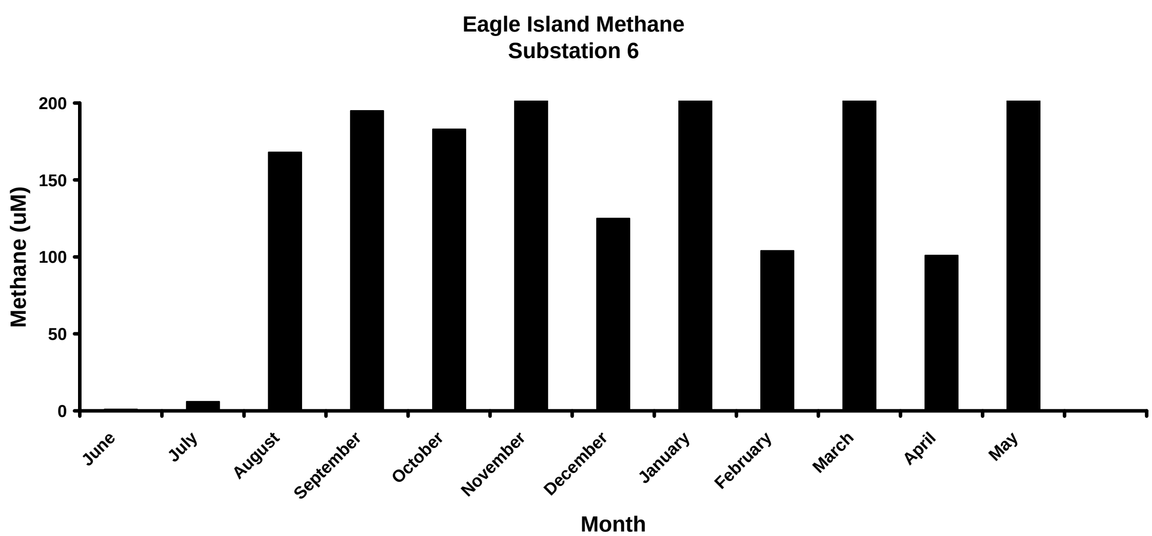
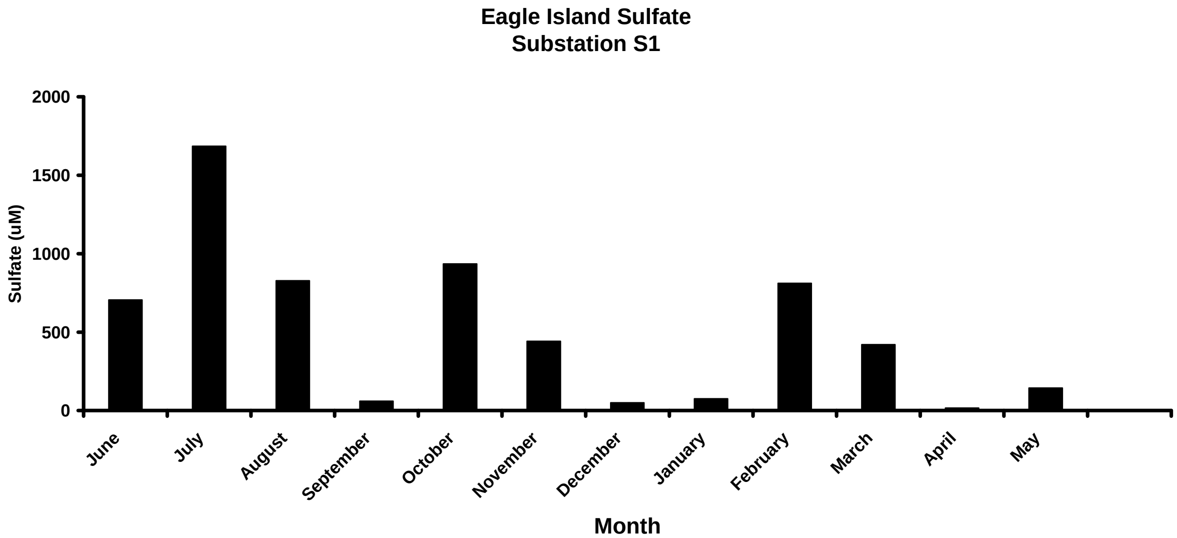


Figure 5.4-1. Methane concentrations of Eagle Island porewaters vs. month. Top shows nearshore site (S1) and bottom shows most upland site (S6).



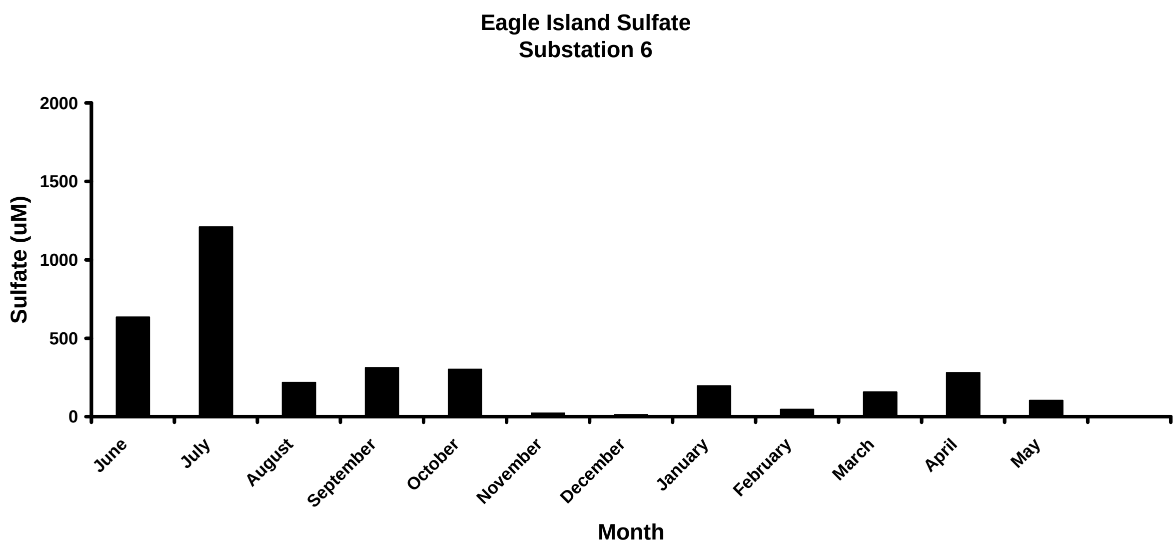


Figure 5.4-2. Sulfate concentrations of Eagle Island porewaters vs. month. Top shows nearshore site (S1) and bottom shows most upland site (S6).

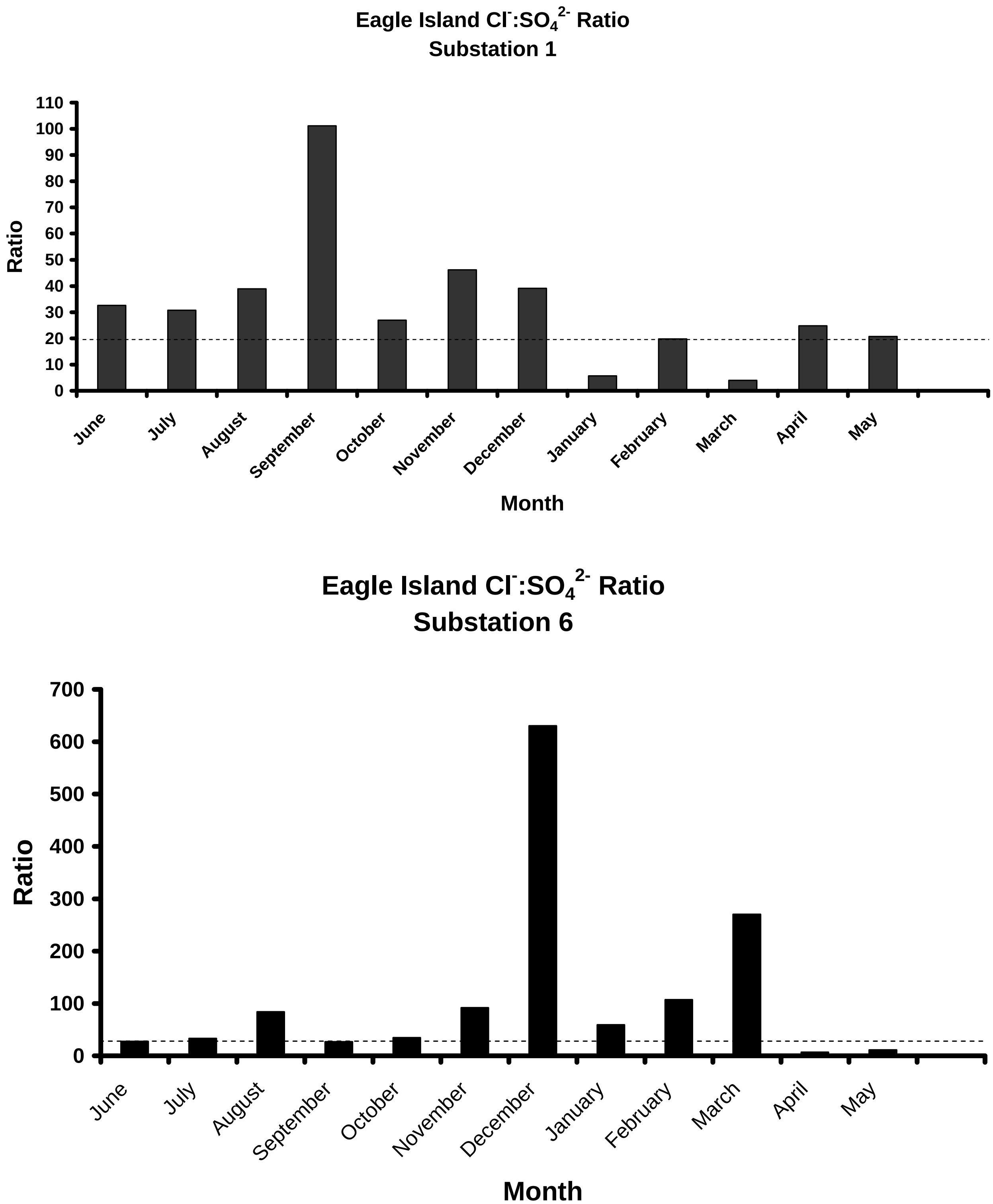
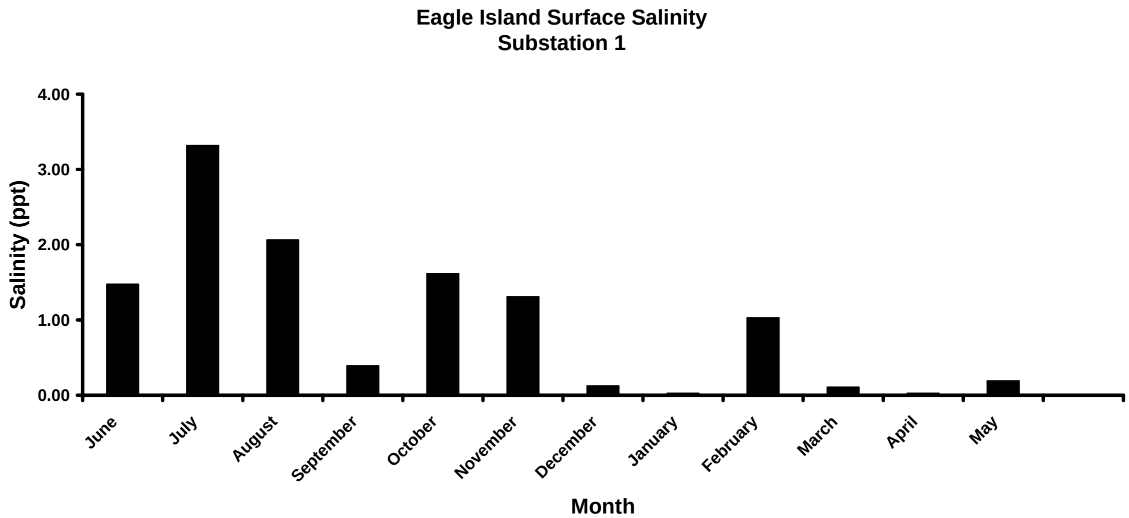


Figure 5.4-3. Chloride to sulfate ratios of Eagle Island porewaters vs. month. Dashed line shows ratio for seawater. Top shows nearshore site (S1) and bottom shows most upland site (S6).



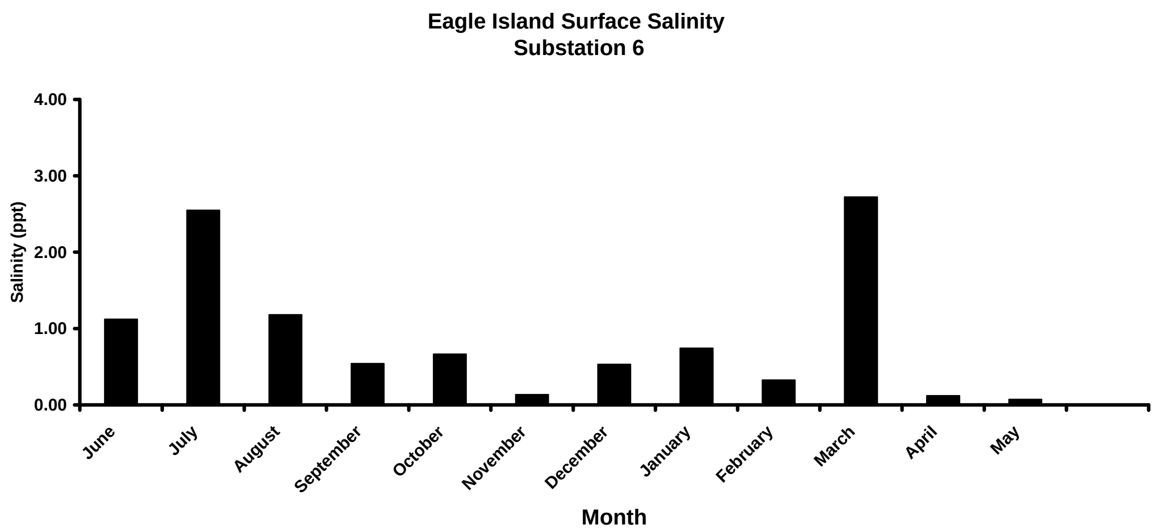


Figure 5.4-4. Salinities of Eagle Island porewaters vs. month. Top shows nearshore site (S1) and bottom shows most upland site (S6).

Table 5.4-1. Eagle Island (P6) Geochemical Classifications by month. Site classifications are as follows: Methanogenic I, Sulfate Reducing II, Methanogenic with evidence of past sulfate reduction I*, Sulfate reducing non-seawater source of sulfate II*. NA indicates insufficient data

Sites	**June 08**	**July**	**August**	**September**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May 09**
S1-1	II	II	II	I*	II	ll	II	I	II	II*	I	I
S1-2	II	II	II	I*	II	I*	II	I	II	II	I	I
S1-3	II	II	I*	NA	II	I*	II	I*	II	l*	NA	NA
S1-4	I*	II	I*	NA	II	ll	II	I*	II	l*	l	L
S1-5	NA	I*	I*	I*	I*	I*	II	I*	I*	l*	I*	NA
S1-6	NA	I*	I*	I*	I*	I*	I*	NA	I*	NA	I*	NA
S2-1	II	II	II	I*	I*	II	I*	II	I*	I*	I*	I*
S2-2	II	II	II	I*	I*	II	I*	I*	I*	I*	NA	I*
S2-3	II	II	II	I*	I*	II	I*	II	NA	I*	I	II
S2-4	II	II	I*	I*	I*	II	I*	II	NA	I*	I*	II
S2-5	I*	I*	I*	I*	I*	II	I*	I*	NA	I*	I*	II
S2-6	I*	I*	I*	I*	I*	I*	I*	I*	I*	I*	I*	II
S3-1	II	I*	I*	II	I*	I*	II	I*	I*	II	I*	II
S3-2	II	I*	I*	I*	I*	I*	II	I*	NA	II	NA	II
S3-3	II	I*	I*	II	I*	I*	NA	I*	NA	I*	NA	II
S3-4	NA	NA	NA	l*	I*	I*	NA	I*	NA	I*	NA	I*
S3-5	NA	I*	NA	NA	I*	I*	NA	I*	NA	I*	NA	I*
S3-6	NA	I*	NA	I*	I*	I*	NA	NA	I*	I*	I*	I*
S4-1	II	I*	l*	II	I*	I*	NA	I*	I*	I*	NA	I*
S4-2	I*	I*	NA	I*	I*	I*	NA	I*	I*	I*	I*	I*
S4-3	I*	I*	NA	I*	I*	I*	NA	I*	I*	I*	NA	I*
S4-4	I*	I*	I*	I*	I*	NA	NA	I*	I*	I*	NA	II
S4-5	I*	I*	NA	I*	I*	NA	NA	I*	I*	I*	NA	I*
S4-6	I*	I*	NA	I*	I*	I*	I*	I*	NA	I*	I*	I*
S5-1	I*	II	I*	I*	II	l*	I*	I*	l*	l*	I*	NA
S5-2	I*	l*	I*	I*	II	I*	NA	I*	l*	I*	I*	l*
S5-3	I*	I*	NA	I*	I*	I*	I*	I*	I*	I*	NA	I*
S5-4	NA	I*	I*	I*	I*	I*	NA	NA	NA	I*	NA	I*
S5-5	NA	I*	NA	II	I*	I*	NA	NA	I*	I*	I*	I*
S5-6	NA	I*	I*	II	I*	I*	NA	NA	I*	I*	l*	I*
S6-1	II	II	I	II	II	l*	I*	I*	I*	l*	I	I*
S6-2	II	II	I*	II	I*	I*	NA	I*	I*	I*	I	I*
S6-3	I*	II	I*	I*	I*	I*	NA	I*	I*	I*	I*	I*
S6-4	I*	I*	I*	I*	I*	I*	l*	I*	I	I*	I*	I*
S6-5	I*	I*	I*	I*	I*	NA	I*	I*	NA	I*	I*	I*
S6-6	I*	I*	I*	ll	I*	NA	I*	I*	I*	I*	I*	I*

5.5 Marsh/Swamp Transect Stations Geochemistry, Annual Variability

5.51 Town Creek (P3)

Salinity at Town Creek during the average year ranged between 0.5 and 2.5 ppt. (Hackney et al., 2005). During the low river flow year salinities reached values as high as 17 ppt. (Hackney et al., 2004). The current year salinities (Table 5.51-1), based on chloride concentrations (Table 5.51-2), were slightly elevated compared to the average year (0.2-5 ppt) The majority of sulfate concentrations were in the 50 – 2,000 µM range (Table 5.51-3) in between the average year concentrations of 100 – 300 µM and the low river flow year concentrations of 500 – 3,000 µM. Methane concentrations during the current year ranged from approximately 20 -300 µM (Table 5.51-4). During both the low river flow year and the average year methane concentrations were similar at this site with concentrations generally in the 10-300 µM range. There is little distinction between classifications at this site between the average and low flow years. During the summer classifications tend to be SR and during the winter MPSR. During the current summer essentially all classifications were SR and during the winter most classifications were MPSR (Table 5.51-1).

Table 5.51-1. Salinity of Sites. Salinity in parts per thousand calculated from chloride concentrations in porewaters.

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Town Creek	1	1	4.07	0.21
P3	1	6	3.42	0.23
	1	11	2.94	0.37
	1	16	2.39	0.59
	1	21	2.32	0.96
	1	26	2.28	1.21
	2	1	2.62	0.44
	2	6	2.69	0.58
	2	11	2.76	1.28
	2	16	2.84	1.61
	2	21	3.10	2.20
	2	26	3.76	2.71
	3	1	4.74	0.85
	3	6	4.91	1.29
	3	11	5.06	1.85
	3	16	4.91	2.17
	3	21	4.74	2.77
	3	26	4.38	2.97

Table 5.51-1 (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Town Creek (continued)	4	1	2.25	0.55
	4	6	2.23	0.48
	4	11	2.28	0.57
	4	16	2.42	0.79
	4	21	2.54	1.19
	4	26	2.87	1.54
	5	1	3.71	0.83
	5	6	3.69	0.48
	5	11	3.53	0.55
	5	16	3.49	0.75
	5	21	3.27	0.98
	5	26	3.10	1.13
	6	1	2.33	2.98
	6	6	3.28	3.69
	6	11	3.44	4.19
	6	16	3.39	4.48
	6	21	3.83	4.63
	6	26	3.96	0.03
Eagle Island P6	1	1	3.32	0.03
	1	6	3.21	0.03
	1	11	3.31	0.15
	1	16	2.80	1.03
	1	21	2.30	0.59
	1	26	1.85	0.83
	2	1	3.50	3.46
	2	6	3.60	0.33
	2	11	3.55	2.60
	2	16	2.76	2.32
	2	21	1.58	1.57
	2	26	0.82	1.14
	3	1	1.58	1.32
	3	6	1.62	1.46
	3	11	1.55	1.49
	3	16	1.51	1.50
	3	21	1.46	1.95
	3	26	1.43	1.94
	4	1	1.52	1.35
	4	6	1.93	1.32
	4	11	1.51	1.30
	4	16	1.31	1.39
	4	21	1.31	1.34
	4	26	1.17	1.44
	5	1	2.07	1.03
	5	6	1.80	1.28

Table 5.51-1. (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Eagle Island (continued)	5	11	1.29	1.37
	5	16	1.09	1.45
	5	21	1.29	1.45
	5	26	1.02	1.44
	6	1	2.55	0.74
	6	6	2.71	0.85
	6	11	2.59	0.93
	6	16	1.79	0.96
	6	21	1.77	0.99
	6	26	1.95	2.21
Indian Creek P7	1	1	5.30	1.08
	1	6	5.07	1.71
	1	11	4.76	2.50
	1	16	3.97	3.95
	1	21	3.37	4.06
	1	26	3.34	5.49
	2	1	7.11	0.20
	2	6	7.09	0.39
	2	11	6.57	0.58
	2	16	6.24	0.76
	2	21	6.30	1.08
	2	26	4.17	1.58
	3	1	4.03	0.29
	3	6	3.12	0.32
	3	11	2.43	0.34
	3	16	2.08	0.34
	3	21	1.70	0.54
	3	26	1.55	0.97
	4	1	1.00	0.11
	4	6	0.55	0.06
	4	11	0.42	0.13
	4	16	0.40	0.15
	4	21	0.47	0.15
	4	26	0.54	0.16
	5	1	0.40	0.05
	5	6	0.44	0.03
	5	11	0.44	0.05
	5	16	0.33	0.04
	5	21	0.27	0.04
	5	26	0.26	0.04
	6	1	0.02	0.02
	6	6	0.02	0.03
	6	11	0.02	0.03
	6	16	0.01	0.03

Table 5.51-1. (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Indian Creek (continued)	6	21	0.02	0.02
	6	26	0.04	0.04
Dollisons Landing P8	1	1	0.07	0.02
	1	6	0.06	0.03
	1	11	0.06	0.03
	1	16	0.06	0.03
	1	21	0.07	0.03
	1	26	0.08	0.03
	2	1	0.07	0.11
	2	6	0.07	0.10
	2	11	0.07	0.09
	2	16	0.07	0.08
	2	21	0.07	0.09
	2	26	0.07	0.09
	3	1	0.07	0.06
	3	6	0.07	0.05
	3	11	0.08	0.05
	3	16	0.08	0.05
	3	21	0.07	0.05
	3	26	0.10	0.06
	4	1	0.06	0.03
	4	6	0.07	0.05
	4	11	0.08	0.06
	4	16	0.07	0.06
	4	21	0.06	0.05
	4	26	0.08	0.05
	5	1	0.08	0.05
	5	6	0.09	0.05
	5	11	0.07	0.05
	5	16	0.06	0.05
	5	21	0.06	0.05
	5	26	0.07	0.07
	6	1	0.06	0.11
	6	6	0.07	0.12
	6	11	0.06	0.12
	6	16	0.07	0.11
	6	21	0.07	0.10
	6	26	0.08	0.10
Black River P9	1	1	0.05	0.04
	1	6	0.04	0.05
	1	11	0.04	0.05
	1	16	0.04	0.05
	1	21	0.04	0.04
	1	26	0.04	0.06

Table 5.51-1. (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Black River (continued)	2	1	0.04	0.04
	2	6	0.05	0.04
	2	11	0.04	0.04
	2	16	0.04	0.04
	2	21	0.04	0.04
	2	26	0.05	0.04
	3	1	0.04	0.04
	3	6	0.04	0.03
	3	11	0.05	0.05
	3	16	0.05	0.06
	3	21	0.06	0.06
	3	26	0.07	0.07
	4	1	0.03	0.05
	4	6	0.03	0.04
	4	11	0.03	0.03
	4	16	0.03	0.05
	4	21	0.03	0.03
	4	26	0.03	0.05
	5	1	0.04	0.05
	5	6	0.05	0.05
	5	11	0.05	0.05
	5	16	0.04	0.06
	5	21	0.04	0.06
	5	26	0.04	0.06
	6	1	0.04	0.04
	6	6	0.04	0.05
	6	11	0.05	0.04
	6	16	0.05	0.05
	6	21	0.05	0.05
	6	26	0.05	0.05
Smith Creek P11	1	1	2.98	1.25
	1	6	2.98	1.45
	1	11	2.76	1.61
	1	16	2.37	1.87
	1	21	2.10	2.10
	1	26	2.44	2.18
	2	1	3.50	1.49
	2	6	3.34	2.03
	2	11	3.29	2.50
	2	16	3.20	2.54
	2	21	2.95	2.89
	2	26	2.62	2.88
	3	1	3.30	0.96
	3	6	3.42	0.85

Table 5.51-1. (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Smith Creek (continued)	3	11	3.21	1.10
	3	16	2.96	1.59
	3	21	2.57	1.99
	3	26	2.34	2.47
	4	1	3.01	1.55
	4	6	3.72	1.87
	4	11	3.88	2.26
	4	16	3.73	2.55
	4	21	3.09	2.63
	4	26	2.81	2.75
	5	1	2.08	1.33
	5	6	2.34	1.58
	5	11	2.54	1.98
	5	16	2.30	2.42
	5	21	2.04	2.72
	5	26	1.94	2.60
	6	1	2.29	0.33
	6	6	2.69	0.50
	6	11	2.67	0.97
	6	16	2.75	1.33
	6	21	2.69	1.69
	6	26	2.78	2.10
Rat Island P12	1	1	2.94	0.14
	1	6	2.88	0.10
	1	11	2.92	0.09
	1	16	2.57	0.10
	1	21	1.84	0.14
	1	26	1.39	0.25
	2	1	3.09	0.07
	2	6	2.94	0.05
	2	11	2.47	0.13
	2	16	1.97	0.28
	2	21	1.75	0.60
	2	26	1.59	0.99
	3	1	1.24	0.13
	3	6	1.08	0.18
	3	11	0.97	0.26
	3	16	1.00	0.34
	3	21	0.93	0.51
	3	26	0.93	0.70
	4	1	1.42	0.79
	4	6	1.39	0.85
	4	11	1.17	1.04
	4	16	1.06	1.12

Table 5.51-1. (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Rat Island (continued)	4	21	1.01	1.12
	4	26	1.03	1.04
	5	1	0.84	0.71
	5	6	0.62	0.70
	5	11	0.52	0.72
	5	16	0.43	0.79
	5	21	0.45	0.78
	5	26	0.55	0.86
	6	1	0.40	0.09
	6	6	0.15	0.09
	6	11	0.08	0.10
	6	16	0.12	0.13
	6	21	0.11	0.19
	6	26	0.09	0.18
Fishing Creek P13	1	1	1.94	1.15
	1	6	4.09	0.11
	1	11	4.13	0.10
	1	16	3.90	0.10
	1	21	3.87	0.15
	1	26	4.06	0.26
	2	1	3.35	0.15
	2	6	3.26	0.10
	2	11	3.13	0.15
	2	16	3.19	0.15
	2	21	3.33	0.15
	2	26	3.46	0.14
	3	1	2.71	1.85
	3	6	2.60	2.11
	3	11	2.63	2.11
	3	16	2.61	2.06
	3	21	2.61	2.30
	3	26	2.64	2.36
	4	1	2.87	0.44
	4	6	2.86	0.42
	4	11	2.83	0.46
	4	16	2.82	0.42
	4	21	2.85	0.51
	4	26	2.61	0.53
	5	1	2.13	0.19
	5	6	2.07	0.20
	5	11	2.08	0.19
	5	16	2.07	0.16
	5	21	2.07	0.32
	5	26	1.86	0.31

Table 5.51-1. (continued)

Station	Substation	Depth (cm)	Salinity	
			Summer 2008	Winter 2009
Fishing Creek (continued)	6	1	0.28	0.05
	6	6	0.04	0.06
	6	11	0.06	0.07
	6	16	0.05	0.05
	6	21	0.05	0.08
	6	26	0.07	0.08
Prince George P14	1	1	1.00	0.07
	1	6	1.03	0.09
	1	11	1.05	0.09
	1	16	1.09	0.07
	1	21	1.07	0.07
	1	26	1.03	0.08
	2	1	0.73	0.12
	2	6	0.73	0.08
	2	11	0.66	0.08
	2	16	0.66	0.09
	2	21	0.67	0.15
	2	26	0.67	0.24
	3	1	0.71	0.11
	3	6	0.67	0.11
	3	11	0.62	0.11
	3	16	0.57	0.12
	3	21	0.64	0.16
	3	26	0.61	0.21
	4	1	0.99	0.15
	4	6	1.04	0.18
	4	11	0.75	0.28
	4	16	1.06	0.31
	4	21	0.92	0.38
	4	26	0.81	0.48
	5	1	1.04	0.15
	5	6	1.09	0.13
	5	11	1.10	0.11
	5	16	1.10	0.12
	5	21	1.13	0.12
	5	26	1.20	0.13
	6	1	1.01	0.12
	6	6	0.99	0.16
	6	11	0.96	0.20
	6	16	0.95	0.21
	6	21	0.87	0.25
	6	26	0.85	0.25

Table 5.51-2. Chloride Concentrations of Sites. Chloride concentrations of porewaters in µM.

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Town Creek	1	1	63595	3324
P3	1	6	53420	3561
	1	11	45937	5730
	1	16	37340	9224
	1	21	36282	14991
	1	26	35700	18933
	2	1	40912	6944
	2	6	42000	9067
	2	11	43167	20039
	2	16	44440	25116
	2	21	48388	34382
	2	26	58770	42390
	3	1	74047	13350
	3	6	76746	20209
	3	11	79000	28912
	3	16	76696	33843
	3	21	74071	43299
	3	26	68498	46458
	4	1	35149	8516
	4	6	34832	7446
	4	11	35640	8921
	4	16	37778	12291
	4	21	39736	18568
	4	26	44918	23986
	5	1	58004	12893
	5	6	57622	7515
	5	11	55092	8589
	5	16	54515	11660
	5	21	51030	15292
	5	26	48512	17700
	6	1	36376	46522
	6	6	51276	57719
	6	11	53788	65479
	6	16	52955	70020
	6	21	59833	72388
	6	26	61823	522

Table 5.51-2. (continued)

Station	**Substation**	**Depth (cm)**	**Chloride**	
			Summer 2008	**Winter 2009**
Eagle Island	1	1	51854	431
P6	1	6	50156	547
	1	11	51745	2290
	1	16	43726	16097
	1	21	35978	9191
	1	26	28858	12914
	2	1	54754	54035
	2	6	56243	5102
	2	11	55543	40593
	2	16	43202	36177
	2	21	24637	24546
	2	26	12807	17785
	3	1	24697	20679
	3	6	25387	22872
	3	11	24265	23229
	3	16	23533	23460
	3	21	22782	30498
	3	26	22352	30299
	4	1	23762	21153
	4	6	30188	20675
	4	11	23670	20322
	4	16	20423	21668
	4	21	20413	20960
	4	26	18209	22533
	5	1	32371	16062
	5	6	28157	20012
	5	11	20131	21463
	5	16	17056	22675
	5	21	20226	22718
	5	26	15938	22454
	6	1	39833	11617
	6	6	42371	13337
	6	11	40404	14457
	6	16	28044	15073
	6	21	27676	15464
	6	26	30480	34539

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Indian Creek	1	1	82749	16829
P7	1	6	79271	26747
	1	11	74362	39039
	1	16	62107	61641
	1	21	52675	63496
	1	26	52241	85716
	2	1	111169	3190
	2	6	110819	6157
	2	11	102723	9029
	2	16	97530	11923
	2	21	98451	16814
	2	26	65096	24683
	3	1	62979	4530
	3	6	48774	5072
	3	11	37929	5328
	3	16	32557	5320
	3	21	26564	8371
	3	26	24294	15111
	4	1	15593	1660
	4	6	8520	957
	4	11	6498	1977
	4	16	6252	2288
	4	21	7355	2360
	4	26	8486	2457
	5	1	6227	716
	5	6	6874	529
	5	11	6852	792
	5	16	5161	567
	5	21	4236	607
	5	26	4005	700
	6	1	339	349
	6	6	305	401
	6	11	299	432
	6	16	232	395
	6	21	297	382
	6	26	551	613

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Dollisons Landing P8	1	1	1038	359
	1	6	926	441
	1	11	994	460
	1	16	1012	460
	1	21	1127	489
	1	26	1294	544
	2	1	1108	1696
	2	6	1086	1539
	2	11	1089	1349
	2	16	1058	1318
	2	21	1081	1477
	2	26	1033	1348
	3	1	1113	945
	3	6	1130	800
	3	11	1192	712
	3	16	1228	709
	3	21	1160	732
	3	26	1538	909
	4	1	943	519
	4	6	1156	774
	4	11	1187	925
	4	16	1056	923
	4	21	967	829
	4	26	1181	818
	5	1	1203	752
	5	6	1333	786
	5	11	1036	829
	5	16	940	815
	5	21	910	813
	5	26	1167	1045
	6	1	935	1795
	6	6	1037	1849
	6	11	918	1884
	6	16	1054	1702
	6	21	1102	1564
	6	26	1284	1586

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Black River	1	1	837	657
P9	1	6	613	728
	1	11	648	754
	1	16	574	841
	1	21	596	701
	1	26	651	987
	2	1	680	625
	2	6	723	627
	2	11	645	680
	2	16	639	649
	2	21	643	619
	2	26	764	639
	3	1	667	589
	3	6	700	426
	3	11	790	849
	3	16	765	868
	3	21	910	984
	3	26	1045	1081
	4	1	445	713
	4	6	471	695
	4	11	459	433
	4	16	449	793
	4	21	460	536
	4	26	482	826
	5	1	702	722
	5	6	722	797
	5	11	714	820
	5	16	621	948
	5	21	589	988
	5	26	620	975
	6	1	652	676
	6	6	686	759
	6	11	770	702
	6	16	771	776
	6	21	788	808
	6	26	828	780

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Smith Creek	1	1	46540	19607
P11	1	6	46549	22640
	1	11	43058	25117
	1	16	36956	29200
	1	21	32769	32795
	1	26	38168	33987
	2	1	54743	23322
	2	6	52122	31742
	2	11	51480	39067
	2	16	50053	39659
	2	21	46025	45156
	2	26	40866	44940
	3	1	51595	15033
	3	6	53471	13281
	3	11	50217	17110
	3	16	46282	24875
	3	21	40091	31139
	3	26	36506	38650
	4	1	46966	24168
	4	6	58054	29231
	4	11	60584	35244
	4	16	58231	39781
	4	21	48248	41078
	4	26	43944	42896
	5	1	32529	20735
	5	6	36588	24683
	5	11	39694	30955
	5	16	35990	37815
	5	21	31866	42498
	5	26	30351	40594
	6	1	35718	5226
	6	6	41999	7804
	6	11	41768	15103
	6	16	42971	20711
	6	21	42005	26447
	6	26	43381	32805

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Rat Island	1	1	45899	2167
P12	1	6	44954	1513
	1	11	45572	1351
	1	16	40137	1559
	1	21	28753	2121
	1	26	21784	3928
	2	1	48228	1154
	2	6	45976	811
	2	11	38579	1984
	2	16	30808	4353
	2	21	27345	9325
	2	26	24817	15422
	3	1	19426	2025
	3	6	16885	2799
	3	11	15201	4038
	3	16	15572	5302
	3	21	14465	7947
	3	26	14604	10974
	4	1	22142	12342
	4	6	21704	13253
	4	11	18212	16322
	4	16	16578	17422
	4	21	15749	17557
	4	26	16086	16204
	5	1	13127	11152
	5	6	9717	10935
	5	11	8156	11178
	5	16	6687	12301
	5	21	6973	12205
	5	26	8519	13394
	6	1	6230	1451
	6	6	2268	1349
	6	11	1272	1486
	6	16	1834	2000
	6	21	1750	3034
	6	26	1361	2886

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Fishing Creek	1	1	30355	18040
P13	1	6	63832	1753
	1	11	64486	1564
	1	16	60919	1538
	1	21	60495	2333
	1	26	63397	4134
	2	1	52277	2362
	2	6	50866	1609
	2	11	48899	2355
	2	16	49921	2332
	2	21	51976	2346
	2	26	54038	2244
	3	1	42294	28885
	3	6	40631	32920
	3	11	41113	32908
	3	16	40822	32200
	3	21	40760	35910
	3	26	41323	36921
	4	1	44768	6927
	4	6	44711	6531
	4	11	44269	7118
	4	16	44029	6564
	4	21	44524	8031
	4	26	40835	8242
	5	1	33207	2951
	5	6	32402	3067
	5	11	32451	2919
	5	16	32394	2556
	5	21	32338	5007
	5	26	29013	4915
	6	1	4448	803
	6	6	631	890
	6	11	1012	1081
	6	16	842	789
	6	21	821	1202
	6	26	1049	1312

Table 5.51-2. (continued)

Station	Substation	Depth (cm)	Chloride	
			Summer 2008	Winter 2009
Prince George	1	1	15629	1161
P14	1	6	16038	1334
	1	11	16381	1336
	1	16	16985	1108
	1	21	16699	1117
	1	26	16144	1269
	2	1	11424	1809
	2	6	11459	1291
	2	11	10314	1268
	2	16	10319	1426
	2	21	10447	2405
	2	26	10496	3726
	3	1	11127	1647
	3	6	10460	1707
	3	11	9758	1768
	3	16	8960	1897
	3	21	9925	2576
	3	26	9505	3295
	4	1	15487	2331
	4	6	16172	2741
	4	11	11746	4307
	4	16	16633	4865
	4	21	14350	5941
	4	26	12641	7567
	5	1	16320	2341
	5	6	17103	1991
	5	11	17187	1677
	5	16	17265	1821
	5	21	17662	1939
	5	26	18695	2090
	6	1	15789	1939
	6	6	15540	2536
	6	11	14988	3189
	6	16	14842	3324
	6	21	13584	3975
	6	26	13223	3940

Table 5.51-3. Sulfate Concentrations of Sites. Porewater sulfate concentrations are µM. ND indicates no data.

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Town Creek	1	1	1667	138
P3	1	6	899	96
	1	11	186	90
	1	16	70	67
	1	21	53	58
	1	26	33	108
	2	1	129	141
	2	6	144	121
	2	11	120	61
	2	16	126	56
	2	21	321	60
	2	26	981	104
	3	1	1690	132
	3	6	1614	172
	3	11	1644	210
	3	16	2093	318
	3	21	2018	396
	3	26	1793	392
	4	1	456	291
	4	6	508	253
	4	11	589	285
	4	16	577	192
	4	21	660	221
	4	26	850	313
	5	1	1506	309
	5	6	1443	183
	5	11	1131	175
	5	16	1009	233
	5	21	893	240
	5	26	654	282
	6	1	753	748
	6	6	1071	978
	6	11	1168	1321
	6	16	1060	1384
	6	21	1308	1469
	6	26	1547	ND
Eagle Island	1	1	1685	76
P6	1	6	1394	60
	1	11	1119	50
	1	16	581	129
	1	21	227	19

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Eagle Island (continued)	1	26	46	ND
	2	1	1268	1306
	2	6	1054	20
	2	11	989	724
	2	16	719	526
	2	21	266	258
	2	26	78	81
	3	1	128	97
	3	6	31	51
	3	11	16	17
	3	16	ND	16
	3	21	19	14
	3	26	15	ND
	4	1	10	56
	4	6	25	48
	4	11	16	36
	4	16	15	49
	4	21	10	46
	4	26	13	95
	5	1	383	20
	5	6	136	27
	5	11	26	22
	5	16	15	ND
	5	21	16	ND
	5	26	30	ND
	6	1	1210	196
	6	6	949	26
	6	11	686	49
	6	16	284	23
	6	21	137	78
	6	26	68	30
Indian Creek P7	1	1	3038	20
	1	6	3701	27
	1	11	3500	14
	1	16	2447	17
	1	21	1627	13
	1	26	1197	17
	2	1	2543	503
	2	6	2351	592
	2	11	1522	566
	2	16	1471	453
	2	21	1480	371
	2	26	789	341
	3	1	1398	30

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Indian Creek	3	6	886	15
(continued)	3	11	730	ND
	3	16	623	16
	3	21	383	ND
	3	26	453	13
	4	1	95	35
	4	6	57	20
	4	11	28	15
	4	16	36	23
	4	21	44	22
	4	26	50	18
	5	1	59	157
	5	6	44	83
	5	11	70	116
	5	16	37	117
	5	21	44	155
	5	26	34	111
	6	1	74	21
	6	6	40	32
	6	11	34	28
	6	16	23	20
	6	21	45	32
	6	26	107	37
Dollisons	1	1	83	279
Landing P8	1	6	21	322
	1	11	19	310
	1	16	16	258
	1	21	14	208
	1	26	13	142
	2	1	28	15
	2	6	18	39
	2	11	24	15
	2	16	19	15
	2	21	22	29
	2	26	24	23
	3	1	15	92
	3	6	10	31
	3	11	12	29
	3	16	19	23
	3	21	10	15
	3	26	16	24
	4	1	15	43
	4	6	18	13
	4	11	16	15

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Dollisons Landing (continued)	4	16	17	13
	4	21	18	24
	4	26	34	15
	5	1	57	38
	5	6	112	17
	5	11	27	22
	5	16	19	33
	5	21	19	50
	5	26	116	34
	6	1	29	202
	6	6	133	192
	6	11	20	166
	6	16	41	87
	6	21	32	37
	6	26	39	19
Black River P9	1	1	71	188
	1	6	16	166
	1	11	22	128
	1	16	27	97
	1	21	20	59
	1	26	17	63
	2	1	103	200
	2	6	40	203
	2	11	21	200
	2	16	21	123
	2	21	19	61
	2	26	40	35
	3	1	43	46
	3	6	32	37
	3	11	30	46
	3	16	22	37
	3	21	13	42
	3	26	24	45
	4	1	184	30
	4	6	52	19
	4	11	20	19
	4	16	13	24
	4	21	17	21
	4	26	29	19
	5	1	1196	76
	5	6	1088	45
	5	11	883	37
	5	16	249	30
	5	21	29	24

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Black River (continued)	5	26	21	40
	6	1	716	113
	6	6	902	50
	6	11	449	18
	6	16	170	24
	6	21	40	21
	6	26	30	17
Smith Creek P11	1	1	2028	943
	1	6	1975	1011
	1	11	1607	831
	1	16	1002	590
	1	21	488	358
	1	26	602	268
	2	1	1310	284
	2	6	1017	212
	2	11	862	179
	2	16	750	131
	2	21	622	181
	2	26	445	215
	3	1	803	622
	3	6	664	426
	3	11	491	171
	3	16	341	96
	3	21	212	96
	3	26	175	253
	4	1	1357	209
	4	6	1424	266
	4	11	1001	73
	4	16	585	95
	4	21	376	101
	4	26	340	404
	5	1	915	631
	5	6	1016	455
	5	11	897	267
	5	16	517	110
	5	21	386	201
	5	26	322	86
	6	1	1242	488
	6	6	1431	376
	6	11	1271	217
	6	16	1115	139
	6	21	1055	123
	6	26	923	125

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Rat Island	1	1	858	347
P12	1	6	967	231
	1	11	1080	166
	1	16	942	268
	1	21	353	304
	1	26	127	246
	2	1	301	272
	2	6	254	160
	2	11	171	230
	2	16	56	210
	2	21	31	327
	2	26	37	107
	3	1	461	213
	3	6	360	308
	3	11	252	438
	3	16	193	290
	3	21	147	354
	3	26	151	422
	4	1	401	356
	4	6	222	348
	4	11	103	391
	4	16	73	259
	4	21	55	324
	4	26	47	142
	5	1	61	225
	5	6	21	211
	5	11	14	231
	5	16	15	174
	5	21	16	158
	5	26	52	295
	6	1	155	82
	6	6	52	258
	6	11	16	282
	6	16	38	245
	6	21	45	245
	6	26	20	68
Fishing Creek	1	1	1005	756
P13	1	6	1394	625
	1	11	815	846
	1	16	392	830
	1	21	176	1357
	1	26	56	1797
	2	1	170	254

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Fishing Creek (continued)	2	6	382	196
	2	11	371	453
	2	16	308	261
	2	21	277	256
	2	26	240	75
	3	1	796	438
	3	6	858	429
	3	11	884	262
	3	16	827	307
	3	21	814	492
	3	26	874	411
	4	1	1127	492
	4	6	977	359
	4	11	759	332
	4	16	694	278
	4	21	483	291
	4	26	242	249
	5	1	333	305
	5	6	308	407
	5	11	337	271
	5	16	260	305
	5	21	241	218
	5	26	92	225
	6	1	259	225
	6	6	50	284
	6	11	256	329
	6	16	174	129
	6	21	106	319
	6	26	168	541
Prince George P14	1	1	672	455
	1	6	409	650
	1	11	283	681
	1	16	247	521
	1	21	177	537
	1	26	263	622
	2	1	130	880
	2	6	120	673
	2	11	50	599
	2	16	121	585
	2	21	129	689
	2	26	53	444
	3	1	56	1128
	3	6	201	892
	3	11	240	486

Table 5.51-3. (continued)

Station	Substation	Depth (cm)	Sulfate	
			Summer 2008	Winter 2009
Prince George (continued)	3	16	61	260
	3	21	40	179
	3	26	61	246
	4	1	202	382
	4	6	99	83
	4	11	50	190
	4	16	227	209
	4	21	68	314
	4	26	121	208
	5	1	338	332
	5	6	313	165
	5	11	298	27
	5	16	272	38
	5	21	312	203
	5	26	290	306
	6	1	459	495
	6	6	105	204
	6	11	84	161
	6	16	172	153
	6	21	73	157
	6	26	351	282

Table 5.51-4. Methane Concentrations of Sites. Porewater methane concentrations are μM. A [ND] means no data.

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Town Creek	1	1	5	50
P3	1	6	28	72
	1	11	42	115
	1	16	39	165
	1	21	50	153
	1	26	50	155
	2	1	259	2
	2	6	203	197
	2	11	270	249
	2	16	252	267
	2	21	269	339
	2	26	277	187
	3	1	28	71
	3	6	24	118
	3	11	37	147
	3	16	23	161
	3	21	29	171
	3	26	46	130
	4	1	126	3
	4	6	170	13
	4	11	163	32
	4	16	174	49
	4	21	180	64
	4	26	187	83
	5	1	48	93
	5	6	49	104
	5	11	37	110
	5	16	48	125
	5	21	62	154
	5	26	72	147
	6	1	49	53
	6	6	43	32
	6	11	46	56
	6	16	53	56
	6	21	53	45
	6	26	50	20

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Eagle Island	1	1	19	2
P6	1	6	25	8
	1	11	64	98
	1	16	129	246
	1	21	312	268
	1	26	298	265
	2	1	342	177
	2	6	323	297
	2	11	322	320
	2	16	323	396
	2	21	260	355
	2	26	ND	432
	3	1	91	36
	3	6	272	55
	3	11	246	55
	3	16	241	54
	3	21	332	58
	3	26	136	50
	4	1	325	144
	4	6	222	174
	4	11	268	181
	4	16	182	275
	4	21	271	264
	4	26	358	311
	5	1	118	388
	5	6	157	450
	5	11	186	369
	5	16	168	480
	5	21	75	688
	5	26	ND	583
	6	1	6	247
	6	6	25	410
	6	11	63	481
	6	16	44	502
	6	21	31	405
	6	26	37	409

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Indian Creek	1	1	1	277
P7	1	6	ND	288
	1	11	1	309
	1	16	3	261
	1	21	3	310
	1	26	5	282
	2	1	24	1
	2	6	22	2
	2	11	28	2
	2	16	29	7
	2	21	24	9
	2	26	ND	3
	3	1	13	144
	3	6	26	134
	3	11	15	128
	3	16	19	136
	3	21	38	209
	3	26	ND	339
	4	1	74	174
	4	6	70	416
	4	11	78	377
	4	16	82	295
	4	21	90	305
	4	26	120	240
	5	1	145	0
	5	6	148	0
	5	11	184	0
	5	16	137	2
	5	21	166	9
	5	26	298	11
	6	1	165	81
	6	6	185	141
	6	11	141	171
	6	16	119	224
	6	21	108	260
	6	26	ND	179

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Dollisons	1	1	120	1
Landing P8	1	6	162	1
	1	11	99	3
	1	16	113	5
	1	21	134	13
	1	26	111	34
	2	1	216	133
	2	6	152	222
	2	11	98	285
	2	16	105	294
	2	21	68	278
	2	26	106	290
	3	1	166	36
	3	6	177	63
	3	11	177	63
	3	16	191	64
	3	21	191	78
	3	26	195	96
	4	1	86	38
	4	6	131	154
	4	11	220	213
	4	16	180	215
	4	21	188	211
	4	26	154	174
	5	1	280	55
	5	6	284	60
	5	11	255	42
	5	16	246	32
	5	21	265	33
	5	26	273	51
	6	1	92	7
	6	6	151	12
	6	11	155	18
	6	16	164	43
	6	21	185	100
	6	26	180	146

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Black River	1	1	147	46
P9	1	6	221	106
	1	11	281	269
	1	16	272	441
	1	21	261	446
	1	26	272	340
	2	1	13	1
	2	6	11	3
	2	11	15	2
	2	16	21	19
	2	21	25	54
	2	26	18	45
	3	1	82	78
	3	6	130	157
	3	11	214	175
	3	16	302	193
	3	21	224	165
	3	26	186	168
	4	1	31	353
	4	6	138	321
	4	11	349	373
	4	16	431	337
	4	21	411	385
	4	26	421	322
	5	1	6	64
	5	6	2	128
	5	11	7	139
	5	16	24	111
	5	21	72	128
	5	26	127	113
	6	1	16	134
	6	6	72	334
	6	11	180	406
	6	16	141	449
	6	21	258	425
	6	26	280	515

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Smith Creek	1	1	55	36
P11	1	6	135	128
	1	11	182	220
	1	16	91	438
	1	21	71	424
	1	26	209	438
	2	1	50	178
	2	6	65	188
	2	11	94	206
	2	16	164	250
	2	21	141	313
	2	26	38	204
	3	1	163	92
	3	6	186	309
	3	11	47	632
	3	16	184	671
	3	21	230	673
	3	26	252	605
	4	1	282	340
	4	6	345	498
	4	11	369	574
	4	16	428	677
	4	21	263	572
	4	26	387	621
	5	1	33	162
	5	6	351	376
	5	11	273	542
	5	16	281	638
	5	21	309	641
	5	26	411	492
	6	1	ND	3
	6	6	68	34
	6	11	106	135
	6	16	117	176
	6	21	129	223
	6	26	116	179

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Rat Island	1	1	14	9
P12	1	6	10	12
	1	11	16	15
	1	16	37	19
	1	21	74	30
	1	26	62	39
	2	1	39	6
	2	6	45	32
	2	11	73	95
	2	16	94	204
	2	21	169	247
	2	26	184	255
	3	1	99	9
	3	6	73	16
	3	11	80	30
	3	16	86	40
	3	21	85	74
	3	26	72	79
	4	1	174	118
	4	6	238	188
	4	11	231	213
	4	16	197	293
	4	21	203	255
	4	26	183	266
	5	1	56	147
	5	6	173	178
	5	11	143	160
	5	16	158	110
	5	21	84	110
	5	26	73	103
	6	1	141	40
	6	6	192	87
	6	11	216	127
	6	16	215	203
	6	21	180	226
	6	26	217	216

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Fishing Creek	1	1	2	ND
P13	1	6	16	ND
	1	11	56	ND
	1	16	74	ND
	1	21	123	3
	1	26	125	5
	2	1	166	57
	2	6	163	37
	2	11	188	31
	2	16	154	26
	2	21	158	23
	2	26	174	45
	3	1	22	41
	3	6	25	33
	3	11	36	40
	3	16	32	45
	3	21	24	33
	3	26	ND	ND
	4	1	83	ND
	4	6	105	3
	4	11	110	4
	4	16	117	14
	4	21	159	29
	4	26	135	61
	5	1	130	3
	5	6	98	7
	5	11	98	13
	5	16	138	22
	5	21	127	104
	5	26	147	124
	6	1	12	2
	6	6	14	2
	6	11	23	3
	6	16	23	3
	6	21	25	3
	6	26	33	5

Table 5.51-4 (continued)

Station	Substation	Depth (cm)	Methane	
			Summer 2008	Winter 2009
Prince George	1	1	8	1
P14	1	6	41	ND
	1	11	88	ND
	1	16	92	ND
	1	21	109	ND
	1	26	100	1
	2	1	138	2
	2	6	185	12
	2	11	146	9
	2	16	173	88
	2	21	118	27
	2	26	47	130
	3	1	245	2
	3	6	347	1
	3	11	281	25
	3	16	312	52
	3	21	296	100
	3	26	231	125
	4	1	102	6
	4	6	228	72
	4	11	309	109
	4	16	272	103
	4	21	282	112
	4	26	176	99
	5	1	15	64
	5	6	21	137
	5	11	29	110
	5	16	33	67
	5	21	42	98
	5	26	57	103
	6	1	9	17
	6	6	270	258
	6	11	263	315
	6	16	298	293
	6	21	309	281
	6	26	279	260

Table 5.51-5. Classification of Sites. Site classifications are as follows: Methanogenic I, Sulfate Reducing II, Methanogenic with evidence of past sulfate reduction I*, Sulfate reducing non-seawater source of sulfate II*. A [NA] indicates insufficient data.

Station	Sub-station	Depth (cm)	SUMMER							
			2001	2002	2003	2004	2005	2006	2007	2008
Town Creek	1	1	II	II	I*	II	II*	II	II	II
P3	1	6	II	II	I*	I*	II*	II	II	II
	1	11	II	II	I*	I*	II*	II	II	l*
	1	16	II	II	I*	I*	II	II	II	l*
	1	21	II	II	I*	I*	II	I*	II	I*
	1	26	II	II	I*	I*	II	II	II	l*
	2	1	II	II	II	II	II	II	II	l*
	2	6	II	II	II	I	II*	II	II	l*
	2	11	II	I*	II	I	II	I*	II	I*
	2	16	II	I*	II	I	II	I*	II	I*
	2	21	II	I*	I*	I*	II	I*	II	II
	2	26	II	I*	II	I	II	I*	II	II
	3	1	II	II	I*	II	II*	II	II	II
	3	6	II	II	I*	II	II*	II	II	II
	3	11	II	II	I*	II	II	I*	II	II
	3	16	II	II	I*	I*	II	I*	II	II
	3	21	II	II	I*	I*	II	I*	II	II
	3	26	II	II	I*	I*	II	II	II	II
	4	1	II	II	I	II	I*	II	II	II
	4	6	II	II	I*	II	II*	II	II	II
	4	11	II	II	I*	II	II	II	II	II
	4	16	II	II	I*	II	II	II	II	II
	4	21	II	II	I*	II	II	I*	II	II
	4	26	II	II	I*	II	II	I*	II	II
	5	1	II	I*	I*	I*	I	II	II	II
	5	6	II	II	I*	I*	I*	II	II	II
	5	11	II	II	I	I*	I*	I*	II	II
	5	16	II	II	I*	I*	I*	I*	II	II
	5	21	II	II	I*	I*	I*	I*	II	II
	5	26	II	II	I*	I*	I*	I*	II	II
	6	1	II	II	I	II	II*	II	II	II
	6	6	II	II	I*	I*	II	II	II	II
	6	11	II	II	I*	I*	II	II	II	II
	6	16	II	II	I*	I*	II	I*	II	II
	6	21	II	II	I*	I*	II	II	II	II
	6	26	II	II	I*	I*	II	II	II	II
Eagle Island	1	1	II	II	I	II	II	I	II	II
P6	1	6	II	II	NA	II	II	II	II	II
	1	11	II	II	NA	I*	II	I*	II	II
	1	16	II	II	I*	I*	II	I*	II	II

Table 5.51-5. (continued)

Station	Sub-	Depth				SUMMER			
	station	(cm)	2001	2002	2003	2004	2005	2006	2007	2008
Eagle Island	1	21	II	II	I*	I*	I*	I*	I*	I*
(continued)	1	26	II	I*	I*	I*	II	I*	I*	I*
	2	1	II	II	I	I*	II	II	II	II
	2	6	II	II	I	I*	II	II	II	II
	2	11	II	II	I	I*	II	I*	II	I*
	2	16	I*	II	I	I*	II	I*	II	I*
	2	21	I*	II	I*	I*	II	I*	II	I*
	2	26	I*	I*	I*	I*	I*	I*	II	I*
	3	1	II	II	I*	II	II	II	II	l*
	3	6	I*	II	I*	I*	II	II	II	l*
	3	11	I*	II	I*	I*	II	II	II	l*
	3	16	I*	II	I*	I*	II	I*	II	NA
	3	21	I*	II	I*	I*	II	I*	II	I*
	3	26	I*	II	I*	I*	II	I	I	I*
	4	1	II	I*	I*	I*	II	I	I	I*
	4	6	I*	I*	I*	I*	I*	I*	II	I*
	4	11	I*	I*	I*	I*	I*	I*	II	I*
	4	16	I*	I*	I*	I*	I*	I*	II	I*
	4	21	I*	I*	I*	I*	I*	I*	I*	I*
	4	26	I*	I*	I*	I*	I*	II	I*	l*
	5	1	I*	II	I*	I	II	II	II	II
	5	6	I*	II	I*	I*	II	I	II	l*
	5	11	I*	I*	I*	I*	II	I*	II	I*
	5	16	I*	I*	I*	I*	I*	I*	II	I*
	5	21	I*	I*	I*	I*	I*	I*	II	I*
	5	26	I*	I*	I*	I*	I*	I*	I*	I*
	6	1	I*	II	I	I	II	I	II	ll
	6	6	I*	II	I	I	I*	I	II	ll
	6	11	I*	II	I	I*	I*	I	I*	ll
	6	16	I*	II	I*	I	I*	I*	I*	I*
	6	21	I*	II	I*	I	I*	I*	I*	I*
	6	26	I*	I*	I*	II	I	I*	II	I*
Indian Creek	1	1	II	II	I	II	II	I	II	ll
P7	1	6	II	II	I*	I	II	I	II	ll
	1	11	II	II	I*	I	I	I	II	ll
	1	16	II	II	I*	I*	I*	I	II	ll
	1	21	II	II	I*	I*	I*	I*	II	ll
	1	26	I*	II	I*	I*	I*	I*	II	ll
	2	1	II	II	I	I	I	I	II	ll
	2	6	I	II	I*	I	I	I	II	ll
	2	11	I	II	I	I*	I	I	II	ll
	2	16	I*	II	I*	I*	I*	I	II	ll
	2	21	I*	II	I*	I*	I	I	II	ll
	2	26	I	II	I*	I*	I	I	II	II
	3	1	II	I*	I	I	I	I	II	ll
	3	6	I	I*	I	I	I	I	II	ll
	3	11	I*	I*	I	I	II*	I	I	ll
	3	16	I	I*	I	I*	I	I	II	ll
	3	21	I	I*	I	I*	I	I	II	ll
	3	26	II	I*	I*	I*	I	I	II	ll
	4	1	I	II	I	I	I	I	I	ll
	4	6	I	II	I	I*	I	I	I	l*

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	SUMMER 2001	2002	2003	2004	2005	2006	2007	2008
Indian Creek	4	16	I	II	I	I*	I	I*	I	I*
P7	4	21	I	II	I	I*	I	I*	I	I*
	4	26	I	II	I	I*	I	I*	I	I*
	5	1	I	I*	I	I	I	I	I	I*
	5	6	I	I*	I	I	I	I	I	I*
	5	11	I	I*	I	I	I	I	I	I*
	5	16	NA	I*	I	I	I	I	I	I*
	5	21	I*	I*	I	I	I	I	I	I*
	5	26	I	I*	I	I	I	I	I	I*
	6	1	NA	I	I	I	I	I	I	I*
	6	6	NA	I	I	I	I	I	I	II*
	6	11	I	I	I	I	I	I	I	I
	6	16	I	I	I	I	I	I	I	I
	6	21	NA	I	I	I	I	I	I	I
	6	26	I	I	I	I	I	I	I	I
Dollisons	1	1	NA	II	I	I	I	I	I	I
Landing P8	1	6	II	II	I	I	I	I	I	I
	1	11	II	I	I	I	I	I	I	I*
	1	16	II	I	I	I	I	I	I*	I*
	1	21	I	II	I	I*	I	I	I*	I*
	1	26	I	I	I	I*	I	I	NA	I*
	2	1	II	I	I	I	I	I	I	I*
	2	6	I	I*	I	I	I	I	I	I*
	2	11	II	I*	I*	I	I	I	I	I*
	2	16	I*	I*	I*	I	I	I	I	I*
	2	21	II	I*	I*	I	I	I	I	I*
	2	26	I	I*	I*	I	I	I	I	I*
	3	1	I	I	I	I	I	I	I	I*
	3	6	NA	I*	I	I	I	I	I*	I*
	3	11	I	I*	I*	I	I	I	I	I*
	3	16	I	I*	I	I*	I*	I	I	I*
	3	21	I	I*	I*	I	I*	I	I*	I*
	3	26	II	I*	I	I	I*	I	I	I*
	4	1	I	II*	I	I	I	I	I	I*
	4	6	I	I	I	I	I	I	I	I*
	4	11	II	I*	I	I*	I	I	I	I*
	4	16	I	NA	I	I	I	I	I	I*
	4	21	II	I*	I	I	I	I	I	I*
	4	26	II	I*	I*	I	I	I	I	I*
	5	1	I	I	I	I	I	I	I	I
	5	6	I	I	I	I*	I	I	I	I
	5	11	I	I*	I	I*	I	I	I	I*
	5	16	I*	I*	I	I*	I*	I	I	I*
	5	21	II	I*	I	I*	I*	I	I	I*
	5	26	II	I*	I	I*	I*	I*	I	I
	6	1	I	I	I	I*	I*	I	I	I*
	6	6	I*	I	I	I*	I*	I	I	I
	6	11	I*	I*	I	I*	I*	I*	I	I*
	6	16	I*	I*	I	I*	I*	I	I	I
	6	21	I	I*	I	I*	I*	I*	I	I*
	6	26	I	I*	I	I*	I*	I*	I*	I*

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	SUMMER 2001	2002	2003	2004	2005	2006	2007	2008
Black River P9	1	1	NA	I*	I	I	I	I	I	I
	1	6	NA	I*	I	I	I	I	I	I
	1	11	NA	I	I	I*	I	I	I	I
	1	16	NA	II*	I	I*	I	I	I*	I
	1	21	NA	I*	I	I	I	I	I	I
	1	26	II	I*	I	I*	I	I	I	I*
	2	1	I*	I*	I	I	I	I	II	I
	2	6	I*	I*	I	I	I	I	I	I
	2	11	I	I*	I	I	I	I	I	I*
	2	16	I	II*	I	I	I*	I	I*	I*
	2	21	I	I	I	I	I*	I	I*	I*
	2	26	I*	I*	I	I	I	I*	I*	I
	3	1	II	I*	I	I	I	I	II	I
	3	6	II*	I*	I	I	I	I	II	I
	3	11	I	I	NA	I	I	I	I	I
	3	16	I	II*	I	I	I*	I	I	I*
	3	21	I	I	I	I*	I*	I	I	I*
	3	26	I	I	I	I*	I	I*	I	I*
	4	1	II	I*	I	II	I	I	II	II*
	4	6	II*	I	I	I	I	I	II	I
	4	11	II	II*	I	I	I	I	II	I
	4	16	I	II*	I	I*	I	I	II	I*
	4	21	I	II*	I	I	I	I	I	I
	4	26	I	II*	NA	I	I	I	I	I
	5	1	II*	I	I	I	I	II*	I	II*
	5	6	II	I	I	I	I	II*	II	II*
	5	11	II	II*	I	I	I	I	II	II*
	5	16	I	II*	I*	I	I	I	II	II*
	5	21	I	II*	I	I*	I	I	II	I
	5	26	I	I	I	I*	I	I	I	I
	6	1	NA	I	I	NA	I	II*	NA	II*
	6	6	II	II*	I	I	I	I	NA	II*
	6	11	I	II*	I	I	I*	I	NA	II*
	6	16	I*	II*	I	I	I*	I	NA	II*
	6	21	I	I	I	I	I*	I	NA	I
	6	26	I	I	I	I	I*	I	NA	I
Smith Creek P11	1	1	II	II	II	II	II	II	II	II
	1	6	I*	II	II	II	II	II	II	II
	1	11	II	II	II	II	II	II	II	II
	1	16	II	II	II	II	II	II	II	II
	1	21	II	II	II	I	II	I*	II	II
	1	26	II	II	II	I	II	I*	II	II
	2	1	II	II	II*	II	II	I*	II	II
	2	6	I*	II	II	II	II	I*	II	II
	2	11	II	II	II	II	II	I*	II	II
	2	16	II	II	II	II	II	I*	II	II
	2	21	II	II	II	II	II	I*	II	II
	2	26	II	II	II	II	II	I*	II	II
	3	1	II	II	II	II	II	II	II	II
	3	6	II	II	I*	II	II	II	II	II
	3	11	II	II	I*	II	II	II	II	II

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	SUMMER 2001	2002	2003	2004	2005	2006	2007	2008
Smith Creek (continued)	3	21	II	II	I*	I*	II	I*	II	I*
	3	26	II	II	II	I	II	II	II	l*
	4	1	II	II	II	II	II	II	II	II
	4	6	II	II	II	II	II	II	II	II
	4	11	II	II	II	II	II	II	II	II
	4	16	II	II	II	I	II	I*	II	II
	4	21	II	II	II	NA	II	I*	II	II
	4	26	II	II	II	I	II	I*	II	II
	5	1	I*	II	NA	I	II	I	II	II
	5	6	II	II	II	I	II	II	II	II
	5	11	II	II	II	I	II	II	II	II
	5	16	II	II	II	I	II	II	II	II
	5	21	II	II	II	I	II	I*	II	II
	5	26	II	II	II	I	II	I*	II	II
	6	1	II	II	I	II	II	II	II	II
	6	6	I*	II	I	II	II	II	II	II
	6	11	I*	II	I*	II	II	I*	II	II
	6	16	I*	II	II	I	II	I*	II	II
	6	21	NA	II	II	II	II	I*	II	II
	6	26	II	II	II	II	II	I*	II	II
Rat Island P12	1	1	II	II	I	I*	II	I*	II	II
	1	6	II	II	I	II	II	I*	II	II
	1	11	II	II	I	I*	I*	II	II	II
	1	16	II	II	I	I*	II	II	II	II
	1	21	II	II	I*	I*	II	I*	II	II
	1	26	II	II	I*	I*	I*	II	I*	l*
	2	1	I*	II	I	II	I	I*	II	ll
	2	6	I*	II	II	II	I*	II	II	i*
	2	11	I*	II	II	I	I*	II	I*	l*
	2	16	II	II	II	I	I*	I*	II	l*
	2	21	II	I*	I*	I*	I*	II	I*	II
	2	26	NA	II	I*	I*	I*	I	I*	II
	3	1	II	II	I	I	II	I*	II	II
	3	6	I	II	I	II	II	II	II	II
	3	11	I	II	I	II	II	II	II	II
	3	16	I	II	I	II	I	I*	II	l*
	3	21	I*	II	I	II	I	I*	II	ll
	3	26	I*	II	I	II	I	I	II	i*
	4	1	I*	II	I	II	I	I*	II	l*
	4	6	II	II	I	II	I	I*	II	l*
	4	11	I*	II	I	I*	I*	II	II	II
	4	16	I*	II	I*	II	I	I*	II	II
	4	21	I*	I*	I*	II	I	I*	II	II
	4	26	I*	I*	I*	II	I	I	II	II
	5	1	I	II	I*	I*	I*	I*	II	II
	5	6	I	II	I*	I*	I*	I*	II	l*
	5	11	I*	II	I*	I*	I*	II	II	ll
	5	16	I*	II	I*	I*	I*	I*	II	i*
	5	21	I*	II	I*	I*	I*	I*	II	l*
	5	26	I*	II	I*	I*	I*	I	II	l*
	6	1	NA	II	II	I	II*	I*	II	II
	6	6	I	II	II	II	I	I*	I*	II
	6	11	I	II	I*	I	I	I*	I*	II

Table 5.51-5. (continued)

Station	**Sub-station**	**Depth (cm)**	**SUMMER** 2001	2002	2003	2004	2005	2006	2007	2008
Rat Island	6	21	I	II	I*	I	I	I*	II	II
(continued)	6	26	I	II	I*	I*	I	I	I*	l*
Fishing Creek	1	1	NA	II	I	I	I	I	II	ll
P13	1	6	NA	II	I	I	I	I	II	ll
	1	11	I*	II	I	I*	I*	I	II	ll
	1	16	II	II	I	I*	I*	I	II	ll
	1	21	I*	II	I	I*	I*	I	II	l*
	1	26	II	II	I	I*	I*	I*	I*	I*
	2	1	I	II	I	I*	I	I	II	l*
	2	6	I	II	I	I*	I	I	II	ll
	2	11	I	II	I	I*	I	I	II	ll
	2	16	II	II	I	I*	I	I	II	ll
	2	21	II	II	I	I*	I	I	II	l*
	2	26	II	II	I	I*	I	I	II	l*
	3	1	II	II	I	I*	I	I	II	ll
	3	6	I*	II	I	I*	I	I	II	ll
	3	11	I*	II	I	I*	I	I	II	ll
	3	16	I*	II	I	I*	I*	I	II	ll
	3	21	II	II	I*	I*	I*	I	I*	ll
	3	26	I*	II	I*	I*	I*	I*	I*	ll
	4	1	I	II	I	I	I	I	II	ll
	4	6	II	II	I	I	I	I	II	ll
	4	11	I	II	I	I*	I	I	II	ll
	4	16	I	II	I	I*	I	I	II	ll
	4	21	I	II	I	I*	I	I	I	ll
	4	26	I	NA	I	I*	I	I	I	l*
	5	1	I	II	II	I	I	I	II	ll
	5	6	I	II	I	I	I	I	II	ll
	5	11	I	II	I	I	I	I	II	ll
	5	16	I	II	I	I	I	I	II	l*
	5	21	II	II	I*	I*	I	I	II	l*
	5	26	I	II	I	I	I	I	II	l*
	6	1	II	II	I	I	I	I	I	l
	6	6	I	I	II*	I	I	II	I	l
	6	11	I	I	I	I	I	I	I	II*
	6	16	II	I	I	I	I	I	I	II*
	6	21	I*	I	I	I	I	I	I	I
	6	26	I	I	I	I	I	I	I	I
Prince George	1	1	I	II	I	I	I	I	I*	ll
P14	1	6	I	II	I	I	I	I	I*	ll
	1	11	I*	II	I	I	II*	I	I*	l*
	1	16	I	II	I	I	I	I	I*	l*
	1	21	I	I*	I	I	II*	I	I*	l*
	1	26	I*	I*	I	I	I	I	I*	l*
	2	1	I	II	I*	I	I	I	I*	l*
	2	6	I	II	I*	I	I	I*	I*	l*
	2	11	I	II	I*	I	I	I	I	l*
	2	16	I	I*	I*	I	I	I*	I	l*
	2	21	I*	I*	I*	I	I	I	I	l*
	2	26	I*	I*	I*	I	I	I	I	l*
	3	1	I	II	I	I	I	I	I	l*
	3	6	II*	II	I	I	I	I	I*	l*

Table 5.51-5. (continued)

Station	Sub-	Depth	SUMMER							
	station	(cm)	2001	2002	2003	2004	2005	2006	2007	2008
Prince George (continued)	3	11	I	II	I	I	I	I	I*	l*
	3	16	I*	II	I	I	I	I	I*	l*
	3	21	I	I*	I	I	I	I	I*	l*
	3	26	I	I*	I	I	I	I	I*	l*
	4	1	I	II	I	I	I	I	I*	l*
	4	6	I	II	I*	I	I	I	I*	l*
	4	11	I	II	I*	I	I	I	I*	l*
	4	16	I	II	I*	I	I	I	I*	l*
	4	21	I	I*	I*	I*	I	I	I*	l*
	4	26	I	I*	I*	I*	I	I	I*	l*
	5	1	II	II	I	I	I	I	I*	ll
	5	6	II	II	I	I	II*	I	I*	ll
	5	11	I	II	I	I	I	I	I*	l*
	5	16	I	II	I	I	I	I	I*	l*
	5	21	I	II	I	I	I	I	I*	ll
	5	26	I*	I*	I	I	I	I	I*	l*
	6	1	I	I	I	I	I	I	I	ll
	6	6	I	II	I	I	I	I	I*	l*
	6	11	I	I*	I	I	I	I	I*	l*
	6	16	I	I*	I	I	I	I	I*	l*
	6	21	I	I*	I	I	I	I	I*	l*
	6	26	II	I*	I	I	I	I	I*	ll

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	WINTER 2001	2002	2003	2004	2005	2006	2007	2008	2009
Town Creek P3	1	1	II	II	II	I	II	I*	I*	ll	II
	1	6	II	II	II	I*	II	I*	I*	l	II
	1	11	II	II	II	I*	II	I*	I*	I*	II
	1	16	I*	II	II	I*	II	I*	I*	I*	II
	1	21	I*	II	I*	I*	II	I*	I*	I*	II
	1	26	I*	II	I*	I*	II	I*	I*	I*	I*
	2	1	II	II	II	I*	II	I*	I*	I*	II
	2	6	II	II	I*	I*	II	I*	I*	I*	II
	2	11	II	II	I*	I*	I*	I*	I*	I*	II
	2	16	II	II	I*	I*	II	I*	I*	I*	II
	2	21	II	II	I*	I*	I*	I*	I*	I*	II
	2	26	II	II	II	I*	I*	I*	I*	I*	II
	3	1	I	II	II	II	II	I*	I*	I*	II
	3	6	II	II	II	I	II	I*	I*	I*	II
	3	11	II	II	II	I*	II	I*	I*	I*	II
	3	16	I*	II	II	I*	II	I*	I*	I*	II
	3	21	II	II	II	I*	II	I*	I*	ll	II
	3	26	II	II	II	I*	II	I*	I*	ll	II
	4	1	II	II	II	II	II	I*	I*	ll	II
	4	6	I*	II	II	I*	II	I*	I*	l	II
	4	11	I*	II	II	I*	I*	I*	I*	l	II
	4	16	I*	II	II	I*	II	I*	I*	I*	II
	4	21	II	II	II	I*	II	I*	I*	I*	II
	4	26	II	II	II	II	II	I*	I*	I*	II
	5	1	II	II	II	I	II	II	I	ll	II
	5	6	II	II	II	I	II	I*	I*	ll	II
	5	11	II	II	II	I*	II	I*	I*	I*	II
	5	16	II	II	II	I*	II	I*	I*	I*	II
	5	21	II	II	II	I*	II	I*	I*	I*	II
	5	26	II	II	II	II	II	I*	I*	I*	II
	6	1	II	II	II	II	II	I*	I*	I*	II
	6	6	II	II	II	I*	II	I*	I*	ll	II
	6	11	II	II	II	I*	II	I*	I*	ll	II
	6	16	II	II	II	I*	II	I*	I*	ll	II
	6	21	II	II	II	I*	I*	I*	I*	ll	II
	6	26	II	II	II	I*	II	I*	I*	ll	II
Eagle Island P6	1	1	II	II	II	II	II	II*	II*	l	II
	1	6	II	II	II	II	II	II*	II*	l	II
	1	11	II	II	II	II	II	II*	II	l*	II
	1	16	II	II	I	II	II	II*	I*	I*	II
	1	21	II	II	I	II	II	II	I*	I*	II
	1	26	II	II	I*	II	II	II	I*	---	II
	2	1	II	II	II	II	II	II	I*	ll	II
	2	6	II	II	II	II	II	II	I*	I*	II
	2	11	II	II	II	II	II	II	I*	ll	II
	2	16	II	II	II	I*	I*	I*	I*	ll	II
	2	21	II	II	II	I*	I*	II	I*	I*	II

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	2001	WINTER 2002	2003	2004	2005	2006	2007	2008	2009
Eagle Island	2	26	II	II	II	I*	I*	I*	I*	I*	II
(continued)	3	1	II	II	II	II	II	II	II	I*	II
	3	6	II	II	II	II	II	II	II	I*	II
	3	11	II	II	II	II	II	II	II	I*	II
	3	16	I*	II	II	II	II	II	I*	I*	II
	3	21	II	II	I*	I*	II	II	I*	I*	II
	3	26	II	II	I*	I*	I*	II	I*	NA	II
	4	1	II	II	II	II	II	II	II	l*	II
	4	6	II	II	I*	I*	I*	II	I	l*	II
	4	11	II	II	I*	I*	I*	II	I	l*	II
	4	16	I*	II	I*	I*	II	I	I*	I*	II
	4	21	II*	II	I*	I*	I*	I*	I*	I*	II
	4	26	II	II	I*	I*	I*	I*	I*	I*	II
	5	1	II	II	II	II	II	II	I	l*	II
	5	6	II	I*	I*	II	II	II	I*	I*	II
	5	11	II	I*	I*	II	I	II	I*	I*	II
	5	16	II	I*	I*	II	I	I*	I*	NA	II
	5	21	II	II	I*	I	I*	II	I*	NA	I*
	5	26	II	I*	I*	II	I	II	I*	NA	I*
	6	1	I*	I*	II	II	II	II	I*	I*	II
	6	6	I*	I*	I*	II	I	II	I*	I*	II
	6	11	I*	I*	I*	I	I	II	I*	I*	II
	6	16	I*	I*	I*	I	I	II	I*	I*	II
	6	21	I*	I*	I*	I	I	II	I*	I*	II
	6	26	I*	I*	I*	I	I	II	I*	I*	II
Indian Creek	1	1	I	I	I	I	I	II*	I	I*	I
P7	1	6	I	I	II*	II*	I	II*	I	I*	II
	1	11	I	I	II	II*	Na	II	I	I*	II
	1	16	I	I	II	II*	0	I	I	I*	II
	1	21	I	I	II	I	I	I	I*	I*	II
	1	26	I	I	II	I	I*	I*	I*	I*	II
	2	1	I	I*	I*	I	I	I	I	ll	II
	2	6	I	I*	I*	I	I	I	I	ll	II
	2	11	I	I*	I*	I	I	I	I	ll	II
	2	16	I	I*	I*	I*	I	I	I*	ll	I*
	2	21	I	I*	I*	I*	I	I*	I*	ll	I*
	2	26	I	I*	I*	I*	I	I*	I	ll	I*
	3	1	I	I	I*	I	I	I	I	l*	I*
	3	6	I	I	I*	I	I	I	I	l*	I*
	3	11	I	I*	I*	I*	I	I	I*	NA	I*
	3	16	I	I*	I*	I*	I	I	I	l*	II
	3	21	I	I*	I*	I	I*	I	I*	NA	II
	3	26	I	I*	I*	I	I	I	I*	I*	I*
	4	1	I	I	I	I	I	I	I	I*	I*
	4	6	I	I	I*	I	I	I	I	I*	I*
	4	11	I	I	I*	I*	I	I	I	I*	I*
	4	16	I	I	I*	I*	I	I	I	I*	I*
	4	21	I	I	I*	I*	I	I	I	I*	I*

Table 5.51-5. (continued)

Station	Sub-	Depth	WINTER								
	station	(cm)	2001	2002	2003	2004	2005	2006	2007	2008	2009
Indian Creek	4	26	I	I	I*	I*	I	I	NA	I*	I*
(continued)	5	1	I	I	NA	I	I	I	I	II*	I*
	5	6	I	I	I	I	I	I	I	I	I*
	5	11	I	I	I	I	I	I	II*	I	I*
	5	16	I	I	I	I	I	I	I	II*	I*
	5	21	I	I	I	I	I	I	I	II*	I*
	5	26	I	I	I	I	I	I	I	I	I*
	6	1	I	I	I	I	I	I	I	I	I*
	6	6	I	I	I	I	I	I	I	I	I
	6	11	I	I	I	I	I	I	I	I	I
	6	16	I	I	I	I	I	I	I	I	I
	6	21	I	I	I	I	I	I	I	I	I
	6	26	I	I	I	I	I	I	I	I	I
Dollisons	1	1	II*	I	I	I	I	I	I	II*	II
Landing P8	1	6	II*	II*	I	II	I	I	I	II*	II
	1	11	II*	II*	I	II	I	I	I	II*	II
	1	16	II*	II*	I	I	I	I	I	II*	II
	1	21	II	II*	I	I	I	I	I	II*	II
	1	26	II*	I	I	I	I	I	I	II*	II
	2	1	I	I	I	I	I	I	I	I*	I
	2	6	I	I	I	I	I	I	I	I*	I
	2	11	I	I	I	I	I	I	I	I*	I
	2	16	I	I	I	II*	I	I	I	I*	I
	2	21	I	I	I*	II*	I	I	I*	I*	I
	2	26	I	I	I	I	I	I	I*	I*	I
	3	1	I	I	I	I	I	I	I*	I	I
	3	6	I	I	I	I	I	I	I*	I	I
	3	11	II*	I	I	I	I	I	I*	I	I*
	3	16	II*	I	I	I	I	I	I*	I*	I
	3	21	I	I	I	II*	I	I	I*	I*	I
	3	26	I	I	I	I	I	I	I*	I*	I
	4	1	I	I	I	I	I	I	I*	I	I
	4	6	I	I	I	I	I	I	I*	I*	I
	4	11	I	I	I	I	I	I	I*	I*	I
	4	16	I	I	I	I	I	I	I*	I*	I
	4	21	I	I	I	I	I	I	I*	I*	I
	4	26	I	I	I*	I	I	I	I*	I*	I
	5	1	I	I	I	I	I	I	I*	I	I
	5	6	I	I	I	I	I*	I	I*	I*	I
	5	11	I	I	I	I	I*	I*	I*	I*	I
	5	16	I	I	I	I	I*	I*	I*	I	I
	5	21	II*	I	I	I	I*	I*	I*	I	I
	5	26	I	I	I	II*	I	I*	I*	I*	I*
	6	1	I	I	I	I	I	I*	I	I	I
	6	6	I	I	I	I	I*	I*	I	I	I
	6	11	I	I*	I	I	I*	I*	I	I	I
	6	16	I	I	I*	I	I	II	I	I	I
	6	21	I	I	I	I	I	I*	I	I*	I

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	WINTER 2001	2002	2003	2004	2005	2006	2007	2008	2009
P8 Continued	6	26	I	I	I	I	I*	I*	I	I*	I
Black River P9	1	1	I	I	I*	II	I	I	I	II*	II
	1	6	I	I	I	II	I	I	I	II*	II
	1	11	I	I	I	I	I	I*	I	I	I
	1	16	I	I	I	I	I	I*	I	I	I
	1	21	II	I	I	I	I	I*	I	I	I
	1	26	II	I	I	I	I	I	I	I	I
	2	1	II*	I	I	I	I	I	I	II*	II
	2	6	II*	I	I	I	I	I	I	II*	I
	2	11	I	I	I	I	I	I	I	II*	I
	2	16	I	I	I	I	I	I	I*	I	I
	2	21	II	I	I	I	I	I	I*	I	I
	2	26	I	I	I*	I	I	I	I	I	I
	3	1	II*	I	I	I	I	I	I	I	I
	3	6	II*	I	I	I	I	I	I	I	I
	3	11	II*	I	I	I	I	I	I	I	I
	3	16	I	I	I	I	I	I	I	I	I
	3	21	II	I	I	I	I	I*	I*	I	I
	3	26	II*	I	I	I	I	I*	I*	I	I
	4	1	II*	I	I	I	I	I	I*	I	I
	4	6	I	I	I	I	I	I	I*	I*	I
	4	11	II*	I	I	I	I	I	I*	I	I
	4	16	II*	I	I	I	I	I*	I*	I*	I
	4	21	II*	I	I	I	I	I*	I*	I	I
	4	26	II*	I	I	I	I	I	I*	I*	I
	5	1	II*	I	I	I	I	I	I*	I	II
	5	6	II*	I	I	I	I	I	I*	I	II
	5	11	II*	I	I*	I	I	I	I	I	II
	5	16	II*	I	I*	I	I	I	I*	I*	II
	5	21	II*	I*	I	I	I	I	I*	I*	II
	5	26	II*	I	I*	I	I	I	I*	I	I
	6	1	I	I	I	I	I	I	I	I	II
	6	6	I	I	I	I	I	I	I*	I	II
	6	11	I	I	I	I	I	I	I*	I*	I
	6	16	I	I	I	I	I	I*	I	I*	I
	6	21	II*	I	I	I	I	II*	I*	I*	I
	6	26	II*	I	I	I	I	I*	I*	I*	I
Smith Creek P11	1	1	II	II	II	II	II	II	II	II	II
	1	6	I*	II	II	II	II	II	II	II	II
	1	11	II	II	II	II	II	II	I*	II	II
	1	16	II	II	II	II	II	II	I*	II	II
	1	21	II	II	II	II	II	I*	I*	II	II
	1	26	II	II	II	II	II	I*	I*	I*	II
	2	1	II	NA	II	II	II	II	I*	I*	II
	2	6	II	II	II	II	II	II	I*	I*	II
	2	11	II	II	II	II	II	II	I*	I*	II
	2	16	II	II	II	II	II	II	I*	I*	II
	2	21	II	II	II	II	II	II	I*	I*	II

Table 5.51-5. (continued)

Station	Sub-	Depth	WINTER								
	station	(cm)	2001	2002	2003	2004	2005	2006	2007	2008	2009
Smith Creek	2	26	II	II	II	II	II	II	I*	I*	II
(continued0	3	1	II	II	II	II	II	II	I*	ll	II
	3	6	II	II	II	II	II	II	I*	ll	II
	3	11	II	II	II	II	II	I*	I*	I*	II
	3	16	II	II	II	II	II	I*	I*	I*	II
	3	21	II	II	II	II	II	I*	I*	I*	II
	3	26	II	II	II	II	II	I*	I*	I*	II
	4	1	II	II	II	II	II	II	I*	I*	II
	4	6	I	II	II	II	I*	II	I*	I*	II
	4	11	II	II	II	II	I*	I*	I*	I*	II
	4	16	II	II	II	II	I*	I*	I*	I*	II
	4	21	II	II	II	II	I*	I*	I*	I*	II
	4	26	II	II	II	II	II	I*	I*	ll	II
	5	1	II	II	II	II	II	II	I*	ll	II
	5	6	II	II	II	II	II	I*	I*	ll	II
	5	11	II	II	II	II	II	I*	I*	I*	II
	5	16	II	II	II	I*	I*	I*	I*	I*	II
	5	21	II	II	II	I*	I*	I*	I*	I*	II
	5	26	II	II	II	I*	I*	II	I*	I*	II
	6	1	II	II	II	II	II	II	I*	ll	II
	6	6	II	II	II	II	II	I*	I*	ll	II
	6	11	II	II	II	II	II	I*	I*	I*	II
	6	16	II	II	II	I*	II	I	I*	I*	II
	6	21	II	II	II	II	II	I*	I*	I*	II
	6	26	II	II	II	II	II	I*	I*	I*	II
Rat Island	1	1	II	II	II	II	II	II	II*	ll	II
P12	1	6	II	II	II	II	II	II	II*	ll	II
	1	11	II	II	II	II	II	I*	I	I	II
	1	16	II	II	II	II	II	I*	I	I	II
	1	21	II	II	II	I*	II	I	I*	ll	II
	1	26	II	II	II	II	II	II*	I*	l	II
	2	1	II	II	II	II	II	II*	II*	II*	II
	2	6	I	II	II	II	II	II	II	l	II
	2	11	II	II	II	II	II	II	I	I	II
	2	16	II	II	II	II	II	II	I*	l	II
	2	21	II	II	II	II	II	I*	I*	ll	II
	2	26	II	II	II	II	II	I*	I*	I*	II
	3	1	II	II	II	II	II	II	II	l	II
	3	6	II	II	II	II	II	I*	I*	ll	II
	3	11	II	II	II	II	II	I*	I*	ll	II
	3	16	II	II	II	II	I	I*	I*	l	II
	3	21	II	II	II	I	II	I	I*	ll	II
	3	26	II	II	II	I*	I	I*	I*	ll	II
	4	1	II	II	II	II	II	I	I*	ll	II
	4	6	I*	II	II	II	I	I*	I*	ll	II
	4	11	I*	II	II	II	I	I*	I*	ll	II
	4	16	I*	II	I*	I	I*	I*	I*	I*	II
	4	21	I*	II	I*	I	I*	I*	I*	ll	II

Table 5.51-5. (continued)

Station	Sub-	Depth	WINTER								
	station	(cm)	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rat Island (continued)	4	26	I*	II	II	I	I*	I*	I*	I*	II
	5	1	II	II	II	I*	I*	I	I	I*	II
	5	6	I*	I	II	I*	I*	I	I	I*	II
	5	11	I*	II	II	II	II	I	I	I*	II
	5	16	I*	II	II	I*	II	I	I	I*	II
	5	21	I*	I*	II	I*	II	I	I*	I*	II
	5	26	I*	I*	II	I*	II	I	I	I*	II
	6	1	I	NA	II	II*	II*	II*	II*	I	II
	6	6	I	NA	II	II*	II*	II*	II*	I	II
	6	11	I	II	II	II*	II*	II*	I	I	II
	6	16	II	II	II	II	II	II*	II*	I	II
	6	21	I	II	II	I	II	II*	I	I	II
	6	26	I	II	II	I	I*	II*	I	I*	II
Fishing Creek P13	1	1	II	I	I	I	I	I	I	II	II
	1	6	II	I	I	I	I	II*	I	II*	II
	1	11	II	II	II*	I	I*	II*	I	II*	II
	1	16	II	II	II*	II*	I	II*	I	II*	II
	1	21	II	II	II*	I	I	II*	I	II*	II
	1	26	II	II	II*	I	I	II*	I	II*	II
	2	1	II	I	II*	I	I*	I	I	I	II
	2	6	II	II	I	I	I*	I	I	I	II
	2	11	II	II	I	I	I	I	I	II	II
	2	16	I	II	I	I	I*	I	I	I	II
	2	21	I	II	I	I	I*	I	I	I	II
	2	26	I	II	I*	I*	I*	I	I	I	II
	3	1	I	II	I*	I*	II	I	I	II	II
	3	6	I	II	II	I*	I	I*	I*	II	II
	3	11	I	II	I*	I*	I*	I*	I*	I*	II
	3	16	I	II	I*	I*	I*	I*	I*	II	II
	3	21	I	II	I*	I*	I*	I*	I*	II	II
	3	26	II	II	I*	I*	I*	I*	I*	II	II
	4	1	II	II	I	I	I	I	I	II	II
	4	6	II	II	II	I	I	I	I	II	II
	4	11	II	II	II	I	I	I	I	II	II
	4	16	II	II	II	I	I	I	I	I	II
	4	21	I	II	II	I	I	I	I	I	II
	4	26	I	II	II	I	I	I	I	I*	II
	5	1	I	NA	I	I	I	I	I	II	II
	5	6	I	II	I	I	I	I	I	II	II
	5	11	I	II	I	I	I	I	I	I	II
	5	16	I	II	I	I	I	I	I	II	II
	5	21	I	I*	I*	I	I	I	I	I	II
	5	26	I	NA	I*	I	I	I	I	I	II
	6	1	I	I	I	I	I	I	I	II*	I
	6	6	I	I*	I	I	I	I	I	II*	I
	6	11	I	I	I	I	I	I	I	II*	I
	6	16	I	I	I	I	I	I	I	I	I
	6	21	I	I	I	I	I	I	I	II*	I

Table 5.51-5. (continued)

Station	Sub-station	Depth (cm)	WINTER 2001	2002	2003	2004	2005	2006	2007	2008	2009
P13 cont.	6	26	I	I	I	I	I	I	I	II*	II
Prince George	1	1	II*	II*	NA	I	I	I	I	II*	II
P14	1	6	I	II*	II*	I	I	I	I	II*	II
	1	11	I	II	II*	I	I	I*	I*	II*	II
	1	16	I	II	II*	I	I	I	I	II*	II
	1	21	I	II	II*	I	I	I	I	II*	II
	1	26	I	II*	II*	I	I	I	I	II*	II
	2	1	I	II*	I	I	I	I	I*	II*	II
	2	6	I	II*	I	I*	I	I	I*	II*	II
	2	11	I	II*	I	I*	I	I	I*	II*	II
	2	16	II	II*	I	I*	I	I	I*	II*	II
	2	21	I*	II*	I	I*	I*	I	I	II*	II
	2	26	I*	II*	I	I*	I*	I	I	ll	II
	3	1	I	II*	NA	I	I	I*	I*	II*	II
	3	6	I	II*	II*	I	I	I*	I*	II*	II
	3	11	I	II	I	I	I	I	I	II*	II
	3	16	I	II*	I	I	I	I	I*	l	II
	3	21	I	II	I	I*	I	I	I	l	II
	3	26	I	II	I	I*	I*	I	I	l	II
	4	1	I	II*	I	I	I	I	I*	ll	II
	4	6	II*	II*	I	I	I*	I	I	l*	I*
	4	11	I	II	I*	I*	I*	I	I	l	I*
	4	16	I	II*	I*	I*	I*	I	I*	l	I*
	4	21	I	II	I*	I*	I	I	I	ll	I*
	4	26	I	II	I*	I*	I*	I	I	l*	I*
	5	1	I	II	II*	I	I	I	I	ll	I*
	5	6	I	II*	I	I*	I	I	I	l	II
	5	11	I	II	I	I	I	I	I	l*	II
	5	16	II	II	I	I*	I	I	I	l*	II
	5	21	I	II	I	I	I*	I	I	l	II
	5	26	I	II	I	I	I	I	I	ll	II
	6	1	II	II*	II*	I	I	I	I	II*	II
	6	6	I	II	II*	I	I	I	I	l	II
	6	11	I	II	II*	I	I	I	I	l	II
	6	16	I	II	II*	I	I*	I	I	l	II
	6	21	I	I	II*	I	I	I	I	l	II
	6	26	I	I	I	I	I*	I	I	l	II

5.52 Indian Creek (P7)

Salinity at Indian Creek during the average year ranged between 0.01 and 1 ppt. (Hackney et al., 2005). During the low river flow year salinities reached as high as 3 ppt. (Hackney et al., 2004). The current year salinities (Table 5.51-1), based on chloride concentrations (Table 5.51-2), were elevated ranging between 1 – 7 ppt near the creekbank. Sites adjacent to uplands did not appear to be as highly impacted with salinity less than 1 ppt. The majority of summer sulfate concentrations were in the 1,000 – 3,000 μM range near the creekbank and generally <100 μM at the upland sites (Table 5.51-3). These values were well above the average year concentrations of 10 – 350 μM and the low river flow year concentrations of 50 – 2,000 μM. The current winter sulfate concentrations were generally <100 μM and in the range of the average year values. Methane concentrations ranged between approximately 10 - 300 μM. These methane concentrations were similar to the low river flow year and average year concentrations (50 – 300 μM). The current year's classifications were similar to both average year and low river flow year classifications with a combination of SR and MPSR with M at the upland station.

5.53 Dollisons Landing (P8)

Salinity at Dollisons Landing during the average year and the low river flow year ranged between 0.02 and 1 ppt. (Hackney et al., 2005; Hackney et al., 2004). The current year salinities (Table 5.51-1), based on chloride concentrations (Table 5.51-2), were all <0.1 ppt. The majority of sulfate concentrations were in the 10 – 50 μM range with a few in the 100-300 μM range (Table 5.51-3). These values were similar to the average year concentrations of 10 – 600 μM and the low river flow year concentrations of 10 – 400 μM. Methane concentrations were similar for the current year, the low river flow year and the average year (1 – 350 μM). Average year, low river flow year, and the current year classifications were a combination of M and MPSR. The current year had relatively more MPSR than most previous years. The similarity in the biogeochemical conditions and classifications for Dollison's Landing during various years indicates this site may not be as susceptible to salinity intrusions as other locations along the river.

5.54 Black River (P9)

Salinity at Black River during the average year, low river flow year, and the current year were consistently low and range between 0.04 – 0.08 ppt. (Table 5.51-1; Hackney et al., 2004; Hackney et al., 2005). Sulfate concentrations were approximately 10-200 μM during the average year and slightly higher 10-300 μM during the low flow year. During the current year concentration of sulfate were generally low (10 – 50 μM) with the exception of a few elevated concentration in the 1000 μM range at site S5 during the summer. This could reflect reoxidation of sulfide. Methane concentrations at this site in the current, average and low flow year range between (0 – 300 μM). The lowest values were found at S5 during the summer consistent with the elevated levels of sulfate described above. During the average year classifications were mainly M and some

MPSR. During the low river flow year classifications were mainly MPSR and some M. During the current year classifications were similar but had some SR classifications reflecting the higher salinity conditions.

5.55 Smith Creek (P11)

Salinity at Smith Creek during the average year ranged between 1 - 4 ppt. (Hackney et al., 2005). During the low river flow year salinities ranged between 8 - 14 ppt. (Hackney et al., 2004). The current year salinities (Table 5.51-1) ranged between approximately 0.4 - 3 ppt and were very similar to the average year. Sulfate concentrations were in the 100 – 1,500 μM range (Table 5.51-3) slightly lower than average year concentrations of 200 – 5,000 μM and well below the low river flow year concentrations of 2,000 – 12,000 μM. Methane concentrations ranged between 50-700 during the current year. Most methane concentrations in the low river flow year and average year were 10 – 400 μM, while those during the average year were similar ranging between approximately 100-500 μM. The biogeochemical conditions at Smith Creek during the average year were mostly SR due to the influence of salinity at this site. The Classifications during the low river flow year were almost all SR. During the current year the summer was dominated by SR classifications while the winter had mainly MPSR and some SR classifications. This may indicate high levels of sulfate reduction possibly due to high levels of organic material deposited at this site during the fall resulting in rapid consumption of sulfate. It does not appear that the MPSR classifications were due to a lack of sulfate supply since salinities were not low during this year.

5.56 Rat Island (P12)

Salinity at Rat Island during the average year ranged between 0.2 – 0.8 ppt. (Hackney et al., 2005). During the low river flow year salinities ranged between 1 – 8 ppt. (Hackney et al., 2004). The current year salinities (Table 5.51-1) were slightly elevated compared with the average year, with values ranging between 0.1 – 3 ppt. Sulfate concentrations were in the 10 – 400 μM range during the current year, with the exception of a few values in the 1,000 μM range at S1 during the summer (Table 5.51-3). These values were below that of the low river flow year (100 – 6,000 μM) and similar to the 100-300 μM range observed during the average year. Average year methane concentrations reached values of 500 μM. Methane concentrations were in the 10 -300 μM range during the current year reflecting the slightly higher salinities during the current year. The biogeochemical conditions at Rat Island during the average year and the current summer were a combination of SR, MPSR, and M classifications. During the low flow year classifications were mostly SR reflecting the impact of higher sulfate concentrations during that year.

5.57 Fishing Creek (P13)

Salinity at Fishing Creek during the average year ranged between 0.02 – 0.1 ppt. (Hackney et al., 2005). During the low river flow year salinities reached values of 2 - 7 ppt. (Hackney et al., 2004). The current year summer salinities (Table 5.51-1), were similar to the low river flow year with values ranging between 2–4 ppt, with the exception of the upland site S6, which had values all less than 0.1 ppt. Winter salinities were similar to the average year with most values <0.3 ppt, with the exception of a few in the 2 ppt range. The majority of sulfate concentrations were in the 50 – 300 μM range during the average year. Sulfate concentrations during the current year were elevated compared to the average year, with values ranging between 100 – 1,000 μM (Table 5.51-3), but lower than those observed during the low river flow year (1,000 – 5000μM). Methane concentrations in the average year were 10 – 300 μM. Methane concentrations during the current year and the low river flow year were in the 10-200 μM range indicating the influence of the higher salinities during the current year. Average year classifications were mainly M, with a few MPSR, SR, and SRNS. The classifications at most sites during the current year and the low river flow year were SR, with some MPSR and M classifications.

Prince George Creek (P14)

Salinity at Prince George during the average year ranged between 0.02 – 0.2 ppt. (Hackney et al., 2005). During the low river flow year salinities reached values 1 ppt. (Hackney et al., 2004). The current year salinities (Table 5.51-1), were similar to the low river flow year ranging between 0.1 – 1 ppt. The majority of sulfate concentrations were in the 30 – 120 μM range during the average year. Sulfate concentrations during the current year were elevated compared to the average year ranging between 50 – 1,000 μM (Table 5.51-3) similar to values observed during the low river flow year (100 – 1000 μM). Methane concentrations in the average year were 100 – 400 μM. The majority of methane concentrations during the low river flow year were less than 100 μM, reflecting the dominance of sulfate reduction. The current year's methane concentrations were in the 10-300 μM range, slightly lower than the average year reflecting the higher salinities. Average year classifications were mainly M, with a few MPSR, SR, and SRNS. Classifications at most sites during the winter of the current year and the low river flow year were SR with some MPSR. Summer classifications were MPRS and some SR. Both of these seasons reflected higher salinities compared to the average year.

5.6 Long Term Trends and Change

The patterns of variations for the current year and previous years follow.

Year 1 (winter 2000, 2001, summer 2000):

During the first year of the study general, geochemical classifications were established for sites in order to compare with future conditions. Due to the need to establish these classifications, the sampling pattern the first year was different then subsequent years. It began in the first year in the winter and ran through a summer sampling period and into another winter sampling period. In the first report, which included the winters of 2000, 2001, and the summer of 2000 (Hackney et al., 2002), three of these stations were primarily sulfate reducing year-round (P3 - Town Creek, P12 - Rat Island, and P11- Smith Creek), two were primarily methanogenic year round (P8 - Dollisons Landing, and P14 - Prince George), and four exhibited mixed conditions with sulfate reduction typically dominating the geochemistry during the summer and methanogenesis dominating during the winter (P7- Indian Creek , P9 - Black River, P12 - Rat Island, P13 - Fishing Creek) (Hackney et al., 2002).

Year 2 (winter 2002, summer 2001):

In the second report, which included the summer of 2001 and the winter of 2002 (Hackney et al., 2003), two Northeast Cape Fear River sites, Prince George (P14) and Fishing Creek (P13), displayed a dramatic change in winter classification from methanogenic in the winters of 2000 and 2001 to sulfate reducing in the Winter of 2002 resulting from an increase in salinity. The other two sites on the Northeast Cape Fear River, Rat Island (P12) and Smith Creek (P11), also showed signs of increased salinity although their general classification did not change. At Rat Island (P12), several methanogenic classifications converted to sulfate reducing. Smith Creek (P11), which was already a sulfate reducing system, recorded higher salinities in porewaters.

The summer geochemical classifications on the Cape Fear River showed the opposite trend with evidence of a slight freshening of porewaters. Changes in classifications of the Cape Fear River sites were not as dramatic as those observed on the Northeast Cape Fear River. The general trend for Cape Fear River sites was a slight freshening of the porewaters in winter 2002 and saltier conditions in summer 2001 compared to data in the previous report. Town Creek (P3), which is located below the confluence of the Northeast Cape Fear River and the Cape Fear River, displayed a similar trend as that of the Cape Fear River sites, with slightly saltier conditions during the summer and slightly fresher conditions during the winter.

Year 3 (winter 2003, summer 2002):

The increases in porewater salinities observed during previous summers continued through the summer of 2002 in the Northeast Cape Fear River (Fishing Creek, Prince George, Rat Island, and Smith Creek). Due to the continued increase in summer salinities, all four sites were classified as sulfate reducing geochemical classifications for the first time. With the exception of Smith Creek, which already had a sulfate reducing geochemical classification, this was the first time the upper Northeast Cape Fear sites have had a summertime sulfate reducing geochemical classifications. A similar increase in summertime porewater salinity was noted in the Cape Fear River sites immediately above the City of Wilmington (Indian Creek, Eagle Island), while sites further upstream on the Cape Fear River (Black River, Dollisons Landing) had peak salinities occurring during the previous summer (2001). The salinities of Town Creek, the only site below the City of Wilmington monitored for geochemical classification, showed no obvious change in summer porewater salinity.

With the exception of Town Creek, which is below the City of Wilmington, and the Cape Fear River sites immediately above the City of Wilmington (Indian Creek and Eagle Island), all sites had lower winter porewater salinities than previous winters. For the upper Cape Fear River stations (Black River and Dollisons Landing), winter conditions showed a steady decrease in salinity since 2000. Fresher conditions did not cause a shift in geochemical classification for these sites since they were already methanogenic. In the Northeast Cape Fear River (Fishing Creek, Prince George, Rat Island, and Smith Creek), winter (2003) porewater salinities returned to lower values after peaking during the previous winter (2002). The decrease in salinities for the more seaward stations (Rat Island and Smith Creek) was not enough to convert these systems from sulfate reducing geochemical classification. For upstream stations (Fishing Creek and Prince George), several substations that previously converted to sulfate reducing returned to a methanogenic geochemical classification in 2003. Porewater salinities of Town Creek, Indian Creek, and Eagle Island increased during the winter (2003). The changes in geochemical classifications were relatively small for these sites with only slight changes towards higher salinity classifications.

Year 4: (winter 2004, summer 2003)

Low salinity conditions characterize Year 4, summer 2003 and winter 2004. In general, all sites experienced conditions that would be considered low salinity on the basis of previous winters and summers. Several sites had conditions that were the lowest in salinity since the study began in 2000. For the most seaward station, Town Creek, both the winter and summer were the freshest on record. The Cape Fear River sites (Indian Creek, Dollisons Landing, and Black River) had a relatively low salinity winter and a summer that was the freshest observed during this study. While all Northeast Cape Fear River sites had relatively fresher conditions during the 2003-2004 year, there was more variability in the extent to which they experienced low salinities. Fishing Creek had the freshest winter and summer on record, Prince George had the freshest winter on record, and Rat Island had the freshest summer on record. Smith Creek had fresh conditions during both the summer and winter, but not the freshest on record.

Year 5: (winter 2005, summer 2004)

Low salinity conditions characterize Year 5 of the study, summer 2004 and winter 2005. In general, all sites experienced conditions that would be considered low salinity on the basis of previous winters and summers. However, conditions were not as fresh as the 2003-2004 year. Five stations experienced slightly saltier conditions during the summer 2004 compared to summer 2003 (Town Creek, Indian Creek, Black River, Smith Creek, and Fishing Creek), while Prince George experienced slightly fresher conditions. The remainder of sites either had no change or a mix of fresher and saltier conditions within the site. Two stations experienced slightly saltier conditions during the winter 2005 compared to winter 2004 (Town Creek and Rat Island), while Indian Creek experienced slightly fresher conditions. Five sites were essentially the same as winter 2004 (Eagle Island, Black River, Smith Creek, Fishing Creek, and Prince George) and Dollisons Landing had both saltier and fresher conditions within the site.

Year 6: (winter 2006, summer 2005)

In general, fresher conditions continued though Year 6 of this monitoring study, although slight differences were noted between the 2005-2006 year and the previous one. During winter 2006, these slight changes in salinity and mode of organic matter remineralization varied systematically with river location. NECF river sites (Prince George, Fishing Creek, Rat Island, and Smith Creek) displayed a slight freshening, while all but one (Indian Creek) main stream CFR sites showed slightly saltier conditions (Eagle Island, Black River, and Dollisons Landing). Town Creek, which is the most seaward location monitored for geochemistry was noticeably fresher.

During summer 2005 there were no consistent patterns with some sites showing slightly saltier conditions (Rat Island creek bank, Smith Creek, Eagle Island, and Town Creek) and some showing slightly fresher conditions (Fishing Creek, Rat Island upland, and Indian Creek). Generally conditions remained fairly fresh during this summer.

Year 7: (winter 2007, summer 2006)

Fresher conditions continued throughout both the winter and summer of year seven of the monitoring project. Classifications at most sites were essentially the same as year six with the exception of very slightly fresher conditions.

Year 8: (winter 2008, summer 2007)

Year 8 was the most saline year since the beginning of the monitoring project. All stations except the ones located most upstream (P8 Dollison's Landing; P9 Black River; P13 Fishing Creek; P14 Prince George) experienced the highest salinities and subsequent effects since monitoring began. The most upstream stations had elevated salinities similar to the summer of 2002 when previous low river flow conditions were present. The high salinities resulted in a shift towards classifications expected for higher salinities and input of sulfate. Generally methanogenic conditions were replaced by sulfate reducing conditions.

Year 9: (winter 2009, summer 2008)

The current year was generally slightly saltier compared to the average year but not as salty as the low flow year at Indian Creek (P7), Black River (P9), Rat Island (P12), Town Creek (P3), and Eagle Island (P6). Fishing Creek (P13) and Prince George (P14) had conditions were similar to the low flow year. Dollisons Landing (P8) and Smith Creek (P11) did not show any trends towards either salty of fresher conditions.

6.0 BENTHIC INFAUNA COMMUNITIES

6.1 Summary

This chapter summarizes infaunal community patterns in summer at nine sites distributed along the Cape Fear River, Northeast Cape Fear River and Town Creek over the last two years with reference to the initial year (1999-2000) and previous year (2007) of sampling. The nine stations have been continuously monitored as part of a long-term effort to evaluate potential impacts of deepening and widening the Cape Fear River since 1999. During 2001-2002 the system experienced the initiation of channel deepening construction and the associated modification of the channel. Since the initiation of this project, the Cape Fear estuary has experienced periods of drought (2001-2002 and 2007-2008) and large storms (e.g. Hurricane Floyd) with associated freshwater input and periods of recovery. These events and their short-term effects on benthic infaunal communities have been addressed in previous annual reports. Summer 2000 and 2002 continue to represent the lowest diversity for most sites, with highest diversity occurring at most sites during 2003 or 2004. Species richness was highest in 2004 for 5 of the 9 sites showing significant differences. However, there were no consistent patterns for either diversity or richness among the remaining years. Richness and diversity for 2006 was intermediate and not significantly different from 2005. However, during summer 2007, there was a decline in species richness and diversity compared to the initial year. Furthermore during summer 2008, all three community measures (mean total abundance, diversity, and species richness declined at most sites compared to the initial year's level. This report describes the infaunal community patterns in summer 2008 and compares these with the previous (2007) sampling year as well as the initial summer 1999 collection.

This report covers only data from summer 2008 and presents data on selected community characteristics including comparison of diversity, species richness, functional groups and major taxonomic groups among stations, and mean abundances of all taxa collected by station during the 2008 sampling season. For comparative purposes, these community characteristics are presented with analogous data from both summer 1999 (the first year of sampling) and from summer 2007, the previous sampling period (Culbertson et. al. 2009).

Twenty-five species were considered common, representing the majority of individuals collected among all nine sites. As was observed in the 2007 report, oligochaetes dominated most sites representing between 10% and 90% of the total number of individuals overall. Summer 2008 represented a change in patterns for several key community characteristics. Most comparisons among sites and years were not significantly different. Where differences were detected, e.g. in mean abundance, species richness and diversity showed consistent reductions during the 2008 sampling year compared to both the previous sampling season and the initial sampling period. These trends were consistent among major taxonomic groups, numerically dominant taxa, and functional groupings.

6.2 Background

The ship traffic into and out of the Cape Fear River port is essential to the economic development of the Cape Fear region. Trends over the last two decades have been to reduce cost by building larger ships. These ships require deeper channels to operate safely; therefore, the U.S. Army Corps of Engineers initiated a project to deepen the Cape Fear River shipping channel from the mouth of the river to Wilmington Harbor (as discussed in the executive summary of this report). This deepening activity has several potential impacts including the shifting of the tidal salt wedge upstream, changes in tidal amplitude, subsequent shifts in wetland flooding intensity, flooding extent, and changes in inundation time. The consequences of any of these changes could have far reaching impacts to the flora and fauna of the Cape Fear River estuary. Alterations in salinity, flow, and tidal currents are the most likely impacts predicted by numeric models of the Cape Fear River system. Any of these changes would have significant effects on the critical nursery habitats in the Cape Fear River estuary, potentially altering physical and chemical characteristics of the sediment, or the inundation period leading to alterations in the vegetation along the fringing marsh and shifts in dominant infauna, and utilization habits by resident and transient fishes.

As part of the U.S. Army Corps of Engineers project to deepen the Cape Fear River shipping channel from the mouth of the river to Wilmington Harbor, benthic infaunal communities have been monitored at stations predicted to have the greatest potential impacts. The focus of this sampling effort is on the fringing wetlands that border the river and represent critical habitat and nursery areas for a number of commercially and ecologically important taxa. Changes in the composition and abundance of organisms living within or directly on the sediments of the fringing marsh (infauna) may result from changes in salinity, flow, and tidal currents. Benthic infaunal community patterns integrate environmental changes at a specific site over time. Most infaunal groups have limited post-larval mobility or dispersal, with abundances at a site reflecting a combination of recruitment patterns and site-specific processes. Infauna may be relatively long-lived, with lifespans of months to years for some taxa. These organisms occupy an intermediate trophic position, consuming detrital or planktonic food sources and being prey for larger fish and decapods. As a result, the infaunal community present in an area represents cumulative impacts of varying environmental factors over a several month period. Changes in the composition of the infaunal community in response to changing environmental conditions may occur more rapidly than for more motile organisms that can migrate to optimal locations. However, changes in this group may also have fundamental importance for local ecosystem functioning because of their key position in nearshore estuarine food webs.

While many benthic species are resilient to short-term disturbances, long-term change associated with fluctuations in water quality, changes in tidal inundation or amplitude, changes in current flow or local hydrology, or changes in salinity regime and other physical factors may alter species composition and abundance. These physical changes may impact the infaunal community through direct mortality, reduced dispersal, food web alteration, and impacts related to increased stress (e.g. reduced feeding, competition, osmotic stress). The monitoring effort reported here is designed to detect changes in the infaunal communities at selected sites that may be coincident with the timing of deepening of the Cape Fear River shipping channel. This study was designed to distinguish potential long-term changes related to these anthropogenic impacts from year-to-year variability related to climatic fluctuations. Current working hypotheses are: 1) If changes in salinity, tidal amplitude and/or inundation period occur, it will be evidenced by changes in intertidal and shallow subtidal benthic community composition, 2) If alterations of the

Cape Fear River shipping channel significantly changes estuarine flow characteristics, a change in community composition and function reflecting altered recruitment patterns may follow.

Polychaetes, oligochaetes, amphipods, and insect larvae are the dominant infaunal taxonomic groups in the Cape Fear estuary. Bivalves, gastropods, and isopods are consistently present in the system but are not numerically dominant at most sites. Polychaetes and amphipods tend to dominate mesohaline sites in the river, while oligochaetes and insects dominate the oligohaline sites, although site-specific responses may vary among years and may vary in specific taxonomic composition. The relative importance of specific species that dominate a site changes along the estuarine gradient from polyhaline to oligohaline and tidal freshwater conditions. As noted in previous evaluations of the Cape Fear River estuary, both bivalves and gastropods have conspicuously low abundances in estuarine portions of the river both in the intertidal and subtidal habitats (Mallin et al., 1999 and 2001). Infaunal groups demonstrate a variety of reproductive, dispersal, and functional strategies that can directly relate to timing and magnitude of their response to shifting environmental conditions. Polychaetes (segmented worms bearing specialized appendages) occur throughout the estuary and are generally the numerically dominant taxa in euhaline to mesohaline environments. Polychaetes have a variety of living modes including free-living, burrowing, and sedentary forms. Burrowing and tube-dwelling species dominate in most of the intertidal and shallow subtidal areas and near surface and tube-dwelling species are common prey for fish, shrimp, and crabs. Oligochaetes are another group of segmented worms that generally lack specialized appendages, have a burrowing habit, and exhibit direct development. Direct development in this group can result in locally dense patches and the ability to respond quickly to local environmental changes. Their deeper burrowing habit often makes them less available as a prey resource for fish and decapods than tube-dwelling polychaetes or amphipods. Amphipods are a diverse group of brooding crustaceans. This group can exhibit explosive population growth under optimal conditions, and serves as a critical food resource in fringing wetlands during at least certain time periods. Although many are free-living or pelagic, a large proportion of estuarine amphipods are tube builders that can be highly mobile over small spatial scales and may quickly colonize disturbed habitats. Insect larvae are among the most numerous and diverse groups that inhabit the oligohaline and tidal freshwater regions of the estuary, but are generally absent from lower mesohaline and more saline areas. Insect larvae exploit virtually every habitat type in the upper estuary and are distinct from other groups in having aerial dispersal. However, many insects are very sensitive to salt intrusions and are indicators of changing salinity conditions. Like other infaunal groups, this group includes a number of living strategies including surface, tube-dwelling and free-living species that would be susceptible to predation especially by juvenile fish that recruit into the system heavily in the spring and to a lesser extent in the fall of each year.

6.3 Methodology

Infaunal core samples were collected at nine stations along the Cape Fear River estuarine gradient. Three benthic stations are located in Town Creek (P2 at the mouth of Town Creek, P3A and P3B inner Town Creek), three stations in the mainstem Cape Fear above the city of Wilmington, North Carolina (P6-Eagle Island, P7-Indian Creek, and P8-Dollisons's Landing), and three stations in the Northeast Cape Fear River (P11-Smith Creek, P12-Rat Island, and P13-Fishing Creek). These stations are the same as those being monitored for epifauna patterns

(Section 7.0) and represent a subset of those stations being monitored for changes in physical factors that may be causal for possible biotic changes (including tidal elevation, inundation, and biogeochemical composition among other variables).

Infaunal core samples (10 cm diameter x 15 cm deep) were collected at two upper intertidal subsites and two lower intertidal subsites at each station. These subsites are fixed stations that were originally marked (and positions recorded using GPS) in 1999. Three replicate core samples were collected within a one-meter area around these points. Core samples are collected at all stations in June of each year. All samples are fixed in a 10% formalin solution (~4% formaldehyde), with Rose Bengal dye added, later sieved through a 500 micron screen to remove excess sediment, and preserved in 70% isopropanol. All organisms are separated from the remaining sediment by sorting under a dissecting microscope and identified to lowest reasonable taxon, in most cases this is genus or species.

The major deepening efforts for the Cape Fear River channel began in winter 2001 and were ongoing at various areas within the Cape Fear system into 2006. Since the current report summarizes data from infaunal samples taken in June 2008 with comparison to 2007 and initial samples, differences among years may represent changes from background conditions (pre-dredging; 1999-2001), possible initial impacts related to the actual dredging activities (2002-2006) and any developing hydrologic impacts of channel alterations. Full effects of the deepening project cannot be assessed until 2-3 years of post-dredging data are available to compare to pre-dredging conditions and patterns occurring while dredging was ongoing. However, interim community patterns at each site over the 9 years of sampling were assessed in this and previous reports by examining patterns of species diversity, species richness, taxonomic and guild dominance, and community similarity. Per site diversity was calculated using the Shannon Diversity Index and was compared along with per sample taxonomic richness among years by site. For comparison of taxonomic richness, taxa were combined where there was uncertainty among years. Abundances of major taxonomic groups (polychaetes, oligochaetes, amphipods, and insects) and major functional guilds (sedentary/tube dwellers, surface/mobile taxa, deep burrowing taxa, and surface burrowing taxa) were compared among years separately for each site using analysis of variance. Abundances were log-transformed before analyses to meet assumptions of homogeneity of variances. Community similarity was compared among site/year combinations using the ANOSIM and multidimensional scaling data analysis procedures of the PRIMER statistical package (Clarke and Gorley 2001). These procedures examine community similarity based on a Bray-Curtis Similarity matrix. All species were included in this analysis and abundances were square root transformed to reduce dominating effects on analyses by common taxa.

6.4 Faunal Patterns

While four locations (two upper intertidal and two lower intertidal subsites) were sampled at each station, mean total abundances for all infaunal species present at a specific station are given by tidal position. In order to more easily compare the relative abundance and shifts in composition among years and tidal positions, abundance data is presented in three year blocks: 1999 (initial sampling year), 2007 (previous sampling year), and 2008 (current sampling year), by tidal position (high intertidal and low intertidal), and only for taxa that were present at that site/substation combination. Tables 6.4-1a and 6.4-1b represent the mouth of Town Creek (P2) located in the mesohaline region of the Cape Fear River, while Tables 6.4-2a and 6.4-2b and Tables 6.4-3a and 6.4-3b represent the two inner Town Creek sites, P3A and P3B, respectively. The main stem Cape Fear sites represent the salinity gradient from the lower mesohaline to generally oligohaline conditions: Eagle Island (P6) (Tables 6.4-4a and 6.4-4b), Indian Creek (P7) (Tables 6.4-5a and 6.4-5b), and Dollison's Landing (P8) (Tables 6.4-6a and 6.4-6b). The Smith Creek site (P11) (Table 6.4-7a and 6.4-7b), the Rat Island site (P12) (Tables 6.4-7a and 6.4-8b), and the Fishing Creek site (P13) (Tables 6.4-9a and 6.4-9b) represent analogous positions on the NE Cape Fear River. The 2008 sampling season showed a distinct shift in faunal patterns with a general reduction in both the number of taxa present at a site and a reduction in mean total abundance as compared to1999, 2006, or 2007(Hackney et. al., 2008 and Culbertson et al., 2009). While evidence of species replacement was observed in previous year's samples, the 2008 sampling season showed a general decline in species richness and abundance for most all taxonomic groups.

Any taxon that represented 3% of the total abundance was considered common. In the current analysis 1999, 2007, and 2008 sampling period, 25 taxa were considered common. There was little change in the proportion of the oligochaete family Tubificidae between this reporting period and the previous. Tubificidae spp. represented between 10% and 90% of the number of individuals present at most sites (compared to 20-80% in 2007). This grouping was comprised of several species, since many of the individuals placed within the Tubificidae family were too small to reliably identify or incomplete. One distinct difference between the 2008 sampling year and the 2007 year is the shift in mean total abundance. While oligochaetes were still the most abundance taxa for most sites, the mean total abundance declined sharply between 2007 and 2008. Lumbriculidae and *Tubificoides heterochaetus* are other common oligochaete groups, although they only represented a small fraction of the taxa identified. The remaining common taxa were *Anurida maritima* (insect), *Apocorophium lacustre* (amphipod), *Bezzia/Palpomyia* (insect), *Capitella capitata* (polychaete), *Cyathura* (*madelinae*) (tanaid), *Dicrotendipes nervosus* (insect), Diptera sp. (insect), Dolichopodidae sp. (insect), Ephydridae sp., *Hargeria rapax* (amphipod), *Hydracarina* sp. (mite), *Laeonereis culveri* (polychaete), *Mediomastus ambiseta* (polychaete), *Mediomastus* spp.(polychaete), *Orchestia uhleri* (amphipod), *Polypedilium* sp. (insect), *Spirosperma carolinensis* (isopod), Tipulidae sp. (insect), and *Uca* sp. (decapod) (Figure 6.4-1). Most of these taxa were represented among the dominant fauna in the previous sampling year (Culbertson et al., 2009).

Comparison of total abundance among sites during 2008 shows no significant difference among any of the sites (Figure 6.4-2). This is most likely due to the high degree of variability among sites. Analysis of Variance (ANOVA) of among-year patterns in mean abundance for major taxonomic groups (Table 6.4-10) and functional guilds (Table 6.4-11) indicated consistent patterns with reductions in mean abundance for most significant comparisons. In 8 out of 9 significant comparisons for major taxonomic groups, 2008 was significantly lower than either 1999 or 2007 (Table 6.4-10). Insect taxa that had shown possible response to increased salinity continued to show reduced abundances compared to the initial year of the study for sites Eagle Island (P6), Indian Creek (P7), and Fishing Creek (P13) (Table 6.4-10). It should also be noted that four additional comparisons (amphipods (F=3.41) at P6, gastropods (F=3.98) and isopods (F=3.83) at P7, and amphipods (F=4.04) and bivalves (F=4.03) at P8) produced marginally significant F values, but differences could not be detected with pair wise comparisons (Table 6.4-10). Functional guild comparisons showed the same pattern with 2008 abundances significantly less than either 1999 or 2007 in 10 out of 10 comparisons where differences were detected (Table 6.4-11). Some of these differences may be a response to drought conditions that continued into June 2008 wheninfauna were sampled. During the 2007 sampling year rainfall in the Cape Fear River basin was ~27 inches below average. Rainfall for 2008 reached nearly the same levels of below average precipitation before the drought broke in late 2008. The shift in insect taxa reported in the 2007-2008 sampling year and the continued decline of certain infaunal taxa in 2008 could be explained by the reduced river discharges and increases in salinity at some sites.

While Indian Creek had been the only site to show a distinct decline in species richness in 2007 (Culbertson et al., 2009), this was not the case for the 2008 sampling season. Analyses show five significant declines in species richness (in this case species richness is the mean total number of taxa per sample present at the site) (Table 6.4-12). In all five comparisons there were fewer species present in 2008 than either 2007 or 1999, with one comparison (Indian Creek) showing differences between 1999 and 2007 (Table 6.4-12). Species' diversity exhibited only one significant variation among years (Table 6.4-12), with Smith Creek (P11) showing a reduction in diversity in 2008 compared to 1999 and no difference between 1999 and 2007. During the 2007 sampling, the Indian Creek site experienced changes in vegetation cover associated with the development of adjacent uplands, as well as logging and removal of the understory in the immediate vicinity. This area continues to experience development in the upland areas, and some modification to the intertidal and wet areas in the form of mowing in some areas. Had this site experienced recovery, there should have been some evidence in the form of shifts in either diversity or species richness. Based on the current comparisons there was no change in either diversity or species richness (Table 6.4-12).

Among site comparisons for 2008 revealed one significant difference in diversity. The Smith Creek (P11) site had significantly lower diversity ($F=3.00$, $p>0.006$) than any of the other sites (Figure 6.4-3). Likewise among site comparisons for species richness detected a marginal difference ($F=2.14$ $p>0.045$). However, pair wise comparisons could not determine where a potential difference existed (Figure 6.4-4). The continued decline in species richness and diversity from 2007-2008 at some sites suggests continued changes in the system that may have long-term impacts to the biological communities at some sites.

Table 6.4-1a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected on the Town Creek mouth site (P2) during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
amphipod sp.	0.17(0.17)	0(0)	0(0)
Apocorophium lacustre	0(0)	0(0)	0.25(0.25)
Apocorophium louisianum	0(0)	166.00(147.07)	0(0)
Apocorophium sp.	0(0)	7.75(7.75)	0(0)
Bezzia/Palpomyia sp.	0.50(0.50)	0(0)	0(0)
juv. Bivalve	1.00(0.36)	0.25(0.25)	0.25(0.25)
Capitella capitata	0(0)	0(0)	2.50(2.50)
Cassidinidea lunifrons	0.17(0.17)	0(0)	0(0)
Corophium sp.	0.17(0.17)	0(0)	0(0)
Cyathura polita	0(0)	0.75(0.75)	0(0)
Dicrotendipes nervosus	0(0)	0.50(0.29)	0(0)
Dicrotendipes sp.	2.00(0.93)	0(0)	0(0)
Eteone heteropoda	0(0)	0.50(0.29)	0(0)
Fabriciola trilobata	0(0)	68.00(33.48)	0(0)
Gammarus tigrinus	0(0)	1.50(0.64)	0.25(0.25)
Hargeria rapax	0(0)	85.25(79.32)	23.75(12.29)
Hobsonia florida	3.67(2.01)	3.00(1.78)	0(0)
insect sp.	0.17(0.17)	0(0)	0(0)
Laeonereis culveri	0.17(0.17)	0.50(0.29)	0(0)
Marenzelleria viridis	1.67(1.67)	0.25(0.25)	0(0)
Neanthes succinea	0(0)	1.25(0.95)	3.50(1.19)
Nereis riisei	0.67(0.49)	0(0)	0(0)
Oligochaeta sp.	36.50(11.55)	0(0)	0(0)
Orchestia uhleri	0(0)	0.25(0.25)	0.25(0.25)
Owenia sp.	0.17(0.17)	0(0)	0(0)
Palaemonetes pugio	0.17(0.17)	0(0)	0(0)
Parandalia sp.	1.00(0.63)	0(0)	0(0)
Parandalia sp. A	0(0)	1.00(1.00)	0(0)
Polydora ligni/cornuta	12.17(10.83)	8.25(7.92)	0(0)
Polydora socialis	5.50(4.11)	0(0)	0(0)
Polypedilum sp.	1.50(0.72)	0(0)	0(0)
Streblospio benedicti	0.83(0.31)	7.75(3.06)	12.5(11.84)
Tanais sp.	0.33(0.33)	0(0)	0(0)
Tubificidae spp.	0(0)	101.75(39.13)	4.75(3.47)
Tubificoides heterochaetus	0(0)	7.50(3.80)	4.50(4.50)

Table 6.4-1b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected on the Town Creek mouth site (P2) during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
amphipod sp.	0.17(0.17)	0(0)	0(0)
Apocorophium sp.	0(0)	0.25(0.25)	0(0)
Collembola sp.	0.17(0.17)	0(0)	0(0)
Edotea (*montosa*)	0.17(0.17)	0(0)	0(0)
Gammarus tigrinus	0.33(0.33)	0(0)	0(0)
Hobsonia florida	0.83(0.83)	0(0)	0(0)
Laeonereis culveri	0.17(0.17)	0.25(0.25)	0(0)
Mediomastus ambiseta	1.17(0.83)	3.00(2.38)	5.25(2.78)
Mediomastus sp.	1.67(0.99)	3.00(2.12)	3.25(1.70)
Neanthes succinea	0(0)	0.25(0.25)	0(0)
Nemertea sp.	0.17(0.17)	0(0)	0.50(0.29)
Oligochaeta sp.	4.83(2.21)	0(0)	0(0)
Parandalia sp.	2.50(0.85)	0(0)	0(0)
Parandalia sp. A	0(0)	2.00(0.71)	1.50(0.50)
Paraprionospio pinnata	0.17(0.17)	0(0)	0(0)
Polydora ligni/cornuta	0.83(0.83)	0(0)	0(0)
Rangia cuneata	0(0)	0.25(0.25)	0(0)
Streblospio benedicti	3.00(1.69)	5.25(0.75)	7.00(3.49)
Syllidae sp.	0.17(0.17)	0(0)	0(0)
Tubificoides heterochaetus	0(0)	13.75(3.77)	0(0)

Table 6.4-2a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P3A upper Town Creek sites during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Acarina sp.	0.17(0.17)	0(0)	0(0)
Americorophium aquafuscum	0(0)	0.50(0.50)	0(0)
Apocorophium lacustre	0(0)	0.25(0.25)	0(0)
Bezzia/Palpomyia sp.	0(0)	0.25(0.25)	0(0)
juv. Bivalve	0.17(0.17)	0.25(0.25)	0(0)
Cassidinidea lunifrons	0(0)	0.25(0.25)	0(0)
Collembola sp.	0.33(0.21)	0(0)	0(0)
Cyathura (madelinae)	0(0)	0.50(0.50)	0.25(0.25)
Dolichopodidae sp.	0(0)	0.25(0.25)	0(0)
Dolichopus sp.	1.83(1.83)	0(0)	0(0)
Gammarus tigrinus	0.33(0.33)	0(0)	0(0)
Hydracarina sp.	0(0)	0(0)	0.25(0.25)
insect pupae	0.17(0.17)	0(0)	0(0)
insect sp.	0.17(0.17)	0(0)	0(0)
insect sp. b	0.17(0.17)	0(0)	0(0)
insect sp. g	0.33(0.33)	0(0)	0(0)
Laeonereis culveri	0.67(0.67)	0(0)	0(0)
Oligochaeta sp.	36.67(24.02)	0(0)	0(0)
Orchestia uhleri	0(0)	0.75(0.48)	1.25(0.63)
Orthocladiinae sp.	0(0)	0.25(0.25)	0.25(0.25)
Tubificidae spp.	0(0)	31.00(8.61)	9.25(4.13)
Uca minax	0.17(0.17)	0(0)	0(0)
Uca pugilator	0.50(0.34)	0(0)	0(0)
Uca pugnax	0.17(0.17)	0(0)	0(0)

Table 6.4-2b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P3A upper Town Creek sites during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
Ampharetidae sp.	0.17(0.17)	0(0)	0(0)
amphipod sp.	0.67(0.33)	0(0)	0(0)
Americorophium aquafuscum	0(0)	2.75(0.85)	0(0)
Apocorophium lacustre	0(0)	8.25(5.26)	0.50(0.29)
Apocorophium louisianum	0(0)	1.00(1.00)	0.25(0.25)
Apocorophium sp.	0(0)	1.25(1.25)	0.50(0.50)
Bezzia/Palpomyia sp.	0(0)	0(0)	0.50(0.50)
Boccardiella sp.	0(0)	0(0)	0.25(0.25)
juv. Bivalve	0.17(0.17)	0(0)	0(0)
Cassidinidea lunifrons	0.17(0.17)	0.50(0.50)	0(0)
Cyathura (madelinae)	0(0)	1.50(0.87)	0.75(0.75)
Cyathura (polita)	0(0)	0(0)	0.25(0.25)
Cyathura polita	0(0)	1.00(1.00)	0(0)
Dicrotendipes nervosus	0(0)	1.75(0.63)	10.50(10.50)
Dolichopodidae sp.	0(0)	0.25(0.25)	0.25(0.25)
Gammarus plumosa	0.17(0.17)	0(0)	0(0)
Gammarus tigrinus	2.67(2.12)	0(0)	0(0)
juv. Gastropod	0.17(0.17)	0(0)	0(0)
Hargeria rapax	0(0)	0.25(0.25)	0.50(0.50)
Hobsonia florida	3.17(1.33)	4.25(2.59)	0.50(0.50)
insect larva b	0.17(0.17)	0(0)	0(0)
insect pupae	0.17(0.17)	0(0)	0(0)
Laeonereis culveri	0(0)	2.00(0.91)	0(0)
Marenzelleria viridis	0.33(0.33)	0(0)	0(0)
Mediomastus ambiseta	0.17(0.17)	0(0)	0(0)
Mediomastus califoriensis	0.17(0.17)	0(0)	0(0)
Melita nitida	0(0)	0.50(0.50)	0(0)
Munna sp.	0.17(0.17)	0(0)	0(0)
Oligochaeta sp.	5.00(3.85)	0(0)	0(0)
Palaemonetes pugio	0(0)	0.25(0.25)	0(0)
Polydora ligni/cornuta	0.17(0.17)	0(0)	0(0)
Polydora sp.	0.17(0.17)	0(0)	0(0)
Polypedilum sp.	1.00(0.36)	0(0)	0(0)
Procladius sp.	2.50(0.92)	0(0)	0(0)
Streblospio benedicti	0.17(0.17)	0.50(0.50)	0(0)
Tanytarsus sp.	0.50(0.34)	0(0)	0(0)
Tubificidae spp.	0(0)	27.25(10.78)	12.25(8.62)
Uca pugilator	0.17(0.17)	0.25(0.25)	0(0)
Uca sp.	0.17(0.17)	0.25(0.25)	0(0)

Table 6.4-3a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P3B upper Town Creek sites during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Americorophium aquafuscum	0(0)	0.50(0.29)	0(0)
Anurida maritima	0(0)	0.75(0.75)	1.00(0.71)
Apocorophium lacustre	0(0)	0.25(0.25)	0(0)
Bezzia/Palpomyia sp.	0(0)	1.00(0.71)	0.75(0.48)
juv. Bivalve	0.40(0.24)	0(0)	0(0)
Cassidinidea lunifrons	0(0)	0.75(0.48)	0(0)
Collembola sp.	0.40(0.24)	0(0)	0(0)
Cyathura (madelinae)	0(0)	0.25(0.25)	0.25(0.25)
Dolichopodidae sp.	0(0)	0(0)	1.00(0.58)
Dolichopus sp.	0.40(0.40)	0(0)	0(0)
Ephydra sp.	0(0)	0(0)	0.50(0.50)
Gammarus tigrinus	0(0)	0(0)	0.50(0.50)
Hargeria rapax	0(0)	0.25(0.25)	0(0)
Hobsonia florida	0(0)	0.25(0.25)	0(0)
insect larvae c	0.40(0.24)	0(0)	0(0)
Laeonereis culveri	0(0)	0.75(0.48)	0(0)
Marenzelleria viridis	0.20(0.20)	0(0)	0(0)
Megalops sp.	0(0)	0(0)	0.25(0.25)
Munna sp.	0.20(0.20)	0(0)	0(0)
Oligochaeta sp.	16.40(6.24)	0(0)	0(0)
Orchestia sp.	0.20(0.20)	0(0)	0(0)
Orchestia uhleri	0(0)	0(0)	1.50(1.19)
Orthocladiinae sp.	0(0)	0.50(0.29)	0(0)
Tubificidae spp.	0(0)	29.75(16.38)	5.50(1.55)
Uca sp.	0.20(0.20)	0.25(0.25)	0(0)

Table 6.4-3b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P3B upper Town Creek sites during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
Americorophium aquafuscum	0(0)	1.25(0.75)	0(0)
Americorophium sp. A	0(0)	1.50(0.96)	0(0)
amphipod sp.	0.33(0.21)	0(0)	0(0)
Apocorophium lacustre	0(0)	0(0)	8.25(8.25)
Apocorophium louisianum	0(0)	0.50(0.50)	0(0)
Bezzia/Palpomyia sp.	0(0)	0(0)	0.25(0.25)
Cassidinidea lunifrons	0.17(0.17)	0(0)	0.25(0.25)
Cyathura (madelinae)	0(0)	0.25(0.25)	1.25(0.95)
Dicrotendipes nervosus	0(0)	0(0)	8.00(8.00)
Dicrotendipes sp.	0.17(0.17)	0(0)	0(0)
Dolichopodidae sp.	0(0)	0(0)	0.75(0.75)
Gammarus lawrencianus	0.83(0.83)	0(0)	0(0)
Gammarus sp.	0.17(0.17)	0(0)	0(0)
Gammarus tigrinus	1.83(1.83)	0(0)	0.50(0.29)
Heteromastus filiformis	0.17(0.17)	0(0)	0(0)
Hobsonia florida	2.50(0.88)	0(0)	0(0)
Hydracarina spp.	0(0)	0.25(0.25)	0.50(0.50)
Laeonereis culveri	0(0)	4.25(2.29)	1.25(0.63)
Marenzelleria viridis	0.17(0.17)	0(0)	0(0)
Marinogammarus sp.	0.17(0.17)	0(0)	0(0)
Munna sp.	0.50(0.34)	0(0)	0(0)
Nimbocera sp.	0.50(0.50)	0(0)	0(0)
Oligochaeta sp.	4.83(2.36)	0(0)	0(0)
Polydora sp.	0.33(0.33)	0(0)	0(0)
Polypedilum sp.	0.67(0.49)	0(0)	0(0)
Procladius sp.	0.50(0.34)	0(0)	0(0)
Streblospio benedicti	0(0)	0.25(0.25)	0(0)
Tubificidae spp.	0(0)	26.50(11.49)	3.50(1.50)

Table 6.4-4a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at the lowest main-stem Cape Fear site P6 during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Americorophium aquafuscum	0(0)	0.25(0.25)	0(0)
Anurida maritima	0(0)	0(0)	0(0)
Bezzia/Palpomyia sp.	0.60(0.24)	0.50(0.29)	0.50(0.50)
juv. Bivalve	0.20(0.20)	0(0)	0(0)
Cassidinidea lunifrons	1.00(1.00)	0.50(0.29)	0(0)
Collembola sp.	1.60(0.75)	0(0)	0(0)
Curculionidae sp.	0.40(0.40)	0(0)	0(0)
Cyathura (*madelinae*)	0.40(0.40)	0.50(0.29)	0.50(0.29)
Cyathura polita	0.80(0.58)	0(0)	0(0)
Diptera sp. (pupae)	0(0)	0(0)	0.25(0.25)
Dolichopodidae sp.	0(0)	0.50(0.29)	0.25(0.25)
Dolichopus sp.	0.80(0.80)	0(0)	0(0)
Eukiefferiella (*claripennis*)	0.20(0.20)	0(0)	0(0)
juv. Gastropod	0.20(0.20)	0(0)	0(0)
Hemipodus roseus	0.80(0.80)	0(0)	0(0)
insect larva c	0.20(0.20)	0(0)	0(0)
insect sp. h	1.00(1.00)	0(0)	0(0)
insect sp. i	0.40(0.40)	0(0)	0(0)
Laeonereis culveri	3.20(2.03)	2.00(1.08)	0.25(0.25)
(Lumbriculidae sp.)	0(0)	0.50(0.29)	0(0)
Melita nitida	0(0)	0(0)	0.25(0.25)
Neanthes succinea	0(0)	0(0)	0.25(0.25)
Oligochaeta sp.	9.60(4.84)	0(0)	0(0)
Orchestia sp.	1.20(0.97)	0(0)	0(0)
Orchestia uhleri	1.00(0.55)	0(0)	0(0)
Procladius sp.	0.20(0.20)	0(0)	0(0)
Tubificidae spp.	0(0)	9.00(6.39)	8.25(5.79)
Uca pugilator	0.40(0.40)	0(0)	0(0)
Uca sp.	0.20(0.20)	0.50(0.29)	1.00(0.41)

Table 6.4-4b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at the lowest main-stem Cape Fear site P6 during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
Acarina sp.	0.20(0.20)	0(0)	0(0)
amphipod sp.	0.80(0.58)	0(0)	0.25(0.25)
Bezzia/Palpomyia sp.	0.60(0.40)	0(0)	0.25(0.25)
juv. Bivalve	0.60(0.40)	0(0)	0(0)
Boccardiella sp.	0(0)	0.50(0.29)	0(0)
Cassidinidea lunifrons	1.00(0.77)	0.25(0.25)	0(0)
Collembola sp.	0.20(0.20)	0(0)	0(0)
Cyathura polita	5.00(5.00)	0(0)	0(0)
Diptera sp.	0(0)	0.25(0.25)	0(0)
Dolichopodidae sp.	0(0)	0.25(0.25)	0(0)
Dolichopus sp.	0.20(0.20)	0(0)	0(0)
Eukiefferiella (*claripennis*)	0.40(0.40)	0(0)	0(0)
Gammarus daiberi	0.20(0.20)	0(0)	0(0)
juv. Gastropod	0.40(0.24)	0(0)	0(0)
Hargeria rapax	0(0)	0.25(0.25)	0(0)
Hobsonia florida	0.20(0.20)	0(0)	0(0)
insect pupae	1.80(1.11)	0(0)	0(0)
insect sp.	0.20(0.20)	0(0)	0(0)
Melita nitida	0(0)	0.50(0.50)	0(0)
Melita sp.	1.00(1.00)	0(0)	0(0)
Munna sp.	1.00(1.00)	0(0)	0(0)
Nemertea sp.	0(0)	0.25(0.25)	0(0)
Oligochaeta sp.	49.60(18.88)	0(0)	0(0)
Polydora socialis	2.60(2.60)	0(0)	0(0)
Polypedilum sp.	0.40(0.40)	0(0)	0(0)
Procladius sp.	0.60(0.60)	0(0)	0(0)
Spionidae sp.	0(0)	0(0)	0.25(0.25)
Streblospio benedicti	0(0)	0(0)	0.25(0.25)
Tubificidae spp.	0(0)	3.50(1.04)	0.25(0.25)
Tubificoides heterochaetus	0(0)	0(0)	0.50(0.50)
Uca sp.	0.40(0.40)	0.75(0.75)	0(0)

Table 6.4-5a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P7 on the main-stem Cape Fear during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Asellus sp.	0(0)	0.25(0.25)	0(0)
Bezzia/Palpomyia sp.	0.20(0.20)	0(0)	0(0)
Celina sp.	0.20(0.20)	0(0)	0(0)
Chrysops sp.	0.20(0.20)	0(0)	0(0)
Coleoptera sp.	0(0)	0.25(0.25)	0(0)
Coleoptera sp. (larva)	0(0)	0(0)	0.25(0.25)
Collembola sp.	0.40(0.24)	0.25(0.25)	0(0)
Cryptochironomus sp.	0.20(0.20)	0(0)	0(0)
Cyathura (*madelinae*)	0.40(0.40)	0(0)	0(0)
Dolichopodidae sp.	0(0)	0.50(0.50)	0(0)
Dolichopus sp.	1.60(0.51)	0(0)	0(0)
juv. Gastropod	0.20(0.20)	0(0)	0(0)
Hargeria rapax	0(0)	0.25(0.25)	0(0)
Hydracarina sp.	0(0)	0.25(0.25)	0(0)
insect pupae	0.20(0.20)	0(0)	0(0)
Laeonereis culveri	0(0)	0.75(0.75)	0(0)
Lirceus sp.	1.40(1.17)	0(0)	0(0)
Lumbriculidae sp.	7.40(3.32)	0(0)	0.25(0.25)
(Lumbriculidae sp.)	0(0)	2.75(1.55)	1.25(1.25)
Micropsectra sp.	0.80(0.37)	0(0)	0(0)
Oligochaeta sp.	52.20(15.47)	0(0)	0(0)
Orchestia (platensis)	0.20(0.20)	0(0)	0(0)
Orchestia uhleri	0.60(0.60)	1.50(0.87)	1.25(0.95)
Pristinella sp.	0.40(0.40)	0(0)	0(0)
Spirosperma carolinensis	0(0)	8.75(3.42)	0(0)
Tabanus sp.	0.20(0.20)	0(0)	0(0)
Tipulidae sp.	0(0)	0(0)	0.75(0.75)
Tubificidae spp.	0(0)	11.50(4.56)	14.00(9.67)
Tubificoides heterochaetus	0.20(0.20)	0(0)	0(0)
Uca pugilator	0.40(0.40)	0(0)	0(0)
Uca sp.	0(0)	0(0)	0.50(0.50)

Table 6.4-5b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P7 on the main-stem Cape Fear during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
Bezzia/Palpomyia sp.	0.20(0.20)	0(0)	0(0)
juv. Bivalve	0.60(0.40)	0(0)	0(0)
Cassidinidea lunifrons	0.60(0.24)	0(0)	0(0)
Chironomus sp.	0.20(0.20)	0(0)	0(0)
Collembola sp.	0(0)	0(0)	0.25(0.25)
Cryptochironomous sp.	0.60(0.60)	0(0)	0(0)
Cyathura (*madelinae*)	0.40(0.24)	0(0)	0(0)
Dolichopus sp.	0.20(0.20)	0(0)	0(0)
Gammarus daiberi	0.20(0.20)	0(0)	0(0)
Gammarus tigrinus	0.60(0.40)	0(0)	0(0)
juv. Gastropod	1.00(0.45)	0(0)	0(0)
insect pupae	0.40(0.24)	0(0)	0(0)
insect sp. a	0.40(0.24)	0(0)	0(0)
Laeonereis culveri	0(0)	0(0)	0.25(0.25)
Lumbriculidae sp.	0(0)	0(0)	0.25(0.25)
(Lumbriculidae sp.)	0(0)	0.50(0.29)	0(0)
Megalops sp.	0.20(0.20)	0(0)	0(0)
Oligochaeta sp.	17.80(4.55)	0(0)	0(0)
Paratendipes sp.	0.20(0.20)	0(0)	0(0)
Polypedilum sp.	1.00(1.00)	0(0)	0(0)
Procladius sp.	0.20(0.20)	0(0)	0(0)
Spirosperma carolinensis	0(0)	0.25(0.25)	0(0)
Tubificidae spp.	0(0)	71.75(42.76)	4.75(1.75)

Table 6.4-6a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P8 on the main-stem Cape Fear during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Acarina sp.	0.17(0.17)	0(0)	0(0)
Anurida maritima	0(0)	2.00(1.08)	1.25(0.75)
Bezzia/Palpomyia sp.	0.33(0.33)	0.25(0.25)	0(0)
juv. Bivalve	11.17(4.32)	0.50(0.29)	0(0)
Coleoptera sp.	0.33(0.33)	1.00(1.00)	0(0)
Collembola sp.	1.50(0.43)	0(0)	0(0)
Diptera sp.	0(0)	0.50(0.29)	0(0)
Dolichopodidae sp.	0(0)	2.50(1.85)	0.50(0.50)
Dolichopus sp.	2.17(0.75)	0(0)	0(0)
Ephydridae sp.	0(0)	0(0)	0.50(0.50)
Fabriciola trilobata	0(0)	0.25(0.25)	0(0)
Gammarus tigrinus	1.33(1.33)	0(0)	0(0)
juv. Gastropod	0.50(0.34)	0(0)	0(0)
Helophorus linearis	0(0)	0(0)	0.25(0.25)
Hydaticus sp. (larvae)	0.33(0.21)	0(0)	0(0)
insect sp.	0.17(0.17)	0(0)	0(0)
Isochaetides curvisetosus	0(0)	6.25(3.61)	0(0)
Lumbriculidae sp.	5.00(2.89)	0(0)	0(0)
(Lumbriculidae sp.)	0(0)	7.25(2.14)	0.75(0.75)
Micropsectra sp.	3.17(3.17)	0(0)	0(0)
Noterus (*capricornis*)	0.17(0.17)	0(0)	0(0)
Oligochaeta sp.	73.50(14.07)	0(0)	0(0)
Orchestia uhleri	3.50(1.48)	0.75(0.25)	0.50(0.50)
Paratendipes sp.	0(0)	0.25(0.25)	0(0)
Pericoma/Telmatoscopus sp.	0(0)	3.50(3.18)	0(0)
Polypedilum sp.	0.17(0.17)	0(0)	0(0)
Rheotanytarsus sp.	0.33(0.33)	0(0)	0(0)
Spirosperma carolinensis	0(0)	7.25(3.01)	0.50(0.29)
Stratiomya sp.	0.17(0.17)	0(0)	0(0)
Tanytarsus sp.	1.00(1.00)	0(0)	0(0)
Tipula sp.	0(0)	0.50(0.50)	0(0)
Tipulidae sp.	0(0)	0.50(0.50)	0(0)
Tubificidae spp.	0(0)	64.00(8.18)	2.50(0.50)
Tubificoides heterochaetus	0.17(0.17)	0(0)	0(0)
Uca pugilator	0.17(0.17)	0(0)	0(0)

Table 6.4-6b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P8 on the main-stem Cape Fear during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
Anurida maritima	0(0)	4.50(4.50)	0(0)
Asellus sp.	0(0)	0.50(0.50)	0(0)
Bezzia/Palpomyia sp.	0.33(0.33)	0.25(0.25)	0.50(0.29)
juv. Bivalve	1.67(0.56)	0(0)	0(0)
Cassidinidea lunifrons	0.83(0.83)	0(0)	0(0)
Coelotanypus sp.	0(0)	0.50(0.29)	0(0)
Collembola sp.	0.17(0.17)	2.75(2.75)	0(0)
Cryptochironomous sp.	0.33(0.33)	0.75(0.48)	0.25(0.25)
Cyathura (*madelinae*)	0.67(0.67)	0(0)	0(0)
Dolichopodidae sp.	0(0)	0.75(0.48)	0.25(0.25)
Dolichopus sp.	1.00(0.82)	0(0)	0(0)
Ephydridae sp.	0(0)	0(0)	0.50(0.50)
Gammarus tigrinus	1.50(1.15)	0(0)	0(0)
juv. Gastropod	0.17(0.17)	0(0)	0(0)
Hydracarina sp.	0(0)	0.25(0.25)	0(0)
insect sp. b	0.17(0.17)	0(0)	0(0)
Isochaetides curvisetosus	0(0)	0.25(0.25)	0(0)
Limnodrilus hoffmeisteri	0(0)	0(0)	0.25(0.25)
Lumbriculidae sp.	3.00(1.61)	0(0)	0.25(0.25)
(Lumbriculidae sp.)	0(0)	5.50(2.60)	0.25(0.25)
Megalops sp.	0.17(0.17)	0(0)	0(0)
Micropsectra sp.	0.17(0.17)	0(0)	0(0)
Oligochaeta sp.	122.83(31.34)	0(0)	0(0)
Paratendipes sp.	0.17(0.17)	0(0)	0(0)
Polypedilum/Haterale sp.	2.33(2.33)	0(0)	0(0)
Polypedilum spp.	1.33(0.56)	0(0)	1.50(0.87)
Pristinella sp.	0.67(0.67)	0(0)	0(0)
Rheotanytarsus sp.	0.17(0.17)	0(0)	0(0)
Spirosperma carolinensis	0(0)	6.50(4.27)	0(0)
Tanytarsus sp.	0.33(0.33)	0(0)	0(0)
Tribelos sp.	0.33(0.33)	0(0)	0(0)
Tubificidae spp.	0(0)	48.25(17.06)	5.25(2.02)

Table 6.4-7a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P11 on the NE Cape Fear River during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Americorophium sp. A	0(0)	0.25(0.25)	0(0)
Bezzia/Palpomyia sp.	0(0)	1.75(1.75)	0.50(0.50)
Boccardiella sp.	0(0)	0(0)	0.25(0.25)
juv. Bivalve	0.25(0.25)	0(0)	0(0)
Cassidinidea lunifrons	1.00(0.71)	0(0)	0(0)
Chironomus sp.	0.50(0.50)	0(0)	0(0)
Curculionidae sp.	0.75(0.75)	0.75(0.75)	1.00(1.00)
Curculionidae sp. (larvae)	0(0)	0(0)	0.50(0.50)
Dicrotendipes lobus	1.00(1.00)	0(0)	0(0)
Dicrotendipes nervosus	0.50(0.50)	0(0)	0(0)
Gammarus mucronatus	0.25(0.25)	0(0)	0(0)
Hobsonia florida	7.50(4.33)	2.25(1.44)	0(0)
insect larvae	1.25(1.25)	0(0)	0(0)
insect pupae	1.00(1.00)	0(0)	0(0)
Oligochaeta sp.	10.50(3.68)	0(0)	0(0)
Parandalia sp. A	0(0)	0(0)	0.25(0.25)
Polydora ligni/cornuta	0.25(0.25)	0(0)	0(0)
Polydora socialis	0.25(0.25)	0(0)	0(0)
Polypedilum sp.	0.50(.50)	0(0)	0(0)
Tubificidae spp.	0(0)	55.25(26.72)	56.25(28.36)
Tubificoides heterochaetus	0(0)	0(0)	0.25(0.25)
Uca sp.	0(0)	0(0)	0.25(0.25)

Table 6.4-7b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P11 on the NE Cape Fear River during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
amphipod sp.	0.20(0.20)	0(0)	0(0)
juv. Bivalve	0(0)	0.50(0.29)	0(0)
Cryptochironomous (*fulvens*)	0.20(0.20)	0(0)	0(0)
Gammarus tigrinus	0.60(0.40)	0(0)	0(0)
Hobsonia florida	0.60(0.24)	0(0)	0(0)
Laeonereis culveri	0(0)	16.00(1.47)	0.25(0.25)
Marenzelleria viridis	1.00(0.77)	23.00(4.65)	0(0)
Megalops sp.	0.20(0.20)	0(0)	0(0)
Nemertea sp.	0.20(0.20)	0(0)	0(0)
Oligochaeta sp.	3.60(1.86)	0(0)	0(0)
Parandalia sp. A	0(0)	0(0)	0.75(0.25)
Polypedilum sp.	0.40(0.40)	0(0)	0(0)
Rangia cuneata	0(0)	0.25(0.25)	0(0)
Tubificidae spp.	0(0)	0(0)	0.25(0.25)
Tubificoides heterochaetus	6.20(6.20)	1.75(1.11)	6.75(3.94)

Table 6.4-8a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P12 on the NE Cape Fear River during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for high intertidal areas.

High Intertidal	**June 99**	**June 07**	**June 08**
Anurida maritime	0(0)	0(0)	1.25(1.25)
Apedilum sp.	0(0)	0.25(0.25)	0(0)
Apocorophium lacustre	0(0)	0.50(0.50)	0.25(0.25)
Bezzia/Palpomyia sp.	1.80(0.37)	4.50(0.96)	0.25(0.25)
Boccardiella sp.	0(0)	0(0)	0.50(0.50)
Cassidinidea lunifrons	0.20(0.20)	0.25(0.25)	0(0)
Chironomus sp.	0.20(0.20)	0(0)	0(0)
Coleoptera sp.	0(0)	0.25(0.25)	0(0)
Collembola sp.	0.20(0.20)	0(0)	0(0)
Corophidae sp.	0(0)	0(0)	0.25(0.25)
Corophium (*lacustre*)	0.20(0.20)	0(0)	0(0)
Cricotopus sp.	0.20(0.20)	0(0)	0(0)
Dolichopodidae sp.	0(0)	1.00(0.71)	0(0)
Dolichopus sp.	0.60(0.40)	0(0)	0(0)
Donacia sp.	0.20(0.20)	0(0)	0(0)
juv. Gastropod	0.20(0.20)	0(0)	0(0)
Hargeria rapax	0(0)	0(0)	0.50(0.50)
Hydracarina sp.	0(0)	0(0)	0.25(0.25)
insect larvae g	0.40(0.40)	0(0)	0(0)
insect larvae h	1.20(1.20)	0(0)	0(0)
Laeonereis culveri	1.40(0.51)	0(0)	0.50(0.50)
Megalops sp.	0(0)	0(0)	0.50(0.50)
Monopylephorus irroratus	1.00(1.00)	0(0)	0(0)
Neanthes succinea	0(0)	0(0)	0.50(0.29)
Ocypode quadrata	0.20(0.20)	0(0)	0(0)
Oligochaeta sp.	47.80(9.60)	0(0)	0(0)
Orchestia uhleri	0.20(0.20)	0.25(0.25)	0.25(0.25)
Parandalia sp. A	0(0)	0(0)	0.25(0.25)
Polydora socialis	0(0)	0(0)	0.25(0.25)
Prionospio sp.	0(0)	0(0)	0.25(0.25)
Pristinella sp.	0.20(0.20)	0(0)	0(0)
Tubificidae spp.	0(0)	19.75(8.04)	2.00(1.22)
Uca minax	0.20(0.20)	0(0)	0(0)
Uca pugilator	0.20(0.20)	0.25(0.25)	0(0)
Uca sp.	0(0)	0.25(0.25)	0(0)

Table 6.4-8b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P12 on the NE Cape Fear River during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-sites for low intertidal areas.

Low Intertidal	**June 99**	**June 07**	**June 08**
amphipod sp.	0.20(0.20)	0(0)	0(0)
Anurida maritima	0(0)	0(0)	1.25(0.95)
Apocorophium lacustre	0(0)	0.25(0.25)	0.25(0.25)
Apocorophium sp.	0(0)	0.75(0.75)	0(0)
Bezzia/Palpomyia sp.	0.20(0.20)	0(0)	0.25(0.25)
Boccardiella sp.	0(0)	3.25(3.25)	0(0)
Dicrotendipes nervosus	0(0)	0.25(0.25)	0(0)
Diptera sp. (pupae)	0(0)	0(0)	0.25(0.25)
Gammarus tigrinus	0.20(0.20)	0(0)	0(0)
Hargeria rapax	0(0)	0.25(0.25)	0(0)
Hobsonia florida	0(0)	0.50(0.50)	0(0)
Hydracarina sp.	0(0)	0(0)	0.50(0.50)
Limnodrilus hoffmeisteri	0(0)	0.25(0.25)	0(0)
Mediomastus sp.	0.20(0.20)	0(0)	0(0)
Oligochaeta sp.	1.60(0.51)	0(0)	0(0)
Orchestia uhleri	0(0)	0(0)	0.25(0.25)
Paracladopelma sp.	0.20(0.20)	0(0)	0(0)
Polydora ligni/cornuta	0.20(0.20)	0(0)	0(0)
Polydora socialis	0(0)	0.25(0.25)	0(0)
Polydora sp.	0.20(0.20)	0(0)	0(0)
Polypedilum sp.	0.20(0.20)	0(0)	0(0)
Tubificidae spp.	0(0)	4.00(2.48)	11.25(3.42)
Uca sp.	0(0)	0(0)	0.75(0.48)

Table 6.4-9a. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P13 on the NE Cape Fear River during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-site for high intertidal areas at each station.

High Intertidal	**June 99**	**June 07**	**June 08**
Collembola sp.	0.20(0.20)	0(0)	0(0)
Cyathura polita	0.20(0.20)	0(0)	0(0)
Diptera sp.	0(0)	0.25(0.25)	0.25(0.25)
Dolichopodidae sp.	0(0)	0.25(0.25)	0.75(0.48)
Dolichopus sp.	0.40(0.24)	0(0)	0(0)
Haliplidae sp.	0.20(0.20)	0(0)	0(0)
Hydracarina sp.	0(0)	0(0)	0.25(0.25)
insect pupae	0.20(0.20)	0(0)	0(0)
Laeonereis culveri	0.40(0.24)	0.25(0.25)	0(0)
Lumbriculidae sp.	1.40(1.40)	0(0)	0.50(0.50)
(Lumbriculidae sp.)	0(0)	2.00(0.82)	0(0)
Mediomastus sp.	0.20(0.20)	0(0)	0(0)
Oligochaeta sp.	29.40(6.90)	0(0)	0(0)
Polypedilum sp.	0.60(0.40)	0(0)	0(0)
Spirosperma carolinensis	0(0)	0.50(0.29)	0(0)
Tubificidae spp.	0(0)	31.50(1.76)	3.50(1.44)

Table 6.4-9b. Mean (no. per 0.01 m^2) and (standard error) for all taxa collected at P13 on the NE Cape Fear River during June 1999, 2007, and 2008. The means presented here represent the combination of two sub-site for low intertidal areas at each station.

Low Intertidal	**June 99**	**June 07**	**June 08**
Chiridotea caeca	0.25(0.25)	0(0)	0(0)
Collembola sp.	0(0)	0(0)	0.25(0.25)
Cryptochironomous (*fulvens*)	0.50(0.50)	0(0)	0(0)
insect pupae	0.25(0.25)	0(0)	0(0)
insect sp. d	0.25(0.25)	0(0)	0(0)
insect sp. e	0.50(0.50)	0(0)	0(0)
Laeonereis culveri	0(0)	0.50(0.50)	0(0)
Larval fish	0.25(0.25)	0(0)	0(0)
(Lumbriculidae sp.)	0(0)	0.25(0.25)	0(0)
Oligochaeta sp.	34.25(11.13)	0(0)	0(0)
Polypedilum sp.	0.25(0.25)	0(0)	0(0)
Procladius sp.	0.75(0.48)	0(0)	0(0)
Spirosperma carolinensis	0(0)	0.50(0.50)	0(0)
Tubificidae spp.	0(0)	17.00(5.05)	1.75(0.75)

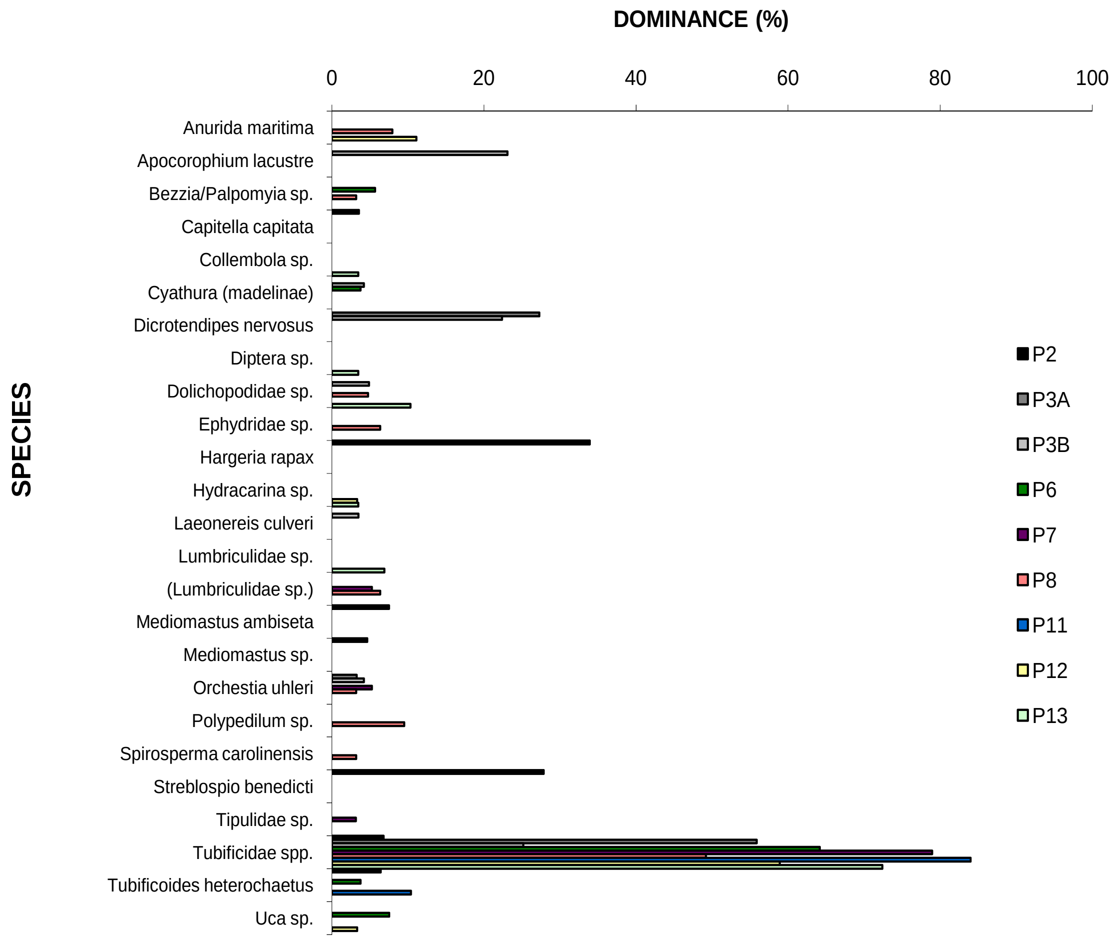


Figure 6.4-1. Common species representing ≥ 3% of the total abundance among sites sampled in 2008. These data represent both upper intertidal and lower subtidal substations.

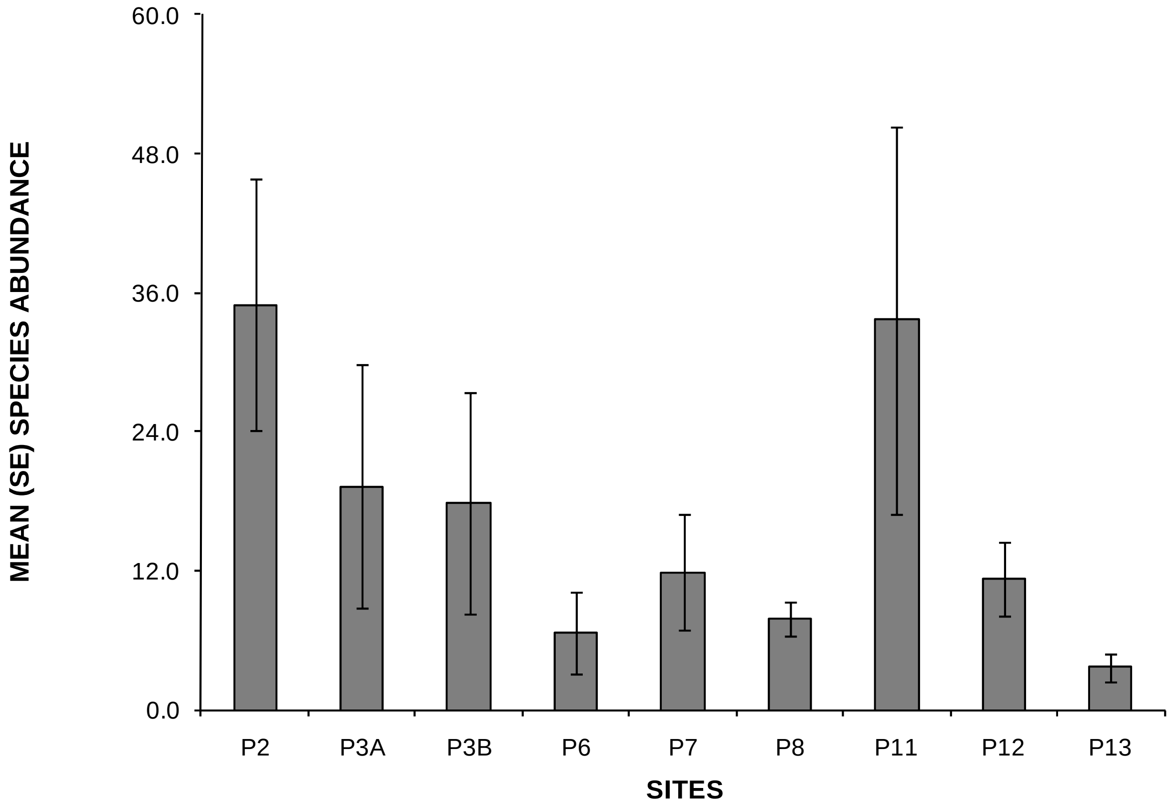


Figure 6.4-2. Mean species abundance among sites sampled in 2008. This data represents both upper intertidal and lower subtidal substations. Bars represent standard error (SE) of the mean.

Table 6.4-10. Among-year comparison of abundance by taxonomic group for each site. Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years with the same superscript do not vary significantly (p<0.05). Years with two letter superscripts were not different from either year. Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates no significant difference.

Site	Group	F(p)	SNK (where ANOVA significant)
P2	Amphipoda	1.74(0.1953)	NS
	Bivalvia	0.98(0.3906)	NS
	Decapoda	0.65(0.5310)	NS
	Insecta	2.88(0.0749)	NS
	Isopoda	0.74(0.4869)	NS
	***Oligochaeta**	**8.93(0.0012)**	**07^a 99^a 08^b**
	Polychaeta	2.60(0.0943)	NS
P3A	Amphipoda	2.76(0.0827)	NS
	Bivalvia	0.67(0.5190)	NS
	Decapoda	1.65(0.2123)	NS
	Gastropoda	0.65(0.5310)	NS
	Insecta	0.55(0.5845)	NS
	***Isopoda**	**4.57(0.0203)**	**07^a 08^{ab} 99^b**
	Oligochaeta	0.70(0.5057)	NS
	Polychaeta	1.52(0.2386)	NS
P3B	Amphipoda	0.70(0.5059)	NS
	Bivalvia	1.58(0.2266)	NS
	Decapoda	0.03(0.9664)	NS
	Insecta	1.44(0.2574)	NS
	Isopoda	0.28(0.7604)	NS
	***Oligochaeta**	**5.32(0.0123)**	**07^a 99^b 08^b**
	Polychaeta	1.41(0.2644)	NS
P6	**Amphipoda**	**3.53(0.0461)**	NS
	Bivalvia	2.57(0.0980)	NS
	Decapoda	0.05(0.9474)	NS
	Gastropoda	3.03(0.0678)	NS
	***Insecta**	**11.60(0.0003)**	**99^a 07^b 08^b**
	Isopoda	1.24(0.3076)	NS
	Oligochaeta	3.24(0.0574)	NS
	Polychaeta	1.78(0.1906)	NS

Table 6.4-10 continued

Site	Group	F(p)	SNK (where ANOVA significant)
P7	Amphipoda	0.04(0.9574)	NS
	Bivalvia	1.55(0.2329)	NS
	Decapoda	0.66(0.5246)	NS
	Gastropoda	**3.98(0.0328)**	NS
	Insecta	**15.17(<.0001)**	**99^{a} 08^{b} 07^{b}**
	Isopoda	**3.83(0.0368)**	NS
	Oligochaeta	1.93(0.1682)	NS
	Polychaeta	0.83(0.4470)	NS
P8	**Amphipoda**	**4.04(0.0302)**	NS
	Bivalvia	**4.03(0.0304)**	NS
	Decapoda	1.43(0.2585)	NS
	Gastropoda	2.04(0.1510)	NS
	*Insecta	2.78(0.0810)	NS
	Isopoda	0.97(0.3930)	NS
	***Oligochaeta**	**66.45(<.0001)**	**99^{a} 07^{a} 08^{b}**
	Polychaeta	1.28(0.2968)	NS
P11	Amphipoda	3.16(0.0623)	NS
	Bivalvia	1.38(0.2734)	NS
	Decapoda	0.47(0.6283)	NS
	Insecta	0.90(0.4205)	NS
	Isopoda	1.52(0.2404)	NS
	Oligochaeta	0.86(0.4360)	NS
	***Polychaeta**	**4.91(0.0173)**	**07^{a} 99^{ab} 08^{b}**
P12	Amphipoda	0.76(0.4782)	NS
	*Decapoda	0.52(0.5991)	NS
	Gastropoda	0.79(0.4674)	NS
	Insecta	0.52(0.6006)	NS
	Isopoda	0.46(0.6364)	NS
	*Oligochaeta	0.63(0.5437)	NS
	Polychaeta	0.25(0.7796)	NS
P13	**Insecta**	**9.26(0.0012)**	**99^{a} 08^{b} 07^{b}**
	Isopoda	2.01(0.1577)	NS
	***Oligochaeta**	**30.01(<.0001)**	**99^{a} 07^{a} 08^{b}**
	Polychaeta	0.96(0.3995)	NS

Table 6.4-11. Among-year comparison of abundance by functional group for each site. Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years with the same superscript do not vary significantly (p<0.05). Years with two letter superscripts were not different from either year. Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates no significant difference.

Site	Group	F(p)	SNK (where ANOVA significant)
P2	***Deep burrowing**	**5.93(0.0078)**	**07^{a} 99^{ab} 08^{b}**
	Surface/mobile	2.41(0.1107)	NS
	Sedentary/tube builder	2.35(0.1163)	NS
P3A	Deep burrowing	0.70(0.5041)	NS
	Surface/mobile	0.09(0.9164)	NS
	Sedentary/tube builder	2.68(0.0878)	NS
P3B	***Deep burrowing**	**5.29(0.0125)**	**07^{a} 99^{b} 08^{b}**
	Surface/mobile	1.03(0.3719)	NS
	Sedentary/tube builder	0.24(0.7884)	NS
P6	Deep burrowing	3.23(0.0580)	NS
	***Surface/mobile**	**6.03(0.0078)**	**99^{a} 07^{ab} 08^{b}**
	Sedentary/tube builder	0.64(0.5385)	NS
P7	Deep burrowing	1.93(0.1682)	NS
	***Surface/mobile**	**8.14(0.0021)**	**99^{a} 08^{b} 07^{b}**
	Sedentary/tube builder	1.66(0.2113)	NS
P8	***Deep burrowing**	**66.45(<.0001)**	**99^{a} 07^{a} 08^{b}**
	***Surface/mobile**	**6.12(0.0069)**	**99^{a} 07^{a} 08^{b}**
	Sedentary/tube builder	**3.95(0.0324)**	NS
P11	Deep burrowing	0.88(0.4299)	NS
	***Surface/mobile**	**3.52(0.0472)**	**07^{a} 99^{ab} 08^{b}**
	***Sedentary/tube builder**	**8.59(0.0018)**	**07^{a} 99^{a} 08^{b}**
P12	*Deep burrowing	0.56(0.5791)	NS
	Surface/mobile	0.12(0.8863)	NS
	Sedentary/tube builder	0.96(0.3986)	NS
P13	***Deep burrowing**	**29.99(<.0001)**	**99^{a} 07^{a} 08^{b}**
	Surface/mobile	**8.32(0.0020)**	**99^{a} 08^{b} 07^{b}**

Table 6.4-12. Among-year comparison of diversity and species richness for each site. Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years with the same superscript do not vary significantly (p<0.05). Years with two letter superscripts were not different from either year. Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates no significant difference.

Site	Metric	F(p)	SNK (where ANOVA significant)
P2	Species Diversity	2.77(0.0822)	NS
	*Species Richness	3.12(0.0619)	**07^{a} 99^{ab} 08^{b}**
P3A	Species Diversity	0.78(0.4689)	NS
	Species Richness	1.88(0.1737)	NS
P3B	Species Diversity	1.40(0.2655)	NS
	Species Richness	0.11(0.8948)	NS
P6	Species Diversity	3.09(0.0646)	NS
	Species Richness	**4.52(0.0221)**	**99^{a} 07^{ab} 08^{b}**
P7	Species Diversity	1.97(0.1623)	NS
	Species Richness	**13.30(0.0001)**	**99^{a} 07^{b} 08^{b}**
P8	Species Diversity	0.80(0.4614)	NS
	Species Richness	**6.93(0.0040)**	**07^{a} 99^{a} 08^{b}**
P11	**Species Diversity**	**6.40(0.0064)**	**99^{a} 07^{ab} 08^{b}**
	Species Richness	2.97(0.0719)	NS
P12	Species Diversity	0.12(0.8885)	NS
	Species Richness	0.21(0.8105)	NS
P13	Species Diversity	0.67(0.5203)	NS
	Species Richness	**5.64(0.0106)**	**99^{a} 07^{ab} 08^{b}**

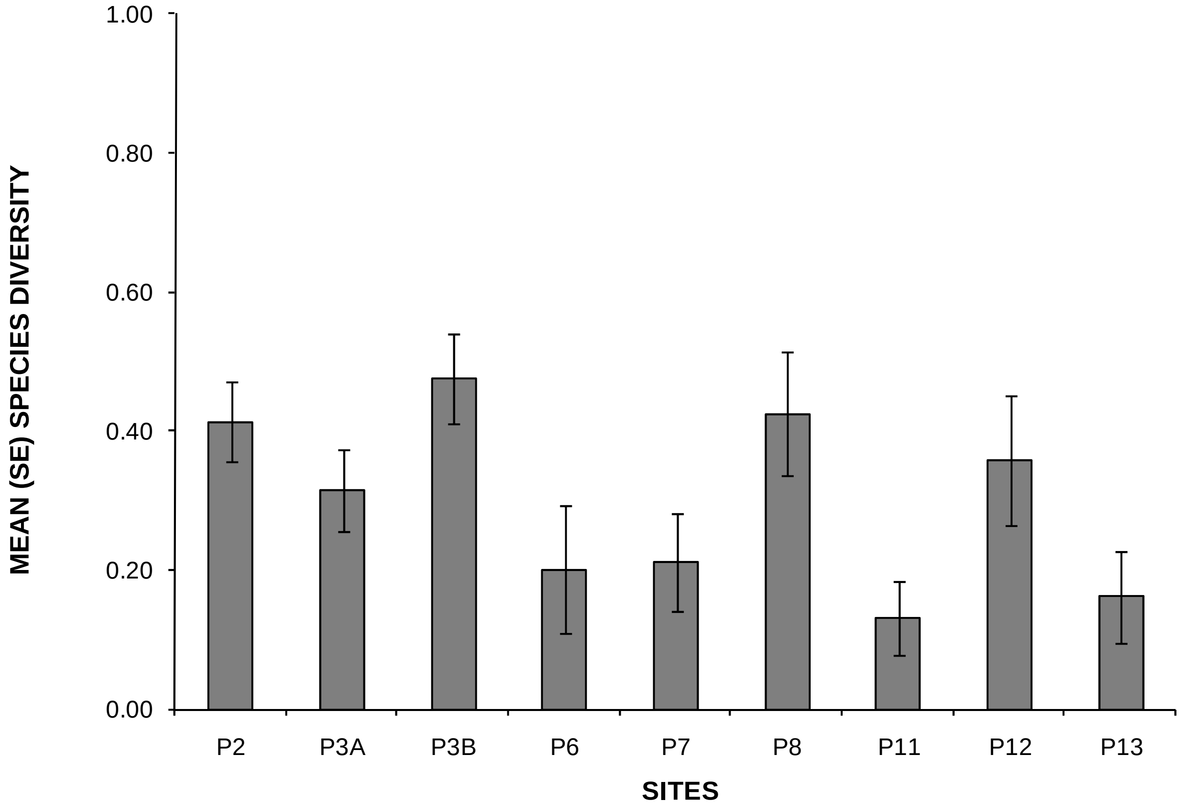


Figure 6.4-3. Mean species diversity among sites sampled in 2008. This data represents both high and low intertidal substations. Diversity was calculated using the Shannon Diversity Index. Bars represent standard error (SE) of the mean.

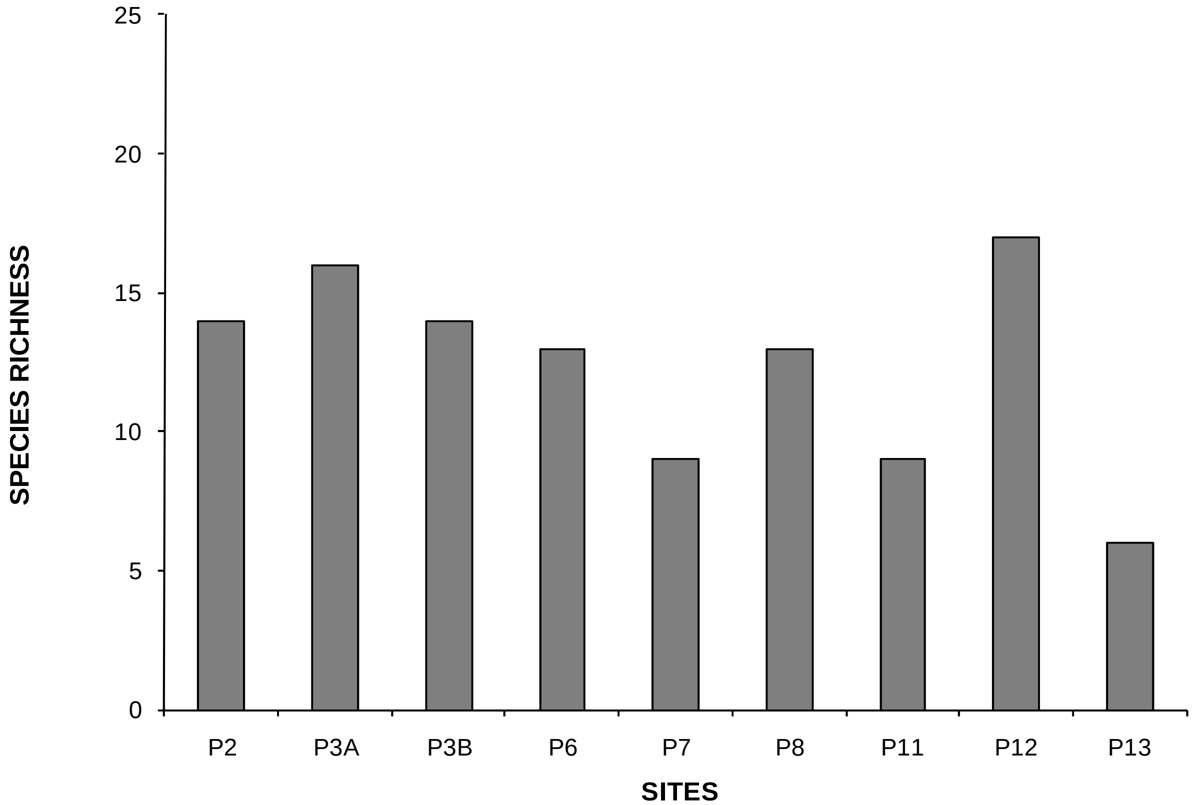


Figure 6.4-4. Species richness among sites sampled in 2008. This data represents both upper intertidal and lower subtidal substations.

7.0 EPIBENTHIC STUDIES: DECAPODS AND EPIBENTHIC FISH

7.1 Summary

Many species, including finfish and crustaceans of commercial importance, utilize marsh and tidal swamp habitats as refuge and forage areas. Their use can span across several life stages including vulnerable early developmental stages, juveniles, and in some cases adults who may spend at least a portion of their lives either living on or associated with the bottom (benthic) habitats. These organisms represent a vital link between benthic secondary production and higher trophic levels. Factors that alter or influence these benthic habitats have the potential to cause upward cascade effects. This study focuses on evaluating the utilization of these habitats by epibenthic species during critical recruitment periods in the spring and fall to detect potential impacts from deepening activities in the lower ~30 kilometers of the Cape Fear River estuary. Factors in this analysis include abundance, diversity, and species richness.

While benthic infauna respond more slowly to the changes in physical factors (mainly due to limited dispersal rates and longer establishment time), the epibenthic community can respond quickly to physical changes as they mature, due to their highly motile nature and responsiveness to the presence of refuge and forage habitat. The distribution and abundance of epibenthic organisms is affected by the distribution, dominance patterns, and species composition of the benthic infauna (critical prey for most of the taxa collected as part of this study), as discussed in Section 6.0.

Two methods were employed to sample epibenthos, Breder traps (a passive sampling device) deployed at multiple tidal positions within the marsh and Drop traps (an active density based sampling method) deployed along the shallow subtidal marsh edge habitat. Previous findings indicated changes in species patterns consistent with developing drought conditions in 2001 and 2002, though this period was also coincident with the initial construction activity (Hackney et al., 2004). The period from 2007 to early 2009 was characterized by lower than average precipitation amounts (State Climate Office Website 2009) and this may have contributed to the lower abundances noted in the spring 2009 data. The majority of the channel deepening of the Cape Fear River was downstream of Wilmington, North Carolina between 2002 and 2004. Planned construction upstream has not been completed. This report presents data from current, initial, and previous years' sampling to evaluate general trends. This evaluation is intended to provide a quick summary of short-term responses in the highly motile epi-benthic community. Evaluations of total abundance among years show that more fish utilized the fringing marshes in fall 2007 compared to the fall 2008 and fall 1999 periods. For the spring sampling periods, 2008 total abundances were higher than the 2009 and 2000 periods. With a few exceptions, the fall and spring richness and diversity data displayed similar patterns with the fall 2007 period exhibiting higher levels than the fall 2008 and 1999 periods and the spring 2008 period being higher than the 2009 and 2000 periods.

7.2 Background

The presence of refuges and sufficient forage habitat are critical to maintaining community diversity and ecosystem function. Shifts in salinity or tidal inundation period have been shown to effect community dynamics and could have an upward cascade effect on prey composition and density. Changes in terms of increase or decrease in tidal inundation periods or changes in salinity could lead to shifts in vegetation type, dominance, or habitat coverage directly altering habitat quality. Tidal fringing marsh and swamps provide essential habitat for juvenile fishes and crustaceans across the estuarine gradient. The maintenance of these habitats supports the commercial and recreational shrimp fishery (both *Farfantepanaeus aztecus* previously identified as *Panaeus aztecus* and *Litopanaeus setiferus* previously identified as *Panaeus setifus*) in the lower Cape Fear River and provides essential refuge for juvenile blue crabs, *Callinectes sapidus*, several species of scianids, and a large number of prey fishes. These are critical fisheries for the Cape Fear region. Changes in the epibenthic organisms (either composition or abundance) could both cause significant impacts to these fisheries and be an indicator of changing species distributions, either through direct impacts to juvenile stages or through the shift in available forage species. Epibenthos are sensitive to changes associated with shifts in salinity and/or tidal inundation. The ingress of juvenile stages of many fishery species is closely dependent on the recruitment of prey species. In general, benthic fauna such as annelids tend towards highest abundances in early spring, following a winter relatively free of predator influence and abundant benthic production. Juvenile fish and crustaceans that depend on this benthic resource start invading the estuary by mid February with full recruitment of multi-species assemblages by early March. There is also a slightly smaller recruitment of benthos in the fall of each year and this too is closely followed by benthic feeding fishes and crustaceans. These annual cycles of species recruitment were the basis for our focus on spring and fall sampling events.

As part of the long-term project to monitor potential changes in the communities that depend on these habitats, we examined the epibenthic community (primarily fish and decapods) found along the marsh and swamp boundary. Aside from resident fish and decapods, epibenthos include juveniles of transient fish, crabs and shrimp, as well as larger snails, amphipods, and isopods. These organisms tend to be highly motile, are often able to utilize a variety of habitats, and may respond rapidly to environmental cues. Many species have larval stages that leave the upper estuary, making recruitment and subsequent impacts on population levels potentially responsive to changes in river hydrology. Examples of epibenthos in the Cape Fear system include important fishery species such as the blue crab (*Callinectes sapidus*), spot (*Leiostomus xanthurus*), flounder (*Paralichthys* spp.), and commercial shrimp (*Farfantepanaeus* sp. and *Litopanaeus* sp). Many epibenthos occupy critical intermediate trophic roles, being predators on benthos or plankton, and prey for larger fish e.g. grass shrimp, *Palaemonetes* spp., killifish ,*Fundulus* spp., and bay anchovy, *Anchoa* sp.. Evaluation of epibenthos provides direct information on possible year class strength of target fishery and indicator species as well as indications of resource and ecosystem responses. Epibenthos may respond quickly to changing conditions because of their ability to move away from unfavorable conditions as well as their dependence on annual recruitment events.

Epibenthic taxa represent indicators of ecosystem level changes for three reasons: 1) their motile lifestyles allow them to quickly respond to physical changes in the environment, 2) juvenile stages of many species represent a critical "bottleneck" in year class strength that is sensitive to hydrodynamic factors affecting larval ingress, and 3) the intermediate trophic role of many epibenthos may lead to greater responsiveness to both changes in primary consumer abundances (e.g. benthos) and higher predator abundances. Changes in the distribution of certain epifaunal organisms, including shifts in dominance at a site or along the upstream/downstream gradient, may indicate changes in tidal amplitude or salinity regimes. Epifauna are sensitive to changes in many physical conditions and may show behavioral avoidance depending on the factor (i.e. rapid shift in dissolved oxygen, temperature, or salinity). Conversely, they may show consistency on the longer temporal scale (i.e. timing of ingress/egress into the estuary and dominance patterns). For many epifauna, especially the juveniles of transient fish, a critical factor may be resource limitation. The presence of a consistent and abundant food resource (including benthic fauna) and refuge (structural habitat within the marsh system) are important for determining population levels and survivorship.

The objective of this section of the monitoring project is to evaluate abundance of organisms utilizing the fringing tidal marshes and wetlands at the stations along the Cape Fear River estuary where benthic infaunal assemblages are being monitored. This report covers sampling in fall 2008 and spring 2009. Data from previous reporting periods (2007-2008 and the initial sampling period 1999-2000) is included here for comparative purposes (Culbertson et. al., 2009).

7.3 Methodology

Marshes and boundary wetlands in the Cape Fear River estuary provide a variety of habitats, especially in the tidally influenced areas that have both intertidal and shallow subtidal edge habitats. We use two sampling methods, Breder traps and Drop traps, to target epifauna with different utilization patterns. Breder trap sampling targets bottom oriented organisms that utilize the intertidal marsh or swamp habitat during the period of tidal inundation. Breder traps are a passive form of sampling that average use patterns over a several hour period. This method has the advantage of being reliably deployed among and within a variety of structures. Drop trap sampling targets those organisms that utilize the shallow subtidal or "edge" habitat. It is an instantaneous method that provides reliable estimates for both bottom oriented and pelagic species, with the advantage of allowing high replication and more understandable relation to actual density, but it is difficult to deploy within heavy structure.

Breder traps are constructed of clear acrylic (31 cm length x 16 cm height x 15 cm width). When submerged, these traps are transparent and catch epibenthic fish and crustaceans, passively, as they move into the tidal wetlands. At each station, traps are placed at three tidal heights; lower intertidal (near mean low water), mid intertidal (submerged ~ 1 m depth at mean high water), and upper intertidal (submerged ~ 0.5 m at mean high water). Two sets of five traps are set at each tidal height with the opening oriented towards the channel or downstream. The orientation of the traps is based on preliminary data that indicates this channel or downstream positioning is optimal for obtaining highest catches. Each trap is secured to the substrate to ensure it maintains proper orientation. All traps are set on the rising tide, and traps are allowed to "fish" for two hours. This time period is based on previous work and represents a compromise between obtaining higher catches and reducing possible loss due to escape, predation, or cannibalism among organisms within the traps. All organisms caught are measured for total length, identified to lowest possible taxon, and representative specimens are preserved for verification. Breder trap sampling is conducted at nine sites: P11 (Smith Creek), P12 (Rat Island) and P13 (Fishing Creek) in the mainstem Cape Fear River, P6 (Eagle Island), P7 (Indian

Creek), and P8 (Dollison's Landing) in the Northeast Cape Fear, and P2 (at the mouth of Town Creek), and two sites at P3 in Town Creek.

Drop traps sample those epibenthos utilizing the lower marsh edge or shallow subtidal regions adjacent to the marsh. The drop trap is an aluminum square that is 1 m on a side and 1 m high with mesh netting, and floats attached to the top edge to prevent organisms from escaping. The trap is deployed from a boat using a large boom that suspends the trap 6-8 feet above the water surface. When the trap is released, its weight drives it into the substrate and seals the bottom to prevent organisms from escaping beneath the trap (each drop is checked for an adequate bottom seal upon deployment to ensure that organisms cannot escape). Eighteen replicate drops are made in the shallow subtidal areas at each station. Replicate samples are taken at least 10 m apart, and at least 20 minutes are allowed between each sample. Once the trap is secured, the contents are removed using a steel frame sweep net with a 2 mm mesh. The trap is considered empty when five consecutive sweeps of the entire trap yield no organisms. All organisms caught are identified, enumerated, and measured for total length. Representatives of each species caught are preserved for verification. Drop sampling is conducted at the same sites as Breder trap sampling, except that the two P3 subsites are sampled as one site because of edge area limitations.

Drop trap and Breder trap sampling was conducted during the same time window for all stations. At least 24 hours separated the use of each method at a site. While Breder traps were deployed on a single day per site, drop trap samples were collected over a 3+ day period for each site. The collection of drop trap data over a multi-day sampling period gives a more accurate evaluation of the use of the subtidal areas adjacent to each site.

Epibenthos were monitored from two distinct sub-habitats with methods specific for each habitat. Mean abundance data is presented by sampling methodology. Breder trap data that targets those species that move into the fringing marsh with the flooding tide is presented with fall and spring data concurrent for each site (Table 7.4-1a - 7.4-9b). Drop trap data that targets lower marsh edge or shallow sub-tidal habitats is presented likewise (Table 7.4-10a - 7.4-17b). Analyses for this report focused on differences in diversity, species richness, and total epifauna by seasons, and across years for both Breder and Drop trap data separately, to evaluate potential trends and community level responses. Because of interactions between seasons and among sites, the data was analyzed among years by site for each season on log transformed data using a One-way Analysis of Variance to meet the assumptions of homogeneous variances. Where significant year effects were found, an SNK test was used to distinguish among years by site. The Shannon diversity index was used to describe diversity patterns at each site. The Shannon diversity index accounts for both species abundance and evenness among species. Overall community comparisons, including all species present, were analyzed using an Analysis of Similarity with Primer 6.0, a multivariate statistical package.

Table 7.4-1a. Mean abundance (SE) for epibenthic fauna collected in Fall Breder trap sampling at station P2 (Town Creek mouth).

Species	Fall 1999			Fall 2007			Fall 2008		
	Low	Mid	Upper	Low	Mid	Upper	Low	Mid	Upper
Callinectes sapidus	0(0)	0(0)	0(0)	0.25(0.16)	0.44(0.44)	0(0)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Cynoscion nebulosus	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)	0(0)
Farfantepenaeus aztecus	0(0)	0(0)	0(0)	0.62(0.32)	0.33(0.33)	0.80(0.36)	0.10(0.10)	0(0)	0.10(0.10)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Gambusia affinis	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Gobiosoma bosc	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0.20(0.13)	0(0)	0(0)
insect sp.	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	1.88(0.69)	2.33(0.50)	3.80(0.88)	1.90(0.38)	1.20(0.36)	3.90(1.39)
Lutjanus griseus	0(0)	0(0)	0(0)	0.12(0.12)	0(0)	0(0)	0(0)	0(0)	0(0)
Lutjanus synagris	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Palaemonetes intermedius	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Palaemonetes pugio	0(0)	0.30(0.15)	0.10(0.10)	0.12(0.12)	0.11(0.11)	1.00(0.21)	0.30(0.21)	0(0)	0.60(0.22)
Palaemonetes vulgaris	0(0)	0(0)	0(0)	0(0)	0.33(0.17)	1.20(0.51)	0.30(0.15)	0.80(0.29)	0.10(0.10)
Paralichthys dentatus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Symphurus plagiusa	0(0)	0(0)	0(0)	0.12(0.12)	0.11(0.11)	0.10(0.10)	0(0)	0(0)	0(0)
Syngathus fuscus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.10(0.10)
Uca pugnax	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-1b. Mean abundance (SE) for epibenthic fauna collected in Spring Breder trap sampling at station P2 (Town Creek mouth).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0.20(0.20)	0.10(0.10)	0.10(0.10)	0(0)	0.10(0.10)	0.20(0.20)
Ctenogobius shufeldti	0.10(0.10)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Fundulus heteroclitus	0.10(0.10)	0.10(0.10)	0(0)	0.10(0.10)	0.40(0.30)	0.80(0.33)	0(0)	0(0)	0.60(0.50)
Hirudinea sp.	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Lagodon rhomboides	0.20(0.13)	0(0)	0(0)	0.10(0.10)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Leiostomas xanthurus	9.90(2.66)	5.00(1.62)	5.30(2.33)	5.90(1.72)	9.40(5.12)	24.0(6.15)	0.20(0.13)	0(0)	0.50(0.27)
Mugil cephalus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0.20(0.20)
Palaemonetes pugio	1.50(0.43)	1.40(0.52)	2.30(1.04)	18.40(4.51)	19.40(3.17)	11.50(2.31)	0.10(0.10)	0.40(0.31)	3.60(1.41)
Penaeidae sp. (postlarvae)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.80(0.36)	0.10(0.10)	0.10(0.10)
Rhithropanopeus harrisii	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)

Table 7.4-2a. Mean abundance (SE) for epibenthic fauna collected in Fall Breder trap sampling at station P3A (Town Creek).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Ctenobobius boleosoma	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Ctenogobius shufeldti	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Eucinostomus sp.	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)
Farfantepenaeus aztecus	0(0)	0(0)	0(0)	0(0)	0.30(0.15)	0(0)	0(0)	0(0)	0.10(0.10)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0(0)	0(0)	0.30(0.15)	0(0)	0(0)	0(0)
Gambusia holbrooki	0(0)	0(0)	0(0)	0.14(0.14)	0.10(0.10)	1.10(0.60)	0(0)	0(0)	0(0)
Lepomis macrochirus	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	0.28(0.28)	3.00(1.08)	1.00(0.36)	0(0)	1.20(0.44)	1.10(0.53)
Palaemonetes pugio	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.20(0.13)	0.89(0.61)	0.80(0.44)	1.70(0.97)
Syngnathus fuscus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Uca pugnax	0.20(0.20)	0.40(0.22)	0.80(0.25)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-2b. Mean abundance (SE) for epibenthic fauna collected in Spring Breder trap sampling at station P3A (Town Creek).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Ctenogobius shufeldti	0(0)	0.10(0.10)	0.20(0.13)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0.10(0.10)	0.80(0.51)	0(0)	0.22(0.15)	0(0)	0(0)	0.10(0.10)
Gambusia affinis	0.10(0.10)	0.50(0.27)	0.50(0.31)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)
Lagodon rhomboides	0(0)	0(0)	0(0)	0.30(0.15)	1.00(0.29)	0.33(0.24)	0.20(0.13)	0.10(0.10)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0(0)	42.40(12.78)	61.56(24.12)	13.56(6.09)	1.60(0.97)	5.00(2.30)	0.70(0.30)
Mugil cephalus	0(0)	0(0)	0(0)	0.20(0.20)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	4.90(2.03)	13.89(6.29)	1.11(0.87)	3.60(0.81)	5.20(2.22)	15.20(8.91)
Paralichthys sp.	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Uca pugnax	1.50(0.62)	2.10(0.57)	2.00(0.67)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-3a. Mean abundance (SE) for epibenthic fauna collected in Fall Breder trap sampling at station P3B (Town Creek).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Archosargus probatocephalus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)
Callinectes sapidus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0.11(0.11)	0.11(0.11)	0.10(0.10)
Ctenogobius shufeldti	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Lagodon rhomboides	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)
Lepomis macrochirus	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	0(0)	0.50(0.34)	1.50(0.62)	0.11(0.11)	0.33(0.24)	0.20(0.13)
Palaemonetes pugio	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.11(0.11)	0.11(0.11)	1.70(0.47)
Paralichthys lethostigma	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)
Uca pugnax	0.50(0.22)	0.20(0.13)	0.40(0.16)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-3b. Mean abundance (SE) for epibenthic fauna collected in Spring Breder trap sampling at station P3B (Town Creek).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0.10(0.10)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)
Ctenogobius boleosoma	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Ctenogobius shufeldti	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Dormitator maculatus	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0.20(0.13)	0.30(0.21)	0(0)	0(0)	0(0)	0.10(0.10)
Gambusia affinis	0.10(0.10)	0.20(0.13)	0.30(0.15)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Lagodon rhomboides	0(0)	0(0)	0(0)	1.90(0.78)	2.60(0.88)	1.40(0.64)	0.50(0.22)	0.30(0.15)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0(0)	91.70(29.37)	84.70(30.06)	165.10(50.38)	2.90(1.35)	30.70(22.82)	10.50(4.77)
Menidia beryllina	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)
Micropogonias undulatus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Mugil cephalus	0(0)	0(0)	0(0)	0(0)	0(0)	0.20(0.13)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0.90(0.41)	1.80(0.71)	2.90(1.29)	0.80(0.36)	0.40(0.31)	1.30(0.45)
Rhithropanopeus harrisii	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.10(0.10)
Uca pugnax	0.70(0.26)	1.20(0.49)	0.60(0.34)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-4a. Mean abundance (SE) for epibenthic fauna collected during Fall Breder trap sampling at station P6 (Eagle Island).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Citharichthys spilopterus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Ctenogobius shufeldti	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0.20(0.13)
Dormitator maculatus	0(0)	0.10(0.10)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)
Farfantepenaeus aztecus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0.10(0.10)	0.50(0.31)
Litopenaeus setiferus	0(0)	0(0)	0(0)	1.00(0.26)	0.60(0.22)	2.00(0.45)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.30(0.15)	1.20(0.63)	0.90(0.59)	1.30(0.65)
Paralichthys albigutta	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Paralichthys dentatus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)
Symphurus plagiusa	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
U/I larval fish	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-4b. Mean abundance (SE) for epibenthic fauna collected during Spring Breder trap sampling at station P6 (Eagle Island).

Species	Spring 2000			Spring 2008			Spring 2009		
	Low	Mid	Upper	Low	Mid	Upper	Low	Mid	Upper
Callinectes sapidus	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Clupeidae sp.	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0.20(0.13)	0.10(0.10)	0(0)
Thermonectus sp.	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Lagodon rhomboides	0(0)	0.10(0.10)	0.20(0.13)	0.30(0.15)	0.30(0.21)	0.50(0.22)	0(0)	0(0)	0.10(0.10)
Leiostomus xanthurus	0(0)	0(0)	0.20(0.13)	1.50(0.76)	2.70(0.82)	71.20(46.98)	0.60(0.34)	0.60(0.34)	1.40(0.56)
Micropogonias undulatus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Mugil cephalus	0(0)	0(0)	0(0)	0(0)	0(0)	0.60(0.27)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0.10(0.10)	0.90(0.31)	0.70(0.21)	0(0)	0(0)	0(0)
Paralichthys dentatus	0.30(0.30)	0.40(0.22)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Paralichthys sp.	0(0)	0(0)	0(0)	0.20(0.13)	0.10(0.10)	0.10(0.10)	1.30(0.37)	0.80(0.25)	0.20(0.13)

Table 7.4-5a. Mean abundance (SE) for epibenthic fauna collected during Fall Breder trap sampling at station P7 (Indian Creek).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Ctenogobius shufeldti	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Dormitator maculatus	0(0)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	0.44(0.24)	0.40(0.16)	0.20(0.13)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0.33(0.24)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Paralichthys lethostigma	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.22(0.15)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0.11(0.11)	0.70(0.33)
Uca pugnax	0.60(0.34)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-5b. Mean abundance (SE) for epibenthic fauna collected during Spring Breder trap sampling at station P7 (Indian Creek).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Ctenogobius shufeldti	0.40(0.16)	1.10(0.28)	4.33(3.85)	0.20(0.13)	0.11(0.11)	0(0)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0.20(0.20)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)
Lagodon rhomboides	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	1.00(0.67)	0(0)	0(0)	0(0)
Lepomis macrochirus	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Mugil cephalus	0(0)	0(0)	0(0)	1.70(1.01)	0.44(0.44)	17.56(17.43)	0(0)	0(0)	0(0)
Paralichthys lethostigma	0(0)	0.30(0.15)	0.67(0.44)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Paralichthys sp.	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.60(0.43)	0.20(0.13)	0(0)

Table 7.4-6a. Mean abundance (SE) for epibenthic fauna collected during Fall Breder trap sampling at station P8 (Dollison Landing).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Cambarus robustus	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0.10(0.10)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.20(0.13)	0(0)	0(0)
Dormitator maculatus	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Eleotris amblyopsis	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Eucinostomus sp.	0(0)	0(0)	0(0)	0(0)	0.30(0.21)	0(0)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)	0(0)
Gambusia holbrooki	0(0)	0(0)	0(0)	0(0)	0.20(0.20)	0.20(0.13)	0(0)	0(0)	0(0)
Gobiosoma bosc	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)
Larimus fasciatus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Lepomis macrochirus	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)
Sternotherus odoratus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Trinectes maculatus	0.20(0.13)	0.20(0.20)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0.40(0.22)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)

Table 7.4-6b. Mean abundance (SE) for epibenthic fauna collected during Spring Breder trap sampling at station P8 (Dollison's Landing).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
amphipod sp.	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)	0.10(0.10)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Lepomis macrochirus	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0.50(0.31)	0(0)	0.20(0.20)
Menidia beryllina	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Mugil cephalus	0(0)	0(0)	0(0)	0(0)	0(0)	0.20(0.13)	0(0)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)

Table 7.4-7a. Mean abundance (SE) for epibenthic fauna collected during Fall Breder trap sampling at station P11 (Smith Creek).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)
Ctenogobius shufeldti	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Dormitator maculatus	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Etropus crossotus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Farfantepenaeus aztecus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Lepomis macrochirus	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	2.89(0.68)	2.60(0.50)	3.80(0.93)	1.50(0.31)	1.10(0.46)	1.20(0.36)
Menidia beryllina	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Micropogonias undulatus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.20(0.13)
Palaemonetes pugio	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0.10(0.10)
Palaemonetes vulgaris	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Paralichthys dentatus	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Trinectes maculatus	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Uca pugnax	0.10(0.10)	0.20(0.13)	8.50(4.17)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
U/I larval fish	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-7b. Mean abundance (SE) for epibenthic fauna collected during Spring Breder trap sampling at station P11 (Smith Creek).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0.20(0.13)	0.20(0.13)	0(0)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.20(0.13)	0(0)
Lagodon rhomboides	0.10(0.10)	0(0)	0(0)	1.90(0.48)	1.40(0.34)	0.60(0.27)	0.20(0.13)	0(0)	0.10(0.10)
Leiostomus xanthurus	1.30(0.76)	0.30(0.21)	1.00(0.39)	71.80(17.44)	98.90(27.78)	141.30(32.69)	0.80(0.29)	2.40(1.27)	21.40(5.35)
Mugil cephalus	0(0)	0(0)	0(0)	0.10(0.10)	0.10(0.10)	0.10(0.10)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0.20(0.20)	0(0)	0.20(0.13)	0(0)	0(0)	0.10(0.10)
Paralichthys sp.	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	1.00(0.37)	0.50(0.27)	0(0)

Table 7.4-8a. Mean abundance (SE) for epibenthic fauna collected during Fall Breder trap sampling at station P12 (Rat Island).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Callinectes sapidus	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0(0)	0(0)	0(0)	0(0)	0(0)	0.12(0.12)	0(0)	0(0)	0(0)
Dormitator maculatus	0.60(0.34)	0(0)	0.40(0.22)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0.10(0.10)
Eleotris amblyopsis	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)
Farfantepenaeus aztecus	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Lepomis macrochirus	0(0)	0.20(0.13)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	0(0)	0.89(0.31)	1.38(0.65)	0.40(0.16)	0.10(0.10)	0.30(0.21)
Palaemonetes pugio	0.10(0.10)	0 (0)	0 (0)	0(0)	0.22(0.15)	0(0)	0(0)	0(0)	0.10(0.10)
Syngnathus fuscus	0(0)	0(0)	0(0)	0.20(0.13)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)
Uca pugnax	0(0)	0.20(0.13)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Uca sp.	0(0)	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)	0(0)

Table 7.4-8b. Mean abundance (SE) for epibenthic fauna collected during Spring Breder trap sampling at station P12 (Rat Island).

Species	Spring 2000			Spring 2008			Spring 2009		
	Low	Mid	Upper	Low	Mid	Upper	Low	Mid	Upper
Ctenogobius boleosoma	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)
Ctenogobius shufeldti	0.60(0.31)	0.60(0.31)	0.10(0.10)	0.90(0.28)	0.30(0.15)	0.10(0.10)	0.30(0.21)	0.30(0.15)	0.10(0.10)
Fundulus heteroclitus	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0.10(0.10)
Lagodon rhomboides	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Leiostomas xanthurus	0.20(0.20)	0.20(0.13)	0.10(0.10)	0(0)	0.20(0.13)	0.50(0.50)	0.40(0.16)	2.00(1.18)	0.10(0.10)
Lepomis macrochirus	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Mugil curema	0(0)	0(0)	0(0)	0(0)	0(0)	0.30(0.15)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0.10(0.10)	0.40(0.22)
Paralichthys dentatus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Paralichthys lethostigma	0(0)	0.30(0.21)	0.30(0.15)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Paralichthys sp.	0(0)	0(0)	0(0)	0.20(0.13)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0(0)	0.20(0.13)	0(0)	0(0)	0.20(0.20)
Uca pugnax	0.10(0.10)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-9a. Mean abundance (SE) for epibenthic fauna collected during Fall Breder trap sampling at station P13 (Fishing Creek).

Species	**Fall 1999**			**Fall 2007**			**Fall 2008**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Ctenogobius boleosoma	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Dormitator maculatus	0.10(0.10)	0.20(0.20)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Lepomis macrochirus	0.60(0.60)	0.30(0.30)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Litopenaeus setiferus	0(0)	0(0)	0(0)	0.80(0.36)	0.75(0.31)	1.00(0.26)	0.30(0.21)	0.20(0.13)	0.40(0.22)
Palaemonetes pugio	0(0)	0(0)	0(0)	0.40(0.16)	0(0)	0.60(0.50)	0(0)	0.30(0.21)	0.50(0.31)
Palaemonetes vulgaris	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.100	0(0)	0(0)	0(0)
Uca minax	0(0)	0(0)	0(0)	0(0)	0.12(0.12)	0.40(0.16)	0(0)	0(0)	0(0)
Uca pugnax	0(0)	0.40(0.30)	0.40(0.30)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Uca sp.	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.20(0.13)

Table 7.4-9b. Mean abundance (SE) for epibenthic fauna collected during Spring Breder trap sampling at station P13 (Fishing Creek).

Species	**Spring 2000**			**Spring 2008**			**Spring 2009**		
	Low	**Mid**	**Upper**	**Low**	**Mid**	**Upper**	**Low**	**Mid**	**Upper**
Ctenogobius shufeldti	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0.10(0.10)	0(0)	0(0)
Fundulus heteroclitus	0(0)	0(0)	0(0)	0.11(0.11)	0(0)	0(0)	0(0)	0(0)	0.25(0.16)
Lagodon rhomboides	0(0)	0(0)	0(0)	0.22(0.15)	0(0)	0(0)	0(0)	0(0)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0(0)	4.11(1.70)	14.60(9.92)	4.20(2.82)	0(0)	0(0)	0(0)
Lepomis macrochirus	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Mugil cephalus	0(0)	0(0)	0(0)	0.22(0.15)	0(0)	0.50(0.34)	0(0)	0(0)	0(0)
Palaemonetes pugio	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0.20(0.13)	0(0)	0(0)	0(0)
Paralichthys sp.	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.10(0.10)	0(0)
Uca pugnax	0(0)	0(0)	0.10(0.10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 7.4-10a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P2 (Mouth of Town Creek).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	0.44(0.44)	2.22(0.76)	1.89(1.25)
Bairdiella chrysoura	0(0)	0.11(0.08)	0(0)
Callinectes sapidus	0.33(0.14)	1.94(0.46)	1.55(0.36)
Chaetodipterus faber	0(0)	0.06(0.06)	0(0)
Ctenogobius shufeldti	0.44(0.20)	0(0)	0(0)
Cynoscion nebulosus	0(0)	0.17(0.09)	0(0)
Dorosoma petenense	0(0)	0.06(0.06)	0(0)
Etropus crossotus	0(0)	0.17(0.09)	0(0)
Eucinostomus sp.	0(0)	0(0)	0.72(0.61)
Farfantepenaeus aztecus	0(0)	1.33(0.59)	0.28(0.14)
Fundulus heteroclitus	0(0)	0.06(0.06)	0(0)
Gobiosoma bosc	0(0)	0.06(0.06)	0.06(0.06)
Litopenaeus setiferus	0(0)	2.06(0.88)	1.00(0.44)
Menidia beryllina	0(0)	0(0)	0.22(0.22)
Palaemonetes pugio	1.39(0.88)	0.17(0.12)	3.61(1.62)
Palaemonetes vulgaris	0(0)	0.89(0.83)	3.17(1.37)
Panopeus herbstii	0.06(0.06)	0(0)	0(0)
Rhithropanopeus harrisii	0.06(0.06)	0(0)	0.11(0.08)
Symphurus plagiusa	0(0)	0.78(0.29)	0.06(0.06)
Syngnathus fuscus	0(0)	0.11(0.08)	0(0)
Syngnathus scovelli	0(0)	0(0)	0.06(0.06)
Uca pugnax	0.06(0.06)	0(0)	0(0)

Table 7.4-10b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P2 (Mouth of Town Creek).

Species	**2000**	**2008**	**2009**
Anguilla rostrata	0(0)	0.11(0.08)	0(0)
Callinectes sapidus	0.06(0.06)	0.28(0.14)	0.44(0.15)
Clupeidae	0(0)	0.28(0.18)	1.11(0.58)
Ctenogobius boleosoma	0(0)	0.11(0.08)	0(0)
Ctenogobius shufeldti	0.17(0.09)	0.06(0.06)	0(0)
Lagodon rhomboides	0.44(0.23)	0(0)	0(0)
Leiostomus xanthurus	7.00(2.41)	3.28(1.29)	2.83(0.60)
Leptocephalus larvae	0(0)	0.06(0.06)	0(0)
Menidia beryllina	5.61(3.20)	0(0)	0(0)
Mugil cephalus	0(0)	0(0)	0.06(0.06)
Palaemonetes pugio	5.56(1.35)	7.06(2.26)	7.28(2.81)
Panopeus herbstii	0.06(0.06)	0(0)	0(0)
Paralichthys dentatus	0.11(0.08)	0(0)	0(0)
Paralichthys sp.	0(0)	0.06(0.06)	0.22(0.15)
Rhithropanopeus harrisii	0(0)	0(0)	0.33(0.18)

Table 7.4-11a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P3 (Town Creek).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	1.36(0.66)	1.39(0.74)	0(0)
Anguilla rostrata	0.06(0.04)	0.06(0.06)	0(0)
Callinectes sapidus	0.11(0.07)	0.39(0.12)	0.17(0.09)
Cambarus robustus	(0.03)(0.03)	0(0)	0(0)
Citharichthys spilopterus	0(0)	0(0)	0.06(0.06)
Ctenogobius boleosoma	0(0)	0(0)	0.28(0.18)
Ctenogobius shufeldti	0.53(0.24)	0.39(0.14)	0.06(0.06)
Cynoscion nebulosus	0(0)	0.11(0.08)	0(0)
Eucinostomus sp.	0(0)	0(0)	1.44(1.00)
Farfantepenaeus aztecus	0(0)	0(0)	0.06(0.06)
Fundulus heteroclitus	0.11(.05)	0.06(0.06)	0.06(0.06)
Gambusia holbrooki	0.80(0.60)	0.06(0.06)	0(0)
Gobionellus oceanicus	0(0)	0.06(0.06)	0.22(0.13)
Gobiosoma bosc	0(0)	0(0)	0.06(0.06)
Lepomis macrochirus	0.08(0.05)	0(0)	0(0)
Litopenaeus setiferus	0(0)	12.61(2.54)	4.00(1.34)
Lutjanus mahogoni	0(0)	0.06(0.06)	0(0)
Menidia beryllina	0.06(0.04)	0.17(0.12)	0.44(0.39)
Micropogonias undulatus	0.11(0.05)	0(0)	0(0)
Palaemonetes pugio	0(0)	2.44(1.20)	136.22(58.93)
Panopeus herbstii	0.06(0.06)	0(0)	0(0)
Paralichthys lethostigma	0(0)	0.06(0.06)	0.06(0.06)
Rhithropanopeus harrisii	0(0)	0.06(0.06)	0(0)
Sesarma cinereum	0(0)	0.06(0.06)	0(0)
Symphurus plagiusa	0(0)	1.00(0.41)	0.44(0.23)
Syngnathus fuscus	0(0)	0.06(0.06)	0(0)
Trinectes maculatus	2.14(0.76)	0(0)	0(0)
Uca pugnax	0.92(0.46)	0(0)	0(0)

Table 7.4-11b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P3 (Town Creek).

Species	**2000**	**2008**	**2009**
Anguilla rostrata	0.08(0.05)	0.06(0.06)	0(0)
Callinectes sapidus	0.19(0.08)	1.17(0.29)	0.89(0.25)
Clupeidae	0(0)	0.06(0.06)	5.67(5.61)
Ctenogobius boleosoma	0(0)	0.44(0.20)	0.17(0.12)
Ctenogobius shufeldti	0.28(0.08)	0.06(0.06)	0.28(0.23)
Fundulus heteroclitus	0(0)	0.06(0.06)	0(0)
Gambusia holbrooki	2.00(0.93)	0(0)	0.17(0.17)
Lagodon rhomboides	0.33(0.14)	2.67(1.11)	0.61(0.28)
Leiostomus xanthurus	0(0)	121.44(41.51)	75.50(26.16)
Lepomis macrochirus	1.58(0.84)	0(0)	0(0)
Menidia beryllina	0.06(0.06)	0(0)	0(0)
Micropogonias undulatus	0(0)	2.33(1.50)	0.06(0.06)
Mugil cephalus	0(0)	3.61(1.94)	1.78(0.87)
Mugil curema	0(0)	0.17(0.12)	0(0)
Palaemonetes pugio	0(0)	112.72(24.49)	48.83(14.01)
Panopeus herbstii	0.06(0.04)	0(0)	0(0)
Paralichthys dentatus	0.45(0.12)	0(0)	0(0)
Paralichthys sp.	0(0)	0.17(0.12)	0.06(0.06)
Rhithropanopeus harrisii	0(0)	0(0)	0.06(0.06)
Trinectes maculatus	0.30(0.14)	0(0)	0(0)
Uca pugnax	0.03(0.03)	0(0)	0(0)

Table 7.4-12a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P6 (Eagle Island).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	0(0)	0.50(0.27)	0.11(0.11)
Callinectes sapidus	0.22(0.10)	0.28(0.11)	0.17(0.12)
Citharichthys spilopterus	0(0)	0(0)	0.06(0.06)
Corbicula fluminea	0.06(0.06)	0(0)	0(0)
Ctenogobius boleosoma	0(0)	0.06(0.06)	0(0)
Ctenogobius shufeldti	0.06(0.06)	0.22(0.13)	0.06(0.06)
Eucinostomus sp.	0(0)	0.39(0.29)	0.06(0.06)
Gobiosoma bosc	0(0)	0(0)	0.06(0.06)
Leiostomus xanthurus	0(0)	0.11(0.08)	0(0)
Litopenaeus setiferus	0(0)	3.72(0.88)	0.06(0.06)
Menidia beryllina	0.11(0.08)	1.11(1.11)	0.39(0.22)
Palaemonetes pugio	0(0)	0.17(0.17)	0.83(0.36)
Palaemonetes vulgaris	0(0)	0.06(0.06)	0(0)
Paralichthys albigutta	0(0)	0.06(0.06)	0(0)
Paralichthys lethostigma	0(0)	0(0)	0.06(0.06)
Rhithropanopeus harrisii	0(0)	0.17(0.12)	0.33(0.14)
Symphurus plagiusa	0(0)	0.67(0.20)	0(0)
Syngnathus fuscus	0(0)	0.11(0.08)	0(0)
Trinectes maculatus	0.44(0.20)	0(0)	0.17(0.09)

Table 7.4-12b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P6 (Eagle Island).

Species	**2000**	**2008**	**2009**
Callinectes sapidus	0(0)	0.44(0.14)	0.17(0.09)
Clupeidae	0(0)	1.83(0.92)	6.22(3.70)
Ctenogobius boleosoma	0(0)	0.06(0.06)	0(0)
Ctenogobius shufeldti	0.11(0.11)	0.39(0.14)	0.39(0.14)
Lagodon rhomboides	0(0)	0.22(0.15)	0(0)
Leiostomus xanthurus	0(0)	43.67(16.93)	2.06(1.07)
Micropogonias undulatus	0(0)	0(0)	0.22(0.17)
Mugil cephalus	0(0)	0.56(0.24)	0.72(0.50)
Palaemonetes pugio	0(0)	10.39(4.98)	1.61(0.57)
Paralichthys dentatus	0.17(0.12)	0(0)	0(0)
Paralichthys sp.	0(0)	0.56(0.23)	3.39(0.72)
Rhithropanopeus harrisii	0(0)	0.06(0.06)	0(0)

Table 7.4-13a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P7 (Indian Creek).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	0(0)	0.67(0.67)	0(0)
Callinectes sapidus	0.06(0.06)	0.06(0.06)	0(0)
Citharichthys spilopterus	0(0)	0(0)	0.06(0.06)
Ctenogobius shufeldti	0.06(0.06)	0.33(0.11)	0.06(0.06)
Dorosoma pretense	0.06(0.06)	0(0)	0(0)
Esox lucius	0.06(0.06)	0(0)	0(0)
Eucinostomus sp.	0(0)	0.06(0.06)	0.11(0.08)
Evorthodus lyricus	0(0)	0(0)	0.06(0.06)
Fundulus heteroclitus	0.06(0.06)	0(0)	0(0)
Gambusia holbrooki	0.06(0.06)	0(0)	0(0)
Gobionellus oceanicus	0(0)	0.11(0.08)	0(0)
Leiostomus xanthurus	0(0)	0.06(0.06)	0(0)
Litopanaeus setiferus	0(0)	0.89(0.20)	0(0)
Menidia beryllina	0(0)	0.33(0.20)	0(0)
Palaemonetes pugio	0(0)	0.28(0.16)	0.67(0.50)
Paralichthys lethostigma	0(0)	0.06(0.06)	0(0)
Symphurus plagiusa	0(0)	0.06(0.06)	0(0)
Trinectes maculatus	0(0)	0(0)	0.11(0.08)
Uca pugnax	0.06(0.06)	0(0)	0(0)

Table 7.4-13b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P7 (Indian Creek).

Species	**2000**	**2008**	**2009**
Anguilla rostrata	0.71(0.34)	0.11(0.08)	0(0)
Callinectes sapidus	0(0)	0(0)	0.06(0.06)
Clupeidae	0(0)	0.61(0.41)	0(0)
Ctenogobius shufeldti	0.29(0.14)	0.17(0.12)	0.17(0.12)
Lagodon rhomboides	0.35(0.35)	0.06(0.06)	0(0)
Leiostomus xanthurus	0(0)	0.78(0.40)	0(0)
Menidia beryllina	0(0)	0(0)	0.06(0.06)
Mugil cephalus	0(0)	1.72(1.61)	0(0)
Palaemonetes pugio	0(0)	0.06(0.06)	0(0)
Paralichthys dentatus	0.47(0.28)	0(0)	0(0)
Paralichthys sp.	0(0)	2.72(0.93)	10.72(2.88)
Rangia sp.	0.06(0.06)	0(0)	0(0)
Trinectes maculatus	0(0)	0.11(0.08)	0(0)
Uca minax	0(0)	0(0)	0.11(0.08)
Uca pugnax	0.06(0.06)	0(0)	0(0)

Table 7.8-14a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P8 (Dollison Landing).

Species	**1999**	**2007**	**2008**
Ctenogobius shufeldti	0.11(0.08)	0.28(0.11)	1.06(0.27)
Dorosoma petenense	0(0)	0(0)	0.44(0.25)
Eucinostomus sp.	0(0)	0.44(0.24)	0.06(0.06)
Gambusia holbrooki	0.22(0.22)	0(0)	0(0)
Gobionellus oceanicus	0(0)	0(0)	0.06(0.06)
Lepomis macrochirus	0.06(0.06)	0.06(0.06)	0.17(0.12)
Litopenaeus setiferus	0(0)	1.22(0.56)	0(0)
Menidia beryllina	0(0)	0.28(0.28)	0.06(0.06)
Notropis chalybaeus	2.94(1.98)	0(0)	0(0)
Palaemonetes pugio	0(0)	0.17(0.17)	0.06(0.06)
Trinectes maculatus	0.17(0.12)	0.22(0.17)	1.00(0.34)

Table 7.8-14b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P8 (Dollison Landing).

Species	**2000**	**2008**	**2009**
Anguilla rostrata	0(0)	0.11(0.11)	0.11(0.08)
Callinectes sapidus	0(0)	0.06(0.06)	0(0)
Clupeidae	0(0)	13.94(13.94)	0.11(0.08)
Ctenogobius shufeldti	0(0)	0.17(0.12)	0.89(0.28)
Menidia beryllina	0.61(0.39)	0(0)	0(0)
Mugil cephalus	0(0)	0.44(0.30)	0(0)
Paralichthys dentatus	0.11(0.11)	0(0)	0(0)
Paralichthys sp.	0(0)	0.17(0.12)	3.39(1.14)
Trinectes maculatus	0(0)	0(0)	0.06(0.06)
Uca pugnax	0.06(0.06)	0(0)	0(0)

Table 7.4-15a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P11 (Smith Creek).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	0(0)	1.11(0.75)	0.89(0.56)
Callinectes sapidus	0(0)	0.50(0.17)	0.39(0.14)
Ctenogobius shufeldti	0.22(0.13)	0(0)	0.06(0.06)
Eucinostomus sp.	0(0)	0(0)	0.28(0.18)
Farfantepenaeus aztecus	0(0)	0.22(0.13)	0(0)
Leiostomus xanthurus	0(0)	0(0)	0.06(0.06)
Litopenaeus setiferus	0(0)	3.06(0.93)	2.78(1.58)
Menidia beryllina	0(0)	0.06(0.06)	0.06(0.06)
Mugil cephalus	0(0)	0.06(0.06)	0(0)
Mugil curema	0(0)	0.11(0.08)	0(0)
Palaemonetes pugio	0(0)	0.06(0.06)	0.50(0.36)
Rhithropanopeus harrisii	0.06(0.06)	0(0)	0(0)
Symphurus plagiusa	0(0)	0.17(0.17)	0.22(0.13)
Syngnathus fuscus	0(0)	0.06(0.06)	0(0)
Trinectes maculatus	0.22(0.17)	0(0)	0(0)

Table 7.4-15b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P11 (Smith Creek).

Species	**2000**	**2008**	**2009**
Anchoa mitchilli	0(0)	0(0)	0.17(0.17)
Anguilla rostrata	0.33(0.16)	0(0)	0(0)
Callinectes sapidus	0.11(0.08)	0.67(0.21)	0.22(0.10)
Clupeidae	0(0)	1.83(0.95)	2.33(1.27)
Ctenogobius boleosoma	0(0)	0.17(0.12)	0(0)
Ctenogobius shufeldti	0.17(0.12)	0(0)	0.06(0.06)
Lagodon rhomboides	0.72(0.50)	0.17(0.12)	0(0)
Leiostomus xanthurus	14.83(9.79)	40.67(8.11)	6.44(2.52)
Menidia beryllina	0.22(0.17)	0(0)	0(0)
Mugil cephalus	0(0)	0.06(0.06)	0(0)
Palaemonetes pugio	0.06(0.06)	0.50(0.18)	0.11(0.08)
Paralichthys dentatus	1.17(0.44)	0(0)	0(0)
Paralichthys sp.	0(0)	0.06(0.06)	0.89(0.36)
Rangia sp.	0.17(0.12)	0(0)	0(0)

Table 7.4-16a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P12 (Rat Island).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	0(0)	10.22(10.10)	0.39(0.39)
Callinectes sapidus	0(0)	0.72(0.22)	0.11(0.08)
Ctenogobius shufeldti	0.11(0.08)	0.06(0.06)	0(0)
Eucinostomus sp.	0(0)	0.22(0.17)	0.11(0.11)
Leiostomus xanthurus	0(0)	0.11(0.11)	0.22(0.15)
Lepomis macrochirus	0.11(0.08)	0(0)	0(0)
Litopenaeus setiferus	0(0)	1.72(0.51)	5.39(1.88)
Menidia beryllina	0(0)	0.39(0.39)	0(0)
Menidia menidia	0(0)	0(0)	0.06(0.06)
Palaemonetes pugio	0(0)	0(0)	3.44(2.32)
Rhithropanopeus harrisii	0(0)	0.11(0.08)	0.06(0.06)
Symphurus plagiusa	0(0)	0.83(0.30)	0.06(0.06)
Uca pugnax	0.06(0.06)	0(0)	0(0)

Table 7.4-16b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P12 (Rat Island).

Species	**2000**	**2008**	**2009**
Anchoa mitchilli	0(0)	0(0)	1.89(1.39)
Callinectes sapidus	0(0)	0.17(0.09)	0.11(0.08)
Clupeidae	0(0)	11.78(7.69)	25.44(16.11)
Ctenogobius boleosoma	0(0)	0.06(0.06)	0(0)
Ctenogobius shufeldti	0.06(0.06)	0.17(0.12)	0.33(0.14)
Fundulus heteroclitus	0(0)	0.17(0.09)	0(0)
Lagodon rhomboides	0(0)	0.11(0.08)	0.06(0.06)
Leiostomus xanthurus	0.11(0.08)	102.67(28.63)	23.78(6.84)
Micropogonias undulatus	0(0)	0(0)	2.00(0.95)
Menidia beryllina	0.17(0.12)	0(0)	0(0)
Mugil cephalus	0(0)	1.28(0.55)	1.83(0.98)
Palaemonetes pugio	0.06(0.06)	2.94(1.21)	9.06(3.35)
Paralichthys dentatus	0.17(0.12)	0(0)	0(0)
Paralichthys sp.	0(0)	0.22(0.13)	1.17(0.41)
Rhithropanopeus harrisii	0(0)	0.06(0.06)	0(0)
U/I larval fish	0.06(0.06)	0(0)	0(0)

Table 7.4-17a. Mean abundance (SE) for epibenthic fauna collected in Fall Drop trap sampling at station P13 (Fishing Creek).

Species	**1999**	**2007**	**2008**
Anchoa mitchilli	0(0)	0.11(0.08)	0(0)
Callinectes sapidus	0(0)	0.11(0.08)	0.06(0.06)
Eucinostomus sp.	0(0)	0.11(0.11)	0.06(0.06)
Lepomis macrochirus	0.06(0.06)	0(0)	0(0)
Litopenaeus setiferus	0(0)	1.22(0.48)	0.17(0.12)
Membras martinica	0(0)	0.06(0.06)	0(0)
Menidia beryllina	0(0)	0(0)	0.33(0.14)
Palaemonetes pugio	0(0)	0.06(0.06)	0.11(0.08)
Paralichthys lethostigma	0(0)	0(0)	0.06(0.06)
Rhithropanopeus harrisii	0(0)	0.06(0.06)	0.06(0.06)
Symphurus plagiusa	0(0)	0.06(0.06)	0(0)
Uca pugnax	0.11(0.11)	0(0)	0(0)

Table 7.4-17b. Mean abundance (SE) for epibenthic fauna collected in Spring Drop trap sampling at station P13 (Fishing Creek).

Species	**2000**	**2008**	**2009**
Anguilla rostrata	0.17(0.17)	0(0)	0.06(0.06)
Callinectes sapidus	0(0)	0.11(0.08)	0.06(0.06)
Clupeidae	0(0)	2.83(1.54)	1.50(1.33)
Ctenogobius boleosoma	0(0)	0(0)	0.06(0.06)
Ctenogobius shufeldti	0.22(0.15)	0.06(0.06)	0.28(0.19)
Gobiidae sp.	0(0)	0.06(0.06)	0(0)
Leiostomus xanthurus	0(0)	6.50(2.00)	1.22(0.72)
Lepomis macrochirus	0.11(0.11)	0(0)	0(0)
Menidia beryllina	1.39(0.97)	0(0)	0.06(0.06)
Micropogonias undulatus	0(0)	0(0)	0.11(0.08)
Mugil cephalus	0(0)	0.06(0.06)	0(0)
Palaemonetes pugio	0(0)	0(0)	0.06(0.06)
Paralichthys dentatus	0.33(0.16)	0(0)	0(0)
Paralichthys sp.	0(0)	0.17(0.12)	2.17(0.72)
Trinectes maculatus	0.33(0.20)	0.06(0.06)	0(0)

7.4 Community Evaluation

Dominance Patterns

Previous reporting periods show that the number of species collected peaked in 2002-2004 (Hackney et al., 2004, 2005). Total species richness for the Drop traps and Breder traps were 40 and 30, respectively. During the fall 2008 to spring 2009 sampling period, drop traps captured 24 and 17 taxa, respectively; whereas, Breder traps captured 25 and 15 taxa over the same time period. Several species were numerically dominant (comprising > 3% of the total number of individuals collected), and consistently appeared among sites and/or seasons, among years, and across habitats. During the fall 2008 period, *Palaemonetes pugio* (grass shrimp) and *Litopenaeus setiferus* (commercial white shrimp) were the most common taxa collected in both shallow subtidal habitats (drop trap) and intertidal marsh habitats (Breder trap) across most sites (Figure 7.4-1 and Figure 7.4-3). In the spring, while *Palaemonetes pugio* was still common at most sites in both habitats, it shared dominance with *Leiostomus xanthurus* (spot) and *Paralichthys* sp. (flounder) (Figure 7.4-2 and Figure 7.4-4). Clupeidae (herring) were common at most sites in the spring 2009 shallow marsh habitat and *Ctenogobius shufeldti* (freshwater goby) were common at a number of sites in the intertidal marsh habitats (Figure 7.4-2 and Figure 7.4-4).

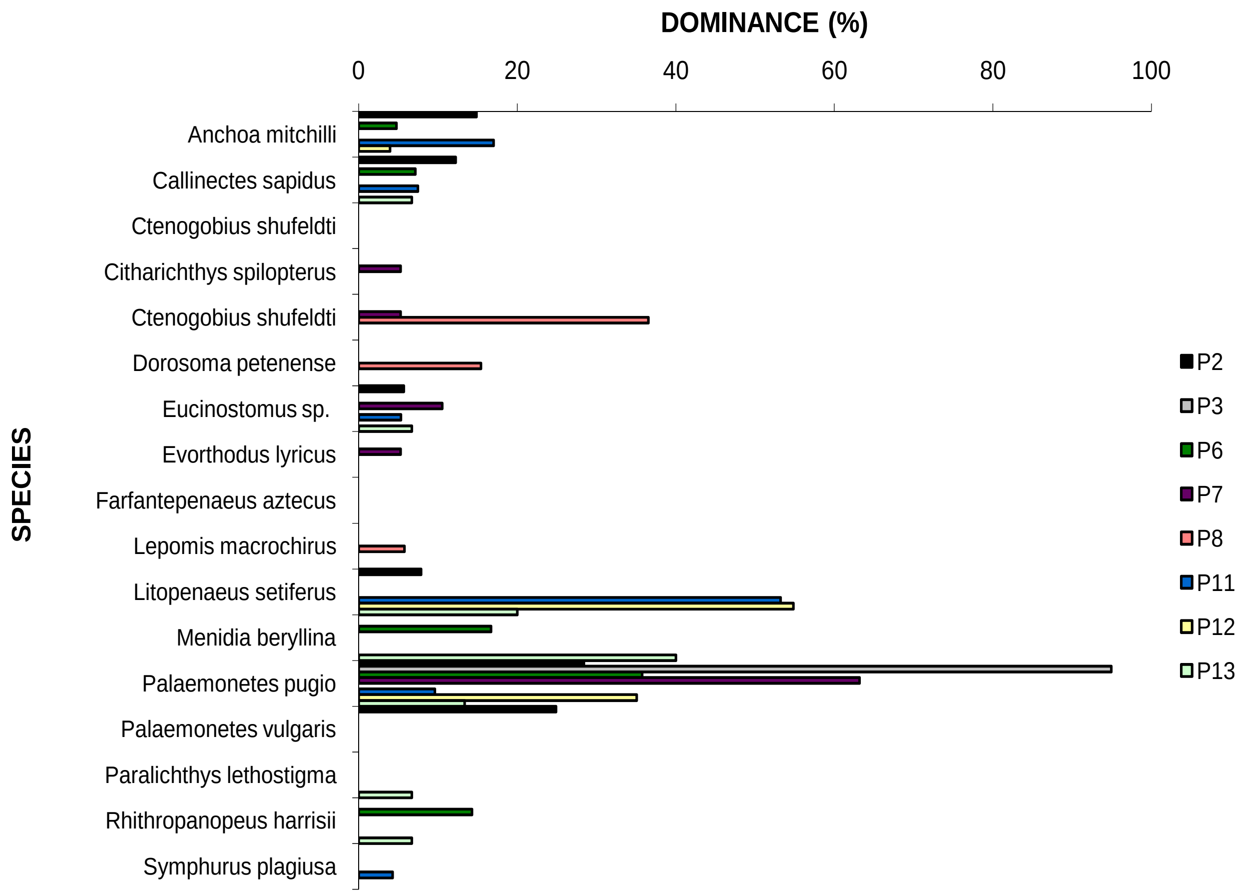


Figure 7.4-1.Common species representing ≥ 3% of the total abundance among sites sampled by Drop trap in Fall 2008.

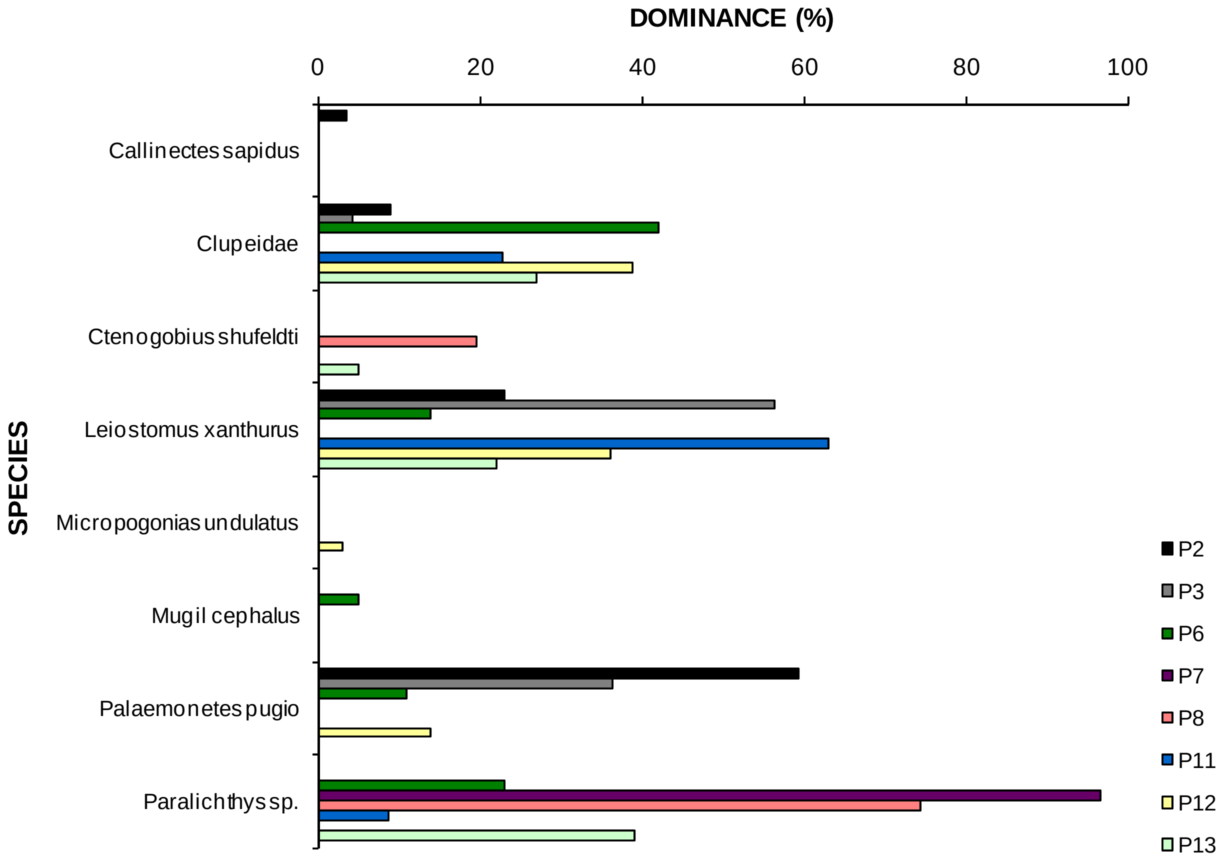


Figure 7.4-2. Common species representing ≥ 3% of the total abundance among sites sampled by Drop trap in Spring 2009.

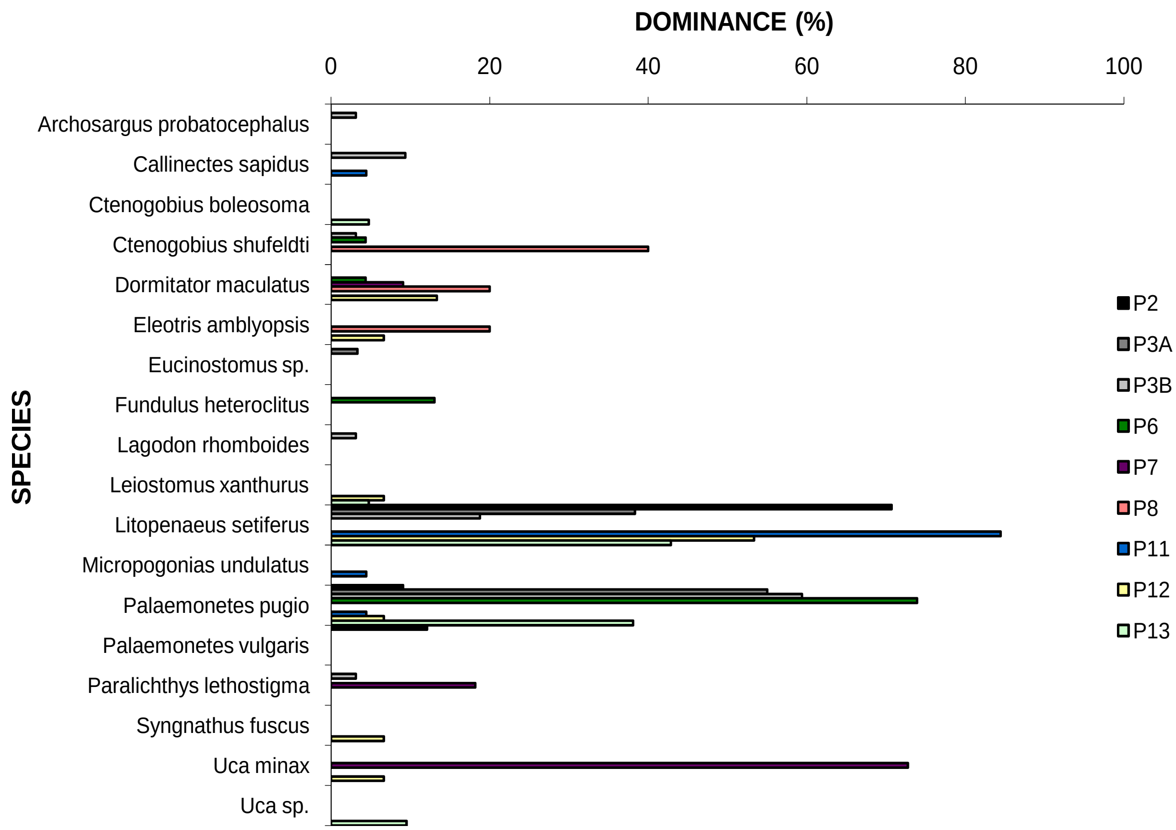


Figure 7.4-3. Common species representing ≥ 3% of the total abundance among sites sampled by Breder trap in Fall 2008.

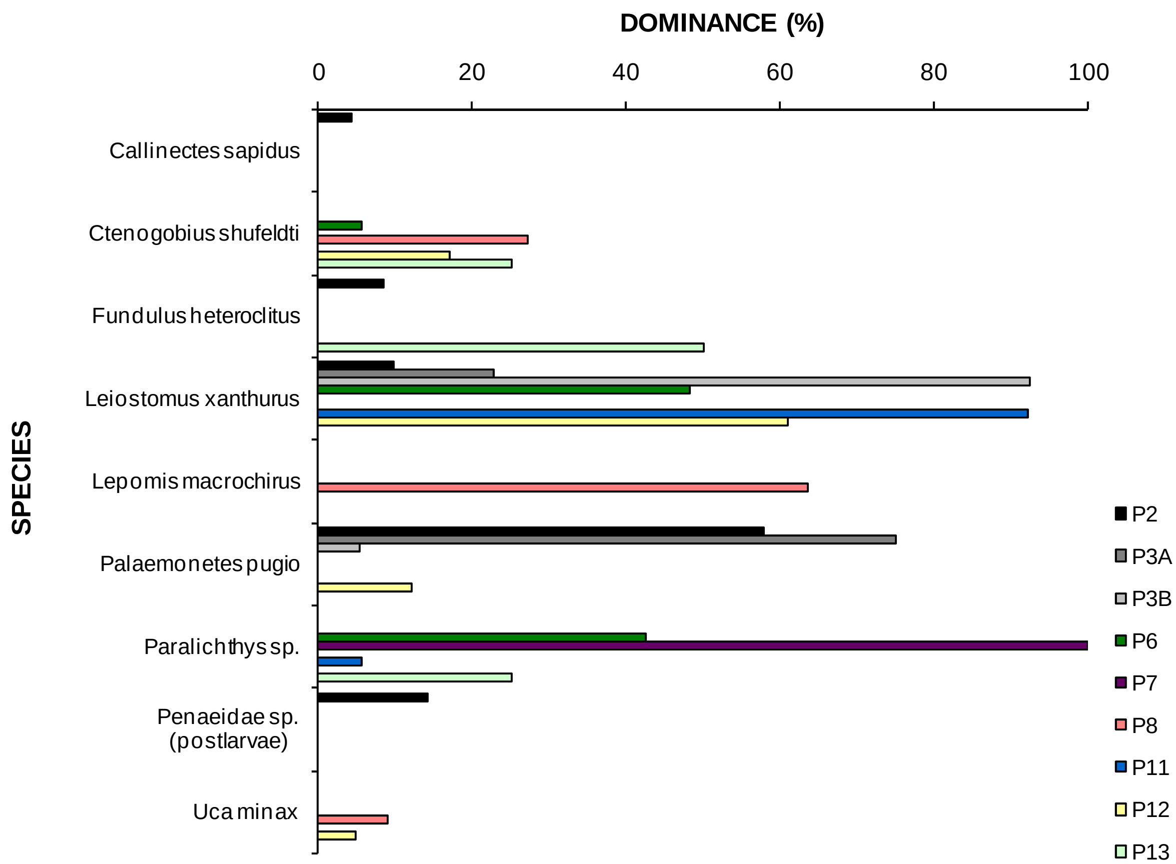


Figure 7.4-4. Common species representing ≥ 3% of the total abundance among sites sampled by Breder trap in Spring 2009.

Community Measures

Analysis of species richness data from both the marsh interior (Breder trap) and marsh edge (Drop trap) detected significant differences in utilization among years, across both sampling seasons, and at most sites. Five significant comparisons from nine analyses for the marsh interior (Table 7.4-18) during fall 2008 showed this period to have lower species richness than the fall of 2007, but greater than the initial sampling year, 1999. All eight comparisons for the marsh edge (Table 7.4-24) were statistically significant during the fall 2008 period with all sites exhibiting the same pattern as the marsh interior except for sites P8 and P11. At these two sites, the fall 2008 period had greater species richness than the fall 2007 period and the fall 1999 period. Spring marsh interior data demonstrated a similar pattern to the fall 2008 data with 2009 having lower species richness than the previous spring (2008), but greater richness than the initial spring sampling in 2000, which found six statistically significant comparisons from nine analyses (Table 7.4-19). There was an exception to this pattern at P2 where the spring 2009 richness was lower than both the 2008 and 2000 collections. There were six significant comparisons from eight analyses for the spring 2009 marsh edge (Table 7.4-25). At three of the sites, P3, P6 and P7, the spring 2009 period had lower species richness than the 2008 period, but greater than spring 2000. At the other two sites, P8 and P12, the 2009 collections had higher species richness than both the 2008 and 2000 collections.

Comparisons of mean total abundance showed consistent differences among the current, previous, and initial years. Marsh interior sampling, with Breder traps, showed four significant comparisons from nine analyses in fall 2008 and five significant comparisons from spring 2009 (Table 7.4-22 and Table 7.4-23). For the fall collections, all sites exhibited highest total mean abundances in 2007. The 2008 collection found higher abundances than the 1999 collections in all cases, except at P8, where the 2008 mean abundances were lower than both the 2007 and 1999 collections. Comparisons at all sites exhibited higher mean total abundance in the 2008 sampling collections. The spring 2009 mean total abundances were higher than spring 2000, in all cases except at P2 where the 2009 mean abundances were lower than both the 2008 and 2000 collections. Sampling along the shallow subtidal areas of the marsh edge (drop trap) for the fall showed six significant comparisons from eight analyses among years (Table 7.4-28), with greater mean total abundance in the previous year (2007) with the exception of P3 where it was lower than the 2008 period and higher than the 1999 period. Mean total abundance in the marsh edge for spring showed six significant comparisons from eight analyses among years (Table 7.4-29), with greater mean total abundance in the previous year (2008) relative to the current sampling period (2009) and the initial sampling period 2000 for five out of the six significant comparisons. The exception was at P7 where the 2009 mean abundances were higher than both the 2008 and 2000 periods. Diversity measures for the two sampling types showed similar patterns, although not as strong for some sites. Diversity was greatest in the fall sampling periods, with five significant comparisons from nine analyses in the marsh interior (Table 7.4-20), and six significant comparisons from eight analyses for the marsh edge (Table 7.4-26). For most sites the diversity was greatest for the 2007 period followed by 2008 and 1999 periods. Spring diversity for the marsh interior showed three significant comparisons from nine analyses (Table 7.4-21). Site P7 showed greatest diversity in 2008 followed by the 2000 and 2009 periods. Site P11 showed highest diversity in the 2009 period followed by the 2008 and 2000 periods. Site P13 showed highest diversity in the 2008 period followed by the 2009 and 2000 periods. Only three sites (Eagle Island-P6 Dollison's Landing-P8 and Rat Island-P12) showed differences for the marsh edge sampling (Table 7.4-27).

Table 7.4-18 Among-year comparison of species richness for Fall Breder trap samples. Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek Mouth (P2)	**41.30(0.0001)**	**07^{a} 08^{b} 99^{c}**
Inner Town Creek (P3A)	**3.39(0.0485)**	**07^{a} 08^{ab} 99^{b}**
*Inner Town Creek (P3B)	2.88(0.0733)	NS
***Eagle Island (P6)**	**13.08(0.0001)**	**07^{a} 08^{a} 99^{b}**
Indian Creek (P7)	2.31(0.1185)	NS
Dollison Landing (P8)	**4.17(0.0265)**	**07^{a} 08^{b} 99^{b}**
Smith Creek (P11)	0.93(0.4074)	NS
Rat Island (P12)	0.83(0.4468)	NS
Fishing Creek (P13)	**5.54(0.0096)**	**07^{a} 08^{ab} 99^{b}**

Table 7.4-19. Among-year comparison of species richness for Spring Breder trap samples. Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek Mouth (P2)	**4.24(0.0250)**	**08^{a} 00^{ab} 09^{b}**
Inner Town Creek (P3A)	**7.73(0.0022)**	**08^{a} 09^{b} 00^{b}**
Inner Town Creek (P3B)	**13.34(<.0001)**	**08^{a} 09^{b} 00^{c}**
Eagle Island (P6)	**8.01(0.0019)**	**08^{a} 09^{b} 00^{b}**
*Indian Creek (P7)	2.66(0.0884)	NS
Dollison Landing (P8)	1.69(0.2029)	NS
Smith Creek (P11)	**16.31(0.0001)**	**08^{a} 09^{a} 00^{b}**
Rat Island (P12)	0.39(0.6817)	NS
***Fishing Creek (P13)**	**13.51(<.0001)**	**08^{a} 09^{b} 00^{b}**

Table 7.4-20. **Among-year comparison of species diversity for Fall Breder trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek Mouth (P2)	**33.23(0.0001)**	**07^a 08^b 99^c**
Inner Town Creek (P3A)	1.98(0.1582)	NS
Inner Town Creek (P3B)	**8.79(0.0011)**	**08^a 99^b 07^b**
Eagle Island (P6)	**5.81(0.0079)**	**07^a 08^a 99^b**
Indian Creek (P7)	2.99(0.0671)	NS
Dollison Landing (P8)	**8.24(0.0016)**	**07^a 08^b 99^b**
Smith Creek (P11)	1.64(0.2128)	NS
Rat Island (P12)	1.01(0.3778)	NS
Fishing Creek (P13)	**5.99(0.0070)**	**07^a 08^b 99^b**

Table 7.4-21. **Among-year comparison of species diversity for Spring Breder trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek Mouth (P2)	0.87(0.4301)	NS
Inner Town Creek (P3A)	0.62(0.5469)	NS
Inner Town Creek (P3B)	1.48(0.2458)	NS
Eagle Island (P6)	1.86(0.1752)	NS
Indian Creek (P7)	**4.07(0.0285)**	**08^{a} 00^{a} 09^{b}**
Dollison Landing (P8)	0.51(0.6057)	NS
Smith Creek (P11)	**8.93(0.0011)**	**09^{a} 08^{b} 00^{b}**
Rat Island (P12)	0.29(0.7528)	NS
Fishing Creek (P13)	**4.02(0.0295)**	**08^{a} 09^{ab} 00^{b}**

Table 7.4-22. **Among-year comparison of mean total abundance for Fall Breder trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
***Town Creek Mouth (P2)**	**63.64(<.0001)**	**07^a 08^b 99^c**
Inner Town Creek (P3A)	**5.23(0.0073)**	**07^a 08^a 99^b**
Inner Town Creek (P3B)	2.32 (0.1041)	NS
Eagle Island (P6)	**8.47(0.0004)**	**07^a 08^a 99^b**
Indian Creek (P7)	1.36 (0.2611)	NS
Dollison Landing (P8)	**4.79(0.0107)**	**07^a 99^b 08^b**
Smith Creek (P11)	1.18(0.3120)	NS
Rat Island (P12)	2.09(0.1302)	NS
Fishing Creek (P13)	3.23(0.0446)	NS

Table 7.4-23. **Among-year comparison of mean total abundance for Spring Breder trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
***Town Creek Mouth (P2)**	**65.96(<.0001)**	**08^{a} 00^{b} 09^{c}**
***Inner Town Creek (P3A)**	**31.01(<.0001)**	**08^{a} 09^{b} 00^{c}**
***Inner Town Creek (P3B)**	**88.90(<.0001)**	**08^{a} 09^{b} 00^{c}**
Eagle Island (P6)	2.41(0.0961)	NS
Indian Creek (P7)	1.12(0.3326)	NS
Dollison Landing (P8)	1.97(0.1452)	NS
***Smith Creek (P11)**	**136.55(<.0001)**	**08^{a} 09^{b} 00^{c}**
Rat Island (P12)	0.48(0.6191)	NS
Fishing Creek (P13)	**5.06(0.0084)**	**08^{a} 09^{b} 00^{b}**

Table 7.4-24. **Among-year comparison of species richness for Fall Drop trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption.

Site	F(p)	SNK (where ANOVA significant)
Town Creek mouth (P2)	**14.30(<0.0001)**	**07^{a} 08^{a} 99^{b}**
Town Creek Inner (P3)	**6.55(0.0040)**	**07^{a} 08^{ab} 99^{b}**
Eagle Island (P6)	**14.20(<0.0001)**	**07^{a} 08^{b} 99^{c}**
Indian Creek (P7)	**12.04(<0.0001)**	**07^{a} 08^{b} 99^{b}**
Dollison Landing (P8)	**4.07(0.0229)**	**08^{a} 07^{ab} 99^{b}**
***Smith Creek (P11)**	**12.39(<0.0001)**	**08^{a} 07^{a} 99^{b}**
***Rat Island (P12)**	**17.86(<0.0001)**	**07^{a} 08^{a} 99^{b}**
Fishing Creek (P13)	**4.38(0.0176)**	**07^{a} 08^{a} 99^{b}**

Table 7.4-25. **Among-year comparison of species richness for Spring Drop trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek mouth (P2)	0.04(0.9589)	NS
Town Creek Inner (P3)	**12.68 (<0.0001)**	**08^{a} 09^{a} 00^{b}**
***Eagle Island (P6)**	**91.53(<0.0001)**	**08^{a} 09^{a} 00^{b}**
Indian Creek (P7)	**3.90(0.0268)**	**08^{a} 09^{ab} 00^{b}**
***Dollison Landing (P8)**	**10.32(0.0002)**	**09^{a} 08^{b} 00^{b}**
Smith Creek (P11)	2.14(0.1279)	NS
***Rat Island (P12)**	**39.89(<0.0001)**	**09^{a} 08^{a} 00^{b}**
Fishing Creek (P13)	2.64 (0.0809)	NS

Table 7.4-26. **Among-year comparison of species diversity for Fall Drop trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek mouth (P2)	**20.69(<0.0001)**	**07^{a} 08^{b} 99^{c}**
Town Creek Inner (P3)	1.57(0.2231)	NS
***Eagle Island (P6)**	**12.03(<0.0001)**	**07^{a} 08^{b} 99^{c}**
Indian Creek (P7)	**7.04(0.0020)**	**07^{a} 08^{b} 99^{b}**
Dollison Landing (P8)	**4.89(0.0114)**	**08^{a} 07^{ab} 99^{b}**
Smith Creek (P11)	**5.53(0.0067)**	**07^{a} 08^{a} 99^{b}**
Rat Island (P12)	**11.81(<0.0001)**	**07^{a} 08^{a} 99^{c}**
Fishing Creek (P13)	1.88(0.1630)	NS

Table 7.4-27. **Among-year comparison of species diversity for Spring Drop trap samples**. Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek mouth (P2)	0.46(0.6330)	NS
*Town Creek Inner (P3)	0.66(0.5241)	NS
Eagle Island (P6)	**25.09(<.0001)**	**09^{a} 08^{a} 00^{b}**
Indian Creek (P7)	**3.15(0.0514)**	**NS**
Dollison Landing (P8)	**11.53(<.0001)**	**09^{a} 08^{b} 00^{b}**
Smith Creek (P11)	0.19(0.8255)	NS
Rat Island (P12)	**19.42(<.0001)**	**09^{a} 08^{b} 00^{b}**
Fishing Creek (P13)	0.71(0.4943)	NS

Table 7.4-28. **Among-year comparison of total abundance for Fall Drop trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
***Town Creek mouth (P2)**	**9.23(0.0004)**	**07^{a} 08^{a} 99^{b}**
Town Creek Inner (P3)	**7.70(0.0010)**	**08^{a} 07^{b} 99^{b}**
***Eagle Island (P6)**	**19.84(<0.0001)**	**07^{a} 08^{b} 99^{b}**
Indian Creek (P7)	**6.84(0.0023)**	**07^{a} 08^{b} 99^{b}**
Dollison Landing (P8)	0.12(0.8874)	NS
Smith Creek (P11)	**5.97(0.0047)**	**07^{a} 08^{a} 99^{b}**
Rat Island (P12)	1.43(0.2488)	NS
Fishing Creek (P13)	**4.36(0.0179)**	**07^{a} 08^{ab} 99^{b}**

Table 7.4-29. **Among-year comparison of total abundance for Spring Drop trap samples.** Years are listed from greatest abundance to least. F (and p) values are from Analysis of Variance. Where ANOVA indicated a significant year effect (bold), year differences were tested using a SNK post-hoc test. Years that share a letter superscript are not significantly different (p<0.05). Asterisk (*) indicates analysis performed on log transformed data to meet the homogeneity of variance assumption. NS indicates not significant.

Site	F(p)	SNK (where ANOVA significant)
Town Creek mouth (P2)	1.11(0.3384)	NS
Town Creek Inner (P3)	**63.25(<0.0001)**	**08^{a} 09^{b} 00^{c}**
Eagle Island (P6)	**8.57(0.0006)**	**08^{a} 09^{b} 00^{b}**
Indian Creek (P7)	**5.06(0.0100)**	**09^{a} 08^{ab} 00^{b}**
Dollison Landing (P8)	0.82(0.4457)	NS
Smith Creek (P11)	**5.41(0.0074)**	**08^{a} 00^{b} 09^{b}**
Rat Island (P12)	**9.13(0.0004)**	**08^{a} 09^{a} 00^{b}**
***Fishing Creek (P13)**	**3.78(0.0293)**	**08^{a} 09^{a} 00^{b}**

8.0 SENSITIVE HERBACEOUS VEGETATION SAMPLING, YEAR NINE

8.1 Summary

Monitoring of sensitive herbaceous vegetation at seven stations in the Cape Fear River estuary was completed for the eighth year in August 2008. The effects of ocean-derived salts on sensitive herbaceous vegetation were documented for an unusual second consecutive year at two sampling stations in the Cape Fear River estuary monitoring area. A third sampling station contains evidence of its first salinity event. These events have coincided with a minimal or seasonal reduction in flow along the Black, Cape Fear and Northeast Cape Fear Rivers.

The Inner Town Creek sampling station along Town Creek has experienced salinity events irregularly since establishment of this monitoring in 2000 and there was strong evidence that this station had already experienced salinity incursions prior to establishment of monitoring polygons. Repeated salinity incursions have now resulted in loss of most sensitive herbaceous vegetation, most shrubs and all trees in or near the monitoring polygon. Casual observations regarding soil subsidence have also been made. Discharge data have not been available for Town Creek since inception of the monitoring, so the timing of the salinity incursion is assumed to have been during June and July of 2008.

The Indian Creek sampling station, having been disturbed by partial clearing of natural vegetation for development purposes, has experienced what could be considered a minor ocean-derived tidal salt incursion that occurred coincidentally with a seasonal period of low discharge during June and July of 2008 in the Cape Fear River and the Black River. Disturbance at the site may have helped to modify the full effects of the event. The monitoring polygon was relocated to a different area within the existing belt transect. With the cutting of tree and shrub layers a thick growth of herbaceous vegetation had followed partial clearing. The defined limits of the belt transect were verified, the boundaries of the belt transect were repaired and a summary of dominant vegetation was again assessed through the length of the belt transect.

The Fishing Creek site on the Northeast Cape Fear River has experienced its second consecutive salinity event. Last year sensitive vegetation had been impacted by strongly brackish water. This year the most common species, *Pontederia cordata* and *Saururus cernuus*, were largely dead above the surface. This event followed the first observation of substrate subsidence changes in the area. Furthermore it occurred coincidentally with death of tree and shrub species at the site and with documented low flow periods in the Northeast Cape Fear River.

8.2 Introduction and Background

It has been assumed that the effects of flooding and salinity influence the health, occurrence, and distribution of plants within the Cape Fear River Estuary. Salt sensitive plant species have been examined annually at seven stations. These stations remain largely as defined earlier (Table 8.2-1). The current report is the ninth year of sensitive herbaceous vegetation monitoring.

Each monitoring station is subject to astronomical tides characteristic of the lower Cape Fear River estuarine system. During previous years of sampling six of the seven stations have experienced exposure to ocean-derived salts carried by tidal flooding. Effects of ocean-derived salts on vegetation have not been documented at Black River (P9), the uppermost Cape Fear River station. Generalized vegetation zones along a 50-meter wide transect extending from a riverine shore line to uplands at each station were defined and described as a part of an earlier report (CZR Incorporated 2001). Methods and results from past years of sensitive herbaceous species sampling and observations at the seven stations are covered in earlier reports (CZR Incorporated 2001, 2002; Hackney et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008 Culbertson et al., 2009).

Table 8.2-1. Locations, streams and numbers for sensitive herbaceous vegetation monitoring stations in the Wilmington Harbor monitoring project, Cape Fear River Estuary, North Carolina

Station Name	Stream Name	Station Number
Inner Town Creek	Town Creek	P3
Indian Creek	Cape Fear River	P7
Dollisons Landing	Cape Fear River	P8
Black River	Cape Fear River (near Black River)	P9
Rat Island	Northeast Cape Fear River	P12
Fishing Creek	Northeast Cape Fear River	P13
Prince George Creek	Northeast Cape Fear River	P14

Last year the Cape Fear region, as well as more interior portions of the combined watersheds that make up the major tributaries of the lower Cape Fear estuary, underwent a period of low river flows similar to those experienced during the growing season of 2007. During 2007, river flows of fresh water diminished as ocean-derived salts were carried upstream by astronomical tides. The year began with increased freshwater discharges during 2008. The high, 2008 flows persisted well into the growing season during which time near-stream swamps were again flushed. Salinities were diluted well down stream and flows began to diminish during the middle of the growing season (Figures 3.5-A-1 and 3.5-A-2, page 25, Culbertson et al., 2009).

8.3 Methodology

Data collection methods remain largely the same as those used during previous years of sensitive herbaceous vegetation sampling (CZR Incorporated 2002, Hackney et al, 2002, 2003, 2004, 2005, 2006, 2007, 2008 and Culbertson et al., 2009). This year's data for plant species presence and percent cover were gathered from four variable plots and three fixed plots. One of the fixed plots was replaced this year due to disturbances related to development. Percent cover data from previous years were not consulted immediately prior to assessment of conditions for the current year. Assessments are made in the field independent of pre-existing data.

Variable polygon data were taken at Inner Town Creek (P3), Rat Island (P12), Fishing Creek (P13), and Prince George Creek (P14) and used below to demonstrate yearly changes in size, shape, and plant species cover. These variable-size plots have boundaries created by on-site delineations of recognizable assemblages of sensitive herbaceous species. Polygons at three stations with fixed, four-sided plots were chosen because they best represented larger, more widespread sensitive herbaceous vegetation assemblages. Methods and reasons for abandonment and re-establishment of a fixed-sided plot at the Black River site (P9) are covered in an earlier report (Hackney et al., 2005). Methods and reasons for abandonment and re-establishment of a fixed-sided plot at Indian Creek (P7) are covered below. A permanent plot also occurs at Dollisons Landing (P8) (CZR Incorporated 2001). Although the plot at Rat Island (P 12) is a variable plot, its size and shape have remained unchanged since it became dominated by salt-tolerant plant species.

Sampling stations were visited August 4 and 5, 2008, during which time wetland herbaceous vegetation was at its optimum seasonal development. Work at Indian Creek took place on August 6, 2008. Polyvinyl chloride (PVC) stakes were added, moved, or removed at three sites in order to relocate polygon vertices. Each stake was renumbered and reflagged as necessary to allow a clear indication of position. At each station plant species seen in each polygon were listed and their contributed cover percentages were estimated and recorded. Position data for the PVC stakes at the newly established permanent plot stakes at Indian Creek (P7) were recorded using GPS (Global Positioning System) on August 6, 2008. Position data using GPS were taken January 14, 2008 at variable plots, where needed. Details of the GPS data gathering process are covered in earlier reports (Hackney et al., 2002). Multipath problems are intermittent at sites supporting arborescent canopies.

Field personnel responsible for gathering sensitive herbaceous vegetation data and GPS data have not changed since the inception of the project. The same personnel are responsible for analysis and reporting.

8.4 Sensitive Herbaceous Vegetation

The effects hydrologic and salinity events on habitat, growth, and distribution of sensitive herbaceous plant species are being monitored and assessed in tidal marsh and swamp forest communities within the greater Cape Fear estuary. Changes in growth and extent of several perennial species relative to salinity events within established plots have been remarkable. This year, 2008, salinity incursions at two stations, Inner Town Creek (P3) and Fishing Creek (P13) were again noted. However, changes at these sites were anticipated during the previous growing season. Early indications of changes at Indian Creek (P7) were not anticipated.

Polygon sizes are presented below for each site and monitoring year (Table 8.4-1). Data covering sensitive herbaceous vegetation are presented below for each of the sampling stations (Table 8.41-1 through 8.47-1). Polygon configurations are presented for the baseline year (2000), the previous growing season (2007) and the current season (2008) (Figures 8.41-1 through 8.47-1). Data from previous years of sensitive herbaceous vegetation sampling are presented in earlier reports (CZR Incorporated 2001, CZR Incorporated 2002, Hackney et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008 and Culbertson et al., 2009).

Table 8.4-1. Comparison of areas (ft^2) of sensitive herbaceous vegetation polygons for years 2000-2008 at sensitive herbaceous vegetation monitoring sites, Wilmington Harbor monitoring project, North Carolina

Station	Year								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Inner Town Creek (P3)	710.0	1552.5	1311.0	1326.0	1518.1	3619.2	5595.4	3403.3	A= 266.8, B=21.2
Indian Creek (P7)	129.8	129.8	281.9 [a]	281.9	281.9	281.9	281.9	281.9	254.3 [b]
Dollisons Landing (P8)	404.5	404.5	286.1 [a]	286.1	286.1	286.1	286.1	286.1	286.1
Black River (P9)	431.0	1120.0	913.0	567.8	69.5	251.8[b]	251.8	251.8	251.8
Rat Island (P12)	532.9	532.9	532.9	532.9	532.9	532.9	532.9	532.9	532.9
Fishing Creek (P13)	1522.2	1646.1	971.9	682.1	2506.3	2272.8	2305.3	1813.1	0
Prince George Creek (P14)	3931.2	3669.31	5190.2	5265.4	5227.2	5245.9	4654.3	4607.1	4702.7

[a] Changes in area are an artifact of shift to winter GPS data collection (Hackney et al., 2003).
[b] Polygon moved to new location (Hackney 2005 et al., and current report).

River salinity trends from river stations being monitored for changes in cover and species content of sensitive herbaceous vegetation are often used in discussion of changes in vegetation at seven sites, P3, P7, P8, P9, P12, P13, and P14 (Figure 8.4-1). River discharge data available for the Cape Fear River system are used to show river flow trends (Figure 8.4-2). Salinity trends currently divide the seven stations into three salinity groups. The first group of stations has experienced high salinities over the past year (P3, P12, and P13). The second group has experienced low salinities (P7, P8, and P9). The Black River station (P9) has experienced little or no ocean-derived salinity. The salinity at Indian Creek (P7) during the late season of 2008 is unusual in that the increases are slightly higher for 2008 than for 2007.

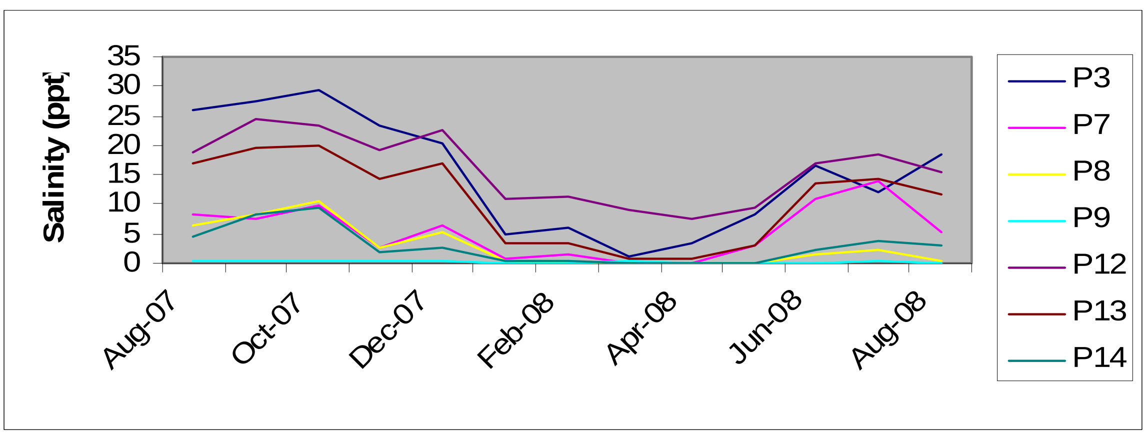


Figure 8.4-1. Trends in maximum salinity, August 2007-August 2008 at seven river sampling stations (P3-P14) Wilmington Harbor monitoring project, North Carolina (Culbertson et al., 2009and supplemental data from Data Collection Platform monitoring June-August, 2008)

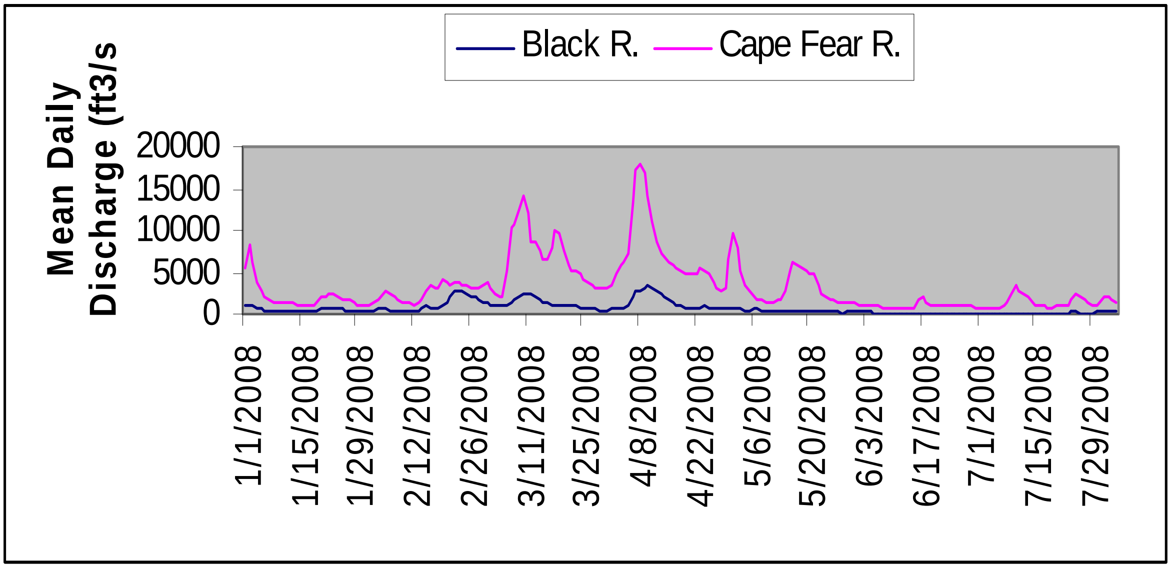


Figure 8.4-2. Trends for discharge on the Black River (Tomahawk, North Carolina) and Cape Fear River (Lock and Dam #1 near Kelly, North Carolina) (http://waterdata.usgs.gov/nc/nwis/current/?type=flow)

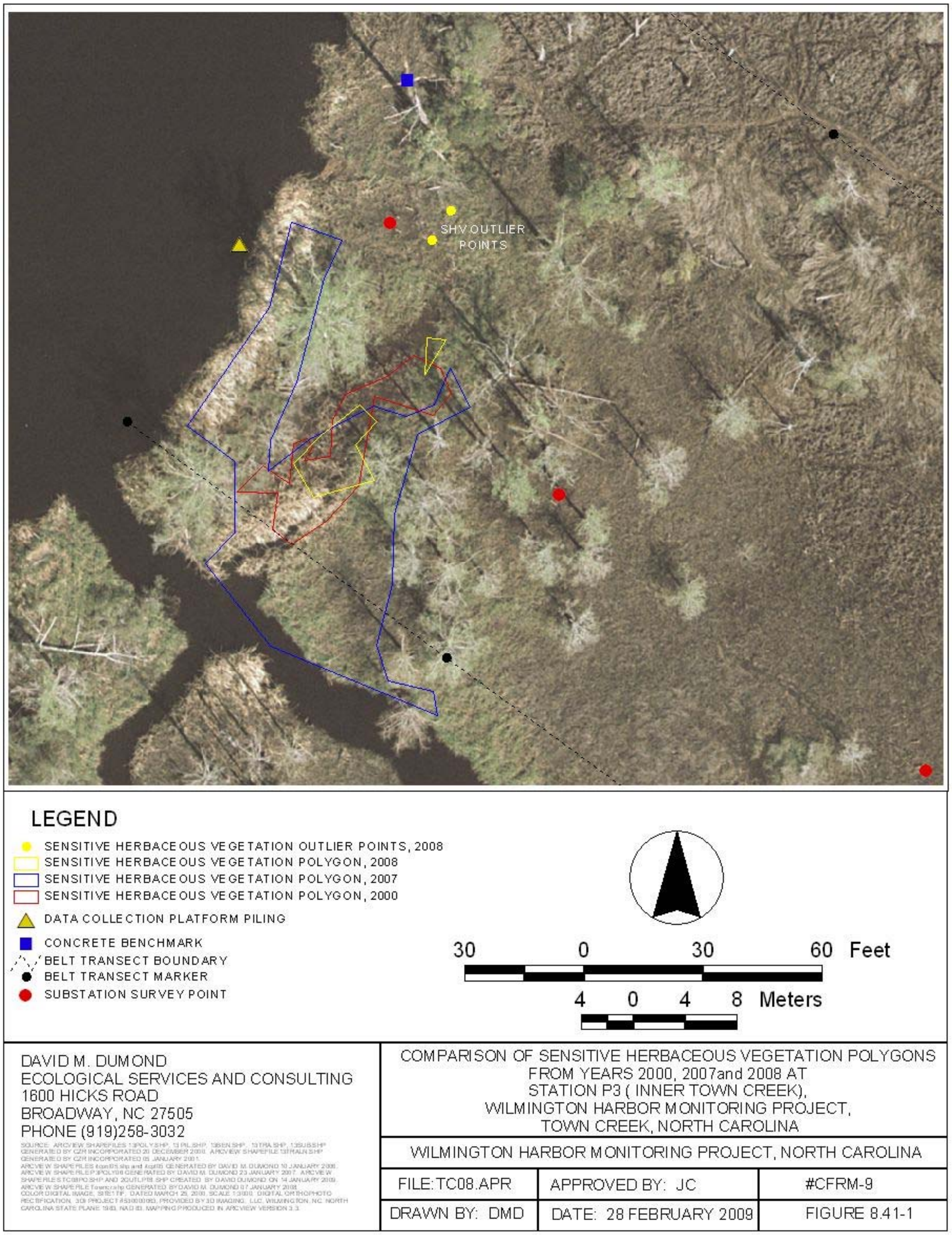
Data available from the US Geological Survey web site indicate a strong seasonal decrease in flow along the Black and Cape Fear Rivers during 2008 (Figure 8.4-2). These data show a low-flow period during June and July that complements the period of highest salinity along the Cape Fear River shown above (Figure 8.4-1). Periods of low flows occur coincidently in the Cape Fear and Black Rivers with both lowest between June 8 and July 23, 2008.

8.41 Town Creek

Two sensitive herbaceous polygon segments (A and B) are present this year at the Town Creek sampling station. The current polygons combined have a total area of only 288ft^2 (Table 8.4-1, Figure 8.41-1, Table 8.41-1). This new area is an order of magnitude smaller than the area of last year's single polygon area and about 5 percent of the largest polygon area (2006). The 2008 polygons remain directly associated with the small stream which drains the area and empties into the adjacent, old rice ditch at low tide.

Conditions which have contributed to the continuing decrease in dominant sensitive herbaceous species at Town Creek have apparently continued. This year, 2008, the larger polygon of 2007 was reduced to two, much smaller, polygons only one of which contained the long-time dominant. Two outlier points were documented this year north of the polygons where *Zizaniopsis miliacea* appeared from rhizomes more than 20 feet northeast of the edge of last year's polygon boundary (Figure 8.41-1). A network of *Zizaniopsis miliacea* rhizome material below the surface of the substrate provide the potential for regrowth, however, its fate is currently tenuous.

Only two other sensitive herbaceous species continue to occupy the segments A and B of the sensitive herbaceous vegetation polygon, *Sagittaria lancifolia* and *Schoenoplectus americanus*. Both represent a low percentage of cover, even in the tiny polygon segments remaining (Table 8.41-1). Three species representing subaerial biomass, *Peltandra virginica*, *Carex hyalinolepis* and *Zizania aquatica*, were not visible within the polygons this year.



Town Creek is one of two sensitive vegetation monitoring stations where high salinity has been documented and where there is strong evidence from the vegetation that high salinity waters are regularly present (Figure 8.4-1). The trend is for the highest salinities to occur with tides during late summer and into fall. During the winter salinities are reduced by dilution from freshwaters from the local watershed. As evapotranspiration increases, salinity increases through spring and summer. Drought phenomena often further reduce freshwater flow during the growing season.

The Town Creek site currently supports a large proportion of bare organic substrate. Rhizomes have failed to produce subaerial biomass in the current environment at this station. Propagula of plant species able to take advantage of changes being driven by high salinity can recruit from other areas in the system if opportunities for dispersal are present. The Town Creek area may not offer such opportunities simply because communities containing a diversity of competitive species are not locally abundant.

Other species seen within the polygon are *Typha angustifolia*, which has become the dominant in the area of the older polygons and *Schoenoplectus tabernaemontani*. Typha angustifolia is now the dominant landward of the polygon while *Spartina cynosuroides* is the dominant grass along the shoreline of Town Creek. *Spartina alterniflora* is now present in the polygon. *Carex hyalinolepis*, once nearly a mono-culture along the eastern boundary of the older polygons is now nearly gone.

Above ground leaves and stems of *Zizaniopsis miliacea* in the polygon and at the outlier points was browning and obviously in poor condition. Brown leaf edges and poorly developed stems were characteristic on *Sagittaria lancifolia*. The area of marsh immediately east of the polygon was either bare muck or supported a bit of remaining *Schoenoplectus tabernaemontani*. The old levee along the west side of the polygon is now dominated by *Spartina cynosuroides*. A creek entering the polygon from the old rice ditch has deepened somewhat and apparently allows tidal water into the area sooner in the tidal cycle. All *Taxodium ascendens* in the area are dead.

Immediate reasons for the continued deterioration of this site seem related directly to continued flooding by saline water. The condition of the mass of multi-species rhizomes below the surface of the substrate is key to whether this site can recover if salinity of flood waters decreases. It appears that the area will certainly experience continued floodwater salinity given the continued occurrences of droughts and low fresh water flows within the watershed.

Table 8.41-1. Comparisons of percent cover contributions by sensitive herbaceous species in major polygons (and outlier points) at the Inner Town Creek Station (P3) for years 2000-2008, Wilmington Harbor monitoring project, Town Creek, North Carolina. -- means species absent.

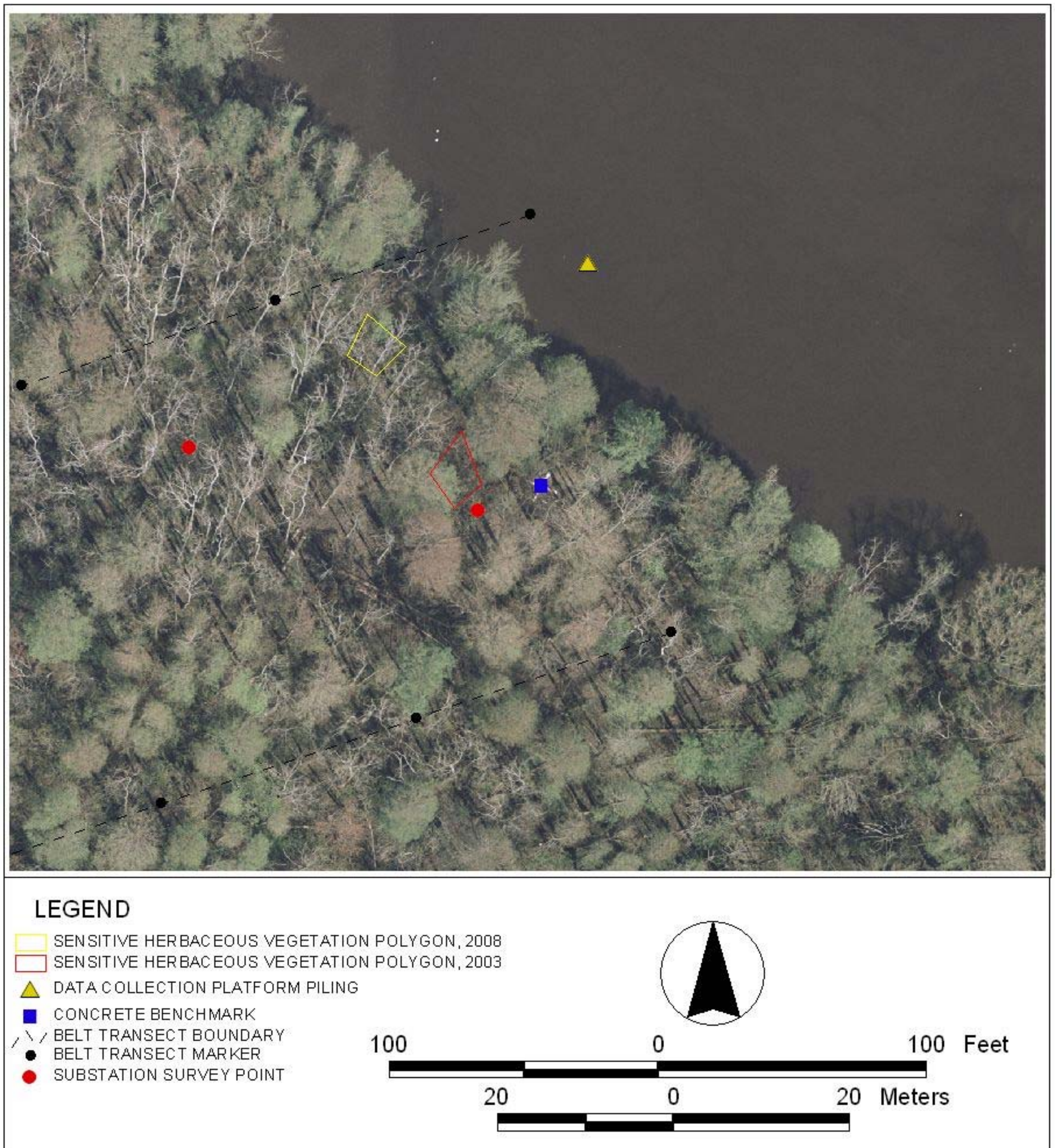
	Year								
Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Zizaniopsis miliacea	70	60	20	50	60 (20)	55 (5)	50	2	5(A)
Sagittaria lancifolia	5	20	5	10	10	10 (30)	2	<1	1(A) <1(B) & 2OP
Peltandra virginica	3	<1	<1	10	<1 (--)	<5 (<1)	1	<1	--
Carex hyalinolepis	1	10	10	40	1	<5	2	<1	--
Schoenoplectus americanus	--	--	10	10	10	>1 (<1)	1	1	1(A)
Zizania aquatica	--	--	--	--	--	-- (<1)	1	<1	--

At present there are no freshwater flow data to compare with salinity data for Town Creek. It is easy to speculate that the conditions which have followed so shortly the drought conditions experienced last year may not be particularly significant and that they may now represent the norm for this site. This possible new norm could have been influenced by gradual (last 10-15 years) substrate subsidence. Observations of subsidence are casual and have not, unfortunately, been considered an important factor influencing surface elevation of organic substrates and habitat change by the current research effort.

8.42 Indian Creek

Details of changes associated with development activities adjacent to the Indian Creek site (P7) have been discussed in previous reports (Hackney et al., 2008, Culbertson et al., 2009). Elements at each sampling site include a 50m belt transect and the adjacent data collection platform on a piling in the river (Figure 8.42-1). Each belt transect includes six surveyed substations used for sampling of swamp water and substrate parameters regularly monitored at each site. The near-shore end of the belt transect includes the sensitive herbaceous vegetation polygon that is monitored yearly. Location of the polygon within an area subject to continual tidal flux is critical.

Modifications to the original swamp vegetation in the Indian Creek belt transect resulting from partial site clearing by development interests necessitated reinvestigation of the belt transect, repair of its boundaries and re-establishment of a sensitive herbaceous vegetation polygon. This year, 2008, during the ninth year of sampling at Indian Creek, efforts to return the station to its normal functioning capacity were begun. The 50m wide belt transect was resurveyed, the boundaries repaired and the sensitive herbaceous species polygon was moved to a new location on the river shoreline, sampled. Products of these efforts are discussed in the following two sections. Data for GPS location of the new sensitive herbaceous vegetation plot were gathered, along with completion of other field work at the Indian Creek station, on August 6, 2008.



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SENSITIVE HERBACEOUS VEGETATION POLYGONS FROM YEARS 2003 AND 2008 AT STATION P7 (INDIAN CREEK), WILMINGTON HARBOR MONITORING PROJECT, CAPE FEAR RIVER, NORTH CAROLINA		
WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA		
FILE: ic08.apr	APPROVED BY: JC	#CFRM-9
DRAWN BY: DMD	DATE: 30 February 2009	FIGURE 8.42-1

8.42A Belt Transect Modifications

As a result of partial clearing of pre-existing swamp forest vegetation, most canopy and understory species were cut to within one or two feet of the substrate surface throughout tidal swamp forest that included the 50m belt transect. Some large specimens of *Taxodium ascendens* remain uncut. During the interval since cutting and clearing, regeneration of individuals of woody species has resulted in growth of shoots to several feet. Increase in light to the substrate has promoted growth of a multi-species stratum of herbaceous vegetation.

Originally, two lines of 10ft/ 2in PVC (Polyvinyl Chloride) pipes set at approximately 100ft intervals marked the boundaries of the belt transect. Due to the density of new vegetation growth most of these stakes were not readily visible. To confirm presence of the boundary markers it was necessary to cut lines of sight and along the sides of the belt transect. It was found that all posts were present but that a few needed straightening. Additional installation of posts was unnecessary except for one along the southeast side of the belt transect that was broken and required replacement. This need was relayed to the project field crew chief.

In the original establishment of belt transects during early stages of the project, a summary of the vegetation changes along each transect was included as a part of the description of base line conditions (CZR 2001). Developments brought about by the above partial clearing made necessary a second description of vegetation conditions at Indian Creek.

At Indian Creek regular tidal flux interacts with freshwater seepage from the base of sandy upland habitats. The uplands act as ground water aquifer recharge areas while the base of the upland is an area of groundwater discharge. Tide and seepage combine to define a set of broad ecotones between the river shoreline and the upper edges of the belt transect. These ecotones reflect, in part, a slow transition from intermittently salty environments near the river to more continuously fresh water conditions at the base of upland habitats.

Tidal flooding is a source of sediments and, as well, delivers seeds, rhizomes and other propagula that influence vascular plant growth between the river shoreline and the uplands. As long as precipitation fills recharge areas, seepage at the base of the upland act as a source of micro-nutrients and moisture. A gradient in substrate composition occurs from the river to the base of the upland. This gradient occurs along a gradual transition from river deposits of organics to organics more or less held in a suspension by seepage waters. Sandy soils replace organic soils as uplands truncate wetlands.

Individual stems of *Taxodium ascendens* that were not during the clearing process are scattered in a broken canopy across the ecotone from the shoreline to the base of the upland. Other vascular species are distributed across the above ecotones from the river to the base of the upland and form, in some places, indistinct bands that vary somewhat in species content. These variations may depend, in part, on disturbances associated with human modification of the site.

Surface sediments near the river's intra-tidal shoreline are regularly re-suspended, re-sorted and re-deposited by tides. Slightly higher sediments are generally compact, somewhat drier and intermixed with larger grained material to form an intermittent, low levee that is broken in places by small tidal ebb/flow inlet streams. The top of the levee is usually slightly above normal high water and somewhat flattened from years of functioning as a vessel disembarking pier. Tree species characteristically represented on the levee include *Quercus lyrata* and *Carya aquatica*, *Taxodium ascendens*, and *Quercus michauxii*. Following clearing, representatives of these species may be less than mature. Shrub species are most commonly *Arundinaria gigantea* with a mix of woody vines--*Smilax rotundifolia*, *Toxicodendron radicans*, and *Campsis radicans*. Herbaceous species noted were *Clematis crispa*, *Clematis ternifolia*, *Amaranthus cannabinus*, *Erechtites hieraciifolius*, *Boltonia asteroides* and *Leersia oryzoides*.

Behind, or just landward of the levee there is often a shallow slough or channel into which flooding tides first enter via small inlets the levee. The slough, sloping slightly toward the upland edge of the site, functions in distributing flooding tide water into the rest of the adjacent wetland habitat low enough to experience regular tides. Disturbance has been responsible for removal of most of the arborescent canopy and changes in soils to the extent that this slough now supports a rich mix of woody and herbaceous species with no clear dominants. It extends variably 150-250ft southwest of the levee. Herbaceous vegetation covers much of the woody debris left from cutting. Passage through this area by foot is difficult and visibility along the transect boundary is limited. Signs of recent soil disturbance are indicated by the presence of *Typha latifolia* and *Pluchea odorata*. Areas that have experienced relatively recent salinity events closer to shore support *Bolboschoenus robustus* and *Pluchea odorata*. Other species in this part of the transect are *Fraxinus caroliniana*, generally arising from multi-stemmed bases; *Cornus amomum*, from stump sprouts and underground stems; *Polygonum arifolium*, an annual that scrambles over other species; *Morella cerifera*, from multi-stemmed bases, *Acer rubrum*, from stump and root sprouts; and *Saururus cernuus* that usually arises from frequently flooded organic substrate.

For the next 150-200ft along the belt transect, shrub bases scattered stems of *Ilex verticillata* were apparent. Additional, fresh water species are also occur. Species noted in this reach, other than those seen elsewhere, were *Oenothera riparia*, appearing on scattered hummocks and stump bases; *Rosa palustris*, on hummocks and tree bases; *Mikania scandens*, scattered and common over other vegetation; *Eupatorium capillifolium* on disturbed hummocks above flooding; *Murdania keisak*, in low wet mats between hummocks. *Schoenoplectus tabernaemontani* was scattered through other thick herbaceous growth.

For the next 100-250ft clumps of *Alnus serrulata* were common in nearly freshwater habitats with several species of *Carex* that are characteristically found on old roots, stumps and woody plant bases. *Boehmeria cylindrica*, *Persea palustris*, *Hydrocotyle verticillata*, *Woodwardia areolata*, and *Toxicodendron vernix* increase in abundance toward upland and often are evidence of pockets of sandy substrate as well as fresh seepage water. Many of the above species as well as thicker stands of *Woodwardia virginica*, scattered *Peltandra virginica*, *Sagittaria latifolia*, *Hypericum walteri*, *Physostegia leptophylla*, *Carex albolutescens*, *Rotalla ramosior*, *Ludwigia decurrens* and *Ludwigia leptocarpa* occur, at least intermittently, to the wet, sandy base of upland habitat.

The belt transect, seen as vertical line in Fig. 8.42-1, at Indian Creek supports a disturbed wetland ecotone between regularly, tidally inundated habitat in a suspended muck substrate and a wet sandy freshwater seepage area at the base of an upland habitat. Many local microhabitats have experienced mixing, both horizontally and vertically, due to recent disturbances through the belt transect and throughout the vicinity.

8.42B Sensitive Herbaceous Polygon Modifications at Indian Creek

Sensitive herbaceous vegetation polygon at Indian Creek (P7) has been monitored since 2000. During 2006 cutting of subcanopy and most canopy vegetation by development interests from the wetland forest surrounding the sampling area were underway. Changes that resulted from clearing had several effects in the area of the polygon. Soils were disturbed and erosion rates through the polygon increased. These habitat and substrate changes necessitated movement of the sensitive herbaceous vegetation polygon to a new location in the boundaries of the belt transect. Selection of the new site proved difficult because of the disturbance. This relocation has now been completed and was used for the 2008 sampling period (Figure 8.42-1). The new polygon is in an area of mixed vegetation flooded by daily tides. The baseline species complement along with cover data from the new polygon are included below (Table 8.42-1).

Table 8.42-1. Comparisons of percent cover contributions by sensitive herbaceous species in the sampling polygon at the Indian Creek Station (P7) for years 2000-2008, Wilmington Harbor monitoring project, Cape Fear River, North Carolina (new polygon is right of the vertical line which indicates the belt transect). -- means species absent.

Species	**Year**								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**[a]
Saururus cernuus	2	1	--	2	20	1	5	2	<1
Cicuta maculata	5	2	<1	2	1	1	2	1	--
Polygonum punctatum	<1	<1	--	--	<1	<1	<1	3	<1
Commelina virginica	<1	2	1	<1	--	<1	<1	<1	--
Carex crinita var. *brevicrinus*	<1	<1	10	--	--	<1	1	--	--
Carex hyalinolepis	<1	2	--	1	<1	<1	<1	<1	10
Symphyotrichum elliottii	<1	--	--	--	--	<1	<1	<1	--
Triadenum walteri	<1	<1	--	--	--	--	--	--	--
Lycopus virginicus	<1	--	--	--	--	--	<1	1	<1
Galium sp.	<1	--	--	--	--	--	--	--	--
Phanopyrum gymnocarpum	--	<1	2	1	1	1	2	5	--
Peltandra virginica	--	--	<1	--	--	--	--	--	1
Boehmeria cylindrica	--	<1	--	--	--	<1	<1	--	--
Polygonum virginianum	--	--	--	1	--	<1	--	--	--
Chasmanthium latifolium	--	--	--	1	--	<1	2	--	--
Hymenocallis crassifolia	--	--	--	--	<1	<1	2	--	--

Table 8.42-1 (continued)

Species	Year								
	2000	2001	2002	2003	2004	2005	2006	2007	2008[a]
Cinna arundinacea	--	--	--	--	<1	<1	--	--	<1
Physostegia leptophylla	--	--	--	--	--	--	--	<1	--
Zizania aquatica	--	--	--	--	--	--	--	1	--
Mikania scandens	--	--	--	--	--	--	--	<1	1
Typha latifolia	--	--	--	--	--	--	--	--	5
Juncus effusus ssp. *solutus*	--	--	--	--	--	--	--	--	1
Clematis ternifolia	--	--	--	--	--	--	--	--	2
Rumex verticillatus									5
--Sagittaria lancifolia	--	--	--	--	--	--	--	--	10
Apios americana	--	--	--	--	--	--	--	--	1
Scutellaria lateriflora	--	--	--	--	--	--	--	--	<1
Sium suave	--	--	--	--	--	--	--	--	<1
Boltonia asteroides	--	--	--	--	--	--	--	--	<1
Pontederia cordata	--	--	--	--	--	--	--	--	2

[a] Permanent plot established at new location (see Figure 8.42-1).

Ten sensitive herbaceous species are new to the polygon at the Indian Creek station (Table 8.42-1). Seven other species were associated at some time with the previous polygon. The current polygon is considerably more diverse than the last, due partially to an increase in light and other disturbance effects of canopy and understory cutting. The most important sensitive herbaceous species in the present polygon are *Sagittaria lancifolia*, *Rumex verticillatus*, *Typha latifolia*, and *Carex hyalinolepis*. The presence of *Typha latifolia* reflects a degree of soil disturbance in the area. Four species characteristic of typical oligohaline marshes, *Sium suave*, *Boltonia asteroides*, *Cinna arundinacea*, and *Apios americana* are also present. The presence of *Juncus effusus* ssp. *solutus* may also reflect degree of disturbance.

Three species not considered sensitive herbaceous vegetation are also important. These are *Polygonum arifolium,* which contributed a cover within the polygon of 15%; *Eupatorium capillifolium*, which may become more abundant in the future; and *Bolboschoenus robustus* (previously *Scirpus robustus*), which may indicate past and continuing effects of salt water in the area.

Three woody species, *Taxodium ascendens, Fraxinus* sp., and *Nyssa aquatica* are residual from the dominant woody vegetation prior to the clearing effort. These are not considered sensitive herbaceous species since they are woody. Woody vines, *Campsis radicans* and *Smilax rotundifolia* were also a part of the pre-existing swamp forest habitat that have expanded because of increased light and become denser.

The Indian Creek site is currently transitional along the main stem of the Cape Fear River. It has recently begun to show effects of ocean-derived salts. Eagle's Island has long been converted to a site characterized by ocean-derived sulfate reduction. In 1972, Eagles Island supported the same general vegetation as that now present at Indian Creek. Now, at Indian Creek, the outermost substation shows sulfate reduction and low methane content in soils (Culbertson et al., 2009, Tables 5.51-4 and 5.51-5). Salinity incurions, dependent on low flow and droughts within the main stem Cape Fear River watershed, may begin to manifest further changes at this site, much as those at the Fishing Creek site on the Northeast Cape Fear River (Figure 8.4-1, Figure 8.4-2).

8.43 Dollisons Landing

Data from the Dollisons Landing sensitive herbaceous polygon showed few changes from last year (Table 8.43-1, Figure 8.43-1). There are, however, possible indicators of future change. During 2007, Cape Fear River monitoring data from Dollisons Landing indicated a maximum river salinity of 10.5 for the month of October. This concentration was most likely flushed from the system during the early part of 2008, while essentially fresh water characterized that reach of the river until summer (Culbertson et al., 2009, Table 3.3A-1; Figure 8.4-1). Winter values at the outer swamp monitoring station indicate the prevalence of sulfate reduction in soils (Culbertson et al., 2009, Table 5.51-5). For this station, sulfate reduction was unusual. Maximum salinities in the Cape Fear River near the Dollisons Landing sampling station have remained low during the year prior to the August sampling. The presence of a sulfate reducing environment at Dollisons Landing now is reason expect future changes.

The reason for disappearance of *Pontederia cordata* from the sensitive herbaceous polygon since last year is worth noting since this species' previous cover contribution was 5%. *Saururus cernuus* has remained the dominant species within the polygon, while *Cicuta maculata* has shown a significant increase this year. *Hydrocotyle verticillata* and *Boehmeria cylindrica* were not visible this year. *Impatiens capensis*, not considered a sensitive herbaceous species for purposes of this study, was relatively abundant in the polygon this year. Seeds of this annual species were likely recently deposited. *Pilea pumila* and *Polygonum arifolium* were also present this year. *Nyssa aquatica* and *Taxodium ascendens* were apparently healthy.

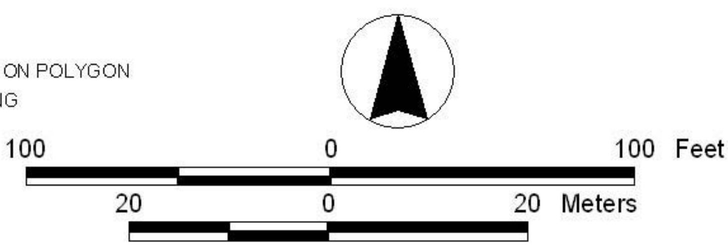
The discovery of winter sulfate reduction in a swamp subsite at Dollisons Landing, reveals the vulnerability of swamps far upstream of the river mouth when upstream flows are reduced.

Table 8.43-1. Comparisons of percent cover contributions by sensitive herbaceous species in the sampling polygon at the Dollisons Landing Station (P8) for years 2000-2008, Wilmington Harbor monitoring project, Cape Fear River, North Carolina. -- means species absent.

Species	Year								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
Saururus cernuus	30	20	35	35	40	50	30	30	30
Boehmeria cylinidrica	<1	--	<1	<1	1	<1	<1	<1	--
Rumex verticillatus	<1	--	2	2	<1	<1	--	--	<1
Cicuta maculata	2	--	2	2	<1	<1	<1	<1	10
Carex sp.	1	--	--	--	--	--	--	--	--
Polygonum punctatum	1	1	3	3	--	<1	1	>1	1
Peltandra virginica	2	1	3	3	<1	1	1	>1	1
Carex crinita	<1	2	--	--	--	--	--	--	--
Dulichium arundinaceum	<1	--	--	--	--	--	--	--	--
Triadenum walteri	<1	--	--	--	--	--	--	--	--
Eryngium aquaticum	--	3	1	1	--	--	<1	--	--
Pontederia cordata	--	<1	--	--	--	<1	<1	5	--
Hymenocallis crassifolia	--	--	<1	<1	<1	--	--	<1	<1
Alternanthera philoxeroides	--	--	<1	<1	--	--	--	--	--
Proserpinaca palustris	--	--	--	--	<1	--	--	--	--
Ipomoea sp.	--	--	--	--	<1	--	--	--	--
Hydrocotyle verticillata	--	--	--	--	--	--	1	<1	--
Lycopus virginicus	--	--	--	--	--	--	<1	--	--

LEGEND

- SENSITIVE HERBACEOUS VEGETATION POLYGON
- DATA COLLECTION PLATFORM PILING
- CONCRETE BENCHMARK
- BELT TRANSECT BOUNDARY
- BELT TRANSECT MARKER
- SUBSTATION SURVEY POINT



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SOURCE: ARCVIEW SHAPE FILES 16POLY.SHP, 16 PIL.SHP, 16BEN.SHP, 16TRA.SHP, 16SUB.SHP GENERATED BY CZR INCORPORATED ON 20 DECEMBER 2000. ARCVIEW SHAPEFILE 16TRALN.SHP GENERATED BY CZR INCORPORATED 10 JANUARY 2001. ARCVIEW SHAPEFILE DOLL.62.SHP GENERATED BY DAVID M. DUMOND, ON 6 FEBRUARY 2003. COLOR DIGITAL IMAGE, SITE11.TIF, DATED MARCH 25, 2000, SCALE 1:3000, DIGITAL ORTHOPHOTO RECTIFICATION, 3DI PROJECT #53000083, PROVIDED BY 3D IMAGING, LLC WILMINGTON, NC. NORTH CAROLINA STATE PLANE1983, NAD 83. MAPPING PRODUCED IN ARCVIEW VERSION 3.3

SENSITIVE HERBACEOUS VEGETATION POLYGON FROM YEAR 2003
AT STATION P8 (DOLLISONS LANDING),
WILMINGTON HARBOR MONITORING PROJECT,
CAPE FEAR RIVER, NORTH CAROLINA

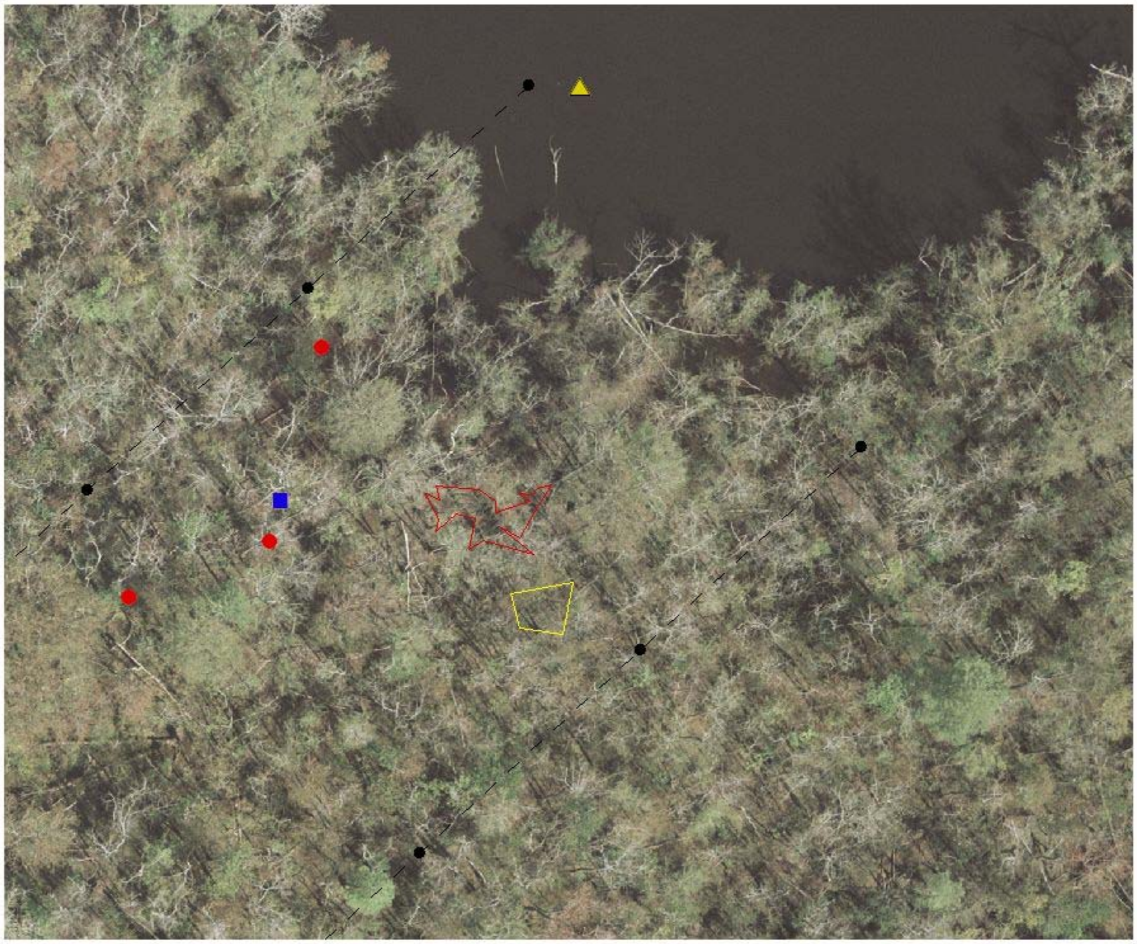
WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE: dl08.APR	APPROVED BY: JC	#CFRM-9
DRAWN BY: DMD	DATE: 30 February 2009	FIGURE 8.43-1

8.44 Black River

Changes in sensitive herbaceous vegetation at the Black River station were minimal over the last year. The dominant species of the vascular plant, *Saururus cernuus*, increased its coverage within the sensitive herbaceous vegetation polygon (Table 8.43-1). The coverage contributed by *Polygonum punctatum* decreased. Three species were, this year, new to the polygon, *Apios americana*, *Hymenocallis crassifolia*, and *Lycopus virginicus*.

There are no indications that ocean derived salts have influenced the contents of the sensitive herbaceous vegetation polygon at the Black River station. No significant salinity events have occurred in waters near the station during the past year (Table 8.4-1). The river monitoring station is located in an area that is dominated by flow from the Black River. Tidal flux within the Cape Fear River influences flow from the mouth of the Black River. However, sulfate reduction was noted during this winter at the lower sub-station and at sub-station 5 (Culbertson et al., 2009, Table 5.51-5).



LEGEND

- SENSITIVE HERBACEOUS VEGETATION POLYGON, 2005
- SENSITIVE HERBACEOUS VEGETATION POLYGON, 2000
- DATA COLLECTION PLATFORM PILING
- CONCRETE BENCHMARK
- BELT TRANSECT BOUNDARY
- BELT TRANSECT MARKER
- SUBSTATION SURVEY POINT

100 0 100 Feet

20 0 20 Meters

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SOURCE: ARCVIEW SHAPE FILES 7POLY.SHP, 17PIL.SHP, 17BEN.SHP, 17TRA.SHP, 17SUB.SHP GENERATED BY CZR INCORPORATED ON 20 DECEMBER 2000. ARCVIEW SHAPEFILE 17TRALN.SHP GENERATED BY CZR INCORPORATED 11 JANUARY 2001. SHAPE FILE AREA-GEN.SHP GENERATED BY DAVID M. DUMOND 21 JANUARY 2005 AND SHAPE FILE brv08.shp GENERATED 10 JANUARY 2008. COLOR DIGITAL IMAGE, SITE1.TIF, DATED MARCH 25, 2000, SCALE 1:3000. DIGITAL ORTHOPHOTO RECTIFICATION. 3DI PROJECT #53000063, PROVIDED BY 3D IMAGING, LLC, WILMINGTON, NC. NORTH CAROLINA STATE PLANE 1983, NAD 83. MAPPING PRODUCED IN ARCVIEW VERSION 3.3.

SENSITIVE HERBACEOUS VEGETATION POLYGONS
FROM YEARS 2000 AND 2008 AT STATION P9 (BLACK RIVER),
WILMINGTON HARBOR MONITORING PROJECT,
NORTHEAST CAPE FEAR RIVER, NORTH CAROLINA

WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE: br08.apr	APPROVED BY: JC	#CFRM-9
DRAWN BY: DMD	DATE: 30 February 2009	FIGURE 8.44-1

Table 8.44-1. Comparisons of percent cover contributions by sensitive herbaceous species in old polygons from years 2000-2004 and new sensitive herbaceous polygon for 2005-2008 at the Black River (P9), Wilmington Harbor monitoring project, Cape Fear River, North Carolina (bold vertical line separates old and new plots). -- means species absent.

Species	**Year**								
	2000	**2001**	**2002**	**2003**	**2004**	**2005** [a]	**2006**[a]	**2007**[a]	**2008**[a]
Ludwigia palustris	50	20	20	1	5	5	--	<1	--
Polygonum punctatum	--	15	1	--	1	<1	<1	5	<1
Symphyotrichum elliottii	--	2	<1	1	<1	<1	<1	<1	<1
Scutellaria lateriflora	--	--	<1	--	--	--	--	--	--
Boehmeria cylindrica	--	--	<1	--	<1	--	<1	1	1
Saururus cernuus	--	--	--	--	--	10	10	3	20
Physostegia leptophylla	--	--	--	--	--	<1	--	<1	<1
Peltandra virginica	--	--	--	--	--	<1	1	<1	--
Cicuta maculata	--	--	--	--	--	--	<1	2	2
Mikania scandens	--	--	--	--	--	--	--	<1	2
Lobelia cardinalis	--	--	--	--	--	--	--	<1	--
Apios americana	--	--	--	--	--	--	--	--	5
Hymenocallis crassifolia	--	--	--	--	--	--	--	--	<1
Lycopus virginicus	--	--	--	--	--	--	--	--	<1

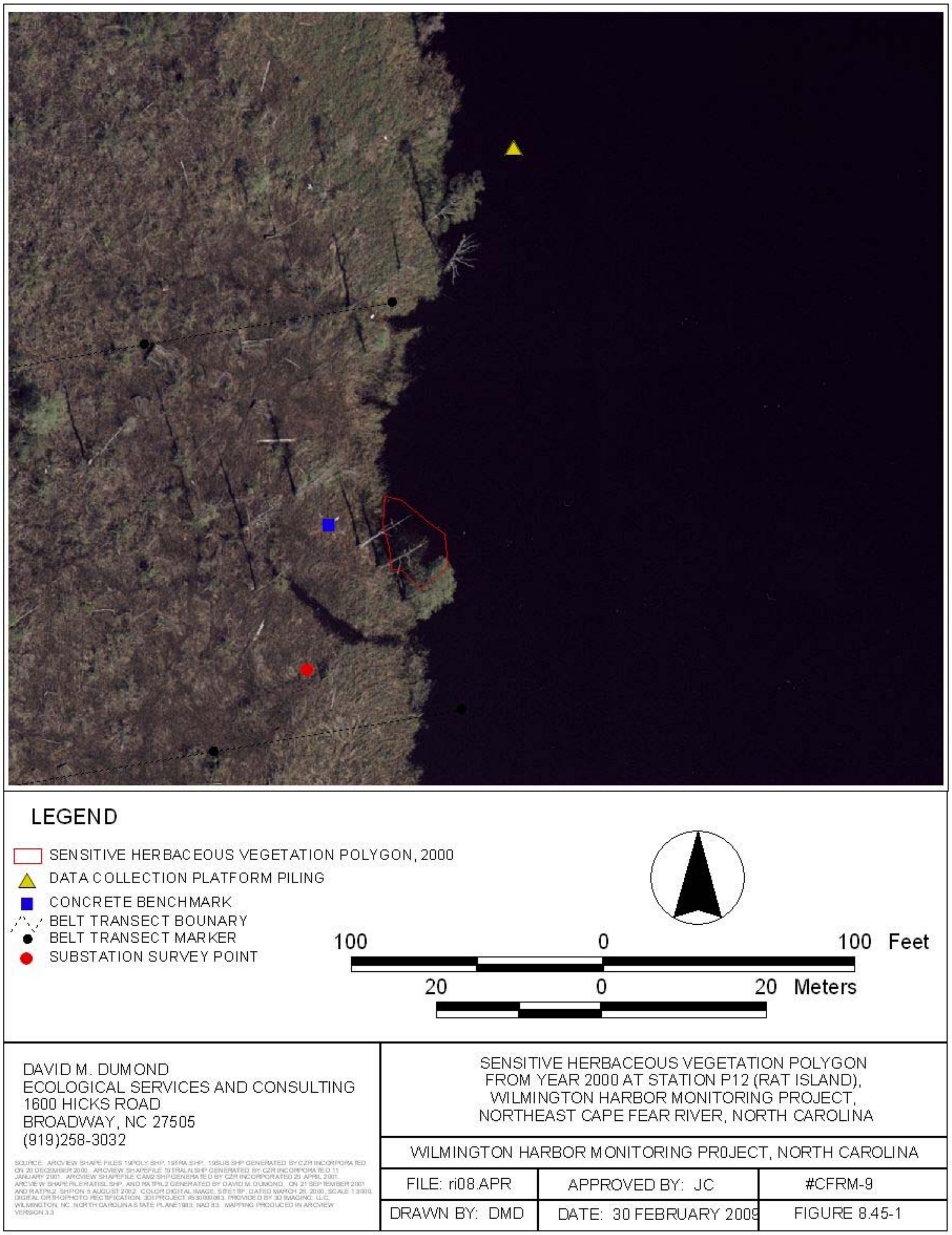
[a] Plot relocated in 2005

8.45 Rat Island

The sensitive herbaceous polygon at the Rat Island (P12) sampling station remains the same size and shape as in previous years (Table 8.41-1, Figure 8.45-1), except for loss of a small portion of vegetated substrate paralleling the Northeast Cape Fear River. This small section occupies a portion of the bank along a shallow, sandy bottom that is subject to erosion by boat wakes. The erosion process has moved further into the polygon than last year.

Four species presently occupy the sensitive herbaceous vegetation polygon at the Rat Island station (Table 8.45-1). These are *Schoenoplectus americanus*, *Sagittaria lancifolia*, *Symphyotrichum subulatum,* and *Spartina cynosuroides*. *Schoenoplectus americanus* and *Spartina cynosuroides* are nearly equal in cover at 60 and 50%, respectively. *Carex hyalinolepis* was not visible in the plot this year. This was the first year since the beginning of sampling that this species has not been noted. Corms of *Hymenocallis crassifolia* were not seen this year, but may have been covered by substrate or by the heavy growth of other species.

Salinity conditions for Rat Island in the Northeast Cape Fear River remain similar as those along Town Creek (Figure 8.4-1). All substations show continuing sulfate reduction metabolism in soils (Culbertson et al., 2009, Table 5.51-5). Diversity of vascular plant species at Rat Island is the lowest seen for this site since sampling began nine years ago.


LEGEND
SENSITIVE HERBACEOUS VEGETATION POLYGON, 2000
DATA COLLECTION PLATFORM PILING
CONCRETE BENCHMARK
BELT TRANSECT BOUNARY
BELT TRANSECT MARKER
SUBSTATION SURVEY POINT
100 0 100 Feet
20 0 20 Meters
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SENSITIVE HERBACEOUS VEGETATION POLYGON
FROM YEAR 2000 AT STATION P12 (RAT ISLAND),
WILMINGTON HARBOR MONITORING PROJECT,
NORTHEAST CAPE FEAR RIVER, NORTH CAROLINA
WILMINGTON HARBOR MONITORING PR0JECT, NORTH CAROLINA
FILE: ri08.APR
APPROVED BY: JC
#CFRM-9
DRAWN BY: DMD
DATE: 30 FEBRUARY 2009
FIGURE 8.45-1

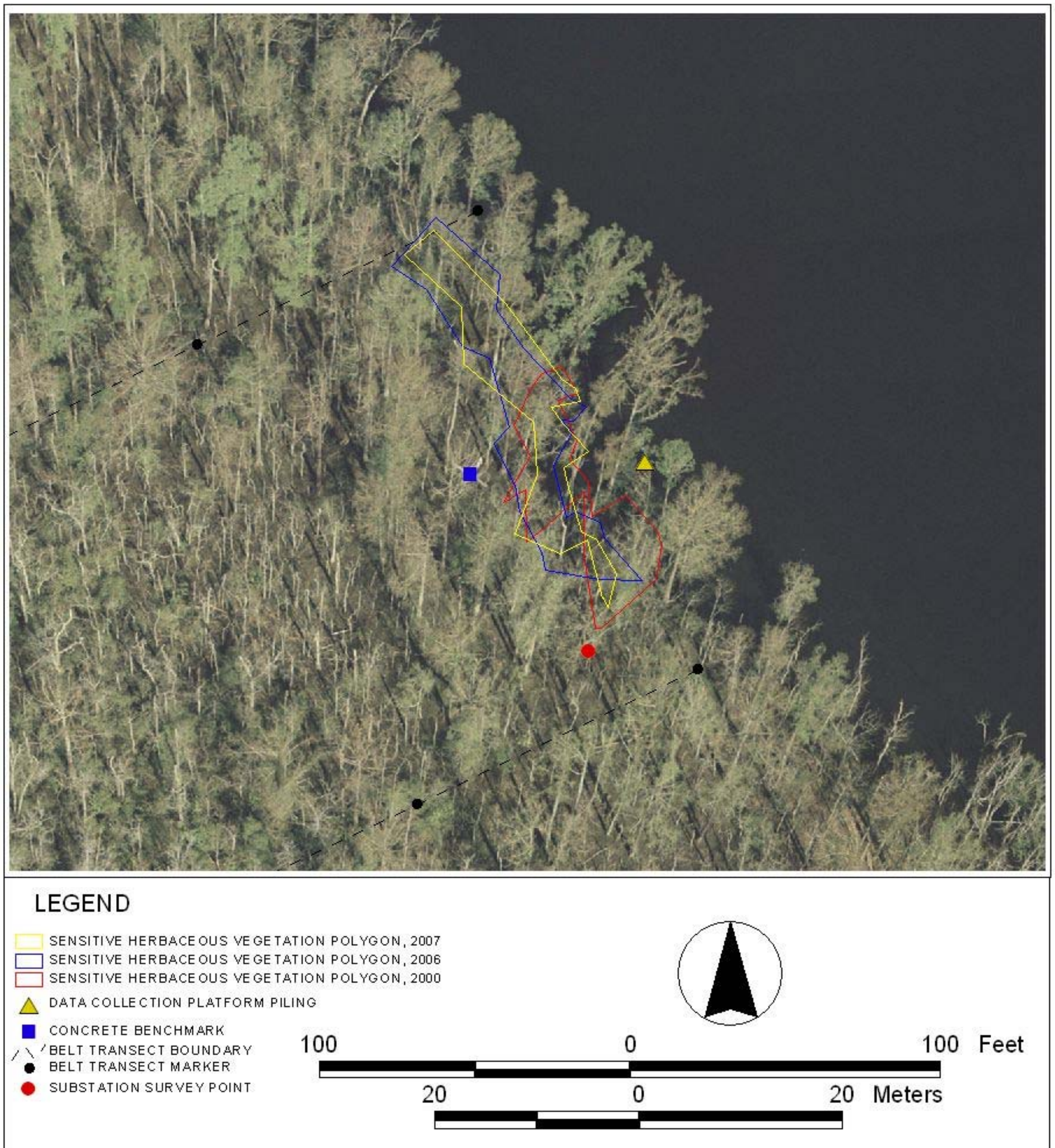
Table 8.45-1. Comparisons of percent cover contributions by sensitive herbaceous species in the polygon for years 2000-2008 at the Rat Island (P12), Wilmington Harbor monitoring project, Northeast Cape Fear River, North Carolina. -- means species absent.

Species	Year								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Schoenoplectus americanus	100	20	30	50	25	90	50	30	60
Carex hyalinolepis	20	8	10	<1	2	<1	2	10	--
Sagittaria lancifolia	10	30	--	5	10	<1	5	<1	<1
Alternanthera philoxeroides	<1	--	<1	--	--	--	--	--	--
Boltonia asteroides	<1	<1	--	--	--	--	--	--	--
Symphyotrichum subulatum	<1	<1	<1	<1	--	--	--	--	<1
Peltandra virginica	--	1	--	--	--	--	<1	--	--
Rumex verticillatus	--	1	--	--	--	--	--	<1	--
Hymenocallis crassifolia	--	<1	--	1	<1	<1	<1	<1	--
Polygonum punctatum	--	--	--	--	<1	--	--	--	--

8.46 Fishing Creek

Last year, 2007, the variable polygon at Fishing Creek was decreased significantly in shape and size due to the effects of a strong salinity incursion (Figure 8.46-1, Table 8.4-1). There had been a decrease of nearly 500 ft^2 and a number of sensitive herbaceous species were missing. This year, 2008, the dominant sensitive herbaceous species, *Saururus cernuus* and *Pontederia cordata*, were essentially missing from the polygon (Table 8.46-1). It was clear there had again been saltwater at this station. There too few culms of the two original co-dominant species to allow redefinition. The size and shape of this year's polygon was retained for re-evaluation next year. Given a period of freshwater flow, *Saururus cernuus* and *Pontederia cordata* rhizomes could again support subaerial stems by August 2009.

This year two species common to the polygon had become co-dominants, *Alternanthera philoxeroides* and *Zizania aquatica*. Species absent from the polygon this year were *Polygonum punctatum*, *Cinna arundinacea*, *Mikania scandens*, and *Leersia oryzoides.* Of the previous dominants, *Saururus cernuus* and *Pontederia cordata*, only small fragments of green connected to otherwise brown tissue and rare live fragment of stem. For all practical puposes, co-dominants present during the previous year were not visible in the polygon. Subaerial plant material had been killed by salt.



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COMPARISON OF SENSITIVE HERBACEOUS VEGETATION POLYGONS FOR YEARS 2000, 2006 AND 2007 AT STATION P13 (FISHING CREEK), WILMINGTON HARBOR MONITORING PROJECT, NORTHEAST CAPE FEAR RIVER, NORTH CAROLINA

WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE: fc08.apr	APPROVED BY: JC	#CFRM-9
DRAWN BY: DMD	DATE: 30 FEBRUARY 2009	FIGURE 8.46-1

As of this year, Fishing Creek had been strongly affected by sea water over two consecutive growing seasons; salinity was high during June, 2007 (Culbertson et al., 2009). This year it high flood water salinity during early July was responsible for the damage (Figure 8.4-1, Figure 8.46-2). The relationship between salinity values and river flow is suggested by a plot of river flow and river level values from the Northeast Cape Fear River at a gagging station near Chinquapin, North Carolina (Figure 8.46-3) and from the staff gage near Burgaw, North Carolina (Figure 846-4). Chinquapin is further up the Northeast Cape Fear River than Burgaw, but both serves as an indication of river conditions at the time high salinity was recorded for the same three-month period in 2008.

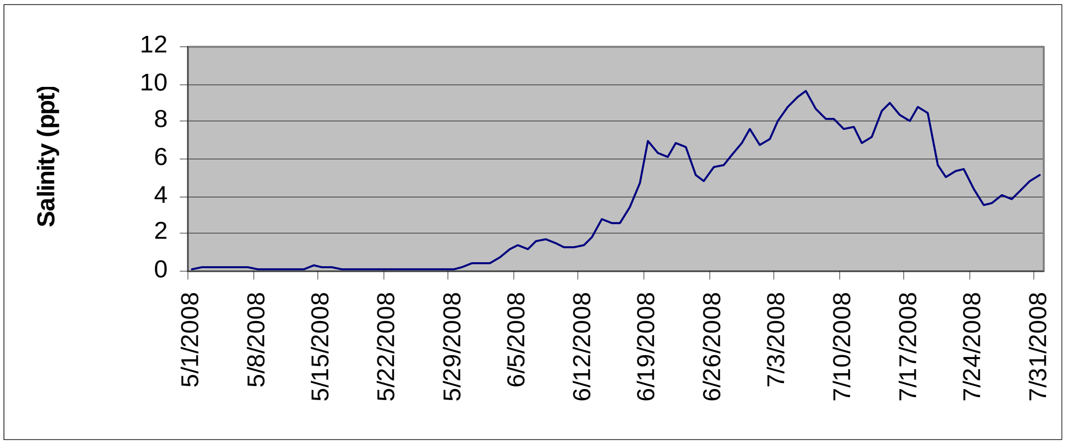


Figure 8.46-2. Mean daily salinity values in the Northeast Cape Fear River at Fishing Creek (P13), Wilmington Harbor monitoring project, Northeast Cape Fear River, North Carolina

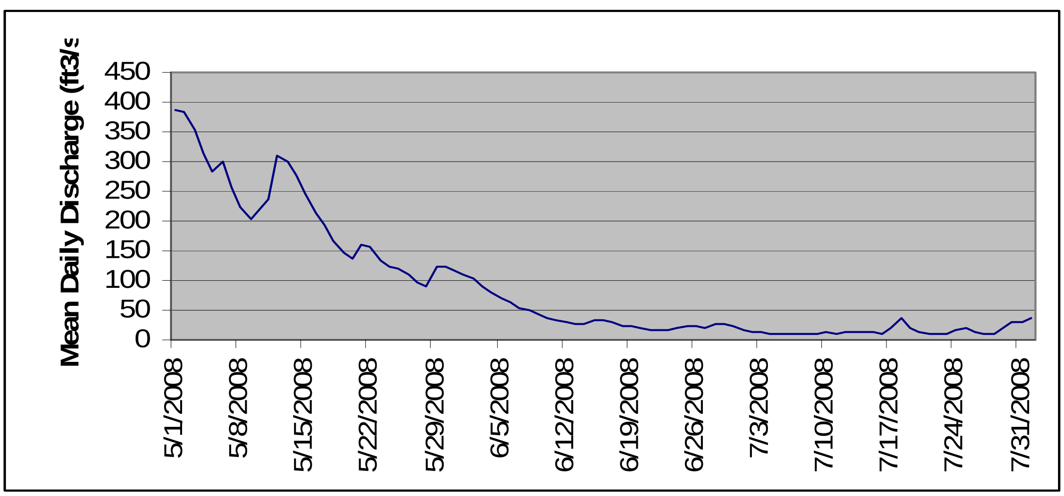


Figure 8.46-3. Mean daily discharge along the Northeast Cape Fear River near Chinquapin, North Carolina
(http://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=02108000)

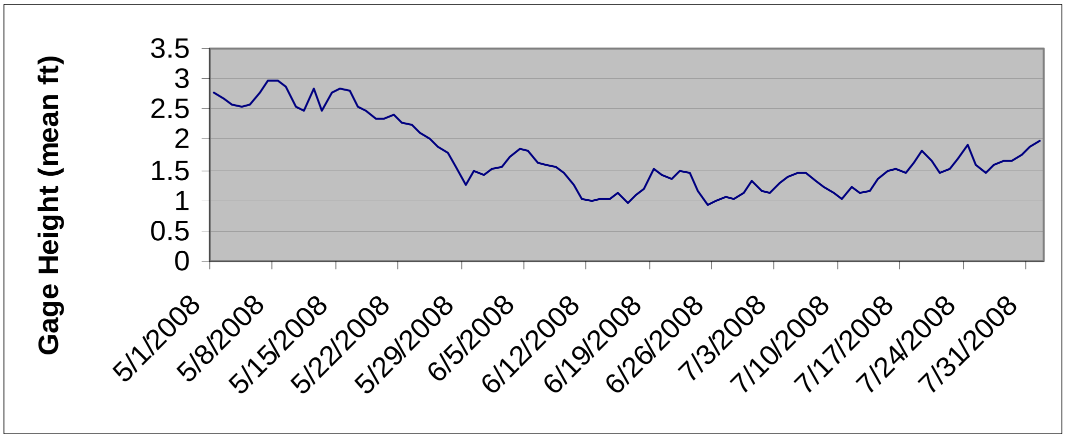


Figure 8.46-4. Mean daily gage height along the Northeast Cape Fear River near Burgaw, North Carolina (http://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=02108000)

The salt water incursion at Fishing Creek occurred between the middle of June and the middle of July. This timeframe is consistent with the degree of plant damage and the extent of damaged plant deterioration observed during August of the same year.

Other impacts noted at Fishing Creek that can be related to recent salinity events include death of some *Taxodium ascendens*, poor growth of *Taxodium ascendens* knees, death of some *Nyssa biflora*, dead upper stems and branches of *Fraxinus* sp., aborted inflorescences of Pluchea odorata (not a sensitive herbaceous species), death of branches of *Nyssa aquatica* and general thinning of the shrub understory near the river shoreline. Much of the shrub understory is dominated by *Morella cerifera*. *Echinochloa walteri*, an annual grass characteristically a member of oligohaline marshes, was new to the area this year.

This year's two new plant dominants in the sensitive herbaceous vegetation polygon, *Alternanthera philoxeroides* and *Zizania aquatica*, are both rhizomatous perennials. Seeds of the former are regularly deposited during ebb tide, particularly during late summer and fall when large rafts of intertwined stems are carried down the Northeast Cape Fear River. *Zizania aquatica* becomes visible above ground when salinity events depress the competitive capability of other, largely freshwater plants. It is possible that *Zizania aquatica* will be an important species in the sensitive herbaceous polygon at Fishing Creek in 2009 even if weather patterns render the river salinities very low through the coming year.

Substrate changes have continued at this site. Last year subsidence appeared to have resulted in a compaction of the organic substrate. This year, erosion of the substrate within the polygon was noted along the outer edge closest to and paralleling the river. Erosion of one or more small channels was cutting into the substrate along this shoreline edge of the sensitive herbaceous polygon as water left the swamp forest on falling tides. The surface of the substrate was exposed more than had been observed during past visits. Harder substrate seemed to be promoting more rapid erosion.

Table 8.46-1. Comparisons of percent cover contributions by sensitive herbaceous species in polygons from years 2000-2008 at the Fishing Creek Station (P13), Wilmington Harbor monitoring project, Northeast Cape Fear River, North Carolina. -- means species absent.

Species	Year								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Pontederia cordata	20	40	50	30	30	35	20	2[a]	<1 [a]
Symphyotrichum elliottii	<1	--	--	--	--	1	--	--	--
Polygonum punctatum	2	1	--	<1	10	2	3	1	--
Sium suave	<1	2	5	1	1	--	2	3[a]	2 [a]
Zizaniopsis miliacea	2	<1	<1	5	5	<1	--	--	1
Saururus cernuus	2	2	--	1	5	1	1	<1[a]	<1
Cicuta maculata	<1	2	--	--	1	1	<1	--	<1
Sagittaria lancifolia	2	20	5	20	5	1	3	3	2 [a]
Orontium aquaticum	<1	--	--	--	--	--	--	--	--
Peltandra virginica	<1	1	5	30	12	5	25	5[a]	2 [a]
Rhynchospora corniculata	<1	<1	--	--	<1	--	<1	<1	<1
Carex sp.	<1	--	--	--	--	--	--	--	--
Alternanthera philoxeroides	--	5	<1	<1	--	1	<1	1	20
Zizania aquatica	--	2	<1	50	<1	<1	<1	<1	10 [a]
Boltonia asteroides	--	1	--	--	<1	<1	<1	<1	<1
Rumex verticillatus	--	<1	2	1	--	<1	<1	<1	1 [a]
Cinna arundinacea	--	<1	--	<1	<1	--	<1	<1[a]	--
Eryngium aquaticum	--	<1	5	2	2	5	2	<1[a]	<1
Schoenoplectus americanus	--	--	<1	--	--	--	--	--	--
Carex hyalinolepis	--	--	--	1	--	--	--	<1	1
Apios americana	--	--	--	<1	<1	<1	<1	--	--
Hymenocallis crassifolia	--	--	--	2	--	--	--	--	1

Table 8.46-1 (continued)

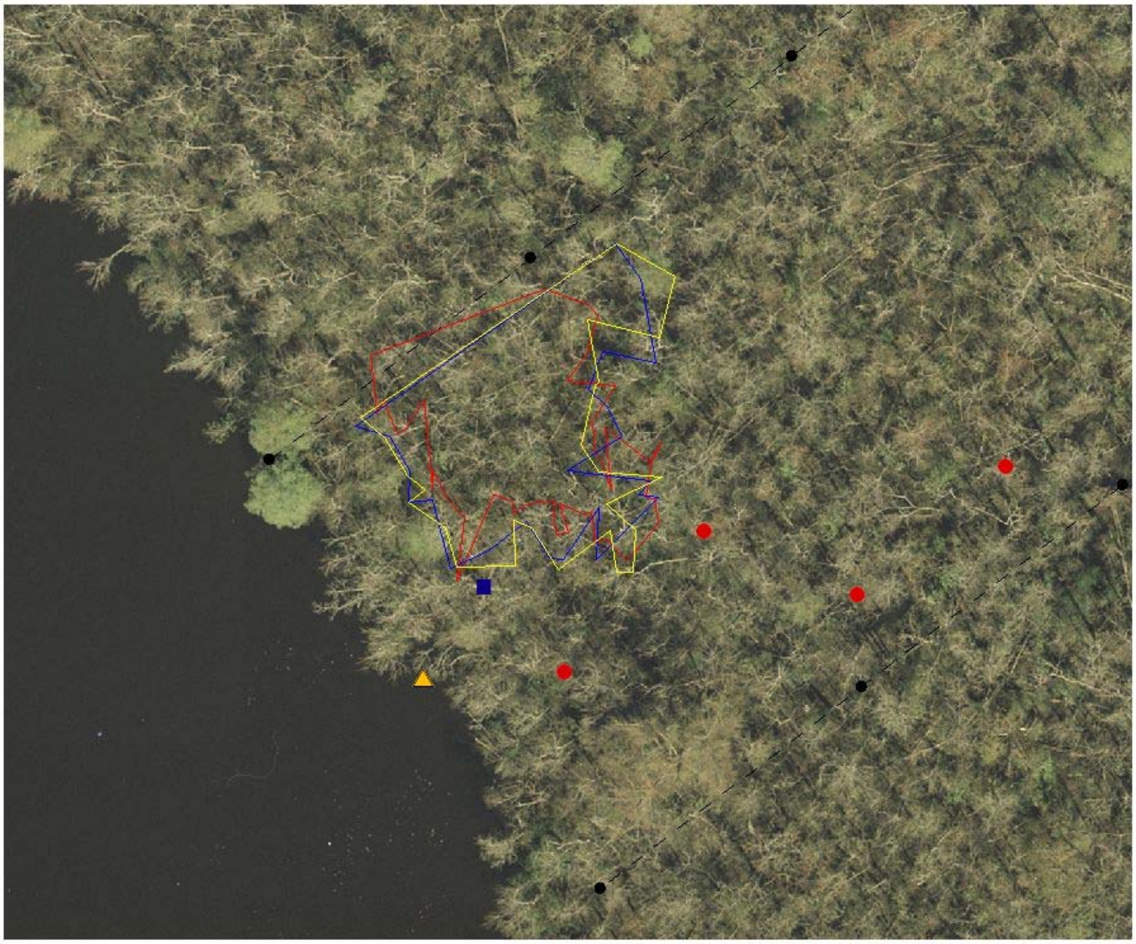
Species	Year								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
Ludwigia palustris	--	--	--	<1	<1	--	<1	--	--
Hypericum mutilum	--	--	--	--	<1	--	--	--	--
Boehmeria cylindrica	--	--	--	--	<1	<1	<1	--	--
Lycopus virginicus	--	--	--	--	--	<1	<1	--	--
Cyperus sp.	--	--	--	--	--	<1	--	--	--
Elymus virginicus	--	--	--	--	--	<1	--	<1	<1
Lobelia cardinalis	--	--	--	--	--	--	<1	--	--
Carex crus-corvi	--	--	--	--	--	--	<1	--	--
Bidens laevis	--	--	--	--	--	--	<1	--	<1
Mikania scandens	--	--	--	--	--	--	<1	<1	--
Leersia oryzoides	--	--	--	--	--	--	--	<1	--

[a]Visible salt damage on plant materials

8.47. Prince George Creek

Shape, size and species content of the sensitive herbaceous vegetation polygon at Prince George Creek have remained similar to previous years (Tables 8.4-1 and 8.47-1, Figure 8.47-1). There was no evidence of salt damage. Apparent changes in shape are most likely related to the effects of GPS multipath anomalies.

Cover by *Saururus cernuus* decreased from last year, but not as low as during 2002 and 2005. The apparent decrease in cover was observed along with a more open aspect at the level of the herbaceous stratum in the swamp forest. Following two years of minimal increases in river salinities during growing season at the Prince George Creek sampling station, there may have been some slight influence on vegetation (Figure 8.4-1). *Peltandra virginica* was more common this year compared with last year, but *Pontederia cordata* had again reappeared. Three species were new to the sensitive herbaceous vegetation polygon. *Sium suave* and *Eryngium aquaticum* are more tolerant of oligohaline waters than many of the other species listed for the polygon (Table 8.47-1). *Apios americana* is generally considered a freshwater wetland species.



LEGEND

SENSITIVE HERBACEOUS VEGETATION POLYGON, 2008
SENSITIVE HERBACEOUS VEGETATION POLYGON, 2007
SENSITIVE HERBACEOUS VEGETATION POLYGON, 2000
DATA COLLECTION PLATFORM PILING
CONCRETE BENCHMARK
BELT TRANSECT BOUNDARY
BELT TRANSECT MARKER
SUBSTATION SURVEY POINT

100 0 100 Feet

20 0 20 Meters

DAVID M. DUMOND
ECOLOGICAL SERVICES AND CONSULTING
1600 HICKS ROAD
BROADWAY, NC 27505
(919)258-3032

SOURCE: ARCVIEW SHAPE FILES 21POLY.SHP, 21PIL.SHP, 21BEN.SHP, 21TRA.SHP, 21SUB.SHP GENERATED BY CZR INCORPORATED ON 20 DECEMBER 2000. ARCVIEW SHAPEFILE 21TRALN.SHP GENERATED BY CZR INCORPORATED 11 JANUARY 2001. ARCVIEW SHAPEFILE Prgc08.shp GENERATED 1/23/07 BY DAVID DUMOND. ARCVIEW SHAPEFILE Prnge07 GENERATED BY DAVID DUMOND 08 JANUARY 2008 AND ARCVIEW SHAPEFILE PRG08PO.SHP GENERATED 14 JANUARY 2009. COLOR DIGITAL IMAGE: SITE1.TIF, DATED MARCH 25, 2000, SCALE 1:3000. DIGITAL ORTHOPHOTO RECTIFICATION: 3DI PROJECT #53000063. PROVIDED BY 3D IMAGING, LLC, WILMINGTON, NC. NORTH CAROLINA STATE PLANE 1983, NAD 83. MAPPING PRODUCED IN ARCVIEW VERSION 3.3.

COMPARISON OF SENSITIVE HERBACEOUS VEGETATION POLYGONS
FOR YEARS 2000, 2007 AND 2008 AT STATION P14 (PRINCE GEORGE CREEK),
WILMINGTON HARBOR MONITORING PROJECT,
NORTHEAST CAPE FEAR RIVER, NORTH CAROLINA

WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE: pgc08.APR	APPROVED BY: JC	#CFRM-9
DRAWN BY: DMD	DATE: 30 February 2009	FIGURE 8.47-1

Table 8.47-1. Comparisons of percent cover contributions by sensitive herbaceous species in polygons from years 2000-2008 at the Prince George Creek Station (P14), Wilmington Harbor monitoring project, Northeast Cape Fear River, North Carolina. -- means species absent.

Species	**Year**								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Saururus cernuus	35	60	20	40	40	20	50	35	30
Polygonum punctatum[a]	20	15	--	<1	20	30	10	2	<1
Peltandra virginica	10	8	1	5	10	5	30	1	2
Pontederia cordata	--	5	--	--	<1	--	<1	--	1
Cicuta maculata	--	<1	<1	<1	--	--	<1	<1	1
Zizania aquatica	--	<1	--	--	--	--	--	--	--
Cinna arundinacea	--	<1	--	--	<1	<1	<1	<1	<1
Boehmeria cylindrica	--	<1	<1	--	--	1	--	<1	--
Carex lupulina	--	<1	<1	--	--	--	--	<1	--
Alternanthera philoxeroides	--	--	<1	--	--	--	--	--	<1
Decodon verticillatus	--	--	<1	<1	<1	<1	<1	<1	--
Hymenocallis crassifolia	--	--	<1	<1	1	1	1	<1	<1
Zizaniopsis miliacea	--	--	--	<1	<1	<1	<1	--	<1
Triadenum walteri	--	--	--	<1	--	--	--	<1	--
Hydrocotyle sp.	--	--	--	--	<1	--	<1	--	--
Lobelia cardinalis	--	--	--	--	--	<1	--	--	--
Ludwigia palustris	--	--	--	--	--	--	<1	--	--
Lycopus virginicus	--	--	--	--	--	--	--	<1	--
Eryngium aquaticum	--	--	--	--	--	--	--	--	<1
Sium suave	--	--	--	--	--	--	--	--	<1
Apios americana	--	--	--	--	--	--	--	--	<1

[a] Previously identified as *Polygonum hydropiper* and *Polygonum hydropiperoides*.

8.5 Discussion

For the second year in a row (2007 and 2008) there have been strong indications of flooding by saltwater at sampling stations along waterways within the greater study area. The effects were most pronounced along Town Creek and the Northeast Cape Fear River, while visible effects along the Cape Fear were minimal in spite of reduced flows (Figure 8.4-2). Sensitive herbaceous species at the Inner Town Creek and Fishing Creek stations suffered the most damage to above-ground tissues as a result of salinity incursions. This response to tidally born ocean-derived salinities may be due largely to seasonally reduced flows in both Town Creek and the Northeast Cape Fear River, which have watersheds completely restricted to the coastal plain where the effects of a regional drought may have been somewhat prolonged.

At Town Creek, the second year of flooding by saline waters has contributed to the loss of most sensitive herbaceous vegetation within the polygon established at that site. More tolerant species, including *Typha angustifolia* and *Spartina cynosuroides,* are encroaching by rhizome growth into the area and assuming dominance. This year, *Spartina alterniflora* is present in the area. Changes in substrate consistency and density, as observed casually, seem to have resulted in a small decrease in elevation in the area, thus allowing deeper flooding by tides. Vegetation characteristic of oligohaline tidal waters has virtually disappeared. Whether rhizome material supporting the original complement of oligohaline species is still present below the surface of the substrate is not known.

The course of events at the Fishing Creek station has been similar with the exception that oligohaline conditions are just beginning to be compromised. Vegetation at this site may still be capable of recovering from stress imposed by abnormal salinities. Some soil changes appear, at least casually, to be taking place relative to erosion and regular inundation by high salinity tides.

Along the Cape Fear River, the Indian Creek station will be the next sensitive herbaceous polygon to undergo change by salt water. This year, indications of change were minimal and related largely to additions of more salt-tolerant species. However, these observations may be subject to misinterpretation of interference from recent soil and vegetation disturbances noted at the site.

It is apparent from data presented above that there have been significant salinity events this year within the project area. These events altered freshwater vegetation at the Fishing Creek station, at the Town Creek station and minimal change at the Indian Creek station. Trees currently dominant in the area, including *Taxodium*, *Nyssa* and *Fraxinus,* are beginning to die. Individuals of these species showing signs of salt damage in this area likely represent age classes between 50 and 100 years old. No inventory has been undertaken. Herbaceous vegetation at Fishing Creek is changing to more salt-tolerant species. Annual species, which are considered highly opportunistic, have changed. Perennial species supported by underground rhizome systems are disappearing from the subaerial environments. There are definite indications that vegetation change is slowly working up the Cape Fear River system. The change is coming about as a result of intolerance to increasing salinities.

9.0 LITERATURE CITED

Culbertson, J. B., M.Crawford, E. Brinker, M. Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., and others. 2009. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 8: June 1, 2007 – May 31, 2008. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biology and Marine Biology, Wilmington, NC.

CZR Incorporated. 2001. Monitor Potential Effects of Increased Tidal Range on the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina. Part B. Initial Baseline Monitoring. Prepared for U. S. Army Corps of Engineers, Wilmington District, Wilmington, NC.

CZR Incorporated. 2002. Monitor Potential Effects of Increased Tidal Range on the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina. Part B. Initial Baseline Monitoring. Prepared for U. S. Army Corps of Engineers, Wilmington District, Wilmington, NC.

Hackney, C. T., M. Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., and others. 2002. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 1: August 1, 2000 – July 31, 2001. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hackney, C. T., M. Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., and others. 2003. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 2: June 1, 2001 – May 31, 2002. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hackney, C. T., M. Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., and others. 2004. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 3: June 1, 2002 – May 31, 2003. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hackney, C. T., M. Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., D.M. DuMond, and others. 2005. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 4: June 1, 2003 – May 31, 2004. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hackney, C. T., Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., D.M. DuMond, and others. 2006. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 5: June 1, 2004 – May 31, 2005. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hackney, C. T., Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., D.M. DuMond, and others. 2007. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 6: June 1, 2005 – May 31, 2006. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hackney, C. T., Posey, L.L. Leonard, T Alphin, G.B. Avery Jr., D.M. DuMond, and others. 2008. Monitoring Effects of a Potential Increased Tidal Range in the Cape Fear River Ecosystem Due to Deepening Wilmington Harbor, North Carolina Year 6: June 1, 2006 – May 31, 2007. Unpublished report prepared for the U. S. Army Corps of Engineers, Wilmington District. University of North Carolina at Wilmington Department of Biological Sciences, Wilmington, NC.

Hesslein, R.H. 1976. An in situ sampler for close interval pore water studies. Limnology and Oceanography 21:912-914.

Hoehler, T.M., M.J. Alperin, D.B. Albert and C.S. Martens. 1994. Field and laboratory studies of methane oxidation in an anoxic marine sediment: Evidence for a methanogen-sulfate reducer consortium. Global Biogeochemical Cycles 8:451-463.

Kelley, C.A., C.S. Marten, and W. Ussler III. 1995. Methane dynamics across a tidally flooded riverbank margin. Limnology and Oceanography 40:1112-1129.

Mallin, M., M. Posey, G. Shank, M. McIver, S. Ensign, and T. Alphin. 1999. Hurricane effects on water- quality and benthos in the Cape Fear watershed: Natural and anthropogenic impacts. Ecological Applications 9(1): 350-362.

Mallin, M., M.H. Posey, T.E. Lankford, M.R. McIver, S.H. Ensign, T.D. Alphin, M.S. Williams, M.L. Moser, and J.F. Merritt. 2001. Environmental assessment of the lower Cape Fear River system 2000-2001. CMS Report No. 01-02.

Pawlowicz, R., B. Beardsley, and S. Lentz. 2002. Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE. Computers and Geosciences 28: 929-937.

APPENDIX A

LIST OF TIDAL RANGE DATA FOR ALL 14 STATIONS USED TO GENERATE FIGURES AND TABLES IN SECTION 3.0 (1 June 2008 – 31 May 2009)

Appendix A. List of tidal range data for all 14 stations used to generate figures and tables in Section 3.0. xxx indicates data loss.

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1	3.26	3.52	2.51	3.63	3.62	3.3	3	2.79	3.55	3.15	2.69	1.96
2	3.53	3.87	2.81	3.97	3.94	3.72	3.45	3.20	3.88	3.54	3.15	2.54
3	4.81	4.99	3.39	5.05	4.92	4.61	4.31	4.10	4.85	4.39	3.85	3.02
4	4.62	4.71	3.07	4.77	4.65	4.23	3.87	3.62	4.57	4.05	3.43	2.49
5	3.2	3.52	2.52	3.65	3.61	3.30	2.98	2.79	3.55	3.15	2.69	1.98
6	3.49	3.78	2.81	3.97	3.92	3.68	3.40	3.24	3.87	3.51	3.10	2.47
7	5.27	5.15	3.61	5.21	5.16	4.85	4.57	4.37	5.06	4.62	4.10	3.29
8	4.2	3.85	2.19	3.74	3.65	3.31	2.97	2.69	3.55	3.09	2.52	1.51
9	3.29	3.36	1.94	3.35	3.25	2.96	2.63	2.39	3.18	2.77	2.27	1.35
10	3.76	3.99	2.53	4.07	4.01	3.63	3.31	3.10	3.91	3.46	2.92	2.04
11	4.26	4.29	2.64	4.33	4.23	3.81	3.46	3.22	4.16	3.64	3.02	2.08
12	4.52	4.45	xxx	4.50	4.39	3.92	3.50	3.22	4.30	3.75	3.06	2.07
13	3.2	3.42	xxx	3.54	3.50	3.10	2.73	2.51	3.40	2.95	2.39	1.61
14	3.3	3.45	xxx	3.51	3.46	3.26	3.01	2.86	3.39	3.08	2.69	2.09
15	4.69	4.56	xxx	4.54	4.43	4.15	3.86	3.66	4.46	3.93	3.38	2.52
16	4.68	4.58	xxx	4.63	4.52	4.05	3.65	3.37	4.43	3.90	3.23	2.22
17	3.55	3.75	xxx	3.87	3.81	3.41	3.05	2.83	3.54	3.27	2.71	1.87
18	3.12	3.39	xxx	3.49	3.45	3.20	2.96	2.82	3.44	3.04	2.65	1.99
19	4.34	4.26	xxx	4.29	4.18	3.88	3.58	3.39	4.12	3.69	3.18	2.35
20	4.75	4.62	xxx	4.70	4.54	4.08	3.67	3.39	4.47	3.93	3.24	2.18
21	3.72	3.83	xxx	3.91	3.81	3.40	3.03	xxx	3.73	3.28	2.71	1.83
22	3.28	3.54	xxx	3.64	3.56	3.34	3.06	2.92	3.49	3.14	2.72	2.08
23	4.26	4.30	xxx	4.39	4.26	3.98	3.67	3.46	4.20	3.76	3.23	2.40
24	4.48	4.50	xxx	4.60	4.43	3.98	3.60	3.30	4.36	3.83	3.16	2.14
25	3.87	4.09	xxx	4.28	4.15	3.74	3.39	3.17	4.07	3.59	2.98	2.04
26	3.52	3.70	xxx	3.84	3.75	3.45	3.14	2.94	3.69	3.26	2.72	1.88
27	3.98	4.06	xxx	4.09	3.96	3.62	3.28	3.06	3.94	3.45	2.87	2.00
28	4.45	4.57	xxx	4.65	4.45	4.04	3.64	3.39	4.41	3.86	3.19	2.19
29	4.19	4.39	xxx	4.54	4.36	3.97	3.57	3.32	4.30	3.79	3.13	2.12
30	3.73	3.97	xxx	3.96	3.86	3.57	3.22	3.01	3.81	3.38	2.80	1.88

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
31	3.87	4.07	xxx	4.01	3.90	3.60	3.25	3.03	3.84	3.40	2.83	1.92
32	xxx	4.70	xxx	4.81	4.63	4.19	3.81	3.50	4.55	4.01	3.34	2.29
33	xxx	4.82	xxx	4.90	4.71	4.24	3.85	3.58	4.62	4.07	3.38	2.31
34	4.1	4.23	xxx	4.28	4.17	3.76	3.39	3.12	4.07	3.59	2.95	1.96
35	4.23	4.20	xxx	4.28	4.17	3.77	3.40	3.11	4.09	3.61	2.95	1.97
36	4.52	4.56	xxx	4.67	4.49	4.07	3.69	3.42	4.43	3.90	3.22	2.21
37	5.01	4.95	xxx	5.03	4.84	4.34	3.92	3.62	4.76	4.17	3.44	2.33
38	4.56	4.52	xxx	4.57	4.44	3.96	3.54	3.23	4.34	3.80	3.08	1.96
39	4.09	4.09	xxx	4.16	4.04	3.64	3.25	2.98	3.95	3.48	2.83	1.82
40	4.75	4.68	xxx	4.78	4.60	4.16	3.76	3.49	4.53	3.99	3.31	2.28
41	5.43	5.24	xxx	5.32	5.09	4.55	4.12	3.80	5.01	4.39	3.62	2.45
42	5.13	4.93	xxx	4.88	4.73	4.18	3.74	3.41	4.63	4.04	3.26	2.06
43	4.12	4.13	2.48	4.12	4.04	3.60	3.22	2.95	3.95	3.46	2.81	1.80
44	4.79	4.72	3.01	4.83	4.65	4.22	3.86	3.58	4.58	4.06	3.42	2.43
45	5.92	5.66	3.37	5.71	5.44	4.87	4.43	4.11	5.36	4.72	3.92	2.71
46	5.6	5.29	2.95	5.31	5.10	4.45	3.93	3.53	4.99	4.32	3.45	2.14
47	4.23	4.12	2.50	4.20	4.09	3.62	3.20	2.89	3.99	3.47	2.81	1.77
48	4.71	4.69	xxx	4.83	4.68	4.29	3.94	3.71	4.61	4.12	3.51	2.57
49	6.61	6.11	xxx	6.14	5.86	5.23	4.75	4.41	5.77	5.09	4.23	2.97
50	5.8	5.28	xxx	5.30	5.05	4.39	3.86	3.45	4.94	4.27	3.39	2.07
51	4.47	4.21	xxx	4.30	4.17	3.70	3.27	2.96	4.07	3.56	2.87	1.80
52	4.89	4.71	xxx	4.77	4.62	4.17	3.79	3.53	4.54	4.04	3.38	2.36
53	6.2	5.81	xxx	5.83	5.55	4.93	4.42	4.06	5.47	4.81	3.96	2.68
54	5.73	5.32	xxx	5.35	5.09	4.42	3.85	3.43	4.97	4.29	3.40	2.02
55	4.35	4.18	xxx	4.27	4.14	3.65	3.23	2.90	4.03	3.52	2.83	1.72
56	4.81	4.59	xxx	4.69	4.50	4.06	3.70	3.43	4.43	3.95	3.29	2.26
57	6.19	5.84	xxx	5.91	5.56	4.92	4.41	4.04	5.47	4.80	3.95	2.62
58	5.63	5.26	xxx	5.30	5.01	4.32	3.75	3.31	4.88	4.18	3.30	1.88
59	4.05	3.99	2.27	4.10	3.97	3.50	3.08	2.76	3.87	3.37	2.69	1.58
60	4.63	4.48	2.81	4.56	4.40	3.99	3.61	3.36	4.32	3.83	3.20	2.18
61	5.82	5.43	3.15	5.42	5.18	4.61	4.12	3.78	5.09	4.46	3.66	2.41

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
62	5.65	5.28	2.89	5.31	5.08	4.44	3.90	3.50	4.99	4.32	3.44	2.11
63	3.93	3.88	2.33	4.02	3.88	3.44	3.03	2.73	3.85	3.31	2.65	1.63
64	4.3	4.26	2.86	4.41	4.24	3.94	3.62	3.40	4.18	3.76	3.23	2.40
65	5.41	5.17	3.19	5.26	5.05	4.61	4.22	3.95	4.97	4.42	3.73	2.67
66	5.26	5.10	3.01	5.06	4.93	4.38	3.92	3.59	4.84	4.25	3.48	2.32
67	3.92	4.08	2.58	4.10	4.02	3.60	3.22	2.96	3.94	3.48	2.86	1.93
68	3.97	4.10	2.84	4.19	4.09	3.80	3.47	3.25	4.02	3.63	3.12	2.35
69	4.95	4.83	3.10	4.87	4.72	4.36	3.96	3.70	4.65	4.16	3.53	2.57
70	4.87	4.87	3.07	4.87	4.71	4.28	3.88	3.61	4.66	4.14	3.48	2.49
71	4.01	4.24	2.80	4.32	4.22	3.85	3.48	3.25	4.16	3.70	3.13	2.25
72	3.72	3.86	2.67	3.98	3.90	3.62	3.27	3.06	3.84	3.43	2.93	2.17
73	4.26	4.26	2.88	4.33	4.21	3.91	3.57	3.35	4.16	3.73	3.19	2.39
74	4.33	4.56	2.91	4.48	4.36	3.97	3.64	3.40	4.29	3.83	3.24	2.33
75	3.82	4.13	2.74	4.09	4.03	3.67	3.35	3.16	3.94	3.53	2.99	2.18
76	3.78	3.90	2.64	4.05	4.01	3.72	3.41	3.23	3.93	3.55	3.04	2.30
77	4.23	4.20	2.75	4.28	4.20	3.88	3.54	3.33	4.14	3.72	3.16	2.34
78	3.79	4.02	2.70	4.13	4.01	3.73	3.45	3.26	3.98	3.60	3.08	2.30
79	3.74	3.98	2.69	4.13	4.01	3.74	3.47	3.28	3.97	3.60	3.09	2.30
80	3.27	3.52	2.31	3.56	3.54	3.30	3.00	2.80	3.48	3.11	2.63	1.89
81	3.06	3.39	2.29	3.44	3.42	3.20	2.93	2.74	3.37	3.02	2.58	1.91
82	3.67	3.98	2.76	4.14	4.00	3.73	3.47	3.29	3.94	3.55	3.07	2.35
83	3.62	4.05	2.73	4.17	4.03	3.75	3.47	3.29	3.98	3.57	3.07	2.32
84	3.43	3.60	2.43	3.69	3.62	3.36	3.09	2.90	3.57	3.20	2.72	2.00
85	3.05	3.27	2.24	3.28	3.23	2.98	2.72	2.54	3.17	2.84	2.42	1.80
86	3.29	3.78	2.67	3.78	3.73	3.51	3.28	3.15	3.67	3.35	2.96	2.38
87	3.85	4.23	2.91	4.29	4.23	3.98	3.73	3.61	4.17	3.79	3.32	2.58
88	3.17	3.52	2.36	3.57	3.54	3.28	3.02	2.84	3.48	3.12	2.67	1.94
89	2.58	2.92	2.10	3.02	3.00	2.79	2.55	2.40	2.95	2.65	2.29	1.72
90	3.24	3.59	2.65	3.74	3.66	3.47	3.25	3.13	3.61	3.31	2.95	2.37
91	3.81	4.07	2.85	4.20	4.09	3.87	3.64	3.60	4.04	3.70	3.27	2.58
92	3.38	3.67	2.50	3.73	3.69	3.44	3.17	2.97	3.64	3.27	2.80	2.08

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
93	2.49	2.89	2.11	2.98	3.00	2.78	2.54	2.37	2.94	2.65	2.27	1.71
94	3.14	3.50	2.67	3.63	3.58	3.41	3.19	3.07	3.53	3.27	2.88	2.23
95	3.91	4.23	3.03	4.35	4.24	4.04	3.79	3.65	4.19	3.86	3.38	2.57
96	3.54	3.83	2.67	3.94	3.89	3.65	3.37	3.19	3.83	3.45	2.98	2.25
97	2.64	2.98	2.19	3.13	3.12	2.91	2.63	2.48	3.08	2.76	2.36	1.79
98	3	3.41	2.59	3.55	3.49	3.32	3.11	2.99	3.46	3.21	2.87	2.39
99	4.13	4.44	3.12	4.53	4.41	4.18	3.96	3.87	4.37	4.02	3.57	2.87
100	3.77	4.01	2.75	4.12	4.05	3.74	3.45	3.26	3.99	3.57	3.09	2.30
101	2.65	3.00	2.26	3.17	3.15	2.89	2.64	2.50	3.10	2.77	2.42	1.85
102	3.04	3.42	2.62	3.56	3.50	3.30	3.11	2.92	3.46	3.18	2.86	2.37
103	4.37	4.60	3.20	4.68	4.56	4.29	4.03	3.88	4.51	4.12	3.64	2.89
104	4.09	4.29	2.87	4.35	4.27	3.96	3.65	3.43	4.22	3.77	3.25	2.39
105	2.82	3.15	2.31	3.27	3.24	3.01	2.74	2.58	3.20	2.86	2.49	1.87
106	3.41	3.57	2.71	3.67	3.61	3.43	3.19	3.07	3.57	3.27	2.94	2.40
107	4.72	4.76	3.29	4.79	4.69	4.41	4.14	3.97	4.60	4.21	3.74	2.96
108	4.5	4.49	2.95	4.54	4.48	4.08	3.73	3.49	4.39	3.91	3.31	2.38
109	3.13	3.30	2.38	3.42	3.41	3.10	2.80	2.61	3.40	2.98	2.53	1.85
110	3.57	3.72	2.82	3.82	3.77	3.56	3.30	3.16	3.72	3.40	3.04	2.46
111	4.97	4.94	3.40	4.97	4.86	4.54	4.23	4.03	4.68	4.33	3.81	2.97
112	4.56	4.68	3.07	4.69	4.58	4.17	3.84	3.61	4.50	4.00	3.41	2.50
113	3.27	3.55	2.51	3.61	3.58	3.27	2.96	2.77	3.54	3.14	2.68	1.99
114	3.68	3.85	2.84	4.00	3.95	3.69	3.38	3.19	3.91	3.54	3.11	2.42
115	5.2	5.22	3.47	5.21	5.06	4.71	4.36	4.14	5.00	4.51	3.93	3.02
116	4.92	4.95	3.08	4.89	4.77	4.30	3.87	3.57	4.70	4.13	3.44	2.36
117	3.65	3.73	2.59	3.81	3.78	3.41	3.05	2.84	3.71	3.27	2.74	1.90
118	3.69	3.89	2.86	4.04	3.95	3.69	3.41	3.25	3.90	3.55	3.13	2.48
119	5.44	5.28	3.46	5.32	5.15	4.76	4.42	4.19	5.07	4.57	3.95	3.00
120	4.9	4.76	2.93	4.78	4.62	4.11	3.69	3.36	4.55	4.01	3.31	2.23
121	3.96	4.06	2.66	4.10	4.01	3.62	3.27	3.01	3.94	3.50	2.93	2.03
122	3.98	4.14	2.77	4.20	4.06	3.74	3.42	3.22	4.02	3.60	3.08	2.27
123	4.93	4.91	3.09	4.97	4.77	4.34	3.94	3.66	4.73	4.20	3.55	2.55

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
124	5.04	4.91	2.96	4.94	4.76	4.22	3.77	3.42	4.70	4.12	3.38	2.23
125	3.9	4.01	2.60	4.09	3.99	3.57	3.17	2.92	3.92	3.46	2.87	1.93
126	3.97	4.14	2.81	4.24	4.12	3.82	3.47	3.28	4.08	3.67	3.12	2.32
127	4.98	5.00	3.16	5.03	4.83	4.42	4.02	3.75	4.80	4.29	3.60	2.63
128	4.98	4.85	2.90	4.89	4.72	4.18	3.72	3.39	4.64	4.05	3.30	2.16
129	3.93	3.97	2.58	4.12	4.01	3.57	3.19	2.93	3.94	3.46	2.85	1.89
130	4	4.18	2.86	4.30	4.19	3.87	3.55	3.32	4.14	3.71	3.15	2.31
131	4.69	4.76	3.08	4.83	4.66	4.29	3.90	3.64	4.63	4.12	3.46	2.49
132	4.99	4.88	3.08	4.99	4.80	4.33	3.91	3.63	4.74	4.18	3.46	2.39
133	4.2	4.30	2.84	4.49	4.35	3.92	3.54	3.32	4.27	3.78	3.15	2.18
134	3.96	4.09	2.84	4.22	4.11	3.83	3.51	3.34	4.06	3.64	3.12	2.30
135	4.37	4.37	2.93	4.45	4.30	3.99	3.64	3.43	4.27	3.80	3.23	2.36
136	4.73	4.79	3.18	4.92	4.73	4.32	3.95	3.71	4.68	4.16	3.52	2.54
137	4.42	4.67	3.12	4.82	4.64	4.24	3.87	3.64	4.59	4.09	3.46	2.48
138	4.05	4.29	2.88	4.37	4.27	3.96	3.59	3.37	4.22	3.77	3.18	2.30
139	4.08	4.14	2.81	4.20	4.11	3.81	3.47	3.24	4.06	3.63	3.07	2.24
140	4.62	4.65	3.18	4.84	4.65	4.27	3.93	3.69	4.59	4.12	3.51	2.62
141	4.88	4.89	3.31	5.05	4.85	4.43	4.08	3.87	4.65	4.29	3.66	2.73
142	4.09	4.26	2.84	4.32	4.23	3.88	3.55	3.33	4.16	3.72	3.15	2.28
143	3.98	4.18	2.78	4.23	4.15	3.82	3.47	3.24	4.12	3.66	3.07	2.23
144	4.36	4.43	2.96	4.51	4.41	4.01	3.63	xxx	4.36	3.85	3.22	2.37
145	4.9	4.92	3.17	4.98	4.87	4.41	4.01	xxx	4.78	4.24	3.56	2.59
146	xxx	4.32	2.67	4.36	4.28	3.88	3.48	3.21	4.19	3.68	3.02	2.02
147	xxx	3.71	2.46	3.82	3.76	3.43	3.08	2.85	3.67	3.24	2.68	1.84
148	4.36	4.32	2.93	4.46	4.35	3.99	3.64	xxx	4.27	3.81	3.21	2.34
149	5.28	5.20	3.25	5.23	5.21	4.61	4.19	xxx	4.99	4.42	3.69	2.62
150	4.72	4.63	2.74	4.58	4.48	4.03	3.60	3.30	4.39	3.83	3.11	2.02
151	3.67	3.64	2.35	3.68	3.65	3.32	2.95	2.70	3.58	3.14	2.55	1.68
152	4.57	4.55	xxx	4.66	4.49	4.20	3.87	3.69	4.47	4.02	3.45	2.58
153	5.54	5.45	3.50	5.55	5.35	4.87	4.48	4.24	5.23	4.68	3.98	2.88
154	5.22	4.86	2.97	4.91	4.77	4.28	3.84	3.53	4.67	4.08	3.36	2.27

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
155	3.59	3.47	2.38	3.61	3.54	3.20	2.84	2.62	3.47	3.04	2.52	1.73
156	4.15	xxx	2.99	4.37	4.25	3.88	3.67	3.50	4.21	3.81	3.35	2.60
157	5.92	xxx	3.66	5.85	5.62	5.08	4.78	4.54	xxx	4.98	4.28	3.19
158	xxx	5.15	3.02	5.11	4.95	4.33	3.84	3.48	4.87	4.22	3.40	2.20
159	xxx	3.40	2.26	3.47	3.42	3.00	2.58	2.33	3.34	2.91	2.35	1.55
160	xxx	4.23	3.12	4.41	4.28	xxx	3.68	3.51	4.21	3.85	3.20	2.71
161	5.93	5.73	3.76	5.80	5.59	xxx	4.76	4.51	5.50	4.96	4.28	3.23
162	5.32	5.09	3.18	5.16	4.99	4.45	3.99	3.68	4.89	4.31	3.55	2.42
163	4.17	4.14	2.79	4.29	4.18	3.76	3.35	3.09	4.09	3.62	3.01	2.09
164	4.46	4.41	3.09	4.54	4.41	4.06	3.72	3.51	4.35	3.91	3.38	2.57
165	5.84	5.52	3.53	5.51	5.31	4.82	4.42	4.14	5.24	4.67	3.97	2.93
166	5.48	5.36	3.28	5.38	5.18	4.60	4.15	3.81	5.09	4.49	3.69	2.51
167	4.25	4.29	2.85	4.44	4.31	3.87	3.47	3.20	4.22	3.76	3.11	2.14
168	xxx	4.56	3.17	4.73	4.63	4.22	3.85	3.55	4.52	4.08	3.49	2.61
169	xxx	5.42	3.53	5.52	5.36	4.84	4.43	4.16	5.24	4.69	3.98	2.93
170	xxx	5.06	3.18	5.13	4.96	4.47	4.03	3.75	4.86	4.30	3.57	2.47
171	4.28	4.26	2.87	4.41	4.29	3.92	3.53	3.29	4.23	3.76	3.15	2.21
172	4.64	4.52	3.11	4.65	4.49	4.15	3.76	3.52	4.44	3.97	3.38	2.51
173	5.48	5.23	3.39	5.29	5.11	4.67	4.23	3.95	5.01	4.47	3.78	2.77
174	5.24	5.02	3.20	5.07	4.92	4.40	3.98	3.71	4.82	4.26	3.55	2.46
175	4.21	4.21	2.85	4.32	4.21	3.80	3.44	3.21	4.25	3.67	3.08	2.15
176	4.33	4.31	2.97	4.36	4.24	3.94	3.59	3.37	4.18	3.75	3.16	2.36
177	5.16	4.92	3.25	4.97	4.83	4.44	4.03	3.79	4.74	4.24	3.60	2.63
178	5.08	4.97	3.20	4.99	4.91	4.44	4.00	3.74	4.82	4.26	3.56	2.52
179	4.12	4.21	2.87	4.30	4.24	3.85	3.46	3.23	4.18	3.70	3.10	2.19
180	4.11	4.14	2.95	4.27	4.18	3.88	3.53	3.32	4.11	3.70	3.18	2.35
181	4.74	4.65	3.19	4.74	4.63	4.29	3.92	3.69	4.55	4.09	3.50	2.59
182	4.5	4.45	3.01	4.57	4.46	4.08	3.73	3.50	4.39	3.90	3.30	2.39
183	3.91	4.00	2.80	4.16	4.16	3.70	3.38	3.18	3.32	3.54	3.01	2.19
184	3.79	3.85	2.73	3.98	3.87	3.59	3.27	3.08	3.83	3.42	2.92	2.16
185	4.04	4.06	2.85	4.16	4.07	3.79	3.47	3.27	4.01	3.60	3.08	2.30

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
186	4.28	4.47	3.11	4.60	4.48	4.13	3.80	3.59	4.41	3.94	3.35	2.44
187	4.08	4.33	3.00	4.46	4.33	3.98	3.64	3.43	4.23	3.81	3.23	2.34
188	3.49	3.63	2.56	3.73	3.65	3.39	3.07	2.88	3.60	3.20	2.70	1.92
189	3.6	3.71	2.65	3.80	3.74	3.49	3.20	3.03	3.67	3.29	2.81	2.06
190	3.83	4.00	2.79	4.06	4.03	3.71	3.39	3.19	3.93	3.50	2.95	2.10
191	3.76	4.08	2.81	4.05	4.01	3.68	3.36	3.16	3.92	3.49	2.95	2.11
192	xxx	3.79	2.59	3.78	3.77	3.47	3.17	2.96	3.68	3.27	2.74	1.97
193	xxx	3.64	2.49	3.66	3.69	3.38	3.05	2.83	3.61	3.19	2.64	1.84
194	xxx	3.88	2.76	3.96	3.94	3.70	3.43	3.26	3.88	3.50	3.03	2.30
195	xxx	4.17	2.89	4.20	4.15	3.90	3.62	3.44	4.08	3.68	3.16	2.39
196	3.22	3.56	2.30	3.42	3.35	3.10	2.85	2.70	3.30	2.99	2.54	1.81
197	2.83	3.29	2.23	3.24	3.18	2.98	2.75	2.62	3.13	2.86	2.47	1.81
198	3.4	3.63	2.58	3.79	3.73	3.49	3.22	3.06	3.67	3.29	2.80	2.09
199	3.67	3.80	2.66	3.88	3.81	3.54	3.27	3.10	3.75	3.35	2.85	2.11
200	3.08	3.25	2.24	3.29	3.25	2.99	2.76	2.61	3.19	2.90	2.48	1.76
201	2.48	2.82	2.06	2.94	2.93	2.71	2.49	2.36	2.86	2.64	2.27	1.64
202	3.01	3.40	2.55	3.57	3.52	3.33	3.10	2.98	3.43	3.16	2.77	2.14
203	3.58	3.92	2.75	4.03	3.95	3.73	3.48	3.34	3.89	3.54	xxx	2.30
204	3.2	3.48	2.40	3.53	3.47	3.22	2.97	2.83	3.44	3.13	xxx	1.91
205	2.24	2.69	2.00	2.82	2.80	2.59	2.35	2.23	2.76	2.53	xxx	1.59
206	2.8	3.24	2.44	3.34	3.34	3.16	2.94	2.81	3.26	3.02	xxx	2.12
207	3.77	4.07	2.87	4.14	4.10	3.87	3.65	3.52	4.02	3.69	xxx	2.49
208	3.37	3.63	2.48	3.71	3.68	3.44	3.16	2.99	3.62	3.27	xxx	1.96
209	2.42	2.78	2.04	2.91	2.88	2.69	2.40	2.24	2.83	2.57	xxx	1.55
210	2.86	3.33	2.58	3.50	3.43	3.28	3.07	2.96	3.36	3.14	xxx	2.31
211	3.79	4.12	2.95	4.23	4.15	3.95	3.73	3.68	4.08	3.76	xxx	2.61
212	3.67	3.92	2.74	4.00	3.94	3.70	3.43	3.26	3.89	3.55	xxx	2.28
213	2.56	2.94	2.19	3.07	3.07	2.86	2.59	2.42	3.02	2.77	xxx	1.76
214	3.02	3.42	2.67	3.55	3.53	3.37	3.15	3.02	3.47	3.26	xxx	2.41
215	4.21	4.50	3.24	4.58	4.49	4.27	4.04	3.91	4.45	4.11	xxx	2.93
216	3.95	4.18	2.87	4.27	4.20	3.86	3.55	3.36	4.16	3.72	xxx	2.34

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
217	2.76	3.13	2.34	3.31	3.28	2.99	2.71	2.54	3.22	2.90	xxx	1.87
218	3.23	3.52	2.71	3.63	3.60	3.41	3.18	3.01	3.53	3.29	xxx	2.39
219	4.72	4.80	3.35	4.81	4.73	4.45	4.18	3.99	4.64	4.26	xxx	2.95
220	4.42	4.48	2.97	4.49	4.42	4.03	3.70	3.44	4.35	3.86	xxx	2.34
221	3.21	3.49	2.53	3.57	3.54	3.23	2.94	2.74	3.49	3.12	xxx	1.94
222	3.74	3.80	2.81	4.01	3.91	3.63	3.34	2.78	3.83	3.46	xxx	2.37
223	5.05	4.90	3.33	5.02	4.87	4.50	4.17	3.99	4.77	4.28	xxx	2.86
224	4.84	4.83	3.14	4.85	4.74	4.29	3.91	3.65	4.66	4.12	xxx	2.42
225	3.6	3.75	2.64	3.86	3.83	3.46	3.10	2.87	3.75	3.32	xxx	1.95
226	3.89	4.10	3.06	4.24	4.21	3.89	3.64	3.39	4.12	3.75	xxx	2.63
227	5.23	5.21	3.53	5.27	5.14	4.72	4.42	4.19	5.05	4.55	xxx	3.04
228	5.07	4.96	3.20	5.04	4.88	4.39	3.97	3.69	4.79	4.22	xxx	2.49
229	4	4.09	2.86	4.24	4.13	3.74	3.37	3.15	4.06	3.60	xxx	2.19
230	4.36	4.41	2.96	4.55	4.44	4.07	3.72	3.01	4.35	3.91	xxx	2.54
231	5.41	5.25	3.33	5.32	5.17	4.70	4.31	4.03	5.05	4.51	3.87	2.86
232	5.24	5.11	3.29	5.21	5.04	4.56	4.13	xxx	4.95	4.38	3.69	2.58
233	4.64	4.56	3.04	4.68	4.54	4.13	3.73	xxx	4.46	3.97	3.34	2.34
234	4.44	4.45	3.02	4.59	4.45	4.09	3.71	xxx	4.37	3.93	3.36	2.49
235	5.4	5.30	3.38	5.37	5.20	4.73	4.30	xxx	5.11	4.56	3.87	2.83
236	5.4	5.19	3.16	5.23	5.05	4.51	4.04	xxx	4.96	4.35	3.58	2.38
237	4.78	4.65	2.96	4.76	4.60	4.15	3.73	3.46	4.52	3.98	3.30	2.23
238	4.53	4.63	2.97	4.61	4.46	4.06	3.70	3.46	4.38	3.90	3.31	2.36
239	5.14	5.16	3.21	5.10	4.92	4.45	4.05	4.02	4.83	4.29	3.63	2.56
240	5.51	5.21	3.18	5.28	5.09	4.52	4.05	3.71	4.99	4.39	3.60	2.40
241	4.92	4.67	2.95	4.79	4.63	4.14	3.71	3.44	4.52	3.99	3.29	2.21
242	4.63	4.57	2.98	4.67	4.52	4.11	3.71	3.44	4.43	3.93	3.31	2.37
243	4.7	4.69	3.03	4.78	4.64	4.20	3.80	3.78	4.55	4.03	3.38	2.41
244	5.3	5.06	3.25	5.18	5.01	4.51	4.08	3.71	4.91	4.35	3.63	2.52
245	5.04	4.90	3.17	5.05	4.87	4.40	3.96	3.41	4.78	4.23	3.53	2.44
246	4.67	4.61	3.04	4.71	4.58	4.20	3.80	3.38	4.49	3.99	3.38	2.42
247	4.56	4.38	2.93	4.49	4.36	4.01	3.63	3.53	4.29	3.81	3.23	2.32

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
248	5.1	4.72	3.22	4.88	4.73	4.34	3.97	3.77	4.66	4.17	3.55	2.64
249	5.21	4.91	3.27	5.04	4.84	4.49	4.09	3.66	4.82	4.31	3.65	2.67
250	4.53	4.55	3.06	4.62	4.48	4.20	3.81	3.54	4.46	3.99	3.41	2.48
251	3.99	4.22	2.88	4.25	4.15	3.85	3.49	3.37	4.08	3.67	3.15	2.32
252	4.44	4.65	3.24	4.76	4.59	xxx	3.91	3.72	4.52	4.09	3.56	2.72
253	5	5.07	3.47	5.27	5.12	xxx	4.33	3.84	5.02	4.51	3.91	2.93
254	4.28	4.32	2.90	4.42	4.34	4.00	3.63	3.56	4.26	3.77	3.23	2.32
255	3.6	3.75	2.66	3.86	3.80	3.53	3.20	3.28	3.74	3.33	2.87	2.11
256	4.07	4.24	3.05	4.41	4.31	4.00	3.68	3.69	4.25	3.85	3.34	2.56
257	4.79	4.82	3.29	4.93	xxx	4.43	4.09	4.11	4.74	4.26	3.66	2.77
258	4.33	4.44	2.96	4.47	4.41	4.05	3.69	3.40	4.34	3.86	3.29	2.40
259	3.38	3.66	2.58	3.71	3.68	3.40	3.06	2.99	3.62	3.23	2.78	2.04
260	3.87	4.13	3.02	4.30	4.18	3.92	3.61	3.49	4.12	3.75	3.30	2.61
261	4.87	4.92	3.42	5.07	4.92	4.58	4.25	xxx	4.85	4.39	3.82	2.97
262	4.35	4.37	2.90	4.41	4.35	4.00	3.65	xxx	4.27	3.80	3.24	2.37
263	3.24	3.50	2.50	3.61	3.59	3.31	2.99	2.80	3.52	3.15	2.71	2.01
264	3.93	4.13	3.05	4.32	4.22	3.91	3.64	3.45	4.16	3.78	3.30	2.64
265	5	5.04	3.45	5.16	5.03	4.65	4.33	4.11	4.28	4.48	3.91	3.02
266	4.5	4.57	3.04	4.61	4.54	4.19	3.82	3.58	4.47	3.98	3.39	2.47
267	3.31	3.54	2.55	3.66	3.63	3.35	3.02	2.81	3.57	3.18	2.72	1.99
268	4.09	4.23	3.16	4.39	4.32	3.85	3.74	3.55	4.26	3.88	3.45	2.74
269	5.21	5.19	3.59	5.30	5.16	4.61	4.26	4.24	4.37	4.61	4.05	3.14
270	4.81	4.68	3.15	4.74	4.64	4.26	3.65	3.65	4.55	4.06	3.48	2.55
271	3.76	3.89	2.77	3.97	3.92	3.62	3.07	3.06	3.88	3.44	2.97	2.19
272	4.31	4.41	3.22	4.57	4.47	3.97	xxx	3.62	4.44	4.01	3.54	2.76
273	5.53	5.35	3.71	5.47	5.29	4.74	xxx	4.36	4.65	4.71	4.12	3.20
274	xxx	4.96	3.17	5.10	4.90	4.45	xxx	3.67	4.78	4.24	3.53	2.47
275	xxx	4.19	2.84	4.38	4.24	3.83	xxx	3.12	4.16	3.67	3.07	2.17
276	xxx	4.48	3.17	4.67	4.54	4.12	xxx	3.63	4.48	4.05	3.53	2.75
277	xxx	5.28	3.49	5.37	5.21	4.70	xxx	4.15	5.11	4.61	3.98	3.02
278	5.07	4.80	3.09	4.88	4.74	4.32	xxx	3.64	4.65	4.15	3.51	2.50

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
279	4.36	4.24	2.88	4.37	4.24	3.90	xxx	3.30	4.19	3.75	3.19	2.32
280	4.33	4.35	3.02	4.49	4.33	4.03	xxx	3.47	4.29	3.86	3.34	2.55
281	5.21	5.21	3.38	5.30	5.11	4.70	xxx	4.03	5.04	4.52	3.88	2.89
282	4.93	4.82	3.00	4.86	4.72	4.27	xxx	3.52	4.63	4.08	3.39	2.31
283	4.09	4.17	2.77	4.28	4.18	3.83	xxx	3.20	4.11	3.65	3.07	2.15
284	4.42	4.33	2.88	4.43	4.28	3.95	xxx	3.34	4.21	3.76	3.20	2.30
285	5.04	4.82	3.08	4.87	4.70	4.30	xxx	3.62	4.61	4.10	3.47	2.48
286	4.93	4.82	3.04	4.91	4.76	4.31	xxx	3.59	4.67	4.13	3.43	2.33
287	4.35	4.33	2.83	4.43	4.31	3.94	xxx	3.28	4.23	3.76	3.14	2.14
288	4.3	4.33	2.88	4.41	4.29	3.96	xxx	3.35	4.22	3.76	3.18	2.29
289	4.72	4.70	3.03	4.77	4.64	4.25	xxx	3.59	4.57	4.05	3.40	2.43
290	4.63	4.62	2.98	4.69	4.58	4.18	xxx	3.52	4.50	3.99	3.33	2.33
291	4.22	4.33	2.86	4.43	4.33	3.98	xxx	3.38	4.24	3.78	3.18	2.24
292	4.39	4.19	2.74	4.24	4.14	3.83	xxx	3.17	4.05	3.58	3.00	2.09
293	4.43	4.24	2.77	4.27	4.18	3.86	xxx	3.22	4.10	3.62	3.02	2.13
294	4.47	4.49	2.98	4.53	4.47	4.10	xxx	3.50	4.39	3.90	3.28	2.36
295	3.96	4.13	2.80	4.21	4.16	3.83	xxx	3.25	4.06	3.64	3.06	2.19
296	3.98	3.97	2.76	3.99	3.94	3.71	xxx	3.15	3.87	3.48	2.97	2.20
297	3.93	3.89	2.72	3.92	3.87	3.64	xxx	3.10	3.80	3.41	2.92	2.16
298	4.16	4.22	2.97	4.25	4.19	3.92	xxx	3.43	4.12	3.71	3.23	2.47
299	4.15	4.23	2.97	4.31	4.23	3.96	xxx	3.46	4.19	3.75	3.26	2.46
300	3.86	3.89	2.75	3.98	3.92	3.67	xxx	3.13	3.86	3.44	2.98	2.21
301	3.33	3.42	2.47	3.46	3.46	3.23	xxx	2.71	3.47	3.01	2.60	1.96
302	3.67	4.30	3.07	4.22	4.21	xxx	xxx	3.55	4.15	3.80	3.37	2.73
303	3.9	4.30	3.04	4.24	4.20	xxx	xxx	3.52	4.14	3.77	3.31	2.60
304	3.31	3.58	2.72	3.72	3.68	3.47	xxx	3.05	3.63	3.32	2.95	2.34
305	3.33	3.75	2.78	3.83	3.79	3.56	xxx	3.13	3.73	3.41	3.04	2.40
306	3.11	3.46	2.56	3.55	3.53	3.30	xxx	2.88	3.46	3.16	2.81	2.22
307	3.47	3.78	2.82	3.93	3.91	3.70	xxx	3.41	3.84	3.53	3.15	2.52
308	3.19	3.46	2.51	3.57	3.54	3.32	xxx	2.89	3.47	3.12	2.73	2.07
309	2.53	2.84	2.17	2.96	2.95	2.76	xxx	2.35	2.91	2.61	2.30	1.78

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
310	2.83	3.21	2.49	3.37	3.36	3.18	xxx	2.84	3.31	3.05	2.76	2.25
311	3.42	3.82	2.82	3.95	3.92	3.72	xxx	3.36	3.81	3.55	3.18	2.53
312	3.02	3.31	2.38	3.37	3.36	3.16	xxx	2.73	3.31	2.99	2.59	1.94
313	2.23	2.63	1.95	2.65	2.67	2.51	xxx	2.12	2.64	2.37	2.08	1.60
314	2.8	3.30	2.54	3.44	3.38	3.25	xxx	2.95	3.35	3.10	2.85	2.37
315	3.56	3.97	2.96	4.17	4.07	3.90	xxx	3.58	4.03	3.73	3.37	2.71
316	2.95	3.31	2.38	3.41	3.39	3.20	xxx	2.83	3.35	3.04	2.67	2.06
317	2.2	2.42	1.83	2.53	2.56	2.42	xxx	2.02	2.51	2.28	2.01	1.57
318	2.47	2.82	2.27	3.00	2.99	2.89	xxx	2.63	2.95	2.80	2.61	2.21
319	3.65	3.95	2.91	4.05	3.98	3.80	3.63	3.54	3.94	3.66	3.35	2.74
320	3.13	3.46	2.42	3.54	3.47	3.26	3.01	2.87	3.43	3.09	2.71	2.05
321	2.21	2.64	2.03	2.77	2.73	2.57	2.37	2.25	2.70	2.46	2.19	1.72
322	2.69	3.05	2.37	3.20	3.19	3.04	2.89	2.76	3.15	2.93	2.66	2.14
323	3.85	4.05	2.89	4.13	4.09	3.88	3.69	3.55	4.04	3.73	3.33	2.62
324	3.54	3.75	2.54	3.82	3.76	3.50	3.20	3.01	3.70	3.30	2.84	2.06
325	2.53	2.87	2.13	3.01	2.97	2.77	2.51	2.36	2.92	2.62	2.28	1.70
326	2.96	3.30	2.53	3.45	3.40	3.22	3.02	2.89	3.36	3.09	2.78	2.24
327	4.06	4.32	3.01	4.42	4.34	4.08	3.82	3.68	4.28	3.89	3.44	2.68
328	3.88	4.05	2.69	4.13	4.07	3.77	3.43	3.21	3.99	3.54	3.03	2.15
329	2.93	3.24	2.29	3.32	3.30	3.07	2.75	2.55	3.23	2.87	2.47	1.76
330	3.36	3.69	2.71	3.73	3.68	3.47	3.22	3.06	3.64	3.31	2.95	2.35
331	4.59	4.74	xxx	4.76	4.65	4.33	4.04	3.88	4.59	4.14	3.64	2.81
332	4.48	4.46	2.82	4.49	4.41	4.00	3.59	3.31	4.32	3.78	3.17	2.14
333	3.42	3.50	2.43	3.61	3.57	3.26	2.92	2.69	3.50	3.07	2.61	1.81
334	4.07	4.04	2.94	4.17	4.09	3.84	3.56	3.37	4.02	3.63	3.21	2.47
335	5.38	5.15	3.38	5.18	5.04	4.65	4.28	4.03	4.91	4.42	3.82	2.83
336	5.07	4.96	3.12	5.01	4.84	4.34	3.90	3.60	4.74	4.18	3.48	2.34
337	xxx	3.93	2.69	4.07	3.96	3.57	3.19	2.94	3.88	3.43	2.87	1.96
338	xxx	4.47	xxx	4.60	4.49	4.16	3.86	3.65	4.39	3.99	3.50	2.70
339	5.53	5.23	xxx	5.29	5.12	4.71	4.35	4.11	5.00	4.51	3.91	2.91
340	5.34	5.19	3.27	5.28	5.12	4.64	4.20	3.89	5.03	4.46	3.76	2.67

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
341	4.55	4.54	2.99	4.69	4.55	4.15	3.75	3.47	4.46	3.98	3.38	2.43
342	4.59	4.70	3.29	4.89	4.72	4.26	4.01	3.76	4.65	4.22	3.67	2.79
343	5.96	5.78	3.67	5.86	5.62	5.01	4.68	4.39	5.55	4.98	4.25	3.14
344	5.51	5.23	3.16	5.28	5.08	4.55	4.05	3.70	4.98	4.37	3.60	2.41
345	4.97	4.83	3.05	4.92	4.78	4.32	3.88	3.56	4.68	4.13	3.45	2.37
346	5.12	4.97	3.16	5.06	4.89	4.41	3.99	3.69	4.79	4.25	3.56	2.50
347	5.62	5.41	3.32	5.47	5.24	4.70	4.22	3.90	5.15	4.56	3.80	2.64
348	5.61	5.27	3.13	5.31	5.11	4.55	4.02	3.66	5.00	4.39	3.58	2.32
349	5.46	5.14	3.12	5.19	5.03	4.49	4.00	xxx	4.90	4.33	3.55	2.35
350	5.26	5.01	3.01	5.08	4.87	4.35	3.86	xxx	4.76	4.18	3.41	2.22
351	5.25	5.03	3.01	5.10	4.89	4.36	3.87	xxx	4.80	4.20	3.44	2.24
352	5.43	5.16	3.07	5.21	5.02	4.43	3.93	xxx	4.92	4.31	3.52	2.26
353	5.5	5.19	3.11	5.24	5.04	4.46	3.96	xxx	4.93	4.33	3.54	2.28
354	5.33	5.01	2.99	5.05	4.86	4.31	3.82	xxx	4.75	4.16	3.39	2.17
355	4.7	4.53	2.78	4.61	4.46	3.97	3.52	xxx	4.35	3.82	3.11	2.01
356	5.35	5.28	3.23	5.14	5.01	4.48	4.06	xxx	4.92	4.36	3.63	2.52
357	5.82	5.58	3.32	5.39	5.25	4.67	4.20	xxx	5.15	4.55	3.76	2.55
358	5.08	4.83	2.95	4.90	4.73	4.25	3.77	xxx	4.62	4.09	3.35	2.21
359	4.48	4.36	2.76	4.44	4.30	3.91	3.48	xxx	4.20	3.73	3.07	2.06
360	4.64	4.65	3.05	4.73	4.60	4.18	3.80	xxx	4.52	4.04	3.40	2.44
361	5.37	5.15	3.27	5.23	5.06	4.56	4.13	xxx	4.97	4.43	3.70	2.61
362	4.77	4.58	2.81	4.62	4.49	4.08	3.63	xxx	4.40	3.90	3.19	2.13
363	3.95	4.11	2.55	4.04	3.95	3.64	3.25	xxx	3.88	3.45	2.84	1.93
364	4.36	4.50	2.91	4.47	4.34	3.98	3.63	xxx	4.28	3.83	3.24	2.34
365	4.91	4.82	3.11	4.92	4.78	4.35	3.97	xxx	4.70	4.19	3.54	2.51
366	4.3	4.32	2.73	4.37	4.27	3.91	3.52	xxx	4.18	3.71	3.09	2.12
367	3.5	3.69	2.46	3.81	3.72	3.44	3.09	xxx	3.66	3.26	2.71	1.89
368	4.09	4.22	2.92	4.40	xxx	3.94	3.62	xxx	4.21	3.79	3.24	2.40
369	4.78	4.81	3.15	4.91	xxx	4.39	4.02	xxx	4.69	4.21	3.58	2.60
370	4.06	4.21	2.66	4.18	4.13	3.79	3.41	xxx	4.04	3.60	3.00	2.09
371	3.04	3.44	2.30	3.43	3.39	3.14	2.82	xxx	3.32	2.97	2.49	1.76

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
372	3.88	4.17	2.95	4.29	4.18	3.93	3.62	xxx	4.12	3.75	3.25	2.51
373	4.62	4.70	3.19	4.83	4.70	4.39	4.04	xxx	4.65	4.20	3.60	2.71
374	4.1	4.22	2.82	4.26	4.20	3.93	3.58	xxx	4.14	3.71	3.16	2.29
375	3.29	3.52	2.51	3.64	3.60	3.38	3.04	xxx	3.54	3.17	2.71	1.98
376	3.69	3.96	2.92	4.13	4.02	3.78	3.51	xxx	3.97	3.62	3.19	2.51
377	4.52	4.68	3.22	4.78	4.63	4.35	4.06	xxx	4.58	4.17	3.63	2.79
378	4.12	4.21	2.82	4.29	4.19	3.92	3.57	xxx	4.14	3.70	3.16	2.30
379	3.42	3.64	2.58	3.76	3.68	3.45	3.14	xxx	3.64	3.26	2.81	2.08
380	3.85	4.24	2.95	4.25	4.14	3.90	3.61	xxx	4.13	3.74	3.26	2.50
381	4.67	4.93	3.24	4.85	4.73	4.42	4.08	xxx	4.69	4.22	3.66	2.77
382	4.34	4.35	2.84	4.36	4.29	3.98	3.59	xxx	4.21	3.74	3.16	2.26
383	3.65	3.73	2.60	3.81	3.77	3.53	3.17	xxx	3.70	3.31	2.81	2.04
384	4.03	4.24	3.01	4.37	4.26	3.99	3.68	xxx	4.21	3.82	3.31	2.52
385	4.89	4.98	3.32	5.04	4.89	4.53	4.19	xxx	4.84	4.36	3.74	2.80
386	4.37	4.35	2.79	4.39	4.29	3.94	3.56	xxx	4.21	3.73	3.11	2.14
387	3.88	3.95	2.65	4.06	3.99	3.68	3.33	xxx	3.91	3.48	2.93	2.05
388	4.43	4.39	2.94	4.54	4.41	4.04	3.65	xxx	4.31	3.84	3.23	2.29
389	4.75	4.74	3.08	4.87	4.73	4.32	3.92	xxx	4.49	4.12	3.46	2.45
390	4.91	4.82	3.12	4.91	4.80	4.38	3.97	xxx	4.70	4.18	3.48	2.43
391	3.98	4.00	2.74	4.14	4.06	3.71	3.32	xxx	3.98	3.53	2.94	2.04
392	4.32	4.30	3.07	4.41	4.32	4.03	3.68	xxx	4.26	3.83	3.31	2.53
393	4.93	4.80	3.27	4.88	4.75	4.41	4.04	xxx	4.54	4.20	3.60	2.71
394	4.51	4.46	3.04	4.55	4.46	4.12	3.75	xxx	4.37	3.92	3.33	2.43
395	4.24	4.27	2.97	4.36	4.30	3.99	3.63	xxx	4.22	3.79	3.23	2.36
396	4.37	4.22	2.90	4.19	4.11	3.84	3.48	xxx	xxx	3.60	3.09	2.25
397	4.65	4.52	3.04	4.51	4.39	4.09	3.72	xxx	4.30	3.84	3.29	2.41
398	4.57	4.68	3.15	4.82	4.68	4.29	3.93	xxx	4.59	4.11	3.47	2.51
399	4.2	4.26	2.97	4.40	4.28	3.93	3.58	xxx	4.19	3.76	3.18	2.31
400	4.27	4.30	2.99	4.46	4.34	4.00	3.63	3.40	4.26	3.83	3.26	2.41
401	4.32	4.35	3.01	4.49	4.37	4.02	3.65	3.42	4.29	3.85	3.27	2.41
402	4	4.15	2.94	4.27	4.19	3.90	3.49	1.39	4.12	3.70	3.15	2.22

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
403	4.2	4.29	3.01	4.41	4.33	4.07	3.67	xxx	4.27	3.85	3.30	2.35
404	4.28	4.36	3.00	4.51	4.40	4.08	3.73	xxx	4.33	3.89	3.30	2.39
405	4.11	4.23	2.92	4.36	4.28	3.94	3.59	xxx	4.21	3.78	3.19	2.28
406	3.88	4.11	2.88	4.20	4.13	3.88	3.57	3.36	4.09	3.69	3.18	2.37
407	4.3	4.51	3.07	4.55	4.48	4.21	3.89	3.69	4.42	3.99	3.45	2.57
408	4.01	3.96	2.61	3.94	3.90	3.61	3.26	3.03	3.80	3.38	2.83	1.96
409	3.54	3.62	2.52	3.71	3.66	3.41	3.11	2.92	3.58	3.20	2.70	1.95
410	xxx	4.12	2.83	4.21	4.15	3.84	3.54	3.33	4.09	3.67	3.11	2.20
411	xxx	4.11	2.79	4.14	4.07	3.77	3.44	3.22	4.02	3.59	3.03	2.10
412	3.99	4.03	2.76	4.07	4.05	3.77	3.42	3.18	3.99	3.58	3.03	2.20
413	3.48	3.52	2.51	3.57	3.60	3.35	3.03	2.83	3.53	3.16	2.67	1.93
414	3.14	3.46	2.52	3.43	3.46	3.24	3.00	2.84	3.46	3.13	2.74	2.12
415	4.13	4.29	2.93	4.23	4.21	3.95	3.70	3.52	4.18	3.78	3.28	2.51
416	3.39	3.50	2.30	3.59	3.51	3.23	2.93	2.73	3.43	3.05	2.57	1.78
417	2.69	3.00	2.11	3.10	3.07	2.83	2.56	2.39	3.00	2.68	2.29	1.64
418	3.07	3.34	2.38	3.41	3.40	3.17	2.95	2.81	3.35	3.02	2.62	1.99
419	3.65	3.76	2.54	3.80	3.77	3.52	3.27	3.10	3.72	3.35	2.87	2.12
420	3.2	3.33	2.19	3.39	3.34	3.08	2.80	2.62	3.29	2.94	2.47	1.71
421	2.46	2.68	1.93	2.79	2.76	2.53	2.30	2.16	2.71	2.44	2.09	1.50
422	2.77	3.05	2.23	3.14	3.13	2.91	2.73	2.62	3.08	2.80	2.45	1.89
423	3.45	3.66	2.51	3.70	3.67	3.41	3.19	3.33	3.61	3.27	2.83	2.13
424	2.93	3.11	2.07	3.17	3.14	2.88	2.71	2.57	3.09	2.77	2.36	1.70
425	2.3	2.59	1.80	2.66	2.66	2.43	2.27	2.13	2.63	2.35	2.00	1.45
426	2.43	2.75	2.00	2.86	2.84	2.64	2.50	2.40	2.80	2.55	2.24	1.74
427	3.31	3.43	2.36	3.51	3.45	3.23	3.07	2.95	3.39	3.09	2.71	2.07
428	3.07	3.21	2.10	3.28	3.22	3.00	2.83	2.67	3.16	2.83	2.42	1.70
429	2.16	2.48	1.75	2.63	2.58	2.39	2.26	2.12	2.54	2.27	1.95	1.38
430	2.57	2.60	1.86	2.72	2.72	2.55	2.45	xxx	2.68	2.47	2.17	1.71
431	3.45	3.40	2.21	3.41	3.41	3.22	3.05	xxx	3.36	3.07	2.65	2.02
432	3.35	3.44	2.18	3.46	3.44	3.23	3.01	2.79	3.37	3.01	2.55	1.79
433	2.42	2.65	1.84	2.79	2.77	2.58	2.41	2.23	2.71	2.43	2.08	1.48

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
434	2.68	2.99	2.20	3.10	3.10	2.90	2.77	2.65	3.03	2.79	2.47	1.92
435	3.55	3.78	2.54	3.83	3.80	3.55	3.38	3.23	3.73	3.40	2.96	2.22
436	3.65	3.82	2.50	3.89	3.83	3.57	3.35	3.14	3.75	3.36	2.87	2.00
437	2.84	3.14	2.17	3.25	3.23	3.00	2.79	2.60	3.15	2.82	2.42	1.70
438	3.17	3.48	2.51	3.62	3.54	3.35	3.13	2.98	3.49	3.17	2.78	2.15
439	3.89	4.16	2.83	4.27	4.16	3.92	3.70	3.57	4.11	3.72	3.25	2.48
440	4.18	4.25	2.77	4.31	4.27	3.95	3.58	3.33	4.20	3.69	3.09	2.12
441	3.31	3.49	2.41	3.61	3.59	3.31	2.97	xxx	3.52	3.09	2.59	1.78
442	3.56	3.86	2.82	4.00	3.93	3.71	3.47	xxx	3.88	3.53	3.11	2.43
443	4.46	4.60	3.13	4.67	4.57	4.29	3.99	3.79	4.52	4.08	3.53	2.67
444	4.47	4.50	2.95	4.57	4.49	4.14	3.75	3.48	4.41	3.92	3.27	2.27
445	4.15	4.16	2.81	4.26	4.18	3.86	3.49	3.24	4.09	3.64	3.06	2.15
446	4.05	4.18	2.88	4.30	4.18	3.91	3.60	3.38	4.14	3.70	3.19	2.37
447	5.17	5.10	3.25	5.15	4.96	4.56	4.17	3.90	4.92	4.37	3.71	2.67
448	5.18	4.86	2.89	4.92	4.73	4.26	3.76	3.40	4.63	4.05	3.29	2.08
449	4.57	4.38	2.74	4.47	4.33	3.94	3.51	3.20	4.23	3.73	3.07	2.01
450	5.02	4.84	3.07	4.95	4.76	4.33	3.94	3.63	4.67	4.16	3.44	2.36
451	5.51	5.22	3.18	5.30	5.07	4.56	4.11	3.79	4.98	4.41	3.61	2.42
452	5.58	5.19	3.12	5.23	5.04	4.51	4.00	3.66	4.93	4.33	3.53	2.29
453	5.36	5.05	3.09	5.11	4.93	4.44	3.95	3.63	4.83	4.25	3.49	2.29
454	5.48	5.12	3.10	5.19	4.96	4.45	3.97	3.43	4.87	4.29	3.51	2.30
455	5.64	5.19	3.11	5.25	5.01	4.48	4.00	3.65	4.92	4.33	3.53	2.30
456	5.79	5.25	3.11	5.31	5.10	4.56	4.05	3.68	5.02	4.40	3.59	2.32
457	5.9	5.36	3.18	5.41	5.20	4.64	4.11	3.74	5.11	4.48	xxx	2.38
458	5.82	5.31	3.12	5.35	5.13	4.56	4.03	3.67	5.02	4.39	xxx	2.29
459	5.43	5.02	3.00	5.11	4.90	4.37	3.87	3.53	4.80	4.20	3.42	2.20
460	5.77	5.23	3.23	5.33	5.14	4.59	4.11	3.78	5.04	4.44	3.66	2.44
461	6.19	5.52	3.32	5.56	5.35	4.75	4.24	3.88	5.24	4.61	3.78	2.49
462	5.97	5.62	3.24	5.51	5.28	4.72	4.20	3.81	5.19	4.55	3.72	2.44
463	5	4.77	2.90	4.73	4.56	4.11	3.64	3.31	4.47	3.92	3.21	2.11
464	5.38	5.11	3.44	5.25	5.09	4.42	4.25	xxx	5.01	4.50	3.86	2.83

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
465	6.4	5.84	3.69	5.88	5.64	4.87	4.66	xxx	5.56	4.96	4.21	3.02
466	5.52	5.08	3.12	5.10	4.88	4.43	3.98	3.66	4.78	4.24	3.50	2.39
467	4.76	4.53	2.92	4.64	4.50	4.13	3.72	3.43	4.41	3.93	3.27	2.26
468	5.04	4.85	3.12	4.88	4.76	4.30	3.91	3.64	4.68	4.17	3.50	2.47
469	6.21	5.75	3.49	5.68	5.48	4.90	4.43	4.11	5.39	4.77	3.98	2.77
470	5.47	4.97	2.85	5.01	4.79	4.28	3.76	3.40	4.69	4.09	3.29	2.07
471	4.21	4.01	2.53	4.15	4.03	3.68	3.28	3.00	3.94	3.49	2.85	1.88
472	4.49	4.33	2.85	4.46	4.33	3.94	3.60	3.38	4.27	3.82	3.20	2.24
473	5.35	5.01	3.08	5.07	4.89	4.39	3.97	3.68	4.81	4.27	3.54	2.41
474	4.75	4.56	2.73	4.59	4.45	4.02	3.60	3.29	4.35	3.85	3.14	2.08
475	3.72	3.78	2.44	3.89	3.78	3.47	3.12	2.87	3.71	3.31	2.71	1.82
476	4.1	4.11	2.71	4.23	4.11	3.80	3.47	3.25	4.04	3.63	3.06	2.18
477	5.08	4.97	3.08	5.00	4.85	4.43	4.03	3.77	xxx	4.23	3.66	2.50
478	4.29	4.27	2.49	4.28	4.15	3.76	3.36	3.07	4.04	3.57	2.89	1.83
479	3.15	3.32	2.11	3.42	3.36	3.10	2.78	2.54	3.27	2.91	2.37	1.53
480	3.89	3.94	2.67	4.07	3.98	3.73	3.43	3.23	3.91	3.52	3.01	2.19
481	4.42	4.41	2.83	4.53	4.41	4.09	3.75	3.52	4.33	3.88	3.28	2.32
482	4.1	4.14	2.64	4.21	4.13	3.81	3.47	3.24	4.04	3.61	3.02	2.10
483	3.15	3.37	2.30	3.50	3.44	3.20	2.90	2.70	3.37	3.01	2.52	1.78
484	3.58	3.79	2.72	3.94	3.88	3.66	3.38	3.19	3.83	3.47	2.99	2.30
485	4.25	4.31	2.93	4.40	4.32	4.06	3.75	3.55	4.26	3.85	3.30	2.48
486	3.91	4.06	2.70	4.06	4.01	3.75	3.48	3.29	3.96	3.55	3.03	2.21
487	3.41	3.67	2.53	3.71	3.65	3.42	3.17	2.99	3.60	3.24	2.77	2.04
488	3.55	3.82	2.72	3.94	3.83	3.61	3.39	3.22	3.79	3.46	3.00	2.29
489	4.18	4.33	2.93	4.40	4.29	4.01	3.76	3.57	4.24	3.85	3.31	2.48
490	4.03	4.03	2.68	4.12	4.04	3.75	3.49	3.28	3.96	3.56	3.03	2.19
491	3.48	3.57	2.49	3.72	3.64	3.41	3.19	2.99	3.62	3.24	2.77	2.02
492	3.69	3.78	2.66	3.93	3.83	3.61	3.39	3.20	3.82	3.45	2.96	2.24
493	4.31	4.34	2.90	4.43	4.33	4.03	3.77	3.56	4.26	3.85	3.29	2.46
494	4.17	4.14	2.67	4.17	4.12	3.81	3.49	3.24	4.03	3.59	3.00	2.08
495	3.9	3.92	2.59	3.98	3.92	3.66	3.36	3.13	3.84	3.44	2.89	2.04

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
496	4.05	4.13	2.74	4.23	4.11	3.81	3.51	3.28	4.04	3.61	3.06	2.19
497	4.26	4.31	2.83	4.39	4.28	3.95	3.64	3.41	4.21	3.75	3.18	2.26
498	4.28	4.30	2.79	4.39	4.28	3.95	3.58	3.33	4.20	3.73	3.11	2.14
499	4.1	4.11	2.69	4.21	4.11	3.79	3.43	3.19	4.03	3.58	2.98	2.05
500	4.22	4.16	2.75	4.31	4.17	3.85	3.51	3.28	4.10	3.64	3.07	2.18
501	4.45	4.44	2.86	4.56	4.40	4.05	3.70	3.45	4.33	3.84	3.23	2.28
502	4.34	4.33	2.75	4.40	4.28	3.90	3.54	3.26	4.20	3.71	3.07	2.09
503	4.37	4.31	2.77	4.39	4.27	3.90	3.55	3.28	4.19	3.71	3.09	2.13
504	4.3	4.15	2.61	4.23	4.10	3.76	3.39	3.12	4.00	3.54	2.93	1.95
505	4.47	4.31	2.68	4.39	4.26	3.89	3.50	3.22	4.15	3.67	3.03	2.03
506	4.29	4.21	2.59	4.26	4.15	3.76	3.39	3.11	4.06	3.58	2.92	1.92
507	4.2	4.09	2.58	4.16	4.05	3.68	3.34	3.07	3.99	3.51	2.88	1.92
508	4.37	4.19	2.62	4.29	4.14	3.75	3.39	3.11	4.05	3.59	2.93	1.93
509	4.13	4.04	2.54	4.15	4.01	3.64	3.27	3.01	3.92	3.48	2.84	1.86
510	3.95	4.03	2.61	4.11	3.99	3.66	3.35	3.14	3.92	3.50	2.93	2.03
511	4.13	4.10	2.63	4.13	3.98	3.65	3.34	3.13	3.93	3.48	2.91	2.01
512	4.03	4.00	2.52	4.05	3.93	3.61	3.28	3.06	3.87	3.43	2.85	1.91
513	3.55	3.61	2.34	3.73	3.64	3.35	3.02	2.80	3.57	3.18	2.62	1.74
514	3.87	4.01	2.73	4.11	4.01	3.73	3.44	3.26	3.96	3.57	3.04	2.23
515	4.53	4.54	2.94	4.56	4.43	4.09	3.79	3.58	4.37	3.92	3.33	2.41
516	4.21	4.08	2.52	4.14	4.01	3.67	3.33	3.05	3.91	3.46	2.85	1.91
517	3.49	3.57	2.33	3.71	3.63	3.35	3.04	2.79	3.53	3.14	2.60	1.77
518	3.58	3.81	2.60	3.94	3.86	3.59	3.36	3.15	3.79	3.41	2.90	2.12
519	4.29	4.33	2.79	4.38	4.26	3.93	3.66	3.43	4.19	3.74	3.16	2.26
520	4.36	4.26	2.58	4.16	4.06	3.72	3.38	3.13	3.99	3.50	2.89	1.93
521	3.33	3.47	2.27	3.45	3.41	3.16	2.87	2.66	3.34	2.96	2.45	1.67
522	3.41	3.66	2.60	3.72	3.70	3.48	3.26	3.10	3.63	3.30	2.84	2.14
523	4.26	4.34	2.87	4.35	4.29	4.00	3.75	3.55	4.22	3.79	3.25	2.38
524	4.06	4.00	2.54	4.07	3.98	3.67	3.37	3.11	3.89	3.44	2.86	1.93
525	3.05	3.20	2.19	3.31	3.27	3.03	2.76	2.54	3.20	2.84	2.36	1.62
526	3.02	3.33	2.44	3.45	3.44	3.22	3.07	2.93	3.39	3.09	2.69	2.09

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
527	3.95	4.04	2.74	4.12	4.08	3.80	3.61	3.44	3.99	3.62	3.12	2.35
528	3.72	3.75	2.41	3.75	3.72	3.41	3.16	2.96	3.61	3.23	2.70	1.84
529	2.8	2.99	2.10	3.04	3.04	2.82	2.63	2.48	2.96	2.67	2.26	1.60
530	2.86	3.13	2.30	3.25	3.25	3.07	2.91	2.78	3.19	2.90	2.52	1.91
531	3.57	3.67	2.54	3.74	3.73	3.51	3.33	xxx	3.66	3.32	2.87	2.13
532	3.52	3.60	2.37	3.62	3.61	3.33	3.11	2.92	3.53	3.15	2.63	1.84
533	2.56	2.84	2.01	2.94	2.93	2.70	2.51	2.33	2.87	2.55	2.12	1.50
534	2.71	3.05	2.35	3.20	3.16	3.00	2.90	2.79	3.12	2.87	2.55	2.07
535	3.48	3.66	2.60	3.75	3.73	3.49	3.35	3.22	3.65	3.33	2.92	2.26
536	3.21	3.41	2.37	3.47	3.44	3.23	3.04	2.88	3.39	3.06	2.63	1.94
537	2.39	2.77	2.06	2.90	2.90	2.72	2.57	2.43	2.85	2.58	2.23	1.67
538	2.59	2.97	2.28	3.09	3.09	2.93	2.83	2.71	3.05	2.79	2.50	2.00
539	3.34	3.63	2.62	3.74	3.69	3.49	3.36	3.24	3.65	3.33	2.96	2.32
540	3.13	3.39	2.36	3.48	3.45	3.23	3.05	2.91	3.38	3.04	2.64	1.98
541	2.46	2.76	2.04	2.87	2.87	2.69	2.53	2.37	2.81	2.52	2.19	1.66
542	2.66	2.94	2.26	3.07	3.06	2.91	2.77	2.62	3.02	2.75	2.44	1.93
543	3.35	3.67	2.63	3.78	3.75	3.54	3.39	3.25	3.70	3.37	2.97	2.32
544	3.35	3.59	2.50	3.65	3.63	3.42	3.27	3.12	3.56	3.22	2.80	2.08
545	2.32	2.59	1.93	2.64	2.66	2.51	2.38	2.24	2.77	2.36	2.05	1.53
546	3.01	3.28	2.56	3.43	3.42	3.26	3.15	3.01	3.40	3.13	2.81	2.30
547	3.65	3.84	2.85	3.96	3.91	3.71	3.56	3.46	3.86	3.54	3.14	2.48
548	3.78	4.02	2.96	4.11	4.07	3.87	3.64	3.47	4.01	3.67	3.23	2.55
549	3.26	3.51	2.62	3.66	3.62	3.42	3.20	3.00	3.58	3.25	2.84	2.20
550	3.07	3.37	2.62	3.58	3.50	3.31	3.17	3.01	3.48	3.21	2.87	2.33
551	3.79	4.15	3.01	4.20	4.10	3.89	3.74	3.60	4.06	3.76	3.36	2.72
552	4.07	4.33	3.05	4.35	4.27	4.02	3.77	3.58	4.20	3.83	3.33	2.54
553	3.87	4.06	2.99	4.21	4.13	3.88	3.61	3.43	4.06	3.70	3.22	2.46
554	3.77	3.89	2.87	4.02	3.94	3.71	3.47	3.31	3.90	3.54	3.10	2.41
555	4.41	4.40	3.11	4.48	4.40	4.13	3.89	3.71	4.34	3.94	3.44	2.67
556	4.63	4.52	3.09	4.65	4.54	4.16	3.83	3.59	4.44	3.98	3.38	2.45
557	4.6	4.51	3.11	4.63	4.52	4.13	3.80	3.57	4.42	3.97	3.38	2.48

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
558	4.65	4.55	3.11	4.56	4.47	4.14	3.84	3.62	4.37	3.95	3.39	2.51
559	4.78	4.69	3.15	4.72	4.60	4.26	3.95	3.74	4.51	4.06	3.49	2.57
560	5	4.75	3.13	4.83	4.67	4.25	3.87	3.62	4.57	4.07	3.42	2.42
561	5.28	5.02	3.28	5.07	4.92	4.47	4.09	3.82	4.81	4.31	3.63	2.58
562	5.25	4.83	3.05	4.77	4.62	4.19	3.82	3.54	4.51	4.01	3.33	2.25
563	5.32	4.79	3.03	4.73	4.58	4.15	3.78	3.51	4.47	3.96	3.29	2.25
564	5.72	5.03	3.05	5.03	4.82	4.28	3.86	3.53	4.73	4.19	3.44	2.25
565	6.11	5.35	3.24	5.28	5.06	4.49	4.05	3.71	4.98	4.41	3.63	2.39
566	6.04	5.52	3.31	5.53	5.32	4.76	4.31	3.97	5.23	4.63	3.82	2.57
567	5.47	5.00	3.05	5.06	4.87	4.38	3.95	3.64	4.77	4.23	3.47	2.30
568	5.52	5.07	3.20	5.12	4.95	4.45	4.05	3.74	4.86	4.36	3.66	2.58
569	6.48	5.94	3.57	5.92	5.71	5.08	4.61	4.24	5.60	4.99	4.16	2.90
570	6.3	5.55	3.12	5.53	5.31	4.64	4.08	3.64	5.18	4.53	3.64	2.28
571	5.43	4.82	2.86	4.89	4.73	4.20	3.74	3.36	4.60	4.06	3.30	2.11
572	5.64	4.78	2.78	4.80	4.62	4.00	3.51	3.09	4.52	3.97	3.23	2.08
573	6.68	5.59	3.14	5.50	5.27	4.56	4.02	3.57	5.16	4.51	3.66	2.37
574	6.26	5.51	2.99	5.46	5.20	4.46	3.86	3.33	5.10	4.43	3.52	2.10
575	5.08	4.57	2.61	4.63	4.46	3.92	3.42	2.99	4.37	3.81	3.05	1.84
576	5.24	4.95	3.07	5.00	4.82	4.39	3.88	3.45	4.83	4.29	3.58	2.41
577	6.59	5.89	3.43	5.82	5.58	5.05	4.44	3.94	5.52	4.86	4.01	2.64
578	6.05	5.29	2.84	5.22	4.96	4.30	3.59	3.00	4.91	4.25	3.38	1.98
579	4.6	4.12	2.41	4.19	4.06	3.52	2.95	2.44	4.00	3.50	2.81	1.72
580	4.7	4.43	2.84	4.53	4.38	3.92	3.38	2.90	4.37	3.89	3.25	2.20
581	6.33	5.73	3.31	5.70	5.43	4.88	4.21	3.64	5.42	4.75	3.91	2.54
582	5.59	4.91	2.57	4.84	4.61	3.95	3.26	2.65	4.54	3.92	3.04	1.68
583	4.2	4.05	2.28	4.10	3.98	3.37	2.78	2.25	3.91	3.45	2.72	1.57
584	4.5	4.43	2.67	4.48	4.35	3.80	3.25	2.76	4.30	3.78	3.04	1.83
585	5.21	4.98	2.89	5.00	4.77	4.20	3.56	3.01	4.77	4.18	3.34	2.00
586	4.92	4.68	2.58	4.69	4.50	3.93	3.33	2.81	4.43	3.88	3.01	1.67
587	3.7	3.76	2.18	3.77	3.67	3.14	2.65	2.19	3.60	3.17	2.48	1.38
588	4.01	4.15	2.65	4.20	4.10	3.70	3.33	2.98	4.04	3.59	2.98	1.93

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
589	4.95	4.75	2.88	4.77	4.59	4.16	3.71	3.33	4.55	4.03	3.31	2.09
590	4.36	4.29	2.52	4.31	4.16	3.73	3.30	2.95	4.09	3.62	2.89	1.74
591	3.32	3.57	2.22	3.69	3.57	3.16	2.78	2.49	3.52	3.12	2.48	1.50
592	3.76	3.95	2.58	4.10	3.97	3.61	3.27	3.04	3.90	3.48	2.87	1.93
593	4.35	4.38	2.74	4.46	4.29	3.92	3.53	3.25	4.23	3.75	3.08	2.01
594	3.94	4.11	2.58	4.18	4.05	3.72	3.37	3.11	3.98	3.54	2.92	1.96
595	3.53	3.55	2.35	3.63	3.51	3.16	2.86	2.64	3.44	3.06	2.51	1.69
596	3.64	3.84	2.62	4.00	3.89	xxx	3.33	3.16	3.81	3.44	2.94	2.18
597	4.12	4.10	2.69	4.08	3.93	xxx	3.36	3.17	3.87	3.46	2.94	2.14
598	4.01	3.99	2.62	3.97	3.87	xxx	3.32	3.14	3.80	3.40	2.90	2.13
599	4.15	4.39	2.78	4.44	4.30	xxx	3.70	3.46	4.29	3.82	3.23	2.32
600	3.59	3.69	2.20	3.66	3.52	xxx	2.91	2.65	3.52	3.12	2.60	1.63
601	3.78	4.02	2.42	4.04	3.93	xxx	3.26	2.98	3.89	3.49	2.94	1.90
602	4.1	4.18	2.40	4.13	4.05	xxx	3.26	2.95	3.98	3.48	2.86	1.70
603	3.83	3.91	2.30	3.91	3.86	xxx	3.11	2.81	3.81	3.32	2.74	1.65
604	3.63	3.77	2.19	3.81	3.73	xxx	3.01	2.71	3.69	3.21	2.63	1.58
605	3.74	3.93	2.29	3.96	3.86	xxx	3.12	2.82	3.79	3.32	2.74	1.66
606	4.28	4.27	2.42	4.30	4.18	xxx	3.30	2.97	4.08	3.56	2.86	1.66
607	4.17	4.12	2.37	4.19	4.08	xxx	3.20	2.88	3.96	3.46	2.78	1.62
608	3.96	4.17	2.40	4.07	3.99	xxx	3.25	2.96	3.94	3.45	2.80	1.69
609	3.73	4.06	2.33	3.94	3.86	xxx	3.17	2.89	3.83	3.35	2.72	1.64
610	3.96	4.10	2.44	4.11	4.03	xxx	3.26	2.99	3.94	3.47	2.80	1.77
611	3.95	4.06	2.45	4.13	4.06	xxx	3.27	3.00	3.97	3.48	2.81	1.76
612	4.23	4.12	2.52	4.20	4.12	xxx	3.37	xxx	4.02	3.54	2.90	1.85
613	3.36	3.19	2.07	3.24	3.20	xxx	2.50	2.29	3.11	2.73	2.20	1.35
614	4.39	4.51	3.19	4.65	4.55	xxx	3.96	3.78	4.49	4.09	3.60	2.79
615	4.74	4.86	3.24	4.99	4.84	xxx	4.20	3.97	4.79	4.32	3.73	2.77
616	4.01	4.23	2.91	4.36	4.26	xxx	3.64	xxx	4.20	3.79	3.26	2.42
617	3.56	3.83	2.69	4.02	3.95	3.68	3.33	3.13	3.88	3.51	3.01	2.21
618	3.87	4.07	2.98	4.22	4.15	3.92	3.58	3.42	4.09	3.74	3.29	2.55
619	4.59	4.62	3.24	4.71	4.61	4.35	4.02	3.83	4.55	4.16	3.65	2.81

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
620	4.39	4.42	3.03	4.54	4.44	4.08	3.72	3.48	4.37	3.94	3.38	2.47
621	3.75	4.03	2.81	4.14	4.07	3.73	3.38	3.16	4.00	3.60	3.10	2.26
622	3.83	4.15	2.97	4.24	4.15	3.89	3.58	3.39	4.09	3.74	3.27	2.49
623	4.54	4.70	3.26	4.78	4.67	4.38	4.06	3.85	4.61	4.20	3.66	2.79
624	4.43	4.48	3.01	4.55	4.46	4.10	3.74	3.49	4.38	3.92	3.36	2.40
625	3.56	3.80	2.71	3.98	3.90	3.59	3.24	3.02	3.83	3.44	2.97	2.12
626	3.57	3.79	2.80	3.94	3.89	3.66	3.36	3.18	3.84	3.49	3.08	2.36
627	4.06	4.13	2.94	4.18	4.10	3.85	3.53	3.32	4.06	3.67	3.21	2.45
628	4.08	4.38	3.10	4.51	4.37	4.14	3.85	3.64	4.33	3.96	3.48	2.68
629	3.45	3.79	2.77	4.01	3.91	3.69	3.40	3.21	3.85	3.53	3.10	2.34
630	3.4	3.65	2.76	3.85	3.81	3.57	3.27	3.10	3.74	3.43	3.03	2.38
631	4.46	4.58	3.25	4.65	4.58	4.30	4.01	3.83	4.51	4.13	3.65	2.89
632	4.27	4.34	2.92	4.38	4.30	3.96	3.63	3.41	4.22	3.78	3.27	2.36
633	3.23	3.56	2.55	3.70	3.67	3.39	3.05	2.84	3.60	3.23	2.81	2.03
634	3.36	3.72	2.77	3.82	3.82	3.61	3.32	3.16	3.76	3.46	3.08	2.41
635	4.33	4.50	3.14	4.53	4.49	4.23	3.95	3.76	4.43	4.05	3.57	2.77
636	4.38	4.36	2.92	4.40	4.33	3.99	3.65	3.40	4.25	3.80	3.26	2.35
637	3.14	3.35	2.43	3.49	3.46	3.17	2.86	2.65	3.38	3.04	2.63	1.91
638	3.28	3.62	2.77	3.74	3.75	3.54	3.30	3.15	3.68	3.41	3.07	2.46
639	4.26	4.47	3.16	4.53	4.49	4.24	3.97	3.79	4.41	4.05	3.60	2.07
640	4.08	4.20	2.90	4.28	4.22	3.91	3.59	3.37	4.14	3.73	3.23	xxx
641	2.61	2.89	2.15	3.02	3.02	2.79	2.53	2.37	2.95	2.67	2.34	xxx
642	2.76	3.18	2.50	3.32	3.32	3.19	3.00	2.91	3.26	3.07	2.83	xxx
643	4.05	4.33	3.18	4.46	4.39	4.19	3.94	3.80	4.33	4.02	3.61	xxx
644	3.8	3.93	2.77	4.03	3.99	3.72	3.41	3.20	3.93	3.54	3.07	xxx
645	2.71	3.01	2.24	3.13	3.15	2.94	2.70	2.52	3.25	2.81	2.49	xxx
646	2.74	3.10	2.41	3.22	3.21	3.06	2.88	2.76	3.16	2.96	2.71	xxx
647	3.89	4.16	3.05	4.25	4.18	3.92	3.68	3.53	4.35	3.79	3.39	xxx
648	xxx	4.86	3.34	4.92	4.90	4.44	4.09	3.83	4.83	4.33	3.71	xxx
649	xxx	2.91	1.96	2.91	3.07	xxx	xxx	xxx	2.98	xxx	2.21	xxx
650	xxx	2.76	2.24	2.85	2.96	xxx	xxx	xxx	2.90	xxx	2.65	xxx

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
651	xxx	4.42	3.39	4.57	4.47	4.17	4.09	3.98	4.43	4.18	3.85	xxx
652	3.67	3.82	2.79	3.91	3.85	3.63	3.34	3.16	3.83	3.50	3.09	xxx
653	2.9	3.33	2.54	3.44	3.43	3.26	3.02	2.88	3.40	3.15	2.84	xxx
654	2.78	3.20	2.43	3.36	3.32	3.13	2.90	2.76	3.28	3.04	2.72	xxx
655	3.39	3.77	2.82	3.93	3.90	3.70	3.49	3.34	3.85	3.57	3.20	xxx
656	3.79	4.04	2.89	4.13	4.10	3.82	3.56	3.39	4.04	3.67	3.23	xxx
657	2.93	3.22	2.39	3.34	3.32	3.06	2.79	2.63	3.28	2.95	2.60	xxx
658	2.97	3.38	2.67	3.59	3.52	3.36	3.15	3.03	3.48	3.24	2.97	xxx
659	3.55	3.89	2.95	4.08	3.99	3.81	3.57	3.43	3.95	3.67	3.31	xxx
660	4	4.30	3.19	4.48	4.40	4.05	3.85	3.65	4.35	3.99	3.53	xxx
661	3.66	3.96	2.96	4.14	4.07	3.72	3.52	3.32	4.01	3.68	3.25	xxx
662	3.48	3.81	2.90	4.02	3.93	3.71	3.45	3.28	3.87	3.59	3.22	xxx
663	3.65	4.02	3.04	4.24	4.15	3.94	3.66	3.49	4.09	3.79	3.40	1.42
664	4.09	4.39	xxx	4.59	4.51	3.96	3.94	3.75	4.46	4.11	3.67	2.88
665	4.4	4.61	xxx	4.77	4.67	4.09	4.07	3.86	4.61	4.23	3.77	2.96
666	3.94	4.16	3.07	4.34	4.23	4.00	3.67	3.46	4.16	3.80	3.38	2.63
667	4.01	4.25	3.13	4.43	4.33	4.10	3.77	3.57	4.17	3.90	3.48	2.71
668	4.61	4.67	3.36	4.82	4.73	4.19	4.04	3.82	4.65	4.24	3.73	2.82
669	5.06	5.00	3.52	5.13	5.00	4.42	4.27	4.04	4.91	4.47	3.92	2.97
670	4.69	4.66	3.24	4.72	4.61	4.28	3.93	3.70	4.52	4.09	3.57	2.69
671	4.44	4.52	3.17	4.60	4.51	4.21	3.87	3.65	4.42	4.01	3.52	2.68
672	4.82	4.74	3.31	4.88	4.73	4.33	4.00	3.75	4.65	4.20	3.65	2.75
673	5.66	5.48	3.61	5.45	5.26	4.78	4.43	4.15	5.18	4.65	4.02	3.01
674	5.38	5.18	3.31	5.09	4.91	4.47	4.20	3.79	4.80	4.28	3.64	2.58
675	4.63	4.46	3.05	4.53	4.42	4.06	3.68	3.43	4.30	3.87	3.31	2.38
676	5.28	5.00	3.45	5.24	5.11	4.40	4.27	3.99	5.02	4.52	3.87	2.85
677	6.11	5.51	3.63	5.58	5.38	4.61	4.46	4.15	5.32	4.74	4.04	2.94
678	5.74	5.39	3.51	5.45	5.25	4.62	4.37	4.06	5.19	4.64	3.96	2.86
679	xxx	4.91	3.30	5.09	4.91	4.32	4.07	3.78	4.83	4.34	3.69	2.65
680	xxx	5.04	3.47	5.19	5.03	4.32	4.22	3.94	4.94	4.46	3.85	2.88
681	6.55	5.91	3.87	5.95	5.77	4.96	4.82	4.50	5.68	5.10	4.37	3.25

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
682	6.19	5.54	3.47	5.54	5.34	4.80	4.32	3.99	5.25	4.66	3.86	2.69
683	5.08	4.71	3.13	4.85	4.69	4.26	3.83	3.54	4.62	4.12	3.44	2.42
684	5.43	5.09	3.47	5.25	5.08	xxx	4.26	3.98	5.02	4.51	3.88	2.87
685	6.45	5.89	3.81	5.96	5.73	xxx	4.76	4.44	5.64	5.05	4.32	3.16
686	6	5.54	3.48	5.57	5.35	4.81	4.35	4.01	5.25	4.68	3.89	2.72
687	4.86	4.73	3.14	4.86	4.71	4.28	3.86	3.55	4.61	4.14	3.46	2.44
688	5.31	4.95	3.36	5.01	4.87	4.42	4.06	3.77	4.78	4.30	3.68	2.71
689	6.24	5.75	3.70	5.74	5.54	4.99	4.60	4.29	5.45	4.88	4.15	3.03
690	6.33	5.65	3.54	5.67	5.45	4.89	4.40	4.09	5.34	4.73	3.94	2.73
691	4.63	4.29	2.94	4.45	4.33	3.92	3.47	3.22	4.24	3.77	3.15	2.19
692	4.99	4.76	3.51	5.04	4.94	xxx	4.22	3.99	4.82	4.43	3.91	3.02
693	6	5.55	3.81	5.73	5.53	xxx	4.68	4.39	5.40	4.92	4.28	3.22
694	5.69	5.44	3.69	5.52	5.36	xxx	4.47	4.18	5.26	4.76	4.10	3.05
695	3.88	3.81	2.70	3.96	3.91	xxx	3.17	2.95	3.84	3.44	2.97	2.18
696	3.97	xxx	3.13	4.29	4.24	xxx	3.71	3.52	4.13	3.88	3.49	2.88
697	5.48	xxx	3.93	5.51	5.37	xxx	4.75	4.50	5.23	4.90	4.36	3.49
698	5.14	4.93	3.54	5.09	4.95	xxx	4.21	3.94	4.87	4.45	3.90	2.97
699	4.24	4.19	3.11	4.36	4.31	xxx	3.65	3.41	4.25	3.89	3.43	2.64
700	4.17	4.19	3.17	4.38	4.32	xxx	3.75	3.56	4.26	3.95	3.54	2.81
701	4.94	4.91	3.59	5.08	4.95	xxx	4.29	4.08	4.87	4.51	4.01	3.16
702	4.81	4.77	3.46	4.88	4.77	xxx	4.10	3.88	4.70	4.31	3.82	2.98
703	3.81	4.08	2.92	4.12	4.13	xxx	3.46	3.24	4.08	3.71	3.24	2.54
704	4.02	4.34	3.18	4.47	4.48	xxx	3.83	3.60	4.42	4.08	3.60	2.89
705	4.54	4.54	3.46	4.77	4.69	xxx	4.12	3.91	4.63	4.31	3.86	3.10
706	3.89	3.96	3.04	4.10	4.07	3.83	3.56	3.37	4.02	3.72	3.35	2.67
707	3.48	3.67	2.83	3.79	3.82	3.60	3.34	3.15	3.76	3.49	3.16	2.53
708	3.58	3.77	2.89	3.94	3.94	3.61	3.45	3.27	3.88	3.61	3.27	2.62
709	3.84	4.01	3.10	4.19	4.14	3.81	3.66	3.49	4.08	3.80	3.46	2.79
710	3.86	3.91	3.02	4.10	4.03	3.80	3.60	3.44	3.98	3.72	3.41	2.77
711	4.03	4.03	3.08	4.22	4.13	3.89	3.66	3.49	4.09	3.81	3.47	2.79
712	3.59	3.75	2.85	3.92	3.87	3.64	3.34	3.15	3.82	3.52	3.15	2.46

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
713	3.21	3.55	2.77	3.74	3.73	3.51	3.26	3.09	3.67	3.41	3.08	2.49
714	3.54	3.78	2.95	3.91	3.86	3.68	3.46	3.32	3.81	3.58	3.26	2.70
715	3.7	4.00	3.04	4.16	4.09	3.91	3.65	3.49	5.03	3.78	3.42	2.77
716	3.9	4.15	3.12	4.29	4.22	4.00	4.11	3.56	4.18	3.86	3.50	2.79
717	2.9	3.01	2.21	3.02	2.98	2.77	2.50	2.38	2.95	2.69	2.39	1.87
718	4.05	xxx	3.07	4.29	4.26	xxx	3.65	xxx	3.80	3.91	xxx	2.89
719	4.61	xxx	3.51	4.98	4.94	xxx	4.31	xxx	4.48	4.54	xxx	3.31
720	3.28	3.52	2.70	3.68	3.70	3.43	xxx	xxx	3.66	3.43	3.14	xxx
721	3.33	3.58	2.82	3.78	3.79	3.54	xxx	3.21	xxx	3.52	3.23	xxx
722	3.25	3.56	2.77	3.75	3.74	3.53	3.31	3.16	3.69	3.45	3.15	2.55
723	4.32	4.55	3.40	4.70	4.61	4.35	4.12	3.96	4.56	4.25	3.87	3.14
724	3.62	3.71	2.68	3.83	3.68	3.46	3.25	3.10	3.65	3.33	2.98	2.35
725	3	3.28	2.51	3.43	3.35	3.19	3.02	2.90	3.32	3.07	2.79	2.28
726	3.99	4.16	3.08	4.33	4.36	4.08	3.80	3.64	4.30	3.94	3.51	2.73
727	3.81	3.61	2.71	3.68	3.72	3.46	3.21	3.07	3.66	3.34	3.00	2.36
728	3.49	3.57	2.73	3.63	3.61	3.42	3.20	3.07	3.56	3.30	3.00	2.47
729	3.37	3.74	2.78	3.81	3.81	3.59	3.32	3.15	3.78	3.45	3.10	2.47
730	3.27	3.62	2.75	3.74	3.72	3.51	3.29	3.13	3.69	3.40	3.11	2.52
731	4.39	4.50	3.29	4.62	4.54	4.28	4.04	3.86	4.47	4.15	3.74	3.01
732	4.07	4.15	2.94	4.24	4.16	3.91	3.62	3.42	4.08	3.71	3.28	2.52
733	3.2	3.46	2.61	3.64	3.61	3.40	3.13	2.95	3.54	3.22	2.88	2.24
734	3.85	3.79	2.87	3.96	3.95	3.71	3.43	3.23	3.88	3.55	3.15	2.49
735	4.59	4.44	3.22	4.55	4.49	4.23	3.94	3.73	4.42	4.05	3.58	2.84
736	4.53	4.44	3.15	4.59	4.46	4.17	3.84	3.63	4.38	3.98	3.48	2.67
737	3.38	3.47	2.56	3.66	3.60	3.35	3.03	2.83	3.54	3.20	2.80	2.11
738	xxx	3.77	2.92	3.93	3.92	3.60	3.47	3.30	3.87	3.60	3.27	2.66
739	xxx	4.70	3.44	4.80	4.73	4.36	4.20	4.01	4.65	4.31	3.87	3.09
740	4.62	4.63	3.30	4.71	4.62	4.33	4.00	3.78	4.53	4.14	3.64	2.81
741	3.3	3.48	2.58	3.64	3.60	3.37	3.07	2.87	3.54	3.22	2.84	2.20
742	3.53	3.78	2.93	3.95	3.93	3.40	3.50	3.31	3.89	3.61	3.28	2.69
743	4.55	4.66	3.50	4.78	4.72	4.14	4.21	4.01	4.66	4.33	3.89	3.15

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
744	4.64	4.65	3.39	4.71	xxx	4.14	4.06	3.84	4.59	4.22	3.73	2.91
745	3.35	3.51	2.58	3.63	xxx	3.15	3.10	2.91	3.56	3.25	2.88	2.23
746	3.53	3.81	2.97	3.99	xxx	xxx	3.56	3.41	3.92	3.67	3.36	2.81
747	4.55	4.73	3.63	4.87	xxx	xxx	4.33	4.14	4.77	4.46	4.05	3.32
748	4.59	4.66	3.40	4.69	xxx	3.95	4.01	3.78	4.57	4.20	3.73	2.92
749	3.55	3.77	2.69	3.79	xxx	3.15	3.21	3.00	3.75	3.40	2.99	2.34
750	3.3	3.65	2.79	3.72	xxx	3.15	3.32	3.17	3.72	3.46	3.16	2.64
751	4.59	4.78	3.64	4.87	xxx	4.15	4.33	4.16	4.76	4.46	4.07	3.37
752	4.65	4.65	3.41	4.78	xxx	4.15	4.09	3.84	4.63	4.24	3.76	2.91
753	3.32	3.56	2.57	3.61	xxx	3.19	3.11	2.91	3.68	3.30	2.94	2.23
754	3.36	3.71	2.81	3.77	xxx	3.19	3.42	3.27	3.86	3.56	3.27	2.69
755	4.63	4.74	3.61	4.89	3.57	4.11	4.34	4.17	4.77	4.45	4.06	3.34
756	4.46	4.39	3.21	4.49	4.44	4.09	3.78	3.55	4.36	3.96	3.49	2.69
757	3.39	3.53	2.61	3.62	3.64	3.35	3.08	2.88	3.59	3.25	2.89	2.29
758	3.37	3.63	2.76	3.79	3.80	3.37	3.36	3.20	3.77	3.46	3.16	2.59
759	4.19	4.27	3.27	4.46	4.39	3.94	3.90	3.71	4.33	4.00	3.63	2.93
760	4.21	4.31	3.24	4.49	4.41	3.93	3.81	3.60	4.34	3.99	3.56	2.81
761	3.55	3.69	2.80	3.84	3.83	3.36	3.25	3.07	3.76	3.44	3.08	2.44
762	3.21	3.58	2.78	3.76	3.74	3.36	3.32	3.18	3.69	3.44	3.17	2.61
763	4.44	4.45	3.36	4.58	4.49	4.08	4.02	3.84	4.45	4.14	3.76	3.05
764	4	4.09	2.96	4.14	4.08	3.82	3.53	3.32	4.03	3.68	3.26	2.55
765	3.98	4.51	3.29	4.64	4.57	4.28	4.00	3.82	4.50	4.13	3.70	3.00
766	xxx	3.69	2.50	3.63	xxx	3.26	3.27	2.77	2.84	3.07	2.64	1.85
767	xxx	2.84	2.02	2.75	xxx	2.55	2.23	2.04	3.42	2.39	2.04	1.39
768	xxx	4.56	3.52	4.87	xxx	xxx	4.43	4.20	xxx	4.51	4.10	3.47
769	xxx	3.93	2.92	4.23	4.23	xxx	3.74	3.55	4.11	3.85	3.43	2.74
770	3.8	3.94	3.11	4.18	4.19	xxx	3.66	3.49	4.12	3.87	3.48	2.86
771	4.51	4.55	3.52	4.77	4.71	xxx	4.20	4.02	4.64	4.35	3.92	3.22
772	4.14	4.16	3.13	4.27	4.20	xxx	3.62	3.40	4.18	3.84	3.43	2.71
773	4.41	4.52	3.43	4.68	4.60	xxx	4.06	3.85	4.56	4.23	3.81	3.08
774	4.06	4.21	3.10	4.39	4.28	4.04	3.69	3.45	4.24	3.89	3.46	2.70

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
776	4.39	4.53	3.37	4.65	4.63	xxx	4.03	3.82	4.58	4.22	3.77	2.99
777	4.81	4.84	3.53	4.96	4.88	xxx	4.22	3.98	4.83	4.44	3.93	3.08
778	4.33	4.46	3.24	4.60	4.48	4.19	3.86	3.65	4.44	4.07	3.60	2.81
779	3.58	3.86	2.88	4.05	3.99	3.71	3.38	3.18	3.94	3.60	3.21	2.52
780	4.45	4.42	3.41	4.74	4.70	xxx	4.04	3.81	4.59	4.26	3.81	3.02
781	5.34	5.10	3.80	5.37	5.25	xxx	4.57	4.31	5.15	4.78	4.24	3.33
782	4.72	4.68	3.38	4.82	4.67	4.26	4.03	3.78	4.63	4.24	3.74	2.87
783	3.91	4.02	2.97	4.19	4.12	3.71	3.50	3.27	4.08	3.72	3.30	2.54
784	4.45	4.43	3.32	4.68	4.61	xxx	3.96	3.71	4.55	4.19	3.73	2.92
785	5.92	5.54	3.98	5.65	5.49	xxx	4.77	4.50	5.42	5.00	4.42	3.47
786	4.83	4.90	3.31	5.01	4.85	4.54	4.11	3.86	4.81	4.36	3.78	2.87
787	4.69	4.40	3.08	4.57	4.41	4.12	3.68	3.44	4.37	3.96	3.43	2.59
788	4.95	4.64	3.25	4.85	4.68	4.15	3.89	3.61	4.62	4.18	3.63	2.74
789	6.21	5.76	3.77	5.88	5.68	5.06	4.78	4.44	5.62	5.06	4.39	3.33
790	5.67	5.24	3.24	5.30	5.09	4.60	4.07	3.68	5.00	4.42	3.66	2.50
791	4.51	4.39	2.89	4.53	4.39	4.00	3.54	3.21	4.31	3.85	3.22	2.26
792	4.76	4.66	3.12	4.73	4.57	4.25	3.82	3.53	4.52	4.08	3.48	2.57
793	6.33	5.97	3.70	5.92	5.68	5.19	4.65	4.28	5.61	5.02	4.24	3.06
794	6.15	5.39	3.04	5.24	5.03	4.48	3.87	3.41	4.90	4.24	3.41	2.10
795	4.61	4.23	2.59	4.23	4.11	3.73	3.25	2.87	4.00	3.49	2.86	1.83
796	5.55	5.21	3.40	5.32	5.15	4.64	4.26	3.94	5.08	4.53	3.84	2.74
797	6.66	5.97	3.68	5.97	5.73	5.10	4.64	4.27	5.64	4.99	4.17	2.90
798	5.89	5.41	3.25	5.40	5.18	4.66	4.11	3.73	5.08	4.47	3.67	2.44
799	4.79	4.54	2.90	4.65	4.49	4.09	3.59	3.27	4.41	3.90	3.22	2.15
800	5.22	5.00	3.33	5.10	4.94	4.51	4.12	3.82	4.89	4.38	3.74	2.72
801	6.31	5.87	3.65	5.81	5.60	5.05	4.61	4.25	5.52	4.91	4.15	2.96
802	5.89	5.43	3.26	5.40	5.20	4.64	4.10	3.73	5.10	4.47	3.67	2.42
803	4.95	4.54	2.95	4.63	4.48	4.04	3.58	3.27	4.41	3.89	3.22	2.18
804	4.55	4.32	2.81	4.45	4.32	3.97	3.53	3.23	4.25	3.78	3.18	2.23
805	xxx	5.64	3.37	5.69	5.45	4.93	4.37	3.98	5.37	4.73	3.93	2.70
806	xxx	5.62	3.11	5.62	5.34	4.67	4.00	3.52	5.24	4.53	3.59	2.18

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
808	4.41	4.38	2.94	4.50	4.41	4.11	3.70	3.44	4.34	3.91	3.33	2.40
809	5.29	5.05	3.17	5.11	4.95	4.61	4.12	3.80	4.89	4.37	3.66	2.55
810	5.16	4.84	2.97	4.86	4.69	4.30	3.79	3.44	4.62	4.11	3.39	2.28
811	4.4	4.28	2.75	4.35	4.24	3.89	3.45	3.15	4.16	3.72	3.09	2.11
812	4.17	4.30	2.81	4.35	4.24	3.95	3.56	3.29	4.19	3.77	3.18	2.25
813	4.87	4.84	3.04	4.85	4.70	4.37	3.93	3.62	4.65	4.16	3.50	2.44
814	4.51	4.41	2.73	4.47	4.34	3.94	3.47	3.13	4.27	3.76	3.09	2.01
815	3.91	4.03	2.60	4.16	4.06	3.71	3.29	2.99	3.99	3.55	2.95	1.98
816	4.14	4.10	2.65	4.20	4.11	3.78	3.36	3.07	4.02	3.58	2.95	1.97
817	4.07	4.03	2.60	4.15	4.05	3.71	3.28	2.99	4.20	3.53	2.90	1.93
818	3.94	4.04	2.70	4.18	4.04	3.74	3.37	3.13	3.99	3.58	3.00	2.13
819	3.87	3.92	2.62	4.06	3.90	3.60	3.22	2.99	3.85	3.44	2.87	2.02
820	3.63	3.82	2.57	3.93	3.85	3.56	3.18	2.94	3.76	3.36	2.82	1.98
821	3.51	3.78	2.53	3.84	3.80	3.52	3.15	2.92	3.70	3.31	2.78	1.95
822	3.39	3.62	2.50	3.71	3.62	3.38	3.08	2.90	3.56	3.22	2.76	2.13
823	3.67	3.83	2.58	3.92	3.81	3.56	3.24	3.04	3.76	3.40	2.88	2.19
824	4.02	4.18	2.81	4.34	4.19	3.87	3.47	3.20	4.12	3.71	3.13	2.19
825	3.4	3.61	2.55	3.79	3.71	3.40	3.06	2.85	4.09	3.28	2.80	1.97
826	3.09	3.36	2.45	3.44	3.44	3.22	2.94	2.77	3.84	3.10	2.71	2.06
827	3.6	3.79	2.65	3.84	3.79	3.58	3.29	3.10	3.74	3.42	2.96	2.22
828	3.71	3.83	2.60	3.92	3.84	3.53	3.11	2.80	3.81	3.44	2.90	2.03
829	2.76	3.14	2.22	3.28	3.25	2.98	2.61	2.32	3.22	2.86	2.40	1.71
830	3.76	4.19	3.17	4.33	4.22	3.93	3.52	3.22	4.15	3.87	3.47	2.85
831	3.84	4.16	3.07	4.35	4.23	3.97	3.58	3.29	4.16	3.86	3.42	2.69
832	3.24	3.66	2.73	3.85	3.77	3.48	3.21	2.72	3.71	3.44	3.04	2.33
833	2.09	2.47	1.73	2.53	2.50	2.18	1.75	1.42	2.44	2.20	1.90	1.40
834	3.45	xxx	2.91	3.89	3.88	xxx	3.18	2.89	xxx	3.56	xxx	2.77
835	4.36	xxx	3.45	4.73	4.67	xxx	4.00	3.70	4.42	4.29	xxx	3.19
836	3.16	3.68	2.78	3.83	3.79	3.52	3.23	3.00	3.74	3.46	3.09	2.48
837	2.75	3.33	2.62	3.55	3.51	3.27	2.98	2.77	3.49	3.27	2.96	2.43
838	3.05	3.38	2.61	3.55	3.55	3.29	3.08	2.90	3.49	3.26	2.92	2.34

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
840	3.7	4.10	2.97	4.21	4.10	3.82	3.49	3.27	4.08	3.71	3.27	2.50
841	2.65	3.31	2.43	3.39	3.36	3.08	2.77	2.55	3.34	3.05	2.72	2.08
842	3.43	3.92	2.91	4.01	3.99	3.64	3.43	3.24	3.95	3.62	3.22	2.55
843	4.2	4.44	3.33	4.60	4.50	4.13	3.88	3.71	4.49	4.14	3.66	2.88
844	4.01	4.35	3.21	4.49	4.36	4.07	3.74	3.56	4.32	3.97	3.51	2.73
845	3.09	3.56	2.62	3.72	3.65	3.36	3.04	2.84	3.61	3.29	2.90	2.22
846	3.33	3.85	2.91	4.02	3.98	xxx	3.42	3.24	3.93	3.63	3.24	2.60
847	4.22	4.59	3.44	4.72	4.63	xxx	4.03	3.84	4.58	4.25	3.79	3.03
848	4.28	4.52	3.31	4.64	4.56	xxx	3.87	3.64	4.49	4.13	3.62	2.79
849	3.36	3.73	2.73	3.89	3.85	xxx	3.17	2.95	3.79	3.46	3.01	2.29
850	3.68	3.98	3.07	4.21	4.15	xxx	3.60	3.45	4.09	3.84	3.41	2.73
851	4.68	4.83	3.66	5.01	4.89	xxx	4.30	4.11	4.83	4.52	4.01	3.18
852	4.53	4.75	3.47	4.87	4.74	xxx	4.00	3.77	xxx	4.28	3.76	2.89
853	3.37	3.82	2.73	3.92	3.84	xxx	3.11	2.91	3.82	3.42	2.99	2.28
854	3.68	xxx	3.11	4.29	4.24	xxx	3.65	3.49	4.16	3.87	3.46	2.82
855	4.86	xxx	3.86	5.29	5.17	xxx	4.54	4.34	5.09	4.76	4.24	3.41
856	4.7	4.87	3.52	5.02	4.87	xxx	4.05	3.79	4.82	4.41	3.82	2.87
857	3.82	4.04	2.96	4.26	4.17	xxx	3.36	3.13	4.09	3.74	3.24	2.44
858	3.68	4.04	3.07	4.25	4.18	xxx	3.58	3.42	4.12	3.81	3.42	2.76
859	4.92	5.15	3.80	5.33	5.17	xxx	4.53	4.32	5.12	4.73	4.23	3.39
860	5.06	5.03	3.50	5.18	4.98	4.40	4.10	3.80	4.92	4.39	3.81	2.82
861	3.79	3.95	2.84	4.12	4.02	3.45	3.18	2.93	3.96	3.55	3.05	2.26
862	3.82	xxx	3.22	4.42	4.35	xxx	3.75	3.59	4.29	3.99	3.58	2.90
863	4.98	xxx	3.84	5.35	5.20	xxx	4.56	4.36	5.13	4.76	4.25	3.38
864	4.97	4.99	3.56	5.07	4.96	4.30	4.13	3.88	4.88	4.44	3.87	2.90
865	4.28	4.37	3.19	4.48	4.43	3.76	3.60	3.40	4.35	3.95	3.45	2.60
866	4.07	4.16	3.09	4.27	4.22	3.76	3.54	3.38	4.16	3.79	3.36	2.62
867	4.86	4.99	3.57	5.04	4.93	xxx	4.23	4.02	5.02	4.45	3.94	3.08
868	4.99	5.01	3.43	5.08	4.92	xxx	4.05	3.78	4.86	4.36	3.75	2.77
869	4.12	4.22	3.07	4.40	4.29	xxx	3.47	3.24	4.23	3.80	3.29	2.46
870	4.27	4.43	3.25	4.65	4.55	xxx	3.84	3.65	4.48	4.08	3.63	2.84

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
872	5.01	4.99	3.48	5.19	5.03	4.30	4.17	3.90	4.94	4.48	3.90	2.93
873	4.54	4.41	3.14	4.57	4.51	3.79	3.67	3.43	4.40	3.99	3.48	2.63
874	3.89	4.06	3.00	4.20	4.14	3.78	3.53	3.35	4.08	3.75	3.33	2.64
875	4.7	4.82	3.44	4.96	4.80	4.42	4.15	3.94	4.76	4.36	3.86	3.03
876	4.66	4.68	3.20	4.81	4.63	4.25	3.82	3.55	4.59	4.13	3.54	2.61
877	4.03	4.27	3.06	4.44	4.30	3.96	3.59	3.35	4.27	3.89	3.37	2.56
878	4.01	4.21	3.03	4.34	4.25	3.95	3.58	3.37	4.19	3.82	3.32	2.55
879	4.03	4.29	3.02	4.42	4.30	3.97	3.57	3.34	4.25	3.84	3.31	2.52
880	4.47	4.72	3.36	4.85	4.70	4.16	3.97	3.74	4.66	4.24	3.70	2.87
881	4.16	4.38	3.16	4.52	4.38	3.87	3.69	3.48	4.34	3.96	3.47	2.67
882	3.51	3.88	2.93	4.03	3.92	3.70	3.42	3.26	3.89	3.60	3.22	2.59
883	3.7	4.12	3.06	4.28	4.13	3.93	xxx	3.42	4.14	3.79	3.36	2.70
884	4.26	4.60	3.34	4.75	4.61	4.06	xxx	3.69	4.58	4.18	3.68	2.88
885	4.77	4.79	3.43	4.89	4.77	4.24	xxx	3.84	4.72	4.32	3.80	2.94
886	4.14	4.27	3.04	4.41	4.30	3.98	xxx	3.40	4.27	3.90	3.38	2.56
887	3.38	3.72	2.76	3.93	3.86	3.54	xxx	3.03	3.82	3.49	3.06	2.36
888	3.94	4.18	3.14	4.38	4.34	xxx	3.69	3.50	4.25	3.90	3.50	2.79
889	5.26	5.05	3.57	5.12	5.04	xxx	4.30	4.06	4.94	4.51	4.00	3.11
890	3.75	3.70	2.43	3.68	3.52	3.27	2.98	2.79	3.49	3.19	2.80	2.08
891	3.1	3.48	2.43	3.53	3.42	3.19	2.91	2.74	3.38	3.13	2.77	2.14
892	4.79	4.96	3.33	5.11	5.00	xxx	4.22	3.97	4.89	4.47	3.91	2.99
893	5.14	5.17	3.41	5.26	5.12	xxx	4.34	4.08	5.04	4.57	3.99	3.03
894	4.45	4.58	2.99	4.64	4.53	4.15	3.76	3.51	xxx	4.02	3.47	2.59
895	3.12	3.52	2.41	3.66	3.62	3.26	2.90	2.70	xxx	3.20	2.76	2.06
896	3.97	4.26	3.11	4.40	4.38	xxx	3.73	3.54	4.29	3.98	3.56	2.85
897	5.41	5.43	3.69	5.48	5.35	xxx	4.63	4.38	5.27	4.84	4.28	3.34
898	4.85	4.92	3.18	4.99	4.83	4.41	3.97	3.67	4.77	4.29	3.70	2.70
899	4.13	4.23	2.89	4.37	4.27	3.87	3.42	3.14	4.20	3.79	3.27	2.38
900	xxx	4.22	3.04	4.36	4.25	3.94	3.58	3.37	4.20	3.86	3.46	2.80
901	xxx	5.32	3.50	5.38	5.19	4.82	4.44	4.19	5.15	4.68	4.13	3.27
902	5.72	5.43	3.27	5.46	5.30	4.75	4.19	3.82	5.22	4.64	3.92	2.79

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
904	5.04	xxx	3.42	5.10	5.00	xxx	4.14	3.85	4.60	4.49	3.94	3.05
905	6.08	xxx	3.80	5.87	5.70	xxx	4.82	4.52	5.31	5.12	4.48	3.43
906	5.52	xxx	3.55	5.46	5.26	4.42	4.33	4.01	5.18	4.69	4.06	3.02
907	4.65	xxx	3.21	4.88	4.72	3.88	3.80	3.50	4.64	4.20	3.62	2.68
908	4.84	xxx	3.41	4.99	4.90	3.88	4.00	3.73	4.74	4.37	3.81	2.89
909	6.21	xxx	3.93	6.05	5.90	4.82	4.90	4.58	5.71	5.23	4.54	3.45
910	6.21	5.57	3.50	5.63	5.40	4.81	4.27	3.91	5.29	4.70	3.94	2.76
911	4.98	4.66	3.13	4.83	4.68	4.15	3.66	3.37	4.58	4.10	3.47	2.46
912	5.18	xxx	3.55	5.35	5.20	xxx	4.25	3.98	5.02	4.62	4.02	3.02
913	5.87	xxx	3.76	5.82	5.61	xxx	4.61	4.30	5.44	4.97	4.30	3.18
914	5.55	5.33	3.56	5.45	5.27	xxx	4.25	3.92	5.16	4.64	3.96	2.88
915	4.75	4.70	3.24	4.85	4.75	xxx	3.75	3.46	4.63	4.18	3.56	2.59
916	4.98	xxx	3.54	5.14	5.06	xxx	4.14	3.89	4.87	4.52	3.93	2.99
917	5.73	xxx	3.84	5.78	5.60	xxx	4.66	4.36	5.44	5.01	4.34	3.28
918	5.56	5.36	3.67	5.66	5.46	xxx	4.42	4.08	5.36	4.82	4.11	2.98
919	4.33	4.21	3.01	4.49	4.38	xxx	3.39	3.09	4.28	3.85	3.26	2.34
920	4.9	xxx	3.59	5.24	5.15	xxx	4.29	4.03	4.38	4.67	xxx	3.19
921	5.65	xxx	3.91	5.79	5.62	xxx	4.75	4.47	4.85	5.09	xxx	3.44
922	4.85	4.75	3.45	4.92	4.75	xxx	3.94	3.67	4.67	4.27	3.74	2.82
923	4.43	4.73	3.41	4.85	4.72	xxx	3.92	3.66	4.65	4.27	3.75	2.86
924	4.11	4.51	3.24	4.64	4.50	xxx	3.77	3.54	4.45	4.07	3.58	2.73
925	4.93	4.90	3.49	5.00	4.87	xxx	4.11	3.86	4.79	4.39	3.86	2.94
926	4.53	4.48	3.13	4.57	4.44	4.07	3.65	3.42	4.37	3.96	3.42	2.56
927	4.18	4.39	3.18	4.54	4.42	4.08	3.70	3.49	4.35	3.99	3.49	2.71
928	4.27	4.37	3.05	4.48	4.39	4.03	3.65	3.41	4.32	3.92	3.37	2.51
929	3.88	3.92	2.79	4.04	3.95	3.58	3.21	2.98	3.89	3.50	3.00	2.24
930	3.64	3.83	2.82	3.95	3.90	3.62	3.30	3.12	3.84	3.51	3.09	2.42
931	3.93	4.22	3.05	4.33	4.27	4.00	3.67	3.48	4.21	3.86	3.41	2.65
932	3.76	4.10	2.90	4.24	4.14	3.81	3.49	3.28	4.08	3.71	3.22	2.41
933	3.52	3.86	2.79	4.05	3.93	xxx	3.25	3.05	3.88	3.51	3.03	2.27
934	3.27	3.57	2.64	3.75	3.66	xxx	3.07	2.91	3.62	3.29	2.87	2.24

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
936	3.53	3.81	2.61	3.93	3.82	xxx	3.18	2.97	3.77	3.41	2.92	2.14
937	2.88	3.32	2.38	3.56	3.44	xxx	2.85	2.66	3.64	3.11	2.66	1.98
938	3.11	3.45	2.51	3.61	3.55	xxx	3.00	2.84	3.50	3.19	2.76	2.11
939	3.6	3.97	2.78	4.11	4.06	xxx	3.47	3.29	4.02	3.63	3.15	2.41
940	3.22	3.47	2.37	3.55	3.54	xxx	3.00	2.83	3.50	3.17	2.73	1.92
941	xxx	1.89	1.31	1.90	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
942	2.53	3.05	2.43	3.24	3.21	xxx	2.86	2.75	3.16	xxx	xxx	xxx
943	3.46	3.75	2.88	3.94	3.88	xxx	3.50	3.38	3.83	3.59	3.28	2.72
944	2.78	3.18	2.46	3.38	3.31	xxx	2.92	2.82	3.29	3.07	2.78	2.28
945	2.35	2.73	2.10	2.92	2.86	2.69	2.46	2.39	2.84	2.64	2.38	1.95
946	xxx	2.50	1.93	2.59	2.63	2.48	2.26	2.18	2.61	2.45	2.20	1.86
947	xxx	3.96	2.87	4.01	3.99	3.81	3.56	xxx	xxx	xxx	xxx	xxx
948	3.24	3.33	2.22	3.24	3.12	2.87	2.56	2.38	3.10	2.77	2.37	1.70
949	xxx	2.39	1.80	2.39	2.32	2.12	1.89	1.77	3.03	2.07	1.86	1.44
950	xxx	4.17	3.20	4.29	4.24	xxx	3.82	3.71	4.17	3.96	3.67	3.10
951	xxx	4.05	2.97	4.16	4.13	xxx	3.61	3.45	4.10	3.81	3.40	2.71
952	3.21	3.58	2.74	3.78	3.69	3.46	3.19	3.03	3.66	3.41	3.05	2.45
953	2.15	2.70	2.01	2.90	2.87	2.66	2.40	2.27	2.80	2.61	2.30	1.87
954	2.59	3.11	2.40	3.30	3.34	xxx	2.88	2.76	3.25	3.05	2.75	2.32
955	3.91	4.28	3.31	4.43	4.40	xxx	3.90	3.76	4.34	4.07	3.70	3.05
956	3.55	3.96	3.00	4.11	4.05	3.79	3.48	3.32	4.04	3.75	3.37	2.71
957	2.66	3.21	2.44	3.41	3.38	3.14	2.85	2.72	3.36	3.11	2.79	2.25
958	3.11	3.68	2.83	3.92	3.85	xxx	3.29	3.14	3.81	3.55	3.20	2.61
959	4.17	4.55	3.47	4.74	4.64	xxx	4.06	3.89	4.59	4.29	3.87	3.14
960	4.02	4.34	3.21	4.47	4.37	3.96	3.68	3.46	4.34	4.00	3.57	2.79
961	3.11	3.59	2.68	3.77	3.71	3.34	3.10	2.91	3.73	3.38	3.02	2.37
962	3.63	3.96	3.05	4.25	4.18	xxx	3.53	3.34	4.12	3.83	3.43	2.76
963	4.62	4.83	3.67	5.09	5.28	xxx	4.29	4.10	4.91	4.56	4.08	3.28
964	4.42	4.56	3.33	4.73	xxx	4.15	xxx	xxx	4.54	4.14	3.64	2.78
965	3.87	4.11	3.04	4.35	xxx	3.77	3.41	3.19	4.17	3.80	3.35	2.55
966	3.89	4.20	3.11	4.37	xxx	3.78	3.55	3.32	4.23	3.87	3.43	2.66

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
968	4.95	4.85	3.28	4.80	xxx	4.20	3.97	3.41	4.50	4.07	3.49	2.50
969	4.16	4.23	3.00	4.25	xxx	3.70	3.27	3.00	4.64	3.63	3.14	2.29
970	4.19	4.24	3.12	4.43	xxx	4.02	3.75	3.47	4.28	3.90	3.45	2.67
971	4.93	4.73	3.35	4.81	xxx	4.35	3.96	3.75	4.64	4.21	3.68	2.81
972	xxx	5.07	3.68	5.16	4.99	xxx	4.13	3.82	4.93	4.44	3.80	2.82
973	xxx	4.57	3.21	4.73	4.56	xxx	3.67	3.42	4.50	4.05	3.47	2.56
974	4.53	4.62	3.40	4.81	4.70	xxx	3.95	3.74	4.63	4.24	3.74	2.92
975	5.27	5.24	3.70	5.37	5.22	xxx	4.42	4.17	xxx	4.70	4.12	3.19
976	5.21	5.13	3.48	5.28	5.11	xxx	4.13	3.82	xxx	4.50	3.83	2.81
977	4.83	4.77	3.32	4.95	4.79	xxx	3.84	3.55	4.71	4.24	3.61	2.64
978	4.76	4.90	3.50	5.07	4.94	xxx	4.12	3.88	4.85	4.42	3.86	2.96
979	5.33	5.44	3.71	5.56	5.39	xxx	4.50	4.22	5.32	4.81	4.18	3.18
980	5.21	5.03	3.33	5.09	4.91	4.44	3.99	3.63	4.85	4.32	3.65	2.63
981	5.02	4.93	3.36	5.03	4.85	4.40	3.94	3.64	4.79	4.29	3.66	2.70
982	xxx	5.31	3.53	5.43	5.25	xxx	4.24	3.92	5.17	4.61	3.91	2.85
983	xxx	4.94	3.34	5.09	4.93	xxx	3.94	3.63	5.44	4.33	3.65	2.65
984	5.07	4.95	3.45	5.14	4.96	xxx	4.30	3.84	4.89	4.41	3.80	2.84
985	4.93	4.90	3.37	5.02	4.84	xxx	3.98	3.70	xxx	4.29	3.71	2.74
986	5.02	4.96	3.65	5.36	5.20	xxx	4.35	4.08	xxx	4.66	4.09	3.15
987	5.05	4.75	3.51	5.21	5.05	xxx	4.18	3.91	4.92	4.51	3.93	2.96
988	4.73	4.71	3.39	4.90	4.76	xxx	3.93	3.67	4.69	4.27	3.73	2.84
989	4.93	5.05	3.63	5.20	5.06	xxx	4.26	4.00	4.98	4.56	4.01	3.12
990	4.3	4.55	3.23	4.68	4.53	xxx	3.80	3.55	4.47	4.07	3.54	2.69
991	4.01	4.55	3.20	4.66	4.52	4.19	3.82	3.58	4.47	4.09	3.58	2.73
992	4.39	4.67	3.18	4.66	4.51	4.15	3.73	3.48	4.45	4.04	3.45	2.59
993	5.31	5.27	3.57	5.33	5.16	4.75	4.28	3.99	5.08	4.60	3.94	3.01
994	xxx	4.31	2.80	4.25	xxx	xxx	3.51	3.23	4.19	3.75	3.18	2.21
995	xxx	3.35	2.39	3.35	3.39	xxx	2.79	2.61	3.35	3.01	2.59	1.84
996	xxx	4.11	2.95	4.29	4.18	3.84	3.50	3.32	4.13	3.74	3.29	2.57
997	3.68	3.70	2.63	3.74	3.64	3.31	3.01	2.83	3.60	3.24	2.81	2.19
998	3.99	4.23	3.16	4.38	4.24	xxx	3.73	3.59	4.18	3.90	3.52	2.86

Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1000	3.67	3.98	3.02	4.09	4.05	xxx	3.50	3.34	4.00	3.73	3.36	2.69
1001	4.7	4.92	3.62	5.01	4.92	xxx	4.30	4.11	4.88	4.53	4.04	3.22
1002	4.09	4.42	3.17	4.54	4.36	4.02	3.64	3.42	4.36	3.97	3.48	2.67
1003	2.98	3.56	2.60	3.71	3.65	3.31	2.98	2.77	3.62	3.27	2.86	2.23
1004	3.59	4.10	3.07	4.24	4.23	xxx	3.57	3.35	4.16	3.84	3.41	2.74
1005	4.85	5.14	3.70	5.18	5.06	xxx	4.38	4.17	4.99	4.63	4.12	3.27
1006	4.31	4.64	3.23	4.73	4.56	4.16	3.77	3.52	4.52	4.10	3.55	2.70
1007	3.12	3.45	2.49	3.65	3.58	3.20	2.85	2.63	3.52	3.17	2.73	2.10
1008	3.34	3.78	2.87	3.97	3.93	xxx	3.38	3.22	3.84	3.58	3.20	2.61
1009	5.18	5.35	3.82	5.42	5.27	xxx	4.62	4.40	5.19	4.81	4.27	3.40
1010	4.5	4.55	3.01	4.55	4.37	3.93	3.49	3.19	4.33	3.85	3.23	2.28
1011	3.48	3.92	2.79	4.05	3.94	3.53	3.14	2.89	3.90	3.51	2.99	2.18
1012	4.35	4.49	3.13	4.60	4.47	4.05	3.62	3.34	4.36	3.93	3.34	2.43
1013	5.53	5.69	3.75	5.69	5.51	5.00	4.45	4.08	5.53	4.82	4.07	2.92
1014	4.97	4.99	2.99	4.95	4.81	4.26	3.92	3.27	4.72	4.13	3.38	2.19
1015	3.57	3.57	2.34	3.64	3.59	3.13	2.67	2.36	3.50	3.07	2.52	1.64
1016	4.97	4.73	3.40	5.16	5.08	xxx	4.08	3.77	4.88	4.50	3.90	2.94
1017	5.49	5.10	3.49	5.49	5.35	xxx	4.32	4.00	5.17	4.71	4.02	2.93
1018	5.23	5.10	3.44	5.26	5.13	xxx	4.07	3.81	4.99	4.54	3.92	2.87
1019	4.42	4.44	3.07	4.64	4.55	xxx	3.61	3.31	4.40	4.00	3.45	2.53
1020	4.65	4.44	3.44	5.00	4.96	xxx	4.10	3.84	4.66	4.43	3.88	3.02
1021	5.33	4.94	3.68	5.47	5.37	xxx	4.44	4.15	5.08	4.80	4.18	3.20
1022	5.22	4.94	3.45	5.09	4.95	xxx	xxx	3.69	4.81	4.35	3.73	2.72
1023	5.01	4.93	3.45	5.13	4.99	xxx	4.04	3.74	5.17	4.40	3.80	2.82
1024	5.24	xxx	3.67	5.54	5.40	xxx	4.42	4.10	5.13	4.79	4.13	3.07
1025	5.24	xxx	3.40	5.05	4.93	xxx	3.96	3.65	4.66	4.34	3.74	2.76
1026	4.79	4.49	3.46	4.95	4.84	xxx	4.01	3.76	4.64	4.33	3.80	2.93
1027	5.07	4.71	3.62	5.21	5.06	xxx	4.23	4.00	4.86	4.55	4.00	3.11
1028	4.62	4.41	3.10	4.65	4.48	3.98	3.58	3.31	4.36	3.93	3.38	2.48
1029	5.25	5.20	3.53	5.35	5.18	4.65	4.24	3.93	5.05	4.56	3.93	2.92
1030	5.51	5.24	3.32	5.31	5.11	4.56	4.03	3.64	4.97	4.42	3.71	2.56

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1032	4.75	4.79	3.14	4.90	4.78	4.30	3.81	3.47	4.65	4.17	3.52	2.51
1033	4.85	4.92	3.20	4.99	4.88	4.40	3.91	3.55	4.75	4.26	3.60	2.58
1034	4.79	4.82	3.18	4.94	4.82	4.34	3.89	3.53	4.68	4.23	3.59	2.55
1035	4.54	4.65	3.13	4.81	4.65	4.18	3.74	3.41	4.51	4.07	3.47	2.49
1036	4.45	4.60	3.11	4.77	4.64	4.19	3.77	3.43	4.52	4.09	3.49	2.56
1037	4.58	4.48	3.03	4.62	4.54	4.10	3.69	3.36	4.41	4.00	3.41	2.50
1038	3.98	4.16	2.85	4.27	4.21	3.78	3.40	3.09	4.09	3.67	3.13	2.26
1039	4.65	4.93	3.21	4.99	4.88	4.42	4.00	3.62	4.75	4.26	3.64	2.64
1040	4.29	4.46	2.76	4.51	4.35	3.85	3.39	2.96	4.22	3.71	3.04	1.95
1041	3.47	3.86	2.55	4.02	3.89	3.42	3.00	2.62	3.78	3.34	2.75	1.79
1042	3.71	4.10	2.70	4.08	4.04	3.62	3.20	2.89	3.89	3.48	2.94	2.04
1043	4.09	4.40	2.82	4.33	4.29	3.86	3.43	3.10	4.13	3.70	3.12	2.18
1044	3.77	4.10	2.68	4.21	4.10	3.67	3.23	2.86	3.97	3.54	2.92	1.96
1045	3.25	3.86	2.60	4.08	3.98	3.56	3.14	2.80	3.88	3.47	2.88	1.95
1046	xxx	3.87	2.57	4.06	3.96	3.52	3.09	2.75	3.85	3.42	2.82	1.85
1047	xxx	3.85	2.59	3.98	3.84	3.42	2.99	2.62	3.72	3.31	2.75	1.85
1048	xxx	3.89	2.73	4.08	3.90	3.54	3.19	2.88	3.80	3.42	2.94	2.11
1049	xxx	3.14	2.20	3.31	3.20	2.83	2.49	2.19	3.12	2.76	2.30	1.56
1050	2.86	3.34	2.49	3.48	3.46	3.15	2.85	2.57	3.40	3.10	2.70	2.11
1051	2.91	3.30	2.40	3.44	3.40	3.08	2.74	2.49	3.31	3.00	2.63	2.04
1052	2.99	3.40	2.58	3.58	3.56	3.25	2.94	2.72	3.46	3.17	2.81	2.22
1053	2.46	3.02	2.20	3.16	3.11	2.90	2.61	2.38	3.12	2.82	2.45	1.90
1054	2.22	2.88	2.23	2.98	3.04	2.84	2.59	2.40	2.99	2.74	2.44	2.04
1055	3.24	3.76	2.87	3.91	3.89	3.67	3.39	3.22	3.81	3.56	3.18	2.60
1056	2.92	3.39	2.48	3.56	3.49	3.20	2.88	2.65	3.40	3.11	2.66	2.01
1057	1.97	2.55	1.90	2.68	2.72	2.45	2.16	1.92	2.62	2.38	2.04	1.53
1058	2.15	2.80	2.16	2.84	2.90	2.70	2.47	2.27	2.82	2.63	2.37	1.95
1059	2.97	3.63	2.76	3.69	3.66	3.44	3.20	3.01	3.57	3.34	2.99	2.44
1060	3.1	3.61	2.68	3.76	3.68	3.38	3.17	2.86	3.55	3.27	2.86	2.22
1061	1.89	2.55	1.87	2.71	2.65	2.37	2.02	1.83	2.58	2.30	1.96	1.47
1062	2.13	2.96	2.33	3.12	3.09	2.91	2.67	2.50	3.04	2.83	2.57	2.21

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1064	2.6	3.26	2.48	3.45	3.36	3.11	2.88	2.74	3.28	3.04	2.68	2.19
1065	2.07	2.72	2.08	2.93	2.86	2.62	2.41	2.26	2.78	2.57	2.27	1.86
1066	2.36	2.98	2.32	3.15	3.12	2.93	2.73	2.60	3.03	2.84	2.54	2.13
1067	3.35	3.88	3.00	4.06	3.97	3.74	3.51	3.37	3.88	3.63	3.25	2.67
1068	3.35	3.75	2.77	3.86	3.74	3.42	3.15	2.98	3.68	3.36	2.93	2.26
1069	2.42	3.07	2.31	3.20	3.15	2.87	2.61	2.43	3.09	2.82	2.46	1.91
1070	3.04	3.60	2.74	3.78	3.75	3.51	3.25	3.08	3.64	3.40	3.03	2.43
1071	4.07	4.42	3.28	4.60	4.48	4.22	3.92	3.74	4.40	4.09	3.63	2.86
1072	3.82	4.02	2.90	4.05	3.88	3.57	3.26	3.06	3.80	3.46	2.98	2.25
1073	3.42	3.85	2.81	3.92	3.83	3.50	3.21	3.05	3.84	3.39	2.95	2.26
1074	3.38	3.33	2.39	3.31	3.32	3.04	2.95	2.59	xxx	2.92	2.50	1.78
1075	3.99	3.66	2.63	3.55	3.52	3.25	2.96	2.75	xxx	3.12	2.68	1.96
1076	4.53	4.60	3.16	4.76	4.64	4.22	3.82	3.53	xxx	4.05	3.46	2.52
1077	3.96	4.16	2.90	4.40	4.26	3.84	3.43	3.17	4.14	3.70	3.12	2.21
1078	4.02	4.37	3.18	4.60	4.50	4.06	3.75	3.52	4.40	4.02	3.52	2.72
1079	4.93	4.99	3.44	5.10	4.98	4.53	4.21	3.96	4.87	4.41	3.84	2.91
1080	5.11	5.07	3.35	5.16	4.93	4.41	3.88	3.47	4.86	4.34	3.68	2.66
1081	4.77	4.88	3.27	5.02	4.88	4.38	3.90	3.49	4.74	4.24	3.59	2.60
1082	4.89	4.99	3.40	5.08	4.97	4.36	3.78	3.27	4.85	4.37	3.75	2.74
1083	5.51	5.39	3.60	5.46	5.35	4.73	4.13	3.59	5.19	4.66	4.00	2.94
1084	4.95	4.68	2.90	4.53	4.38	3.71	3.05	2.45	4.25	3.65	3.00	2.03
1085	xxx	5.01	3.10	4.90	4.74	4.04	3.36	2.75	4.63	4.00	3.32	2.28
1086	xxx	5.18	3.10	5.19	5.03	4.21	3.37	2.69	4.89	4.26	3.46	2.25
1087	5.74	5.46	3.26	5.50	5.34	4.47	3.61	2.92	5.21	4.53	3.70	2.44
1088	6.09	5.36	3.12	5.39	5.21	4.33	3.45	2.69	5.08	4.40	3.54	2.07
1089	4.75	4.17	2.58	4.23	4.07	3.29	2.49	1.78	4.16	3.46	2.77	1.58
1090	5.57	xxx	3.62	5.70	5.55	xxx	3.79	3.08	5.28	4.90	4.20	3.07
1091	5.42	xxx	3.35	5.33	5.17	xxx	3.44	2.74	4.90	4.46	3.74	2.62
1092	5.4	4.67	3.58	5.42	5.21	xxx	3.56	2.89	4.92	4.61	3.97	2.95
1093	5.97	5.24	3.84	5.99	5.76	xxx	4.11	3.40	5.43	5.08	4.38	3.26
1094	5.45	xxx	3.68	5.62	5.44	4.59	3.66	2.87	5.29	4.78	4.06	2.96

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1096	5.3	xxx	3.67	5.55	5.33	4.36	3.49	2.70	5.15	4.69	4.02	2.93
1097	5.86	xxx	3.89	5.97	5.74	4.75	3.87	3.05	5.54	5.05	4.32	3.16
1098	5.35	5.40	3.64	5.61	5.41	4.48	3.55	2.74	5.28	4.71	3.99	2.85
1099	4.55	4.80	3.35	5.07	4.87	3.95	3.05	2.28	4.77	4.26	3.60	2.58
1100	4.72	4.82	3.50	5.14	4.95	4.18	3.37	2.69	4.84	4.38	3.76	2.79
1101	5.69	5.62	3.88	5.84	5.66	4.86	4.00	3.28	5.53	4.99	4.30	3.19
1102	4.98	5.18	3.36	5.28	5.14	4.37	3.56	2.86	4.99	4.42	3.68	2.55
1103	3.93	4.24	2.93	4.46	4.28	3.54	2.76	2.11	4.19	3.72	3.09	2.15
1104	4.1	4.40	3.16	4.61	4.45	3.88	3.26	2.75	4.36	3.93	3.39	2.56
1105	4.97	5.23	3.57	5.31	5.16	4.56	3.92	3.36	5.04	4.54	3.94	2.97
1106	4.47	4.85	3.21	4.96	4.79	4.14	3.48	2.87	4.67	4.14	3.47	2.40
1107	3.46	4.10	2.87	4.37	4.21	3.60	2.96	2.41	4.12	3.67	3.06	2.13
1108	3.65	4.25	3.07	4.49	4.35	3.82	3.23	2.73	4.26	3.85	3.31	2.47
1109	4.78	5.06	3.44	5.16	5.02	4.45	3.83	3.28	4.89	4.39	3.77	2.78
1110	4.15	4.55	3.01	4.65	4.51	3.94	3.32	2.78	4.39	3.89	3.26	2.29
1111	3.21	3.85	2.69	4.09	3.95	3.40	2.82	2.31	3.87	3.44	2.87	2.01
1112	3.35	3.79	2.74	3.99	3.90	3.45	2.99	2.56	3.80	3.42	2.91	2.14
1113	4.19	4.45	3.09	4.53	4.44	3.96	3.45	2.99	4.31	3.88	3.33	2.47
1114	4.15	4.70	2.94	4.62	4.49	3.90	3.33	2.84	4.36	3.83	3.18	2.17
1115	3.45	4.21	2.69	4.19	4.07	3.51	2.97	2.52	3.95	3.49	2.89	1.99
1116	xxx	3.44	2.34	3.48	3.52	3.16	2.76	2.40	3.40	3.09	2.65	1.93
1117	xxx	4.20	2.74	4.14	4.14	3.72	3.28	2.87	4.15	3.61	3.07	2.18
1118	5.05	5.14	3.11	5.24	5.09	4.35	3.68	3.09	4.94	4.33	3.59	2.39
1119	4.09	4.31	2.76	4.48	4.38	3.70	3.07	2.52	4.24	3.71	3.07	2.04
1120	3.59	3.99	2.73	4.14	4.06	3.58	3.09	2.63	3.96	3.54	3.03	2.21
1121	4.06	4.20	2.84	4.31	4.23	3.74	3.25	2.77	4.12	3.69	3.15	2.29
1122	4.25	4.46	2.98	4.57	4.49	3.94	3.38	2.87	4.38	3.94	3.37	2.50
1123	3.97	4.45	2.93	4.59	4.51	3.98	3.43	2.92	4.41	3.95	3.36	2.46
1124	3.96	4.38	2.91	4.53	4.41	3.86	3.26	2.70	4.31	3.85	3.25	2.35
1125	4.59	4.85	3.14	4.94	4.83	4.24	3.61	3.05	4.70	4.20	3.57	2.57
1126	4.37	4.60	2.88	4.70	4.52	3.85	3.17	xxx	4.41	3.89	3.22	2.18

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1128	4.36	4.62	2.90	4.74	4.58	3.90	3.15	2.51	4.46	3.94	3.25	2.18
1129	4.66	4.83	2.98	4.90	4.76	4.05	3.30	2.65	4.62	4.07	3.36	2.23
1130	4.76	4.86	2.99	4.75	4.58	3.88	3.16	2.52	4.04	3.90	3.19	2.08
1131	4.72	4.89	3.02	4.85	4.67	3.96	3.23	2.60	5.42	3.98	3.28	2.17
1132	4.93	4.67	2.82	4.79	4.64	3.90	3.18	2.55	4.48	3.91	3.18	1.96
1133	4.29	3.95	2.52	3.94	3.78	3.05	2.36	1.76	3.93	3.18	2.54	1.60
1134	5.06	4.94	3.41	5.34	5.19	4.28	3.80	3.26	4.99	4.55	3.89	2.88
1135	5.1	5.01	3.37	5.51	5.34	4.47	3.99	3.42	5.14	4.64	3.95	2.79
1136	4.72	5.01	3.37	5.19	5.06	4.45	3.88	3.40	4.91	4.40	3.77	2.77
1137	4.75	4.98	3.33	5.14	5.00	4.38	3.81	3.34	4.85	4.35	3.72	2.72
1138	4.38	4.63	3.15	4.73	4.57	4.09	3.60	3.21	4.44	3.99	3.42	2.55
1139	5.11	5.29	3.43	5.37	5.18	4.64	4.08	3.67	5.06	4.52	3.86	2.84
1140	5	5.12	xxx	5.24	5.06	4.44	3.84	3.36	4.92	4.33	3.61	2.47
1141	4.23	4.57	xxx	4.73	4.60	4.02	3.49	3.02	4.49	3.96	3.32	2.31
1142	4.52	4.72	3.16	4.78	4.66	4.18	4.20	3.31	4.54	4.04	3.44	2.47
1143	4.76	4.88	3.23	4.93	4.79	4.30	3.80	3.41	4.64	4.14	3.52	2.52
1144	4.97	5.25	3.58	5.61	5.47	xxx	4.34	3.92	5.31	4.77	4.11	3.06
1145	4.61	4.61	3.18	4.96	4.84	xxx	3.76	3.37	4.69	4.17	3.54	2.55
1146	4.12	4.29	3.05	4.48	4.38	3.95	3.56	3.26	4.26	3.84	3.30	2.48
1147	4.78	4.99	3.44	5.15	5.02	4.54	4.12	3.79	4.89	4.43	3.85	2.94
1148	4.36	4.71	3.07	4.72	4.64	4.15	3.71	3.35	4.50	4.02	3.42	2.47
1149	3.52	3.90	2.67	3.94	3.88	3.44	3.03	2.69	3.79	3.38	2.87	2.09
1150	3.39	3.73	2.76	3.91	3.83	3.52	3.24	3.01	3.74	3.40	3.00	2.38
1151	3.75	4.11	2.95	4.22	4.13	3.78	3.50	3.26	4.05	3.67	3.22	2.51
1152	3.96	4.36	3.15	4.47	4.36	3.99	3.70	3.46	4.28	3.89	3.42	2.68
1153	3.55	4.00	2.94	4.22	4.12	3.77	3.47	3.25	4.03	3.69	3.23	2.49
1154	3.6	3.86	2.87	4.01	3.93	3.58	3.30	3.10	3.84	3.50	3.06	2.34
1155	4.21	4.58	3.27	4.67	4.57	4.21	3.91	3.68	4.48	4.09	3.61	2.79
1156	4.13	4.53	3.08	4.60	4.52	4.11	3.72	3.43	4.41	3.96	3.41	2.52
1157	2.78	3.43	2.42	3.58	3.56	3.17	2.81	2.57	3.93	3.09	2.64	1.95
1158	3.29	3.70	2.80	3.84	3.85	3.57	3.32	3.14	3.68	3.46	3.07	2.47

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1160	3.79	4.21	3.11	4.37	4.30	3.97	3.67	3.48	4.22	3.86	3.41	2.67
1161	2.7	3.39	2.43	3.60	3.59	3.27	2.99	2.80	3.71	3.18	2.77	2.14
1162	2.85	3.37	2.53	3.43	3.45	3.25	3.06	2.93	3.39	3.14	2.81	2.31
1163	3.73	4.05	3.09	4.06	4.03	3.82	3.60	3.47	4.19	3.69	3.33	2.74
1164	3.4	3.89	2.91	4.01	3.98	3.72	3.44	3.28	xxx	3.58	3.17	2.54
1165	2.3	3.02	2.21	3.19	3.22	2.97	2.73	2.58	xxx	2.87	2.51	1.98
1166	2.44	3.08	2.37	3.19	3.24	3.07	2.90	2.85	xxx	2.94	2.66	2.21
1167	3.35	3.71	2.88	3.76	3.74	3.56	3.37	3.31	3.69	3.42	3.09	2.57
1168	3.03	3.77	2.89	3.94	3.88	xxx	3.53	3.46	3.82	3.58	3.28	2.77
1169	2.21	2.72	2.00	2.87	2.87	xxx	2.54	2.47	2.80	2.58	2.34	1.91
1170	1.87	2.11	1.69	2.30	2.32	2.24	2.17	2.15	2.29	2.13	1.96	1.71
1171	3.29	3.45	2.78	3.60	3.56	3.44	3.32	3.28	3.52	3.33	3.07	2.66
1172	2.88	3.26	2.50	3.41	3.31	3.14	2.97	2.89	3.29	3.06	2.78	2.30
1173	2.24	2.62	2.04	2.78	2.73	2.58	2.42	2.34	2.70	2.52	2.28	1.88
1174	2.05	2.54	2.00	2.70	2.67	2.53	2.40	2.35	2.63	2.48	2.25	1.92
1175	3.21	3.81	2.87	3.92	3.80	3.65	3.50	3.44	3.76	3.56	3.24	2.75
1176	3.38	3.48	2.40	3.50	3.36	3.11	2.86	2.71	3.36	3.09	2.67	2.05
1177	2.3	2.67	2.00	2.82	2.75	2.53	2.31	2.18	2.71	2.54	2.24	1.78
1178	2.75	3.34	2.54	3.53	3.48	3.29	3.08	2.97	3.42	3.22	2.92	2.40
1179	3.32	3.94	2.81	4.00	3.89	3.68	3.47	3.35	3.86	3.59	3.20	2.58
1180	3.71	4.15	2.86	4.03	3.89	3.63	2.42	3.21	3.84	3.52	3.12	2.43
1181	2.94	3.47	2.49	3.52	3.45	3.21	2.96	2.80	3.46	3.11	2.75	2.16
1182	3.28	3.82	2.89	4.03	3.98	3.73	3.48	3.31	3.92	3.64	3.25	2.64
1183	3.84	4.17	3.09	4.31	4.22	3.97	3.71	3.55	4.17	3.85	3.42	2.72
1184	3.96	4.41	3.28	4.67	4.58	4.03	3.91	3.72	4.49	4.13	3.70	2.94
1185	4.07	4.27	3.18	4.51	4.47	3.92	3.83	3.63	4.34	3.99	3.56	2.80
1186	3.61	3.99	2.97	4.19	4.15	3.86	3.59	3.37	4.08	3.78	3.36	2.65
1187	4.4	4.46	3.25	4.64	4.54	4.25	3.96	3.73	4.48	4.13	3.69	2.91
1188	4.47	4.41	3.10	4.59	4.45	4.05	3.68	3.37	4.38	3.96	3.42	2.54
1189	4.55	4.88	3.36	5.04	4.90	4.49	4.09	3.76	4.81	4.36	3.78	2.87
1190	xxx	4.93	3.26	5.03	4.88	4.37	3.87	3.49	4.76	4.23	3.60	2.58

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1192	5.16	5.15	3.40	5.16	5.01	4.51	3.97	3.56	4.85	4.33	3.67	2.65
1193	5.19	5.26	3.45	5.28	5.13	4.61	4.07	3.66	4.94	4.42	3.76	2.72
1194	5.11	4.99	3.27	5.04	4.90	4.38	3.86	3.45	4.75	4.22	3.56	2.49
1195	5.21	5.00	3.30	5.08	4.93	4.42	3.90	3.49	5.14	4.25	3.60	2.54
1196	xxx	5.10	3.27	5.10	4.97	4.36	3.78	3.34	4.79	4.22	3.52	2.37
1197	xxx	5.55	3.45	5.49	5.37	4.71	4.11	3.67	5.42	4.53	3.78	2.59
1198	5.67	5.37	3.23	5.45	5.26	4.46	3.65	3.00	5.09	4.43	3.60	2.27
1199	5.16	4.99	3.08	5.09	4.93	4.19	3.41	2.75	4.79	4.17	3.40	2.20
1200	5.31	5.15	3.23	5.35	5.15	4.26	3.38	2.59	5.02	4.39	3.60	2.33
1201	6.28	5.85	3.52	5.98	5.75	4.81	3.91	3.08	5.56	4.87	3.99	2.58
1202	5.85	5.49	3.15	5.58	5.31	4.24	3.25	2.31	5.14	4.42	3.51	2.06
1203	5.3	5.02	3.01	5.16	4.92	3.88	2.91	2.00	4.79	4.14	3.33	1.99
1204	5.15	5.07	3.08	5.21	4.98	3.92	2.92	1.99	4.86	4.23	3.41	2.07
1205	6.5	6.15	3.52	6.21	5.89	4.74	3.67	2.72	5.73	4.94	3.98	2.41
1206	5.96	5.59	2.90	5.58	5.21	3.97	2.85	xxx	5.07	4.27	3.30	1.68
1207	4.93	4.87	2.66	4.95	4.69	3.55	2.52	xxx	4.57	3.90	3.05	1.62
1208	5.18	4.96	2.76	5.08	4.80	3.61	2.52	xxx	4.69	3.99	3.11	1.64
1209	6.07	5.71	3.12	5.77	5.45	4.20	3.04	xxx	5.30	4.50	3.51	1.91
1210	5.55	5.28	2.67	5.33	4.99	3.62	xxx	xxx	4.85	4.04	3.05	xxx
1211	4.47	4.45	2.33	4.59	4.30	3.02	xxx	xxx	4.21	3.55	2.72	xxx
1212	4.66	4.59	2.51	4.73	4.44	3.20	xxx	xxx	4.34	3.70	2.87	xxx
1213	5.9	5.65	2.98	5.72	5.35	4.02	xxx	xxx	5.19	4.38	3.38	xxx
1214	5.38	5.21	2.46	5.26	4.85	3.47	xxx	xxx	4.71	3.90	2.87	xxx
1215	3.93	4.03	1.99	4.17	3.85	2.60	xxx	xxx	3.78	3.18	2.38	xxx
1216	4.44	4.51	2.50	4.62	4.33	3.17	xxx	xxx	4.24	3.62	2.82	xxx
1217	5.25	5.25	2.80	5.28	4.95	3.72	xxx	xxx	4.81	4.06	3.13	xxx
1218	4.89	xxx	2.53	5.07	4.71	3.51	xxx	xxx	4.57	3.82	2.87	xxx
1219	3.5	xxx	2.07	4.12	3.79	2.67	xxx	xxx	3.72	3.15	2.36	xxx
1220	3.77	4.23	2.45	4.31	4.09	3.15	xxx	xxx	3.99	3.46	2.72	xxx
1221	4.74	4.97	2.77	5.01	4.76	3.73	xxx	xxx	4.61	3.95	3.07	xxx
1222	4.78	4.75	2.49	4.65	4.40	3.44	2.53	xxx	4.25	3.58	2.73	xxx

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1224	3.73	4.35	2.61	4.46	4.24	3.42	2.60	xxx	4.13	3.59	2.86	1.59
1225	4.43	4.58	2.65	4.61	4.39	3.53	2.65	xxx	4.29	3.66	2.88	1.52
1226	4.25	4.63	2.79	4.69	4.48	3.71	2.91	2.20	4.35	3.79	3.07	1.80
1227	3.39	4.25	2.57	4.32	4.10	3.35	2.56	1.88	4.06	3.46	2.78	1.56
1228	3.72	4.48	2.87	4.66	4.49	3.76	3.03	2.38	4.38	3.86	3.20	1.96
1229	4.02	4.36	2.80	4.54	4.36	3.63	2.89	2.23	4.25	3.74	3.06	1.83
1230	3.73	4.20	2.73	4.32	4.13	3.49	2.86	2.31	4.02	3.53	2.95	1.88
1231	3.73	4.15	2.70	4.27	4.11	3.47	2.83	2.27	3.98	3.48	2.90	1.83
1232	3.79	4.32	2.89	4.38	4.29	3.69	3.10	2.54	4.18	3.72	3.14	2.09
1233	4.03	4.31	2.89	4.37	4.25	3.65	3.07	2.51	4.15	3.68	3.10	2.07
1234	3.77	4.24	2.92	4.45	4.35	3.80	3.25	2.75	4.24	3.81	3.26	2.29
1235	4.11	4.37	2.93	4.54	4.44	3.88	3.33	2.81	4.32	3.86	3.28	2.24
1236	3.86	4.01	2.69	4.11	3.99	3.46	2.96	2.48	3.86	3.40	2.84	1.90
1237	4.04	4.33	2.85	4.42	4.30	3.74	3.21	2.72	4.18	3.69	3.09	2.08
1238	4.4	4.67	2.91	4.74	4.59	3.94	3.34	2.78	4.45	3.88	3.20	2.05
1239	4.53	4.95	3.03	5.00	4.83	4.15	3.54	2.97	4.69	4.10	3.38	2.15
1240	4.29	4.56	2.72	4.59	4.42	3.77	3.14	2.58	4.27	3.71	2.98	1.80
1241	3.86	4.19	2.60	4.26	4.14	3.53	2.91	2.36	4.00	3.50	2.81	1.69
1242	4.34	4.63	2.92	4.72	4.56	3.96	3.37	2.85	4.43	3.90	3.24	2.10
1243	4.64	4.90	3.02	5.02	4.81	4.17	3.55	3.03	4.66	4.07	3.36	2.15
1244	4.65	4.80	2.93	4.87	4.71	4.08	3.40	2.86	4.57	3.99	3.23	2.05
1245	3.85	4.15	2.65	4.23	4.13	3.54	2.91	2.37	4.00	3.49	2.82	1.77
1246	4.06	4.32	2.90	4.48	4.34	3.85	3.34	2.89	4.22	3.75	3.18	2.25
1247	4.81	4.93	3.15	5.07	4.87	4.33	3.77	3.32	4.73	4.16	3.50	2.44
1248	4.68	4.82	2.97	4.92	4.75	4.12	3.50	3.00	4.60	3.99	3.27	2.16
1249	3.99	4.22	2.72	4.36	4.23	3.65	3.08	2.60	4.09	3.57	2.92	1.92
1250	4.04	4.26	2.86	4.29	4.19	3.74	3.26	2.87	4.06	3.61	3.04	2.19
1251	5	5.07	3.19	5.06	4.89	4.36	3.80	3.38	4.75	4.19	3.51	2.48
1252	4.73	4.62	2.66	4.66	4.46	3.79	3.17	2.63	4.32	3.73	2.99	1.82
1253	3.82	3.91	2.43	3.93	3.83	3.24	2.70	2.19	3.71	3.23	2.61	1.63
1254	3.91	4.17	2.71	4.23	4.15	3.68	3.21	2.81	4.01	3.56	2.98	2.08

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1256	4.76	4.93	2.89	5.03	4.83	4.14	3.53	3.02	4.68	4.06	3.30	2.08
1257	3.75	4.09	2.52	4.19	4.05	3.45	2.91	2.43	3.93	3.40	2.76	1.74
1258	3.69	4.11	2.68	4.24	4.13	3.67	3.26	2.89	4.00	3.55	3.00	2.17
1259	4.66	4.82	2.97	4.90	4.75	4.21	3.74	3.34	4.60	4.06	3.41	2.40
1260	4.63	4.63	2.74	4.71	4.52	3.94	3.41	2.96	4.39	3.82	3.15	2.05
1261	3.83	4.01	2.47	4.09	3.94	3.44	2.97	2.54	3.84	3.36	2.78	1.81
1262	3.46	3.99	2.58	4.12	4.00	3.59	3.21	2.88	3.89	3.47	2.96	2.14
1263	4.41	4.57	2.85	4.67	4.53	4.05	3.62	3.27	4.38	3.89	3.29	2.36
1264	4.45	4.45	2.64	4.52	4.37	3.80	3.32	2.89	4.22	3.68	3.01	1.97
1265	3.33	3.54	2.26	3.71	3.59	3.10	2.67	2.32	3.47	3.05	2.51	1.65
1266	3.4	3.79	2.57	3.87	3.78	3.40	3.06	2.62	3.67	3.28	2.81	2.07
1267	4.14	4.53	2.88	4.55	4.43	4.01	3.63	3.29	4.32	3.85	3.27	2.38
1268	4.2	4.42	2.74	4.51	4.36	3.86	3.41	3.00	4.23	3.72	3.08	2.06
1269	2.92	3.51	2.23	3.58	3.50	3.03	2.64	2.27	3.39	2.96	2.42	1.55
1270	3.28	3.75	2.66	3.80	3.78	3.47	3.19	2.98	3.68	3.35	2.94	2.31
1271	4.06	4.30	2.96	4.43	4.34	4.02	3.71	3.48	4.23	3.85	3.36	2.62
1272	3.88	4.30	2.87	4.42	4.30	3.88	3.52	3.20	4.19	3.72	3.15	2.29
1273	2.69	3.37	2.34	3.54	3.49	3.11	2.77	2.50	3.37	2.98	2.51	1.79
1274	2.74	3.29	2.50	3.45	3.44	3.21	2.98	2.82	3.33	3.06	2.70	2.13
1275	3.72	4.12	2.95	4.22	4.14	3.88	3.63	3.42	4.05	3.71	3.28	2.59
1276	3.59	4.09	2.79	4.23	4.08	3.76	3.43	3.16	3.99	3.55	3.03	2.23
1277	2.53	3.24	2.32	3.46	3.35	3.03	2.73	2.50	3.32	2.88	2.44	1.79
1278	2.48	3.03	2.27	3.14	3.14	2.92	2.73	2.59	3.05	2.78	2.43	1.93
1279	3.43	3.94	2.71	3.82	3.78	3.55	3.33	3.16	3.69	3.38	2.96	2.33
1280	3.35	3.99	2.68	3.98	3.87	3.58	3.32	3.11	3.78	3.40	2.92	2.18
1281	2.69	3.36	2.42	3.55	3.48	3.19	2.92	2.73	3.39	3.05	2.60	1.94
1282	2.36	2.94	2.18	3.09	3.08	2.88	2.67	2.55	3.01	2.73	2.36	1.83
1283	3.31	3.61	2.55	3.69	3.63	3.42	3.20	3.05	3.56	3.23	2.81	2.17
1284	3.2	3.43	2.21	3.47	3.39	3.10	2.81	2.60	3.32	2.93	2.42	1.63
1285	2.7	3.28	2.18	3.35	3.30	3.01	2.74	2.55	3.25	2.87	2.39	1.64
1286	2.79	3.43	2.30	3.51	3.48	3.19	2.94	2.75	3.40	3.01	2.52	1.74

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1288	3.96	4.23	2.82	4.38	4.24	3.91	3.57	3.35	4.13	3.71	3.15	2.30
1289	3.3	3.59	2.48	3.73	3.64	3.34	3.01	2.83	3.54	3.15	2.69	1.91
1290	2.91	3.32	2.43	3.41	3.37	3.13	2.90	2.77	3.31	2.99	2.60	2.05
1291	3.43	3.74	2.63	3.84	3.78	3.53	3.32	3.16	3.69	3.35	2.90	2.26
1292	3.6	3.95	2.71	4.06	3.98	3.57	3.26	2.99	3.86	3.46	2.97	2.19
1293	3.57	4.09	2.79	4.23	4.14	3.79	3.49	3.20	4.03	3.62	3.12	2.30
1294	3.51	3.94	2.64	4.02	3.95	3.53	3.12	2.73	3.86	3.45	2.90	2.08
1295	3.5	3.90	2.65	3.99	3.93	3.52	3.12	2.74	3.83	3.42	2.89	2.09
1296	4.05	4.35	2.91	4.40	4.30	3.78	3.24	2.78	4.18	3.72	3.15	2.27
1297	4.22	4.61	2.99	4.67	4.57	4.05	3.48	3.02	4.44	3.94	3.33	2.37
1298	4.01	4.35	2.80	4.46	4.35	3.81	3.23	2.74	4.24	3.72	3.09	2.13
1299	3.93	4.19	2.75	4.29	4.17	3.63	3.07	2.57	4.07	3.57	2.96	2.05
1300	4.64	4.77	3.12	4.83	4.71	4.14	3.55	3.06	4.57	4.05	3.40	2.40
1301	4.89	5.07	3.23	5.13	4.98	4.38	3.76	3.26	4.85	4.27	3.58	2.52
1302	4.7	4.91	3.11	5.01	4.88	4.31	3.73	3.26	4.74	4.15	3.45	2.35
1303	4.44	4.57	2.96	4.67	4.56	3.98	3.43	2.97	4.41	3.87	3.21	2.18
1304	4.97	4.92	3.23	4.98	4.86	4.35	3.86	3.45	4.69	4.16	3.50	2.47
1305	5.77	5.64	3.53	5.67	5.48	4.89	4.29	3.86	5.34	4.69	3.94	2.75
1306	5.35	5.25	3.14	5.34	5.15	4.53	3.90	3.45	5.00	4.33	3.53	2.24
1307	4.75	4.71	2.90	4.77	4.62	4.06	3.50	3.08	4.50	3.90	3.19	2.03
1308	5.14	5.10	3.20	5.08	4.93	4.42	3.94	3.59	4.80	4.23	3.55	2.49
1309	6.37	6.08	3.61	6.04	5.77	5.11	4.49	4.07	5.62	4.91	4.08	2.80
1310	6	5.70	3.19	5.76	5.46	4.69	4.03	3.55	5.31	4.55	3.66	2.20
1311	4.91	4.78	2.85	4.90	4.70	4.05	3.50	3.13	4.57	3.97	3.21	1.97
1312	5.27	5.13	3.21	5.26	5.05	4.44	3.93	3.55	4.89	4.26	3.48	2.23
1313	6.66	6.20	3.64	6.23	5.90	5.16	4.52	4.04	5.74	4.95	4.03	2.57
1314	5.93	5.64	3.09	5.64	5.34	4.59	3.93	3.44	5.19	4.44	3.53	2.07
1315	4.73	4.67	2.72	4.75	4.56	3.93	3.38	2.99	4.43	3.82	3.07	1.81
1316	5.22	5.10	3.12	5.14	4.97	4.42	3.91	3.58	4.83	4.22	3.49	2.28
1317	6.58	6.20	3.54	6.15	5.87	5.16	4.50	4.05	5.71	4.93	4.03	2.58
1318	6.34	5.90	3.16	5.87	5.55	4.78	4.06	3.56	5.41	4.60	3.64	2.09

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1320	5.21	5.00	3.14	5.04	4.87	4.37	3.89	3.60	4.72	4.17	3.46	2.29
1321	6.52	6.07	3.55	6.03	5.75	5.10	4.48	4.08	5.59	4.87	3.99	2.59
1322	6	5.63	3.08	5.63	5.31	4.60	3.94	3.50	5.18	4.42	3.50	2.06
1323	4.28	4.33	2.57	4.47	4.26	3.71	3.21	2.89	4.15	3.58	2.86	1.69
1324	4.78	4.75	3.09	4.81	4.67	4.20	3.79	3.56	4.53	4.00	3.35	2.30
1325	6.14	5.84	3.52	5.81	5.59	4.99	4.45	4.12	5.44	4.75	3.94	2.64
1326	5.49	5.06	2.86	5.01	4.76	4.16	3.58	3.20	4.64	3.97	3.16	1.81
1327	4.03	4.02	2.45	4.08	3.92	3.45	3.01	2.70	3.97	3.30	2.64	1.54
1328	4.58	4.53	3.01	4.75	4.61	4.19	3.84	3.60	4.49	3.99	3.34	2.30
1329	5.44	4.96	3.13	5.07	4.88	4.40	3.98	3.70	4.75	4.17	3.44	2.29
1330	4.89	4.84	3.01	4.97	4.76	4.24	3.83	3.54	4.64	4.07	3.36	2.28
1331	4.1	4.29	2.77	4.44	4.25	3.78	3.41	3.18	4.14	3.64	2.99	2.03
1332	3.82	4.12	2.77	4.26	4.12	3.75	3.45	3.26	4.02	3.59	3.04	2.23
1333	4.96	4.80	3.09	4.87	4.71	4.31	3.96	3.73	4.61	4.09	3.47	2.51
1334	3.94	3.85	2.20	3.95	3.72	3.30	2.94	2.66	3.66	3.17	2.55	1.50
1335	3.92	4.13	2.47	4.21	4.04	3.62	3.25	3.00	3.99	3.54	2.94	1.87
1336	3.82	3.43	1.86	3.44	3.36	2.92	2.57	2.39	3.29	2.83	2.26	1.28
1337	3.37	2.85	1.60	2.91	2.82	2.41	2.11	1.94	2.75	2.37	1.86	1.04
1338	4.46	4.59	2.83	4.67	4.56	4.19	3.95	3.62	4.41	3.99	3.38	2.30
1339	3.97	4.10	2.56	4.14	4.02	3.65	3.31	3.11	3.91	3.46	2.86	1.85
1340	3.95	4.17	2.74	4.26	4.14	3.79	3.50	3.33	4.06	3.65	3.12	2.35
1341	4.24	4.40	2.81	4.51	4.36	4.04	3.75	3.56	4.28	3.84	3.27	2.43
1342	3.89	4.12	2.63	4.23	4.07	3.74	3.44	3.24	4.02	3.59	3.03	2.16
1343	4.36	4.60	2.85	4.66	4.50	4.15	3.81	3.59	4.43	3.94	3.35	2.38
1344	3.65	3.79	2.20	3.78	3.68	3.28	2.95	2.71	3.64	3.16	2.56	1.61
1345	3.67	3.94	2.32	3.97	3.88	3.48	3.15	2.89	3.84	3.38	2.76	1.79
1346	3.96	4.14	2.38	4.19	4.05	3.62	3.20	2.90	3.98	3.47	2.81	1.73
1347	4.09	4.29	2.46	4.40	4.23	3.78	3.34	3.06	4.16	3.61	2.94	1.82
1348	3.98	4.08	2.27	4.15	3.98	3.50	3.03	2.70	3.92	3.38	2.69	1.55
1349	3.37	3.56	2.06	3.63	3.56	3.13	2.75	2.45	3.47	3.01	2.40	1.40
1350	3.89	4.06	2.46	4.09	3.99	3.55	3.14	2.82	3.90	3.41	2.79	1.82

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1352	4.12	4.19	2.38	4.24	4.11	3.61	3.11	2.69	4.02	3.47	2.77	1.64
1353	3.51	3.83	2.23	3.89	3.83	3.35	2.88	2.48	3.73	3.23	2.59	1.55
1354	3.98	4.03	2.41	4.06	4.02	3.54	3.11	2.73	3.88	3.40	2.76	1.71
1355	4.5	4.40	2.59	4.42	4.33	3.82	3.23	2.99	4.20	3.67	2.98	1.84
1356	4.46	4.72	2.78	4.77	4.70	4.12	3.59	3.15	4.58	3.97	3.21	1.99
1357	3.25	3.66	2.17	3.60	3.60	3.05	2.56	2.18	3.49	2.99	2.35	1.35
1358	3.18	3.63	2.43	3.58	3.55	3.23	2.93	2.73	3.45	3.13	2.70	2.05
1359	4.72	4.86	3.02	4.88	4.74	4.35	3.97	3.69	4.62	4.12	3.52	2.58
1360	4.51	4.51	2.59	4.52	4.40	3.86	3.34	2.94	4.29	3.71	2.97	1.83
1361	3.41	3.66	2.24	3.73	3.68	3.22	2.79	2.44	3.58	3.14	2.52	1.58
1362	3.55	3.72	2.44	3.73	3.65	3.31	3.00	2.71	3.55	3.14	2.64	1.85
1363	4.52	4.55	2.82	4.54	4.38	3.96	3.54	3.22	4.23	3.74	3.13	2.16
1364	4.71	4.81	2.79	4.89	4.72	4.12	3.58	3.15	4.59	3.96	3.18	1.97
1365	3.31	3.51	2.17	3.60	3.53	3.02	2.58	2.21	3.42	2.95	2.34	1.40
1366	3.18	3.47	2.47	3.54	3.08	3.31	3.10	2.84	3.40	3.09	2.71	2.11
1367	4.64	4.71	3.00	4.73	4.60	4.25	3.95	4.02	4.48	4.00	3.45	2.57
1368	4.41	4.54	2.67	4.58	4.42	3.89	3.40	3.03	4.32	3.72	3.00	1.91
1369	3.1	3.59	2.30	3.73	3.65	3.20	2.80	2.47	3.56	3.09	2.50	1.63
1370	3.22	3.26	2.25	3.32	3.29	3.02	2.75	2.55	3.19	2.83	2.37	1.69
1371	4.53	4.22	2.67	4.15	4.04	3.71	3.37	3.14	3.95	3.50	2.93	2.08
1372	4.61	4.73	2.81	4.75	4.56	4.03	3.55	3.16	4.46	3.89	3.15	1.97
1373	3.22	3.59	2.27	3.68	3.60	3.14	2.73	2.39	3.51	3.05	2.44	1.46
1374	3.08	3.47	2.42	3.59	3.58	3.31	3.04	2.85	4.46	3.13	2.67	1.99
1375	4.34	4.46	2.85	4.52	4.41	4.08	3.73	3.49	4.29	3.82	3.22	2.34
1376	4.26	4.47	2.72	4.50	4.38	3.92	3.49	3.19	4.28	3.73	3.03	2.02
1377	3.13	3.49	2.27	3.59	3.51	3.10	2.73	2.47	3.43	3.00	2.43	1.61
1378	3.07	3.38	2.41	3.51	3.46	3.22	3.01	2.87	3.37	3.05	2.61	2.00
1379	4.07	4.26	2.80	4.33	4.21	3.93	3.65	3.47	4.13	3.71	3.16	2.37
1380	4.21	4.36	2.70	4.46	4.29	3.87	3.49	3.24	4.23	3.68	3.00	2.02
1381	2.94	3.30	2.23	3.47	3.38	2.98	2.65	2.46	3.31	2.87	2.34	1.57
1382	2.91	3.42	2.49	3.56	3.49	3.23	3.02	2.90	3.42	3.08	2.70	2.09

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1384	3.85	4.16	2.53	4.24	4.10	3.71	3.37	3.14	4.06	3.55	2.91	1.98
1385	2.83	2.98	1.99	3.07	3.01	2.65	2.36	2.19	2.95	2.59	2.10	1.43
1386	2.96	3.17	2.39	3.27	3.22	3.01	2.84	2.76	3.14	2.89	2.55	2.07
1387	3.83	4.22	2.86	4.27	4.15	3.93	3.72	3.58	4.09	3.72	3.25	2.54
1388	4.08	4.48	2.84	4.42	4.29	3.96	3.68	3.46	4.24	3.78	3.19	2.26
1389	3.06	3.54	2.37	3.61	3.54	3.20	2.93	2.75	3.47	3.09	2.59	1.80
1390	2.82	3.25	2.43	3.39	3.32	3.12	2.92	2.83	3.27	2.99	2.64	2.12
1391	3.67	4.04	2.80	4.10	3.97	3.77	3.56	3.43	3.93	3.59	3.14	2.49
1392	3.97	4.30	2.85	4.39	4.26	3.91	3.61	3.40	4.19	3.74	3.15	2.30
1393	2.91	3.41	2.42	3.60	3.55	3.22	2.93	2.79	3.46	3.09	2.61	1.90
1394	2.78	3.17	2.40	3.32	3.31	3.11	2.91	2.83	3.26	2.97	2.61	2.07
1395	3.52	3.80	2.73	3.89	3.81	3.60	3.40	3.28	3.79	3.43	3.01	2.39
1396	3.85	4.17	2.88	4.30	4.15	3.85	3.58	3.41	4.10	3.67	3.16	2.40
1397	3.18	3.66	2.60	3.86	3.74	3.43	3.17	3.02	3.68	3.30	2.82	2.12
1398	3.06	3.45	2.55	3.60	3.56	3.34	3.12	3.02	3.51	3.19	2.78	2.19
1399	3.44	3.74	2.70	3.84	3.77	3.57	3.33	3.21	3.73	3.38	2.95	2.33
1400	4.04	4.34	3.09	4.51	4.36	4.10	3.83	3.69	4.30	3.89	3.40	2.67
1401	3.72	3.93	2.81	4.07	3.93	3.63	3.33	3.18	3.86	3.46	2.99	2.27
1402	3.45	3.91	2.83	4.04	3.97	3.73	3.50	3.39	3.92	3.61	3.21	2.60
1403	3.91	4.20	3.01	4.33	4.26	4.04	3.80	3.68	4.22	3.88	3.45	2.78
1404	3.88	4.17	3.02	4.32	4.19	3.94	3.66	3.51	4.14	3.77	3.32	2.62
1405	4.13	4.52	3.19	4.61	4.49	4.14	3.95	3.80	xxx	4.04	3.55	2.83
1406	3.74	4.08	2.83	4.13	4.08	3.80	3.51	3.35	xxx	3.63	3.14	2.41
1407	3.52	3.86	2.75	3.98	3.91	3.62	3.35	3.19	3.87	3.48	3.02	2.32
1408	4.4	4.65	3.29	4.79	4.67	4.18	4.03	xxx	4.59	4.15	3.63	2.85
1409	4.61	4.90	3.39	5.07	4.93	4.45	4.29	xxx	4.84	4.36	3.81	2.97
1410	xxx	4.54	3.12	4.63	4.56	4.22	3.87	3.68	4.48	4.00	3.46	2.63
1411	xxx	3.98	2.82	4.06	4.04	3.70	3.35	3.19	3.97	3.55	3.07	2.32
1412	4.45	4.56	3.32	4.69	4.59	3.94	3.97	3.76	4.51	4.09	3.62	2.84
1413	5.4	5.50	3.77	5.61	5.45	4.74	4.75	4.54	5.19	4.83	4.25	3.30
1414	5.06	4.94	3.25	4.77	4.86	4.43	4.05	3.74	4.77	4.21	3.59	2.61

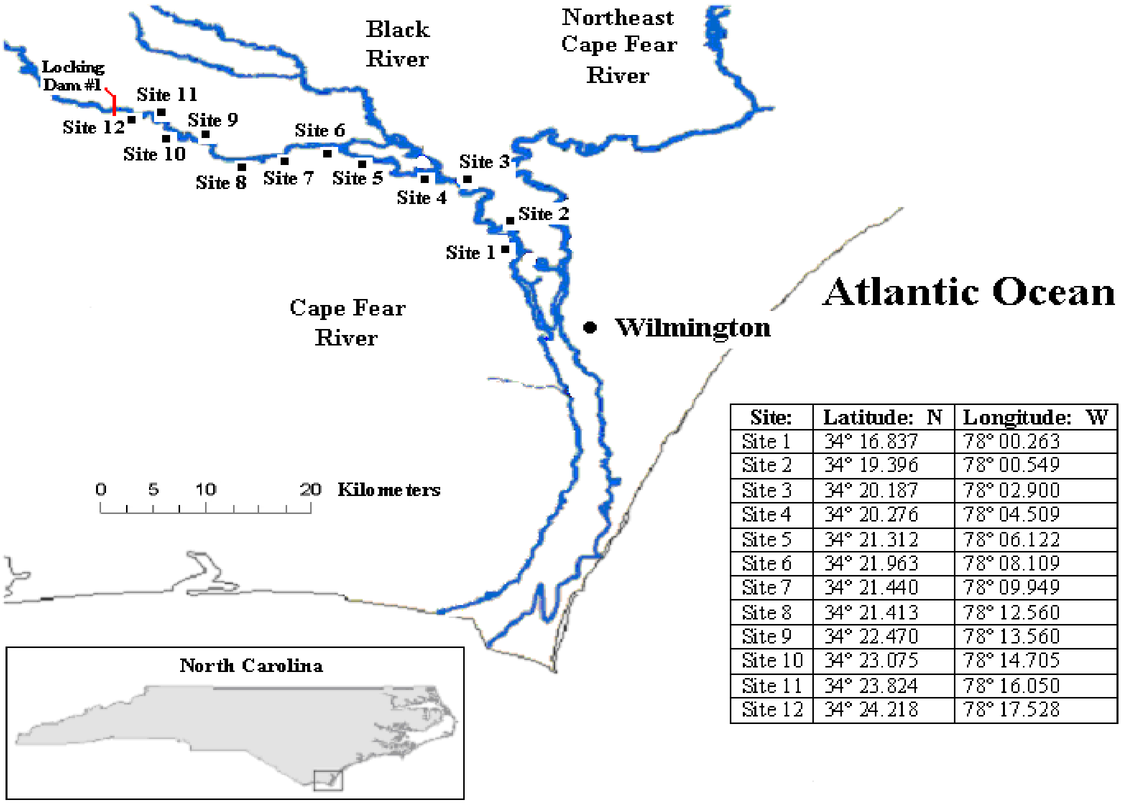
Appendix A. (continued)

Station	P01	P02	P03	P04	P06	P07	P08	P09	P11	P12	P13	P14
1415	4.02											

APPENDIX B

CRUISE DATABASE BY DATE AND SITE SHOWING ALL PARAMETERS COLLECTED BY DEPTH

APPENDIX B: CRUISE DATABASE BY DATE AND SITE SHOWING ALL PARAMETERS COLLECTED BY DEPTH



Site:	Latitude: N	Longitude: W
Site 1	34° 16.837	78° 00.263
Site 2	34° 19.396	78° 00.549
Site 3	34° 20.187	78° 02.900
Site 4	34° 20.276	78° 04.509
Site 5	34° 21.312	78° 06.122
Site 6	34° 21.963	78° 08.109
Site 7	34° 21.440	78° 09.949
Site 8	34° 21.413	78° 12.560
Site 9	34° 22.470	78° 13.560
Site 10	34° 23.075	78° 14.705
Site 11	34° 23.824	78° 16.050
Site 12	34° 24.218	78° 17.528

Location of salinity depth sampling stations.

Physical Measurements Collected At Depth

Site: **1** **Date:** 6/3/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	319.5	uS	25.2	ºC	0.2	ppt	4.91	mg/L
5 ft	319.3	uS	25.2	ºC	0.2	ppt	4.74	mg/L
10 ft	314.3	uS	25.3	ºC	0.2	ppt	4.83	mg/L
15 ft	326.2	uS	25.3	ºC	0.2	ppt	4.90	mg/L
20 ft	325.4	uS	25.3	ºC	0.2	ppt	4.82	mg/L
25 ft	323.6	uS	25.3	ºC	0.2	ppt	4.81	mg/L
30 ft	325.5	uS	25.3	ºC	0.2	ppt	4.82	mg/L
35 ft	323.5	uS	25.3	ºC	0.2	ppt	4.82	mg/L
40 ft	324.6	uS	25.3	ºC	0.2	ppt	4.81	mg/L
45 ft	327.7	uS	25.3	ºC	0.2	ppt	4.65	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 6/3/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	252.2	uS	25.6	ºC	0.1	ppt	4.81	mg/L
5 ft	252.1	uS	25.5	ºC	0.1	ppt	4.82	mg/L
10 ft	253.0	uS	25.5	ºC	0.1	ppt	4.81	mg/L
15 ft	252.2	uS	25.5	ºC	0.1	ppt	4.72	mg/L
20 ft	252.1	uS	25.5	ºC	0.1	ppt	4.76	mg/L
25 ft	252.4	uS	25.5	ºC	0.1	ppt	4.70	mg/L
30 ft	252.5	uS	25.5	ºC	0.1	ppt	4.69	mg/L
35 ft	252.4	uS	25.5	ºC	0.1	ppt	4.74	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 6/3/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	240.9	uS	25.6	ºC	0.1	ppt	5.10	mg/L
5 ft	240.9	uS	25.6	ºC	0.1	ppt	4.91	mg/L
10 ft	240.9	uS	25.6	ºC	0.1	ppt	4.88	mg/L
15 ft	241.0	uS	25.6	ºC	0.1	ppt	4.82	mg/L
20 ft	241.0	uS	25.6	ºC	0.1	ppt	4.75	mg/L
25 ft	241.0	uS	25.6	ºC	0.1	ppt	4.71	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 6/3/2008

Latitude: 34º 20.276 N **Longitude: 78º 04.509 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	270.9	uS	25.8	ºC	0.1	ppt	5.21	mg/L
5 ft	268.9	uS	25.7	ºC	0.1	ppt	5.18	mg/L
10 ft	272.6	uS	25.7	ºC	0.1	ppt	5.13	mg/L
15 ft	268.1	uS	25.7	ºC	0.1	ppt	5.10	mg/L
20 ft	273.4	uS	25.7	ºC	0.1	ppt	5.06	mg/L
25 ft	268.4	uS	25.7	ºC	0.1	ppt	5.09	mg/L
30 ft	268.9	uS	25.7	ºC	0.1	ppt	5.09	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 6/3/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	283.3	uS	25.9	ºC	0.1	ppt	5.92	mg/L
5 ft	238.4	uS	25.8	ºC	0.1	ppt	5.75	mg/L
10 ft	282.9	uS	25.8	ºC	0.1	ppt	5.78	mg/L
15 ft	282.9	uS	25.8	ºC	0.1	ppt	5.69	mg/L
20 ft	282.9	uS	25.8	ºC	0.1	ppt	5.68	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 6/3/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	285.2	uS	25.7	ºC	0.1	ppt	6.19	mg/L
5 ft	283.8	uS	25.7	ºC	0.1	ppt	6.13	mg/L
10 ft	281.9	uS	25.7	ºC	0.1	ppt	6.05	mg/L
15 ft	286.5	uS	25.7	ºC	0.1	ppt	6.14	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 6/3/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	286.1	uS	25.8	ºC	0.1	ppt	6.46	mg/L
5 ft	289.9	uS	25.7	ºC	0.1	ppt	6.18	mg/L
10 ft	289.2	uS	25.7	ºC	0.1	ppt	6.31	mg/L
15 ft	297.5	uS	25.7	ºC	0.1	ppt	6.20	mg/L
20 ft	298.4	uS	25.7	ºC	0.1	ppt	6.13	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 6/3/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	171.3	uS	25.6	ºC	0.1	ppt	6.31	mg/L
5 ft	167.8	uS	25.4	ºC	0.1	ppt	5.42	mg/L
10 ft	171.9	uS	25.4	ºC	0.1	ppt	6.45	mg/L
15 ft	173.0	uS	25.3	ºC	0.1	ppt	5.41	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 6/3/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	150.3	uS	25.8	ºC	0.1	ppt	7.38	mg/L
5 ft	148.8	uS	25.3	ºC	0.1	ppt	6.51	mg/L
10 ft	148.6	uS	25.3	ºC	0.1	ppt	6.16	mg/L
15 ft	148.4	uS	25.3	ºC	0.1	ppt	6.47	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 6/3/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	153.0	uS	26.2	ºC	0.1	ppt	7.43	mg/L
5 ft	150.6	uS	25.4	ºC	0.1	ppt	7.03	mg/L
10 ft	149.9	uS	25.2	ºC	0.1	ppt	6.91	mg/L
15 ft	149.9	uS	25.2	ºC	0.1	ppt	6.28	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 6/3/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	155.5	uS	26.0	ºC	0.1	ppt	7.53	mg/L
5 ft	152.8	uS	25.1	ºC	0.1	ppt	6.91	mg/L
10 ft	152.7	uS	25.0	ºC	0.1	ppt	6.92	mg/L
15 ft	152.7	uS	25.0	ºC	0.1	ppt	6.08	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 6/3/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	155.2	uS	25.4	ºC	0.1	ppt	8.2	mg/L
5 ft	155.1	uS	25.3	ºC	0.1	ppt	8.34	mg/L
10 ft	155.1	uS	25.3	ºC	0.1	ppt	8.08	mg/L
15 ft	155.1	uS	25.2	ºC	0.1	ppt	7.96	mg/L
20 ft	155.1	uS	25.2	ºC	0.1	ppt	7.43	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 7/16/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	2763	uS	28.7	ºC	1.3	ppt	4.22	mg/L
5 ft	2981	uS	28.8	ºC	1.4	ppt	4.4	mg/L
10 ft	3140	uS	28.8	ºC	1.5	ppt	4.32	mg/L
15 ft	3176	uS	28.8	ºC	1.5	ppt	4.48	mg/L
20 ft	3383	uS	28.8	ºC	1.6	ppt	4.35	mg/L
25 ft	3670	uS	28.8	ºC	1.8	ppt	4.38	mg/L
30 ft	3626	uS	28.8	ºC	1.8	ppt	4.37	mg/L
35 ft	3679	uS	28.8	ºC	1.8	ppt	4.41	mg/L
40 ft	3867	uS	28.8	ºC	1.9	ppt	4.33	mg/L
45 ft	4041	uS	28.8	ºC	2	ppt	4.3	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 7/16/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	292.4	uS	28.8	ºC	0.1	ppt	4.88	mg/L
5 ft	292.4	uS	28.9	ºC	0.1	ppt	4.87	mg/L
10 ft	292.2	uS	28.9	ºC	0.1	ppt	4.84	mg/L
15 ft	292.2	uS	28.9	ºC	0.1	ppt	4.81	mg/L
20 ft	292.1	uS	28.9	ºC	0.1	ppt	4.89	mg/L
25 ft	292.2	uS	28.9	ºC	0.1	ppt	4.91	mg/L
30 ft	292	uS	28.9	ºC	0.1	ppt	4.66	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 7/16/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	274.5	uS	28.8	ºC	0.1	ppt	4.83	mg/L
5 ft	274.5	uS	28.8	ºC	0.1	ppt	4.7	mg/L
10 ft	274.5	uS	28.8	ºC	0.1	ppt	4.64	mg/L
15 ft	274.5	uS	28.9	ºC	0.1	ppt	4.57	mg/L
20 ft	274.5	uS	28.9	ºC	0.1	ppt	4.53	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 7/16/2008

Latitude: 34º 20.276 N   **Longitude: 78º 04.509 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	279.5	uS	28.8	ºC	0.1	ppt	4.96	mg/L
5 ft	279.8	uS	28.8	ºC	0.1	ppt	4.84	mg/L
10 ft	279.8	uS	28.8	ºC	0.1	ppt	4.79	mg/L
15 ft	279.6	uS	28.8	ºC	0.1	ppt	4.74	mg/L
20 ft	279.6	uS	28.8	ºC	0.1	ppt	4.71	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 7/16/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	285.8	uS	28.6	ºC	0.1	ppt	5.31	mg/L
5 ft	284.6	uS	28.6	ºC	0.1	ppt	5.08	mg/L
10 ft	285.5	uS	28.6	ºC	0.1	ppt	5.16	mg/L
15 ft	285.7	uS	28.6	ºC	0.1	ppt	5.03	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 7/16/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	310.5	uS	28.5	ºC	0.1	ppt	5.52	mg/L
5 ft	308.8	uS	28.6	ºC	0.1	ppt	5.07	mg/L
10 ft	306.7	uS	28.6	ºC	0.1	ppt	5.19	mg/L
15 ft	310.2	uS	28.6	ºC	0.1	ppt	5.11	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 7/16/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	375.3	uS	28.9	ºC	0.2	ppt	5.33	mg/L
5 ft	376.3	uS	28.9	ºC	0.2	ppt	5.27	mg/L
10 ft	365.6	uS	28.8	ºC	0.2	ppt	5.07	mg/L
15 ft	366.3	uS	28.7	ºC	0.2	ppt	5.08	mg/L
20 ft	369.2	uS	28.7	ºC	0.2	ppt	4.97	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 7/16/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	186.9	uS	28.4	ºC	0.1	ppt	5.76	mg/L
5 ft	188.3	uS	28.4	ºC	0.1	ppt	5.8	mg/L
10 ft	188.7	uS	28.4	ºC	0.1	ppt	5.38	mg/L
15 ft	186.6	uS	28.4	ºC	0.1	ppt	4.97	mg/L
20 ft	184	uS	28.4	ºC	0.1	ppt	4.73	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 7/16/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	170.4	uS	29	ºC	0.1	ppt	5.95	mg/L
5 ft	168.5	uS	28.6	ºC	0.1	ppt	5.12	mg/L
10 ft	168.5	uS	28.5	ºC	0.1	ppt	5.2	mg/L
15 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 7/16/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	165.8	uS	28.9	ºC	0.1	ppt	6.05	mg/L
5 ft	165.4	uS	28.7	ºC	0.1	ppt	5.52	mg/L
10 ft	165.2	uS	28.6	ºC	0.1	ppt	5.16	mg/L
15 ft	165.1	uS	28.6	ºC	0.1	ppt	4.96	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 7/16/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	151.9	uS	29.1	ºC	0.1	ppt	6.49	mg/L
5 ft	150.1	uS	28.3	ºC	0.1	ppt	5.42	mg/L
10 ft	150.4	uS	28.3	ºC	0.1	ppt	5.75	mg/L
15 ft	150.5	uS	28.2	ºC	0.1	ppt	5.35	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 7/16/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	133.5	uS	28.3	ºC	0.1	ppt	5.94	mg/L
5 ft	133.2	uS	28.3	ºC	0.1	ppt	5.98	mg/L
10 ft	132.8	uS	28.3	ºC	0.1	ppt	5.96	mg/L
15 ft	132.6	uS	28.3	ºC	0.1	ppt	5.94	mg/L
20 ft	132.9	uS	28.2	ºC	0.1	ppt	5.92	mg/L
25 ft	132.5	uS	28.3	ºC	0.1	ppt	5.48	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 8/14/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	732	uS	28.1	ºC	0.3	ppt	3.51	mg/L
5 ft	733	uS	28.3	ºC	0.3	ppt	3.28	mg/L
10 ft	737	uS	28.3	ºC	0.3	ppt	2.99	mg/L
15 ft	736	uS	28.4	ºC	0.3	ppt	3.27	mg/L
20 ft	764	uS	28.4	ºC	0.3	ppt	3.37	mg/L
25 ft	779	uS	28.5	ºC	0.4	ppt	3.4	mg/L
30 ft	858	uS	28.5	ºC	0.4	ppt	3.18	mg/L
35 ft	837	uS	28.5	ºC	0.4	ppt	3.24	mg/L
40 ft	911	uS	28.5	ºC	0.4	ppt	3.25	mg/L
45 ft	974	uS	28.5	ºC	0.4	ppt	3.18	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 8/14/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	251.2	uS	27.9	ºC	0.1	ppt	3.79	mg/L
5 ft	251.4	uS	28.1	ºC	0.1	ppt	3.64	mg/L
10 ft	251.6	uS	28.2	ºC	0.1	ppt	3.61	mg/L
15 ft	251.5	uS	28.2	ºC	0.1	ppt	3.64	mg/L
20 ft	251.6	uS	28.2	ºC	0.1	ppt	3.63	mg/L
25 ft	251.3	uS	28.3	ºC	0.1	ppt	3.52	mg/L
30 ft	251.9	uS	28.3	ºC	0.1	ppt	3.62	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 8/14/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	224.5	uS	27.3	ºC	0.1	ppt	4.18	mg/L
5 ft	224.9	uS	27.7	ºC	0.1	ppt	4.00	mg/L
10 ft	224.8	uS	27.8	ºC	0.1	ppt	4.00	mg/L
15 ft	224.9	uS	27.9	ºC	0.1	ppt	4.01	mg/L
20 ft	224.9	uS	28.0	ºC	0.1	ppt	3.95	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 8/14/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	732	uS	28.1	ºC	0.3	ppt	3.51	mg/L
5 ft	733	uS	28.3	ºC	0.3	ppt	3.28	mg/L
10 ft	737	uS	28.3	ºC	0.3	ppt	2.99	mg/L
15 ft	736	uS	28.4	ºC	0.3	ppt	3.27	mg/L
20 ft	764	uS	28.4	ºC	0.3	ppt	3.37	mg/L
25 ft	779	uS	28.5	ºC	0.4	ppt	3.4	mg/L
30 ft	858	uS	28.5	ºC	0.4	ppt	3.18	mg/L
35 ft	837	uS	28.5	ºC	0.4	ppt	3.24	mg/L
40 ft	911	uS	28.5	ºC	0.4	ppt	3.25	mg/L
45 ft	974	uS	28.5	ºC	0.4	ppt	3.18	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 8/14/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	251.2	uS	27.9	ºC	0.1	ppt	3.79	mg/L
5 ft	251.4	uS	28.1	ºC	0.1	ppt	3.64	mg/L
10 ft	251.6	uS	28.2	ºC	0.1	ppt	3.61	mg/L
15 ft	251.5	uS	28.2	ºC	0.1	ppt	3.64	mg/L
20 ft	251.6	uS	28.2	ºC	0.1	ppt	3.63	mg/L
25 ft	251.3	uS	28.3	ºC	0.1	ppt	3.52	mg/L
30 ft	251.9	uS	28.3	ºC	0.1	ppt	3.62	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 8/14/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	224.5	uS	27.3	ºC	0.1	ppt	4.18	mg/L
5 ft	224.9	uS	27.7	ºC	0.1	ppt	4.00	mg/L
10 ft	224.8	uS	27.8	ºC	0.1	ppt	4.00	mg/L
15 ft	224.9	uS	27.9	ºC	0.1	ppt	4.01	mg/L
20 ft	224.9	uS	28.0	ºC	0.1	ppt	3.95	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 8/14/2008

Latitude: 34º 20.276 N **Longitude: 78º 04.509 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	261.8	uS	28.2	ºC	0.1	ppt	4.81	mg/L
5 ft	261.6	uS	28.4	ºC	0.1	ppt	4.7	mg/L
10 ft	261.5	uS	28.4	ºC	0.1	ppt	4.61	mg/L
15 ft	261.2	uS	28.5	ºC	0.1	ppt	4.62	mg/L
20 ft	261.2	uS	28.5	ºC	0.1	ppt	4.57	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 8/14/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	295.7	uS	28.2	ºC	0.1	ppt	5.28	mg/L
5 ft	295.8	uS	28.4	ºC	0.1	ppt	5.29	mg/L
10 ft	296.0	uS	28.4	ºC	0.1	ppt	5.27	mg/L
15 ft	296.6	uS	28.5	ºC	0.1	ppt	5.12	mg/L
20 ft	297.2	uS	28.5	ºC	0.1	ppt	5.13	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 8/14/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	233.6	uS	27.8	ºC	0.1	ppt	5.77	mg/L
5 ft	235.7	uS	28.2	ºC	0.1	ppt	5.68	mg/L
10 ft	237.6	uS	28.2	ºC	0.1	ppt	4.90	mg/L
15 ft	241.1	uS	28.3	ºC	0.1	ppt	5.25	mg/L
20 ft	241.0	uS	28.3	ºC	0.1	ppt	5.06	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 8/14/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	230.9	uS	27.6	ºC	0.1	ppt	5.58	mg/L
5 ft	230.5	uS	27.9	ºC	0.1	ppt	5.34	mg/L
10 ft	226.7	uS	28.0	ºC	0.1	ppt	5.28	mg/L
15 ft	228.9	uS	28.1	ºC	0.1	ppt	5.34	mg/L
20 ft	228.3	uS	28.1	ºC	0.1	ppt	5.29	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 8/14/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	148.7	uS	27.6	ºC	0.1	ppt	5.29	mg/L
5 ft	148.8	uS	27.8	ºC	0.1	ppt	5.16	mg/L
10 ft	148.7	uS	27.9	ºC	0.1	ppt	4.87	mg/L
15 ft	148.8	uS	27.9	ºC	0.1	ppt	4.87	mg/L
20 ft	149.0	uS	28.0	ºC	0.1	ppt	5.06	mg/L
25 ft	148.9	uS	28.0	ºC	0.1	ppt	5.06	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 8/14/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	149.2	uS	28.0	ºC	0.1	ppt	5.86	mg/L
5 ft	149.0	uS	28.0	ºC	0.1	ppt	5.71	mg/L
10 ft	149.0	uS	28.0	ºC	0.1	ppt	5.63	mg/L
15 ft	149.0	uS	28.1	ºC	0.1	ppt	5.46	mg/L
20 ft	148.9	uS	28.1	ºC	0.1	ppt	5.53	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 8/14/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	151.3	uS	27.6	ºC	0.1	ppt	6.11	mg/L
5 ft	151.3	uS	27.8	ºC	0.1	ppt	5.92	mg/L
10 ft	151.3	uS	27.9	ºC	0.1	ppt	5.90	mg/L
15 ft	151.3	uS	27.9	ºC	0.1	ppt	5.83	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 8/14/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	154.5	uS	27.7	ºC	0.1	ppt	5.84	mg/L
5 ft	154.6	uS	27.8	ºC	0.1	ppt	5.87	mg/L
10 ft	154.6	uS	27.9	ºC	0.1	ppt	5.91	mg/L
15 ft	154.6	uS	27.9	ºC	0.1	ppt	5.65	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 8/14/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	156.8	uS	27.2	ºC	0.1	ppt	7.04	mg/L
5 ft	156.8	uS	27.9	ºC	0.1	ppt	6.26	mg/L
10 ft	156.7	uS	28.0	ºC	0.1	ppt	6.16	mg/L
15 ft	156.7	uS	28.0	ºC	0.1	ppt	6.22	mg/L
20 ft	156.8	uS	28.1	ºC	0.1	ppt	6.24	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 9/13/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	74.5	uS	24.7	ºC	0.1	ppt	3.11	mg/L
5 ft	74.3	uS	24.6	ºC	0.0	ppt	3.00	mg/L
10 ft	74.2	uS	24.6	ºC	0.0	ppt	3.04	mg/L
15 ft	74.3	uS	24.6	ºC	0.0	ppt	2.94	mg/L
20 ft	74.3	uS	24.6	ºC	0.0	ppt	2.82	mg/L
25 ft	74.3	uS	24.6	ºC	0.0	ppt	2.80	mg/L
30 ft	74.3	uS	24.6	ºC	0.0	ppt	2.87	mg/L
35 ft	74.3	uS	24.6	ºC	0.0	ppt	2.77	mg/L
40 ft	74.2	uS	24.6	ºC	0.0	ppt	2.74	mg/L
45 ft	74.4	uS	24.6	ºC	0.0	ppt	2.81	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 9/13/2008 **Way point:** **014**

Latitude: 34º 19.396 N   **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	74.8	uS	24.7	ºC	0.0	ppt	3.00	mg/L
5 ft	74.8	uS	24.7	ºC	0.0	ppt	2.95	mg/L
10 ft	74.7	uS	24.7	ºC	0.0	ppt	2.90	mg/L
15 ft	74.7	uS	24.6	ºC	0.0	ppt	2.94	mg/L
20 ft	74.7	uS	24.6	ºC	0.0	ppt	2.92	mg/L
25 ft	74.7	uS	24.6	ºC	0.0	ppt	2.91	mg/L
30 ft	74.7	uS	24.6	ºC	0.0	ppt	2.92	mg/L
35 ft	74.7	uS	24.6	ºC	0.0	ppt	2.92	mg/L
40 ft	74.8	uS	24.6	ºC	0.0	ppt	2.89	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 9/13/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	75.6	uS	24.6	ºC	0.0	ppt	4.05	mg/L
5 ft	75.7	uS	24.5	ºC	0.0	ppt	4.00	mg/L
10 ft	75.6	uS	24.5	ºC	0.0	ppt	3.99	mg/L
15 ft	75.5	uS	24.4	ºC	0.0	ppt	3.96	mg/L
20 ft	75.4	uS	24.4	ºC	0.0	ppt	3.95	mg/L
25 ft	75.3	uS	24.4	ºC	0.0	ppt	3.97	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 9/13/2008

Latitude: 34º 20.276 N **Longitude: 78º 04.509 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	77.9	uS	25.2	ºC	0.0	ppt	4.15	mg/L
5 ft	78.0	uS	24.8	ºC	0.0	ppt	4.12	mg/L
10 ft	78.0	uS	24.8	ºC	0.0	ppt	4.05	mg/L
15 ft	78.0	uS	24.6	ºC	0.0	ppt	4.03	mg/L
20 ft	77.9	uS	24.6	ºC	0.0	ppt	4.06	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 9/13/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	77.6	uS	24.5	ºC	0.0	ppt	4.50	mg/L
5 ft	77.6	uS	24.5	ºC	0.0	ppt	4.22	mg/L
10 ft	77.5	uS	24.5	ºC	0.0	ppt	4.16	mg/L
15 ft	77.6	uS	24.4	ºC	0.0	ppt	4.13	mg/L
20 ft	77.6	uS	24.4	ºC	0.0	ppt	4.12	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 9/13/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	77.5	uS	24.6	ºC	0.0	ppt	4.41	mg/L
5 ft	78.5	uS	24.5	ºC	0.0	ppt	4.13	mg/L
10 ft	78.6	uS	24.5	ºC	0.0	ppt	4.07	mg/L
15 ft	78.7	uS	24.5	ºC	0.0	ppt	4.10	mg/L
20 ft	78.7	uS	24.4	ºC	0.0	ppt	4.10	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 9/13/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	78.6	uS	24.6	ºC	0.0	ppt	4.23	mg/L
5 ft	78.2	uS	24.5	ºC	0.0	ppt	4.16	mg/L
10 ft	78.5	uS	24.5	ºC	0.0	ppt	4.14	mg/L
15 ft	79.4	uS	24.4	ºC	0.0	ppt	4.06	mg/L
20 ft	80.9	uS	24.4	ºC	0.0	ppt	4.00	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 9/13/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	78.1	uS	24.7	ºC	0.0	ppt	4.57	mg/L
5 ft	78.1	uS	24.6	ºC	0.0	ppt	4.35	mg/L
10 ft	78.1	uS	24.5	ºC	0.0	ppt	4.29	mg/L
15 ft	78.1	uS	24.5	ºC	0.0	ppt	4.27	mg/L
20 ft	78.2	uS	24.5	ºC	0.0	ppt	4.28	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 9/13/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	78.4	uS	24.9	ºC	0.0	ppt	4.62	mg/L
5 ft	78.5	uS	24.5	ºC	0.0	ppt	4.33	mg/L
10 ft	79.4	uS	24.5	ºC	0.0	ppt	4.33	mg/L
15 ft	79.5	uS	24.5	ºC	0.0	ppt	4.33	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 9/13/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	79.6	uS	24.8	ºC	0.0	ppt	4.50	mg/L
5 ft	79.5	uS	24.6	ºC	0.0	ppt	4.44	mg/L
10 ft	79.5	uS	24.5	ºC	0.0	ppt	4.41	mg/L
15 ft	79.5	uS	24.5	ºC	0.0	ppt	4.40	mg/L
20 ft	79.5	uS	24.5	ºC	0.0	ppt	4.40	mg/L
25 ft	79.5	uS	24.4	ºC	0.0	ppt	4.38	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 9/13/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	80.4	uS	24.7	ºC	0.0	ppt	4.83	mg/L
5 ft	80.4	uS	24.6	ºC	0.0	ppt	4.48	mg/L
10 ft	80.4	uS	24.5	ºC	0.0	ppt	4.45	mg/L
15 ft	80.4	uS	24.5	ºC	0.0	ppt	4.47	mg/L
20 ft	80.3	uS	24.4	ºC	0.0	ppt	4.46	mg/L
25 ft	80.4	uS	24.4	ºC	0.0	ppt	4.47	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 9/13/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	82.3	uS	25.0	ºC	0.0	ppt	4.82	mg/L
5 ft	81.9	uS	24.6	ºC	0.0	ppt	4.73	mg/L
10 ft	81.9	uS	24.5	ºC	0.0	ppt	4.31	mg/L
15 ft	81.9	uS	24.5	ºC	0.0	ppt	4.55	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 10/11/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	158.4	uS	21.2	ºC	0.1	ppt	7.09	mg/L
5 ft	160.4	uS	21.2	ºC	0.1	ppt	5.94	mg/L
10 ft	165.2	uS	21.1	ºC	0.1	ppt	5.76	mg/L
15 ft	171.2	uS	21.1	ºC	0.1	ppt	5.84	mg/L
20 ft	170.5	uS	21.1	ºC	0.1	ppt	5.85	mg/L
25 ft	169.0	uS	21.1	ºC	0.1	ppt	5.80	mg/L
30 ft	165.9	uS	21.1	ºC	0.1	ppt	5.55	mg/L
35 ft	169.9	uS	21.1	ºC	0.1	ppt	5.65	mg/L
40 ft	164.2	uS	21.1	ºC	0.1	ppt	5.35	mg/L
45 ft	166.0	uS	21.1	ºC	0.1	ppt	5.20	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 10/11/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	129.4	uS	20.9	ºC	0.1	ppt	4.90	mg/L
5 ft	129.5	uS	20.9	ºC	0.1	ppt	4.75	mg/L
10 ft	129.1	uS	20.9	ºC	0.1	ppt	4.97	mg/L
15 ft	129.3	uS	20.9	ºC	0.1	ppt	4.73	mg/L
20 ft	129.5	uS	20.9	ºC	0.1	ppt	4.75	mg/L
25 ft	129.4	uS	20.9	ºC	0.1	ppt	4.72	mg/L
30 ft	129.5	uS	20.9	ºC	0.1	ppt	4.10	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 10/11/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	126.0	uS	20.9	ºC	0.1	ppt	6.05	mg/L
5 ft	125.8	uS	20.9	ºC	0.1	ppt	6.02	mg/L
10 ft	125.8	uS	20.9	ºC	0.1	ppt	5.89	mg/L
15 ft	125.8	uS	20.9	ºC	0.1	ppt	5.50	mg/L
20 ft	125.8	uS	20.9	ºC	0.1	ppt	5.59	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 10/11/2008

Latitude: 34º 20.276 N **Longitude: 78º 04.509 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	125.3	uS	20.9	ºC	0.1	ppt	5.60	mg/L
5 ft	125.2	uS	20.9	ºC	0.1	ppt	5.67	mg/L
10 ft	125.3	uS	20.9	ºC	0.1	ppt	5.49	mg/L
15 ft	125.2	uS	20.9	ºC	0.1	ppt	5.48	mg/L
20 ft	125.2	uS	20.9	ºC	0.1	ppt	5.48	mg/L
25 ft	125.2	uS	20.9	ºC	0.1	ppt	5.49	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 10/11/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	120.6	uS	20.9	ºC	0.1	ppt	4.90	mg/L
5 ft	122.4	uS	20.8	ºC	0.1	ppt	4.85	mg/L
10 ft	122.3	uS	20.9	ºC	0.1	ppt	4.90	mg/L
15 ft	121.7	uS	20.9	ºC	0.1	ppt	4.88	mg/L
20 ft	122.4	uS	20.9	ºC	0.1	ppt	4.87	mg/L
25 ft	122.5	uS	20.9	ºC	0.1	ppt	4.79	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 10/11/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	119.6	uS	20.9	ºC	0.1	ppt	4.81	mg/L
5 ft	119.4	uS	20.9	ºC	0.1	ppt	4.82	mg/L
10 ft	118.7	uS	20.9	ºC	0.1	ppt	4.81	mg/L
15 ft	118.8	uS	20.9	ºC	0.1	ppt	4.72	mg/L
20 ft	118.6	uS	20.9	ºC	0.1	ppt	4.76	mg/L
25 ft	117.9	uS	20.9	ºC	0.1	ppt	4.70	mg/L
30 ft	117.9	uS	20.9	ºC	0.1	ppt	4.74	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 10/11/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	116.0	uS	21.0	ºC	0.1	ppt	5.1	mg/L
5 ft	116.2	uS	20.9	ºC	0.1	ppt	4.91	mg/L
10 ft	115.9	uS	20.8	ºC	0.1	ppt	4.88	mg/L
15 ft	115.9	uS	20.8	ºC	0.1	ppt	4.82	mg/L
20 ft	115.8	uS	20.8	ºC	0.1	ppt	4.75	mg/L
25 ft	115.8	uS	20.8	ºC	0.1	ppt	4.71	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 10/11/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	100.2	uS	20.9	ºC	0.1	ppt	4.90	mg/L
5 ft	100.2	uS	20.9	ºC	0.1	ppt	4.90	mg/L
10 ft	100.2	uS	20.8	ºC	0.1	ppt	4.88	mg/L
15 ft	100.1	uS	20.9	ºC	0.1	ppt	4.87	mg/L
20 ft	100.1	uS	20.9	ºC	0.1	ppt	4.88	mg/L
25 ft	99.8	uS	20.9	ºC	0.1	ppt	4.78	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 10/11/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	97.1	uS	20.7	ºC	0.1	ppt	4.88	mg/L
5 ft	97.1	uS	20.8	ºC	0.1	ppt	4.87	mg/L
10 ft	97.1	uS	20.8	ºC	0.1	ppt	4.87	mg/L
15 ft	97.1	uS	20.8	ºC	0.1	ppt	4.86	mg/L
20 ft	97.1	uS	20.8	ºC	0.1	ppt	4.87	mg/L
25 ft	97.0	uS	20.8	ºC	0.1	ppt	4.86	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 10/11/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	96.6	uS	20.8	ºC	0.1	ppt	4.87	mg/L
5 ft	96.5	uS	20.7	ºC	0.1	ppt	4.87	mg/L
10 ft	96.6	uS	20.7	ºC	0.1	ppt	4.87	mg/L
15 ft	96.6	uS	20.7	ºC	0.1	ppt	4.87	mg/L
20 ft	96.6	uS	20.7	ºC	0.1	ppt	4.87	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 10/11/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	96.9	uS	20.9	ºC	0.1	ppt	4.97	mg/L
5 ft	96.9	uS	20.9	ºC	0.1	ppt	4.95	mg/L
10 ft	96.9	uS	20.9	ºC	0.1	ppt	4.95	mg/L
15 ft	96.9	uS	20.9	ºC	0.1	ppt	4.95	mg/L
20 ft	96.9	uS	20.8	ºC	0.1	ppt	4.93	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 10/11/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	97.7	uS	20.9	ºC	0.1	ppt	4.97	mg/L
5 ft	97.6	uS	20.9	ºC	0.1	ppt	4.96	mg/L
10 ft	97.7	uS	20.9	ºC	0.1	ppt	4.96	mg/L
15 ft	97.5	uS	20.9	ºC	0.1	ppt	4.96	mg/L
20 ft	97.5	uS	20.9	ºC	0.1	ppt	4.95	mg/L
25 ft	97.5	uS	20.9	ºC	0.1	ppt	4.96	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 11/11/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	360.1	uS	15.2	ºC	0.2	ppt	8.15	mg/L
5 ft	439.1	uS	15.2	ºC	0.2	ppt	7.94	mg/L
10 ft	445.4	uS	15.2	ºC	0.3	ppt	7.85	mg/L
15 ft	463.0	uS	15.2	ºC	0.3	ppt	7.84	mg/L
20 ft	345.2	uS	15.2	ºC	0.3	ppt	7.87	mg/L
25 ft	352.7	uS	15.2	ºC	0.2	ppt	8.67	mg/L
30 ft	347.6	uS	15.2	ºC	0.2	ppt	7.97	mg/L
35 ft	342.5	uS	15.2	ºC	0.2	ppt	7.65	mg/L
40 ft	420.8	uS	15.2	ºC	0.2	ppt	7.61	mg/L
45 ft	399.7	uS	15.2	ºC	0.2	ppt	7.65	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 11/11/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	159.7	uS	15.0	ºC	0.1	ppt	6.89	mg/L
5 ft	159.7	uS	15.0	ºC	0.1	ppt	7.04	mg/L
10 ft	159.7	uS	15.0	ºC	0.1	ppt	6.89	mg/L
15 ft	159.6	uS	15.0	ºC	0.1	ppt	6.88	mg/L
20 ft	159.8	uS	15.0	ºC	0.1	ppt	6.73	mg/L
25 ft	160.0	uS	15.0	ºC	0.1	ppt	6.67	mg/L
30 ft	159.9	uS	15.0	ºC	0.1	ppt	6.52	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 11/11/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	152.4	uS	14.8	ºC	0.1	ppt	6.94	mg/L
5 ft	152.3	uS	14.9	ºC	0.1	ppt	6.96	mg/L
10 ft	152.3	uS	14.9	ºC	0.1	ppt	6.65	mg/L
15 ft	152.2	uS	14.9	ºC	0.1	ppt	6.20	mg/L
20 ft	152.4	uS	14.9	ºC	0.1	ppt	6.72	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 11/11/2008

Latitude: 34º 20.276 N **Longitude: 78º 04.509 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	155.6	uS	14.7	ºC	0.1	ppt	6.81	mg/L
5 ft	155.6	uS	14.7	ºC	0.1	ppt	6.81	mg/L
10 ft	155.8	uS	14.8	ºC	0.1	ppt	6.64	mg/L
15 ft	155.9	uS	14.8	ºC	0.1	ppt	6.32	mg/L
20 ft	155.8	uS	14.8	ºC	0.1	ppt	6.63	mg/L
25 ft	155.7	uS	14.8	ºC	0.1	ppt	6.78	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 11/11/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	182.5	uS	14.5	ºC	0.1	ppt	7.54	mg/L
5 ft	182.6	uS	14.7	ºC	0.1	ppt	7.65	mg/L
10 ft	182.6	uS	14.7	ºC	0.1	ppt	7.02	mg/L
15 ft	182.6	uS	14.7	ºC	0.1	ppt	7.47	mg/L
20 ft	182.3	uS	14.7	ºC	0.1	ppt	7.71	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 11/11/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	184.4	uS	14.4	ºC	0.1	ppt	7.47	mg/L
5 ft	184.4	uS	14.7	ºC	0.1	ppt	7.66	mg/L
10 ft	184.6	uS	14.7	ºC	0.1	ppt	6.41	mg/L
15 ft	185.2	uS	14.7	ºC	0.1	ppt	6.71	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 11/11/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	210.6	uS	14.7	ºC	0.1	ppt	7.86	mg/L
5 ft	212.0	uS	14.7	ºC	0.1	ppt	7.7	mg/L
10 ft	215.4	uS	14.7	ºC	0.1	ppt	7.74	mg/L
15 ft	216.2	uS	14.7	ºC	0.1	ppt	7.39	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 11/11/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	119.7	uS	14.4	ºC	0.1	ppt	7.48	mg/L
5 ft	122.4	uS	14.4	ºC	0.1	ppt	7.70	mg/L
10 ft	126.3	uS	14.4	ºC	0.1	ppt	8.02	mg/L
15 ft	126.7	uS	14.4	ºC	0.1	ppt	7.84	mg/L
20 ft	126.5	uS	14.4	ºC	0.1	ppt	8.09	mg/L
25 ft	126.2	uS	14.3	ºC	0.1	ppt	7.94	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 11/11/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	109.9	uS	14.5	ºC	0.1	ppt	8.53	mg/L
5 ft	109.2	uS	14.5	ºC	0.1	ppt	8.33	mg/L
10 ft	109.3	uS	14.4	ºC	0.1	ppt	8.22	mg/L
15 ft	109.2	uS	14.3	ºC	0.1	ppt	8.11	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 11/11/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	109.4	uS	14.3	ºC	0.1	ppt	8.21	mg/L
5 ft	109.4	uS	14.3	ºC	0.1	ppt	8.28	mg/L
10 ft	109.3	uS	14.3	ºC	0.1	ppt	7.64	mg/L
15 ft	109.3	uS	14.3	ºC	0.1	ppt	7.27	mg/L
20 ft	109.4	uS	14.3	ºC	0.1	ppt	7.51	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 11/11/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	110.5	uS	14.3	ºC	0.1	ppt	8.63	mg/L
5 ft	110.5	uS	14.3	ºC	0.1	ppt	8.49	mg/L
10 ft	110.4	uS	14.3	ºC	0.1	ppt	8.58	mg/L
15 ft	110.5	uS	14.3	ºC	0.1	ppt	8.32	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 11/11/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	111.0	uS	14.3	ºC	0.1	ppt	8.22	mg/L
5 ft	111.1	uS	14.3	ºC	0.1	ppt	8.02	mg/L
10 ft	111.0	uS	14.3	ºC	0.1	ppt	8.42	mg/L
15 ft	111.0	uS	14.3	ºC	0.1	ppt	8.28	mg/L
20 ft	111.0	uS	14.3	ºC	0.1	ppt	8.39	mg/L
25 ft	111.0	uS	14.3	ºC	0.1	ppt	8.31	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **1** **Date:** 12/12/2008 **Way point:** **013**

Latitude: 34º 16.837 N **Longitude: 78º 00.263 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	100.4	uS	10.2	ºC	0.1	ppt	13.28	mg/L
5 ft	105.7	uS	10.1	ºC	0.1	ppt	13.94	mg/L
10 ft	107.4	uS	10.1	ºC	0.1	ppt	14.42	mg/L
15 ft	107.4	uS	10.1	ºC	0.1	ppt	14.58	mg/L
20 ft	107.2	uS	10.1	ºC	0.1	ppt	14.57	mg/L
25 ft	107.4	uS	10.1	ºC	0.1	ppt	14.66	mg/L
30 ft	107.4	uS	10.1	ºC	0.1	ppt	14.50	mg/L
35 ft	107.2	uS	10.1	ºC	0.1	ppt	14.29	mg/L
40 ft	106.9	uS	10.1	ºC	0.1	ppt	14.15	mg/L
45 ft	107.0	uS	10.1	ºC	0.1	ppt	13.91	mg/L

Physical Measurements Collected At Depth

Site: **2** **Date:** 12/12/2008 **Way point:** **014**

Latitude: 34º 19.396 N **Longitude: 78º 00.549 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	105.7	uS	10.6	ºC	0.1	ppt	12.89	mg/L
5 ft	105.7	uS	10.6	ºC	0.1	ppt	12.89	mg/L
10 ft	105.7	uS	10.6	ºC	0.1	ppt	12.98	mg/L
15 ft	105.8	uS	10.5	ºC	0.1	ppt	12.83	mg/L
20 ft	105.7	uS	10.5	ºC	0.1	ppt	12.69	mg/L
25 ft	106.0	uS	10.5	ºC	0.1	ppt	12.72	mg/L
30 ft	105.9	uS	10.5	ºC	0.1	ppt	12.45	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **3** **Date:** 12/12/2008 **Way point:** **015**

Latitude: 34º 20.187 N **Longitude: 78º 02.900 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	96.2	uS	11.0	ºC	0.1	ppt	12.9	mg/L
5 ft	96.1	uS	11.0	ºC	0.1	ppt	12.57	mg/L
10 ft	96.3	uS	11.0	ºC	0.1	ppt	12.32	mg/L
15 ft	96.2	uS	11.0	ºC	0.1	ppt	12.25	mg/L
20 ft	96.2	uS	11.0	ºC	0.1	ppt	12.06	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **4** **Way point:** **016** **Date:** 12/12/2008

Latitude: 34º 20.276 N **Longitude: 78º 04.509 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	148.8	uS	10.4	ºC	0.1	ppt	12.88	mg/L
5 ft	148.0	uS	10.4	ºC	0.1	ppt	12.43	mg/L
10 ft	147.4	uS	10.4	ºC	0.1	ppt	12.36	mg/L
15 ft	147.9	uS	10.4	ºC	0.1	ppt	12.66	mg/L
20 ft	148.8	uS	10.4	ºC	0.1	ppt	12.54	mg/L
25 ft	149.9	uS	10.4	ºC	0.1	ppt	12.49	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **5** **Way point:** **017** **Date:** 12/12/2008

Latitude: 34º 21.312 N **Longitude: 78º 06.122 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	124.2	uS	10.1	ºC	0.1	ppt	12.14	mg/L
5 ft	124.4	uS	10.1	ºC	0.1	ppt	12.52	mg/L
10 ft	128.2	uS	10.1	ºC	0.1	ppt	12.45	mg/L
15 ft	128.4	uS	10.1	ºC	0.1	ppt	12.39	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **6** **Way point:** **018** **Date:** 12/12/2008

Latitude: 34º 21.963 N **Longitude: 78º 08.109 W**

Depth	**Conductivity**		**Temp**		**Salinity**		**D.O.**	
Surface	151.5	uS	10.3	ºC	0.1	ppt	12.44	mg/L
5 ft	151.3	uS	10.3	ºC	0.1	ppt	12.38	mg/L
10 ft	154.3	uS	10.3	ºC	0.1	ppt	12.49	mg/L
15 ft	157.5	uS	10.3	ºC	0.1	ppt	12.55	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **7** **Way point:** **019** **Date:** 12/12/2008

Latitude: 34º 21.440 N **Longitude: 78º 09.949 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	101.6	uS	10.1	ºC	0.1	ppt	12.59	mg/L
5 ft	99.9	uS	10.1	ºC	0.1	ppt	12.62	mg/L
10 ft	98.9	uS	10.1	ºC	0.1	ppt	12.51	mg/L
15 ft	98.8	uS	10.1	ºC	0.1	ppt	12.52	mg/L
20 ft	99.2	uS	10.1	ºC	0.1	ppt	12.59	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **8** **Way point:** **020** **Date:** 12/12/2008

Latitude: 34º 21.413 N **Longitude: 78º 12.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	97.6	uS	9.9	ºC	0.1	ppt	12.72	mg/L
5 ft	97.6	uS	9.9	ºC	0.1	ppt	12.51	mg/L
10 ft	97.7	uS	9.8	ºC	0.1	ppt	12.61	mg/L
15 ft	97.5	uS	9.8	ºC	0.1	ppt	12.59	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **9** **Way point:** **021** **Date:** 12/12/2008

Latitude: 34º 22.470 N **Longitude: 78º 13.560 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	98.6	uS	9.9	ºC	0.1	ppt	12.9	mg/L
5 ft	98.5	uS	9.9	ºC	0.1	ppt	12.82	mg/L
10 ft	98.4	uS	9.9	ºC	0.1	ppt	12.65	mg/L
15 ft	98.5	uS	9.9	ºC	0.1	ppt	12.68	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **10** **Way point:** **022** **Date:** 12/12/2008

Latitude: 34º 23.075 N **Longitude: 78º 14.705 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	99.4	uS	9.9	ºC	0.1	ppt	12.45	mg/L
5 ft	99.4	uS	9.9	ºC	0.1	ppt	12.52	mg/L
10 ft	99.3	uS	9.9	ºC	0.1	ppt	12.65	mg/L
15 ft	99.3	uS	9.9	ºC	0.1	ppt	12.65	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **11** **Way point:** **023** **Date:** 12/12/2008

Latitude: 34º 23.824 N **Longitude: 78º 16.050 W**

Depth	Conductivity		Temp		Salinity		D.O.	
Surface	100.7	uS	9.9	ºC	0.1	ppt	13.27	mg/L
5 ft	100.5	uS	9.9	ºC	0.1	ppt	13.18	mg/L
10 ft	100.6	uS	9.9	ºC	0.1	ppt	13.01	mg/L
15 ft	100.4	uS	9.9	ºC	0.1	ppt	12.99	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

Physical Measurements Collected At Depth

Site: **12** **Way point:** **024** **Date:** 12/12/2008

Latitude: 34º 24.218 N **Longitude: 78º 17.528 W**

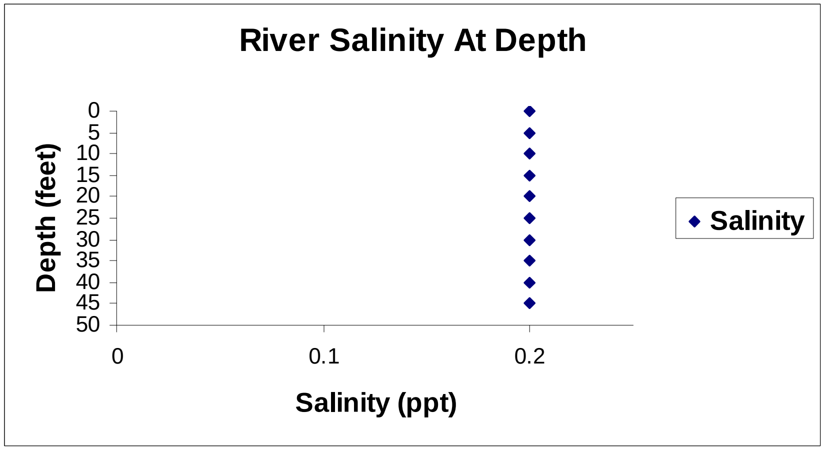
Depth	Conductivity		Temp		Salinity		D.O.	
Surface	100.8	uS	9.9	ºC	0.1	ppt	13.56	mg/L
5 ft	100.8	uS	9.9	ºC	0.1	ppt	13.20	mg/L
10 ft	100.8	uS	9.9	ºC	0.1	ppt	13.08	mg/L
15 ft	100.8	uS	9.8	ºC	0.1	ppt	12.96	mg/L
20 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
25 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
30 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
35 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
40 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L
45 ft	ND	uS	ND	ºC	ND	ppt	ND	mg/L

APPENDIX C

SALINITY PROFILES FOR ALL SITES FOR ALL COLLECTION DATES

Sampling Date: 6/03/08

Site 1



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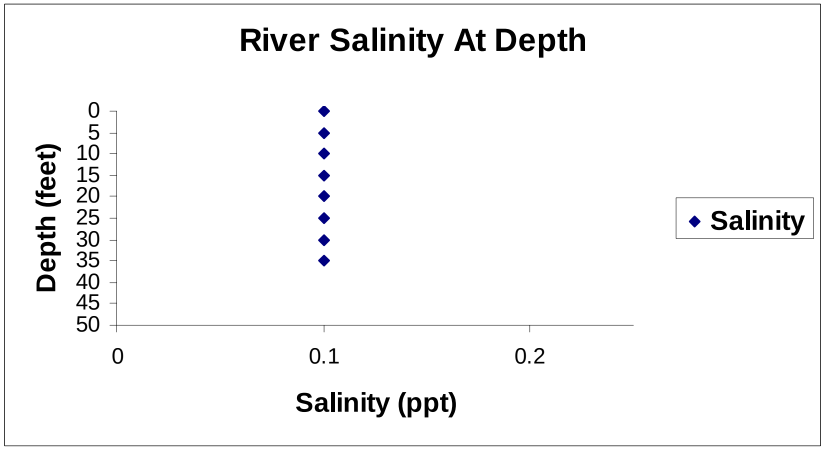

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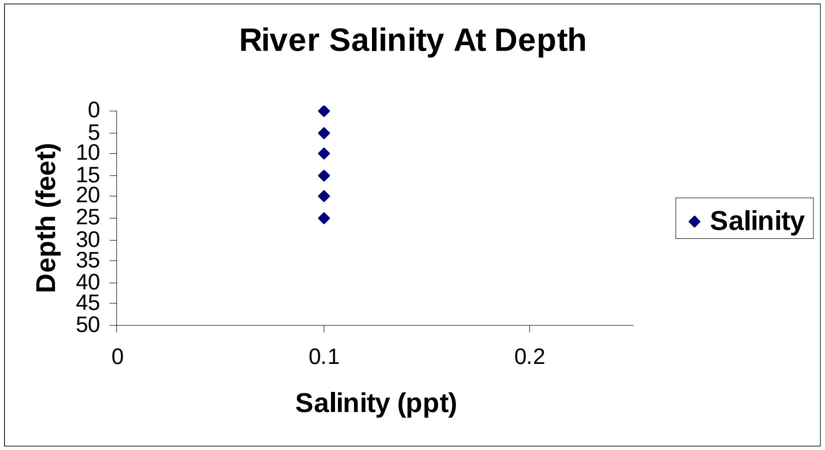

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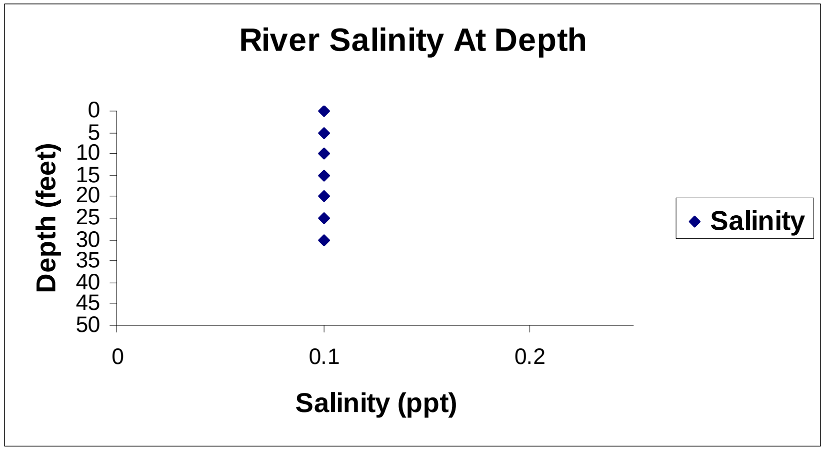

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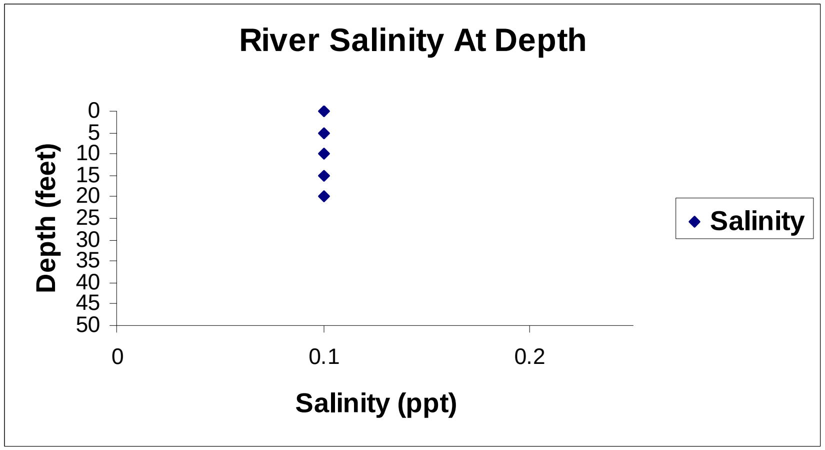

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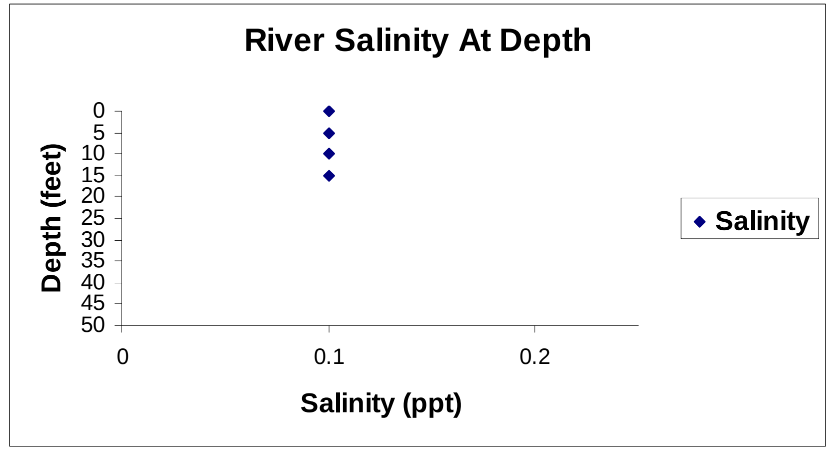

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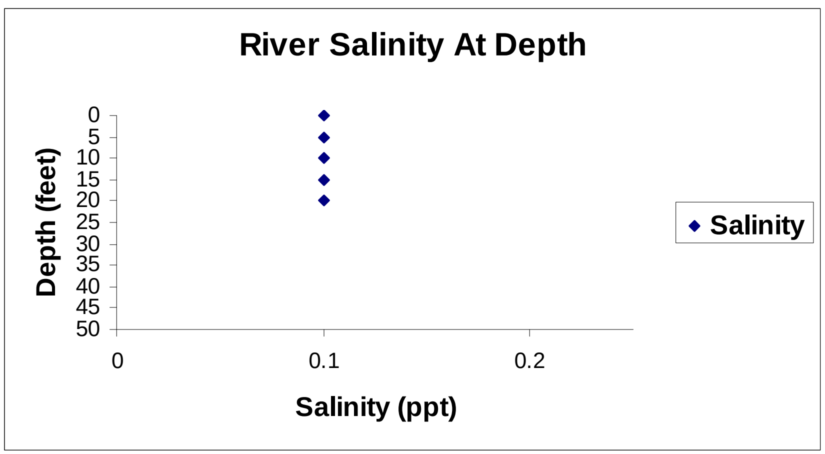

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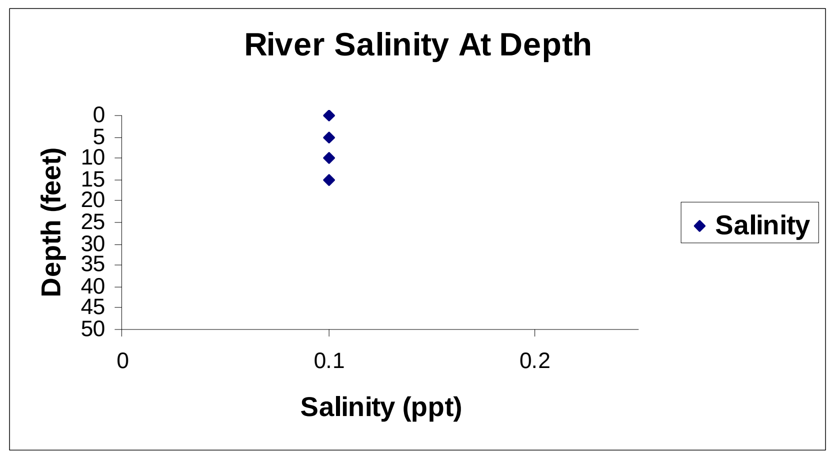

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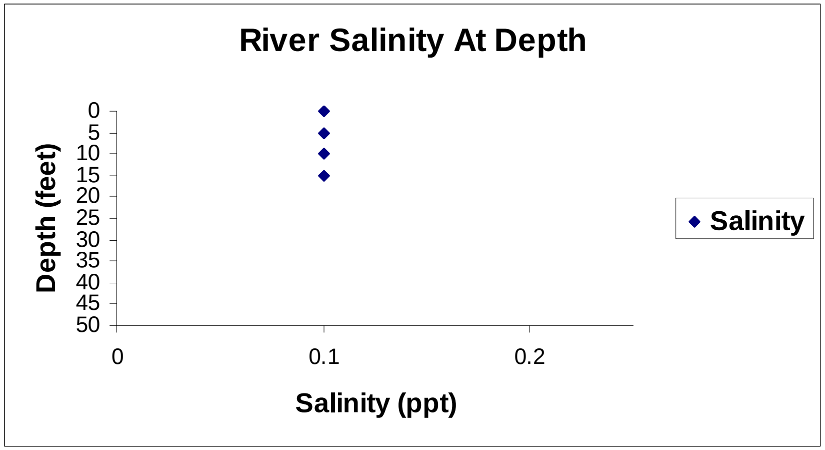

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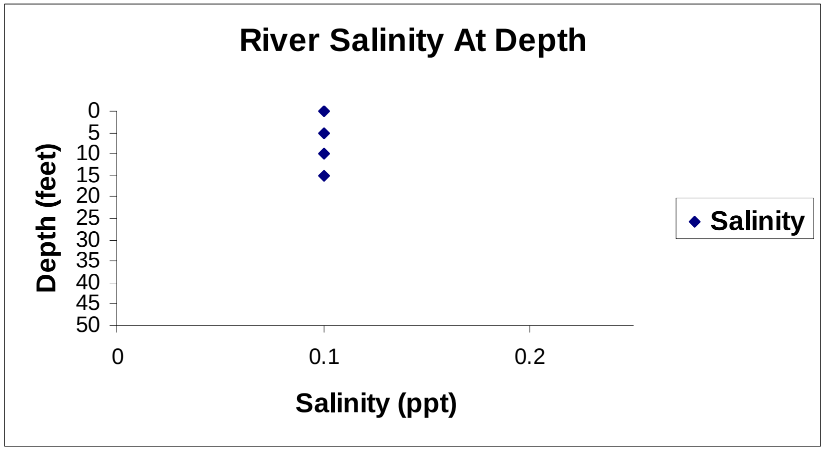

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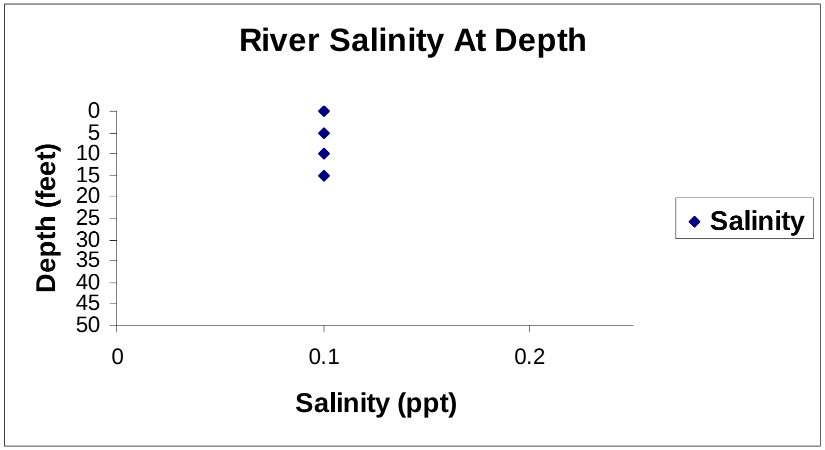

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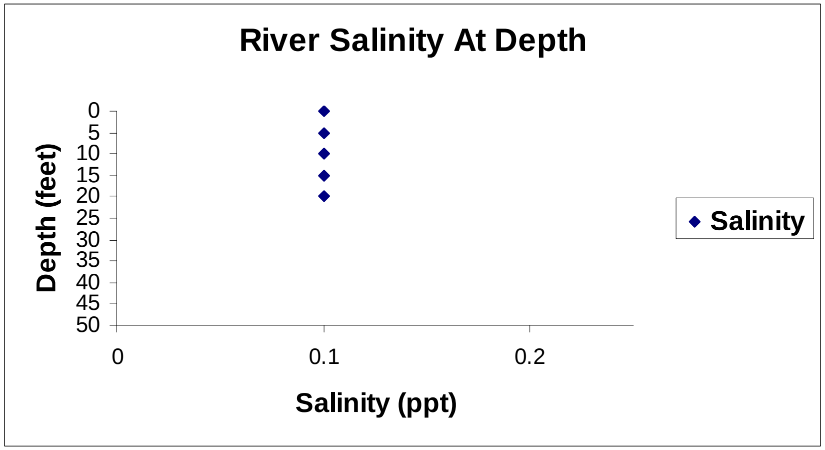

Sampling Date: 7/16/08

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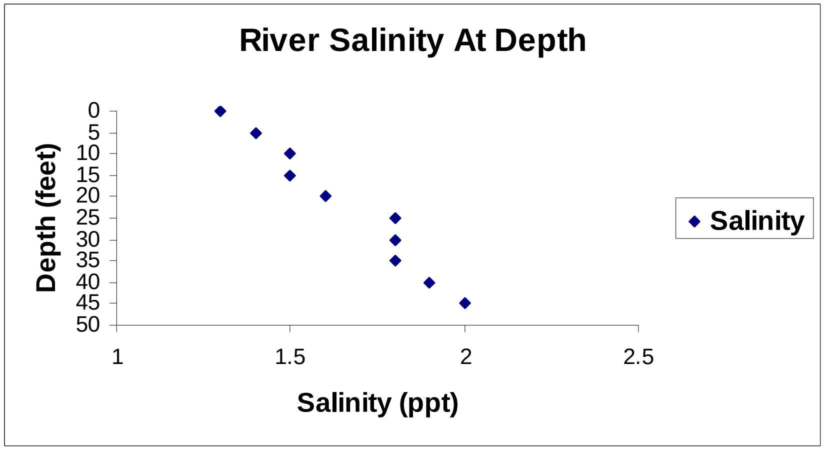

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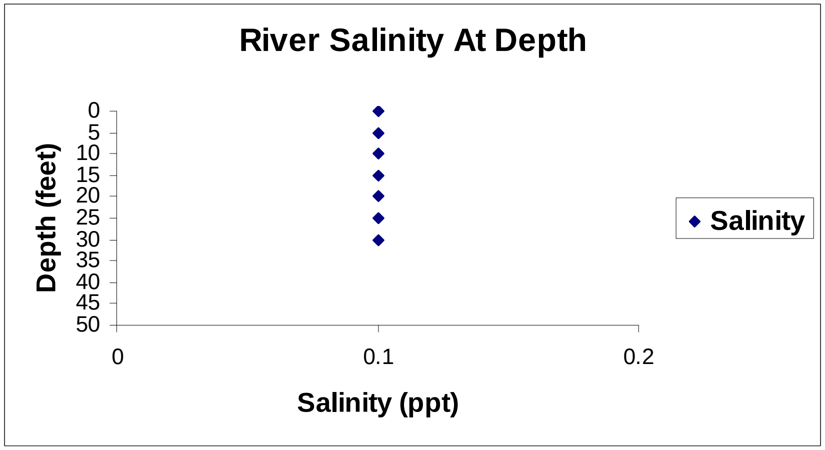

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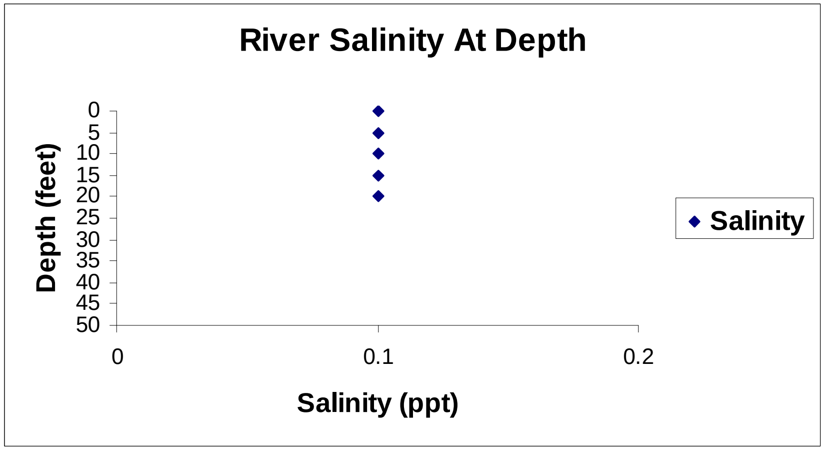

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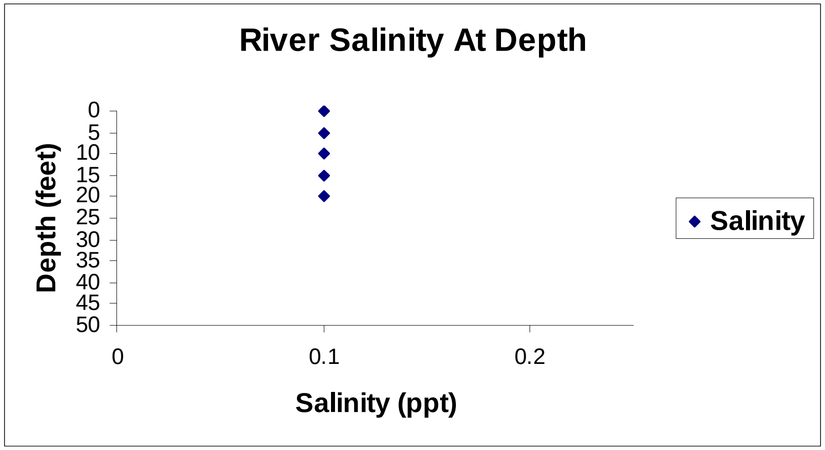

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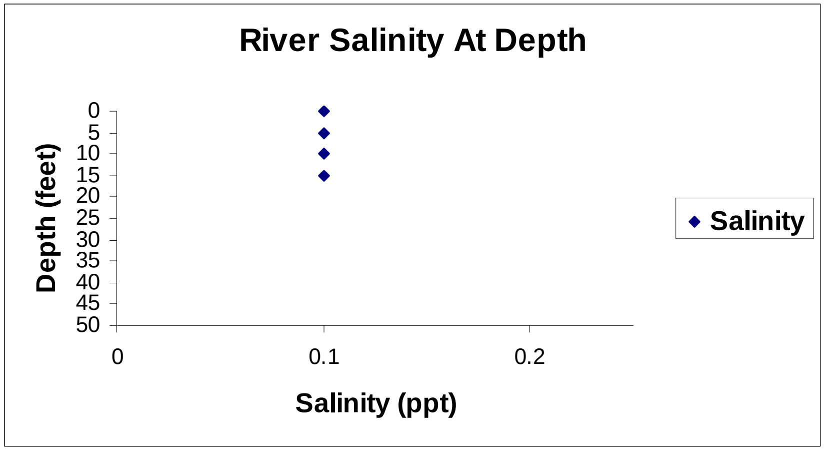

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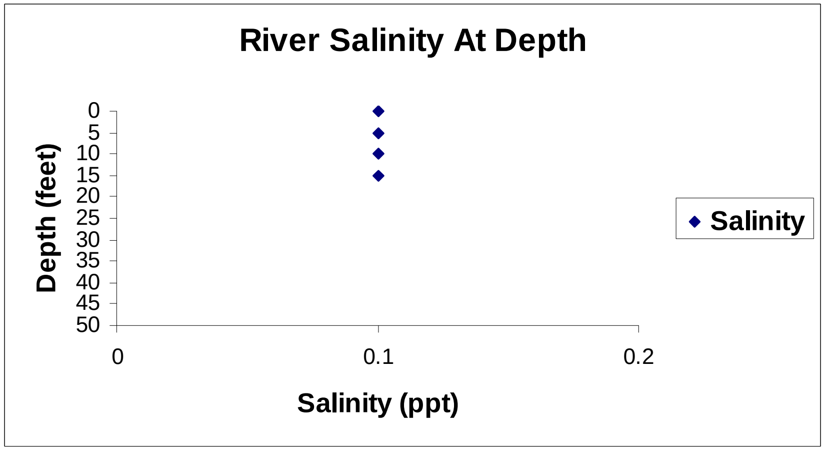

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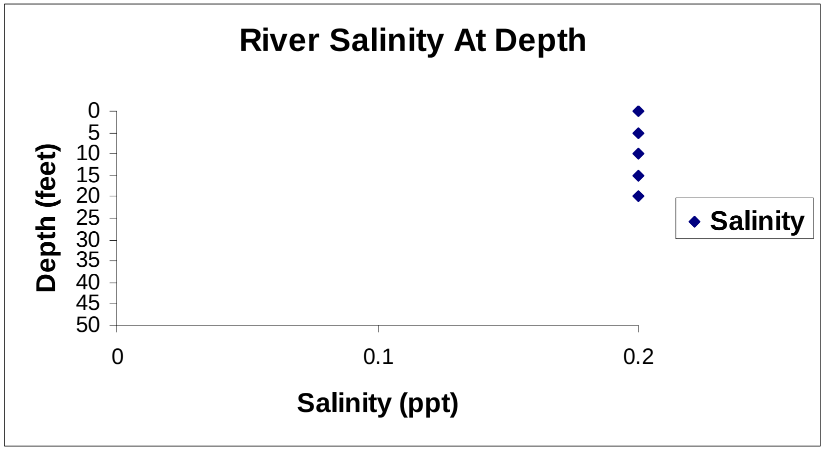

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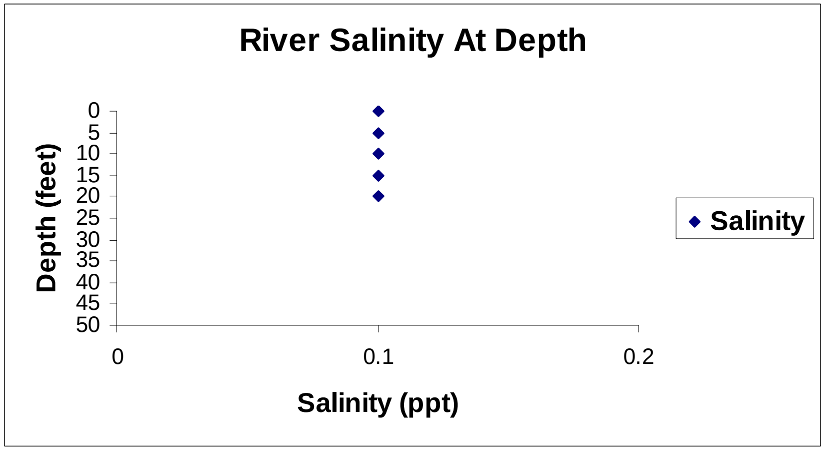

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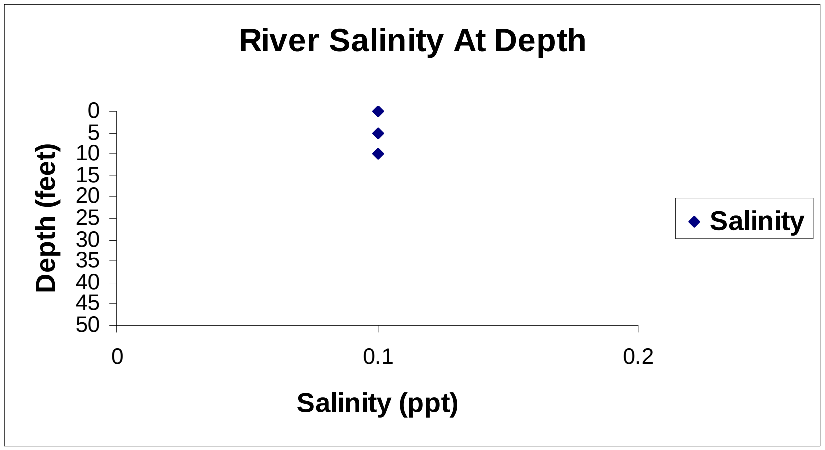

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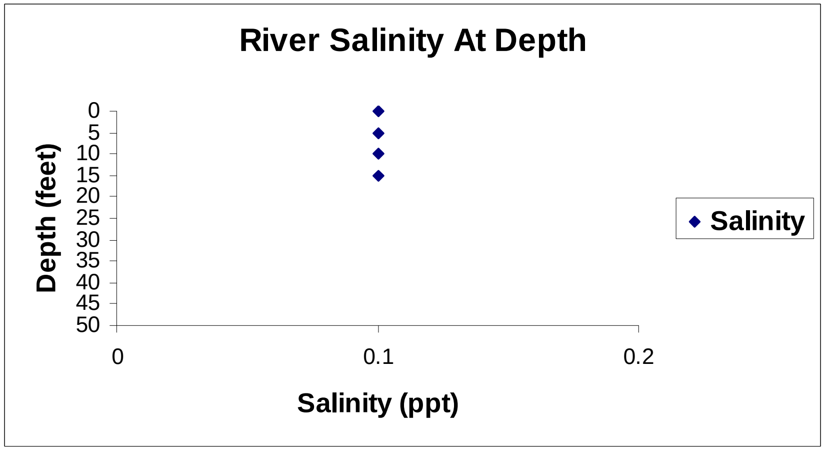

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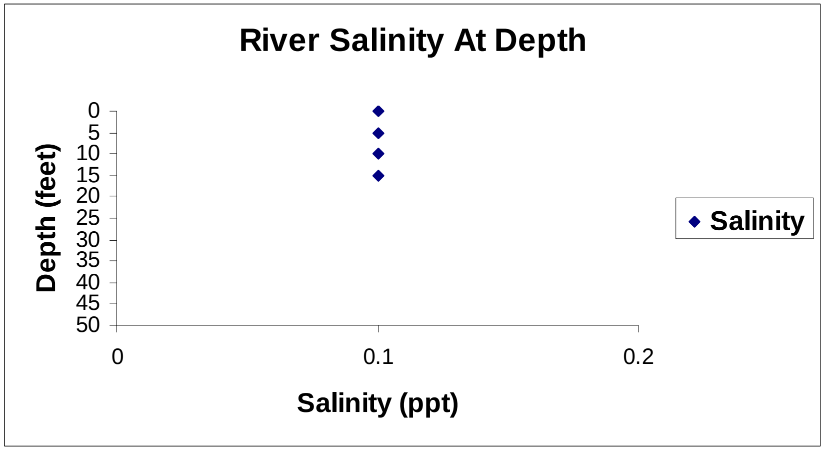

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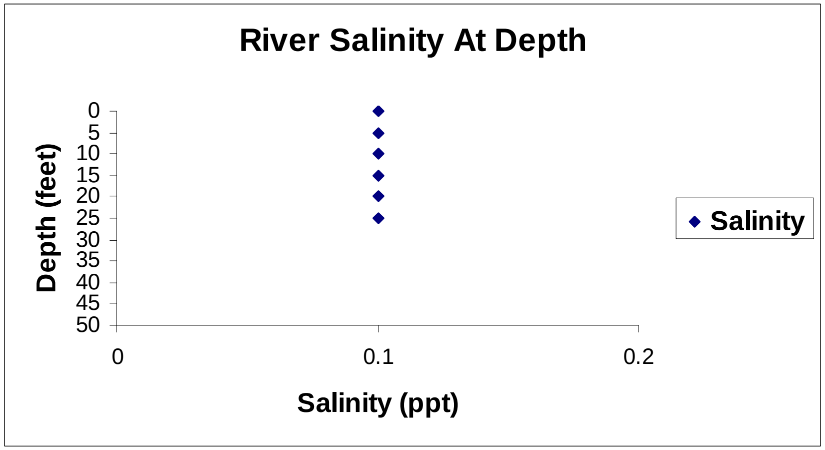

Sampling Date: 8/14/08

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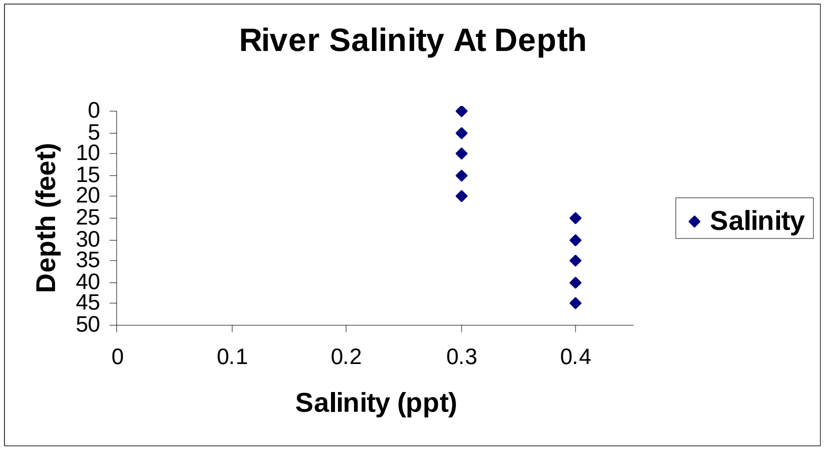

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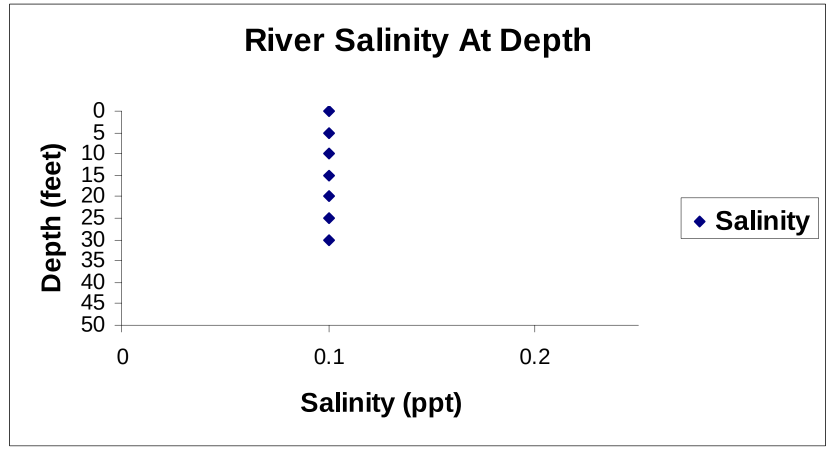

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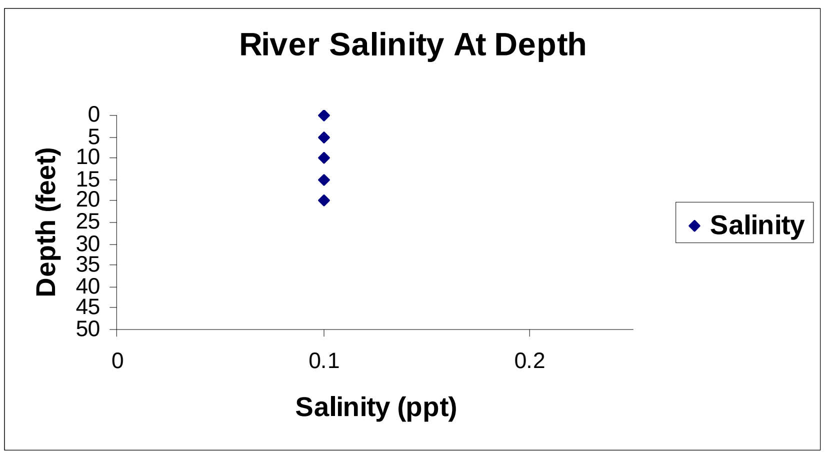

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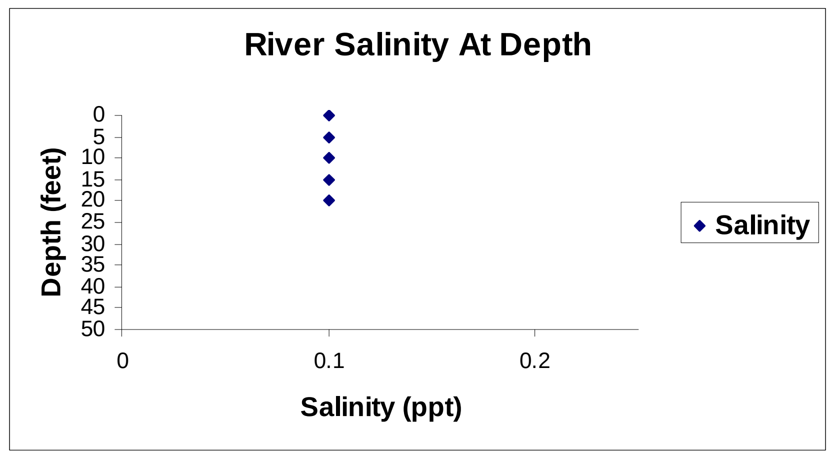

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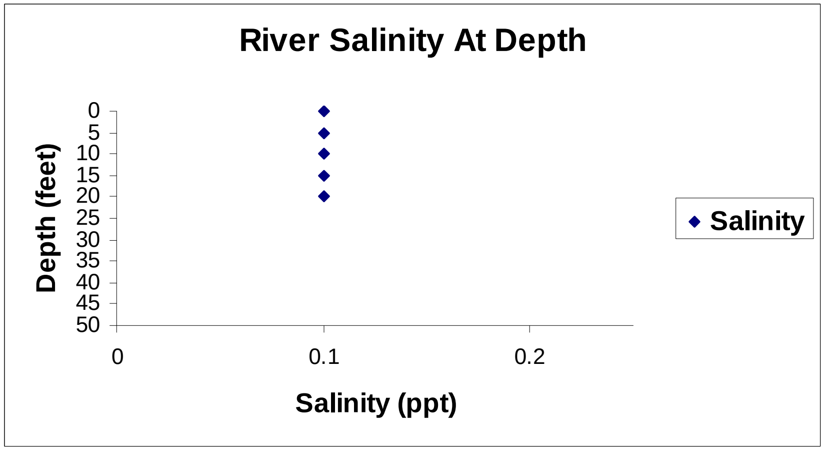

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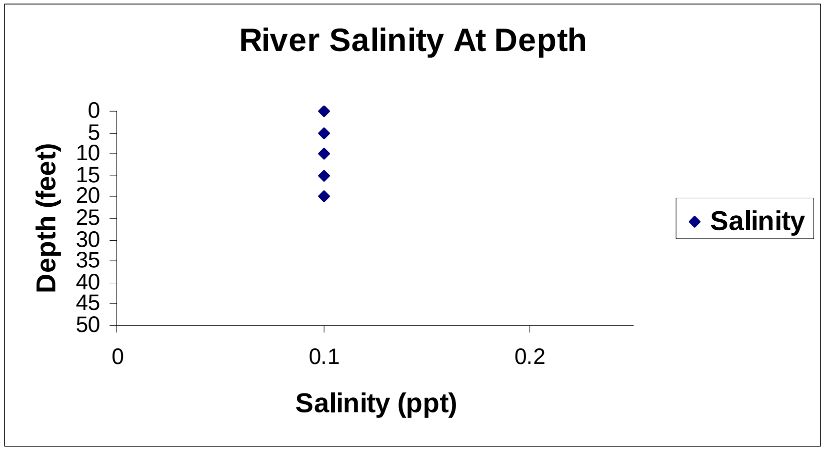

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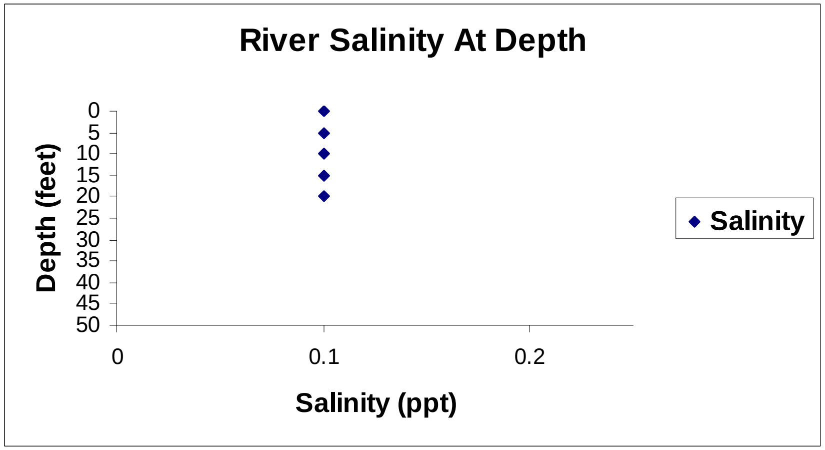

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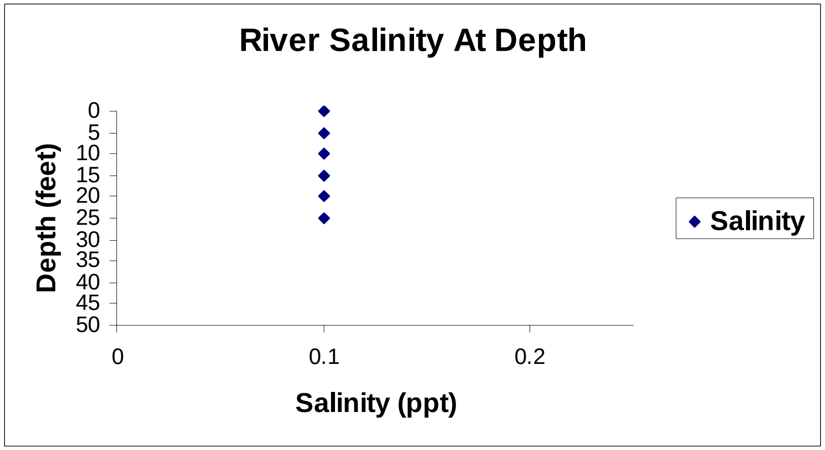

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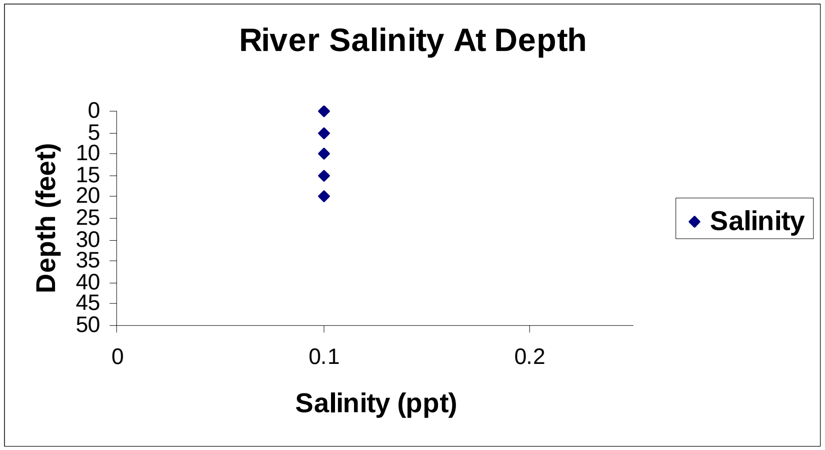

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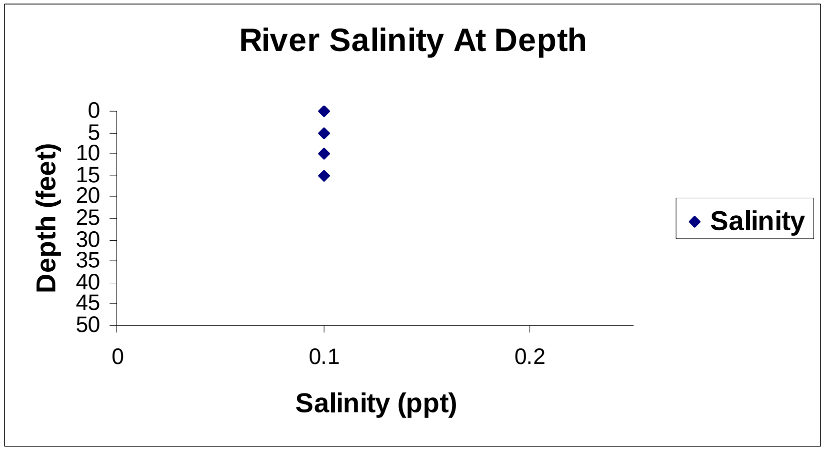

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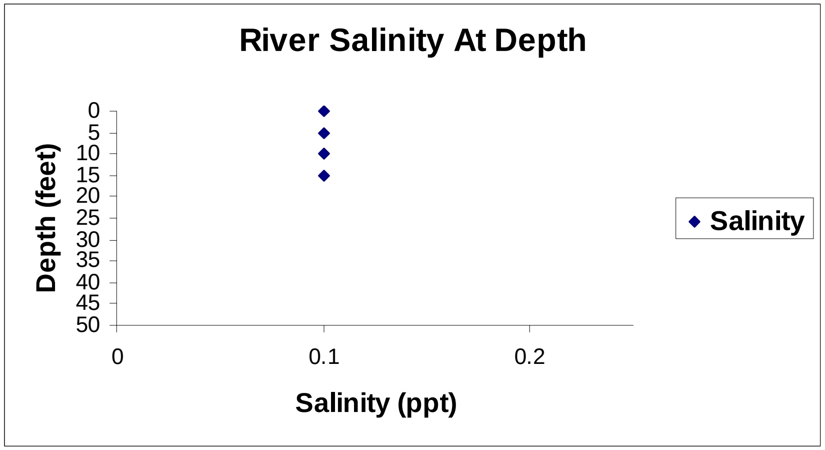

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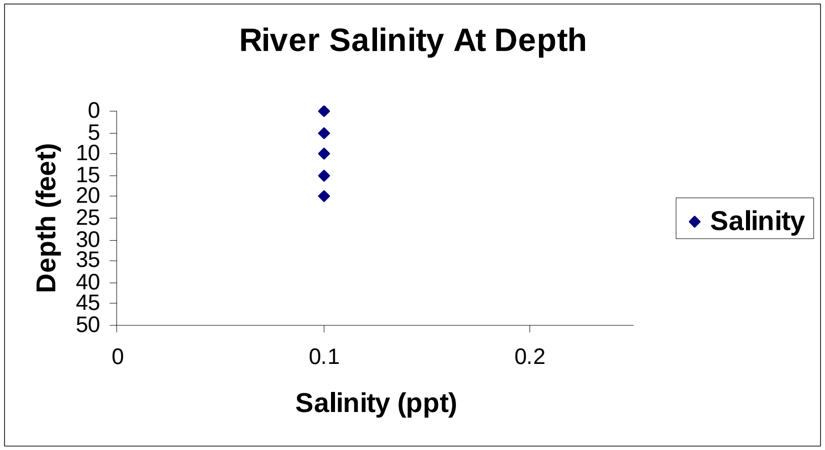

Sampling Date: 9/13/08

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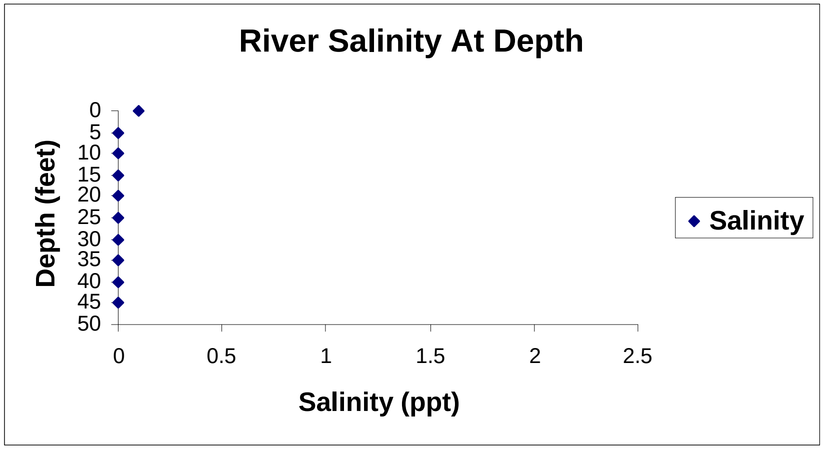

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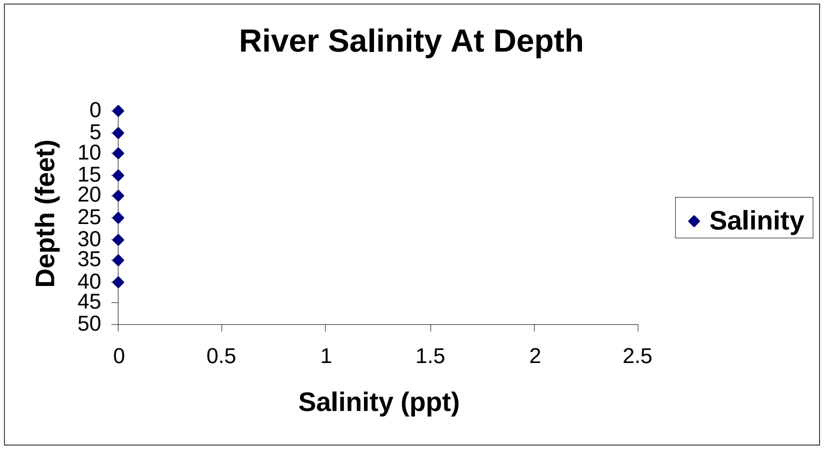

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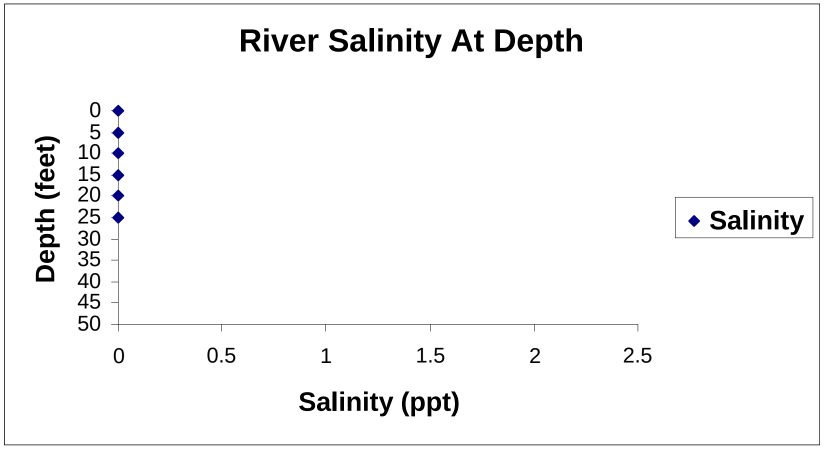

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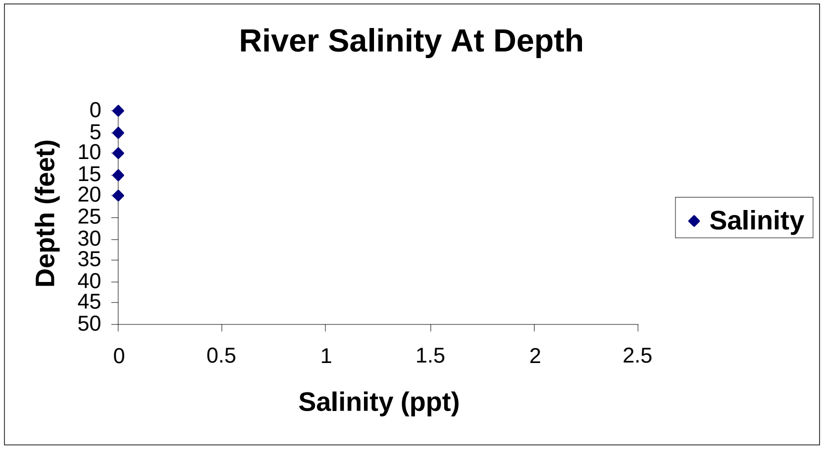

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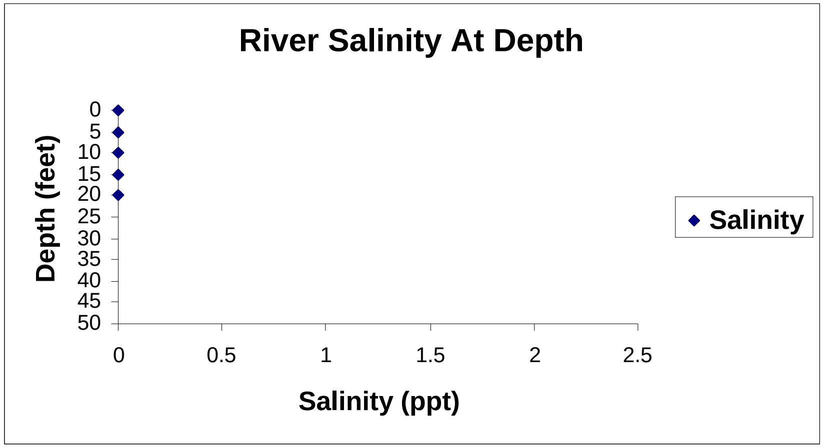

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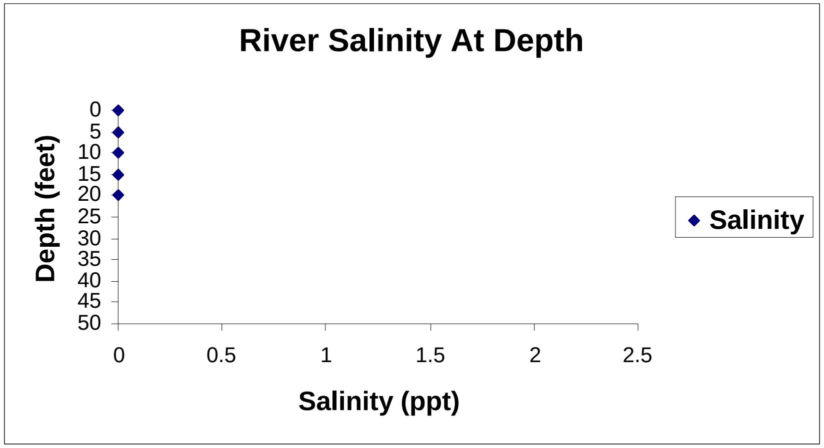

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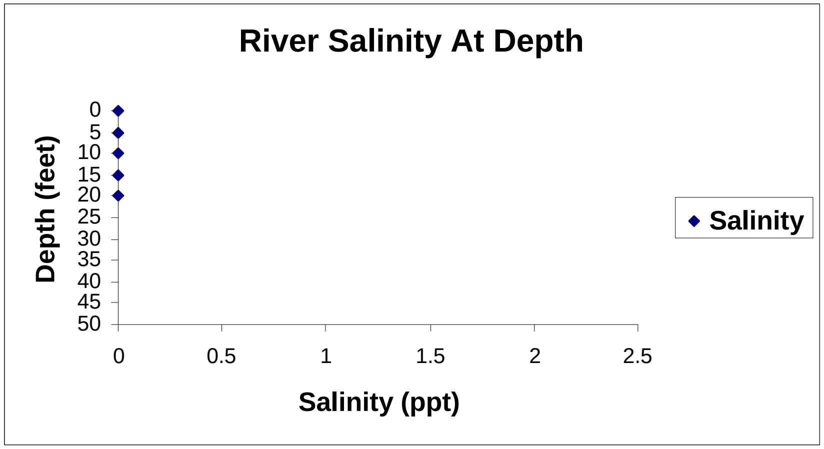

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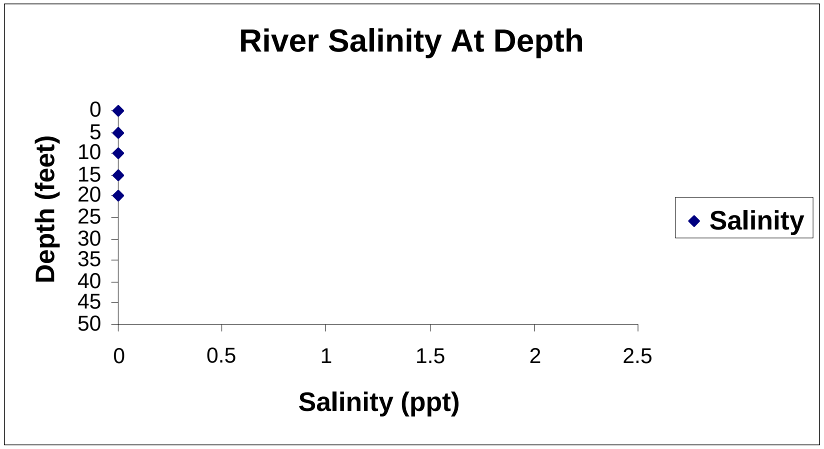

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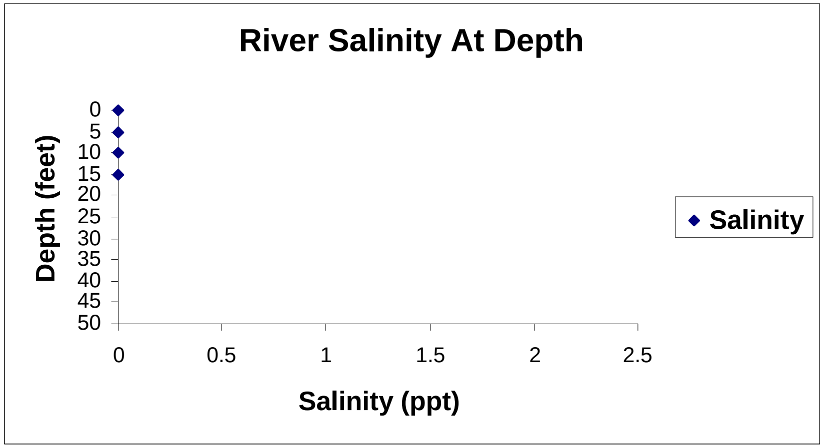

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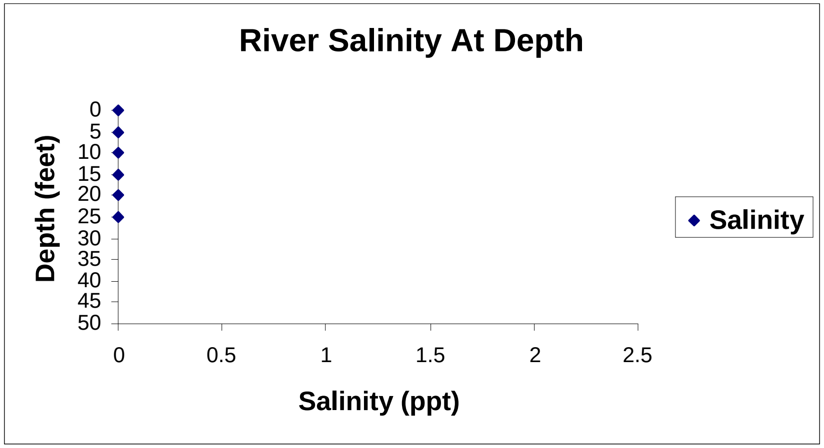
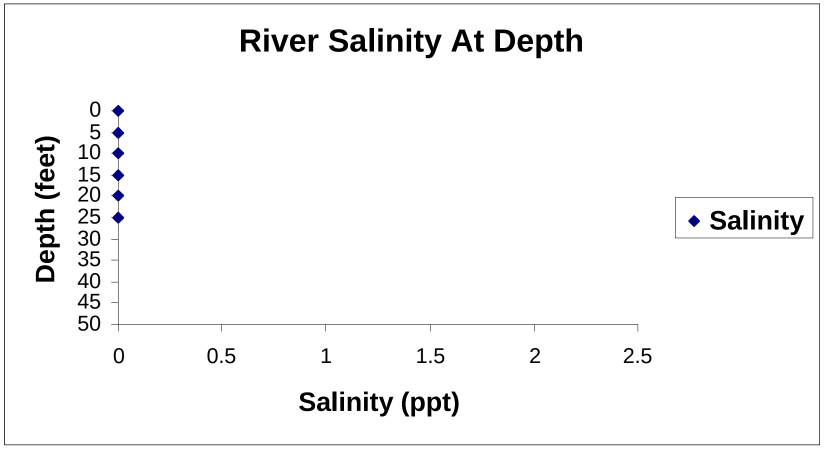


Site 11



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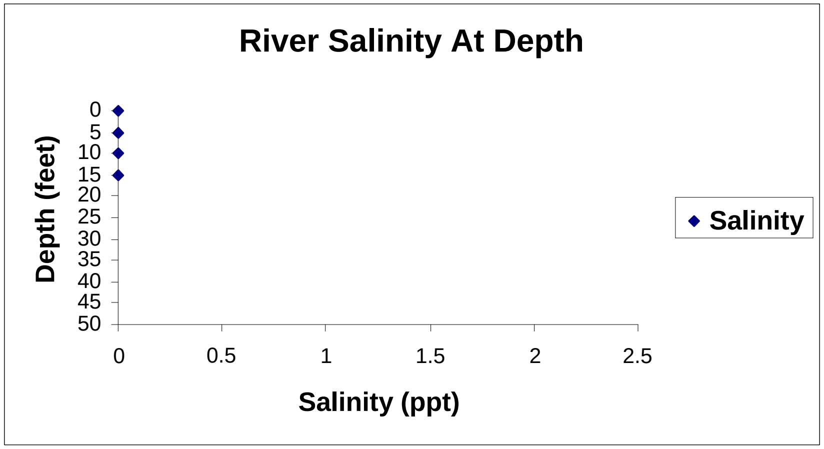

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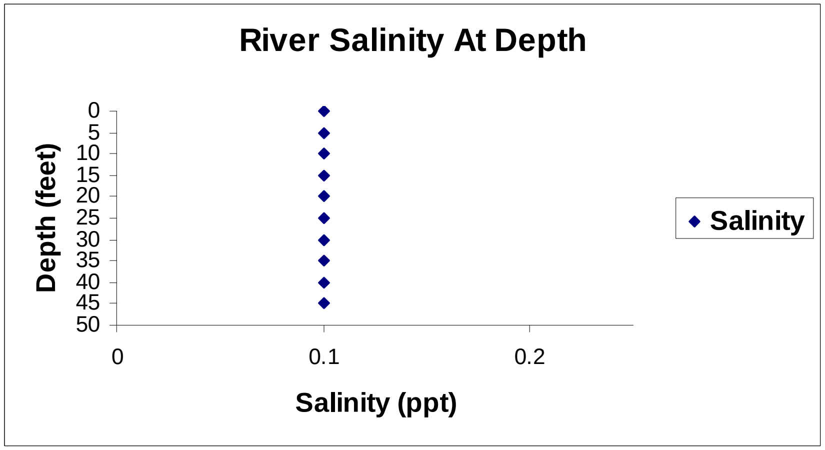

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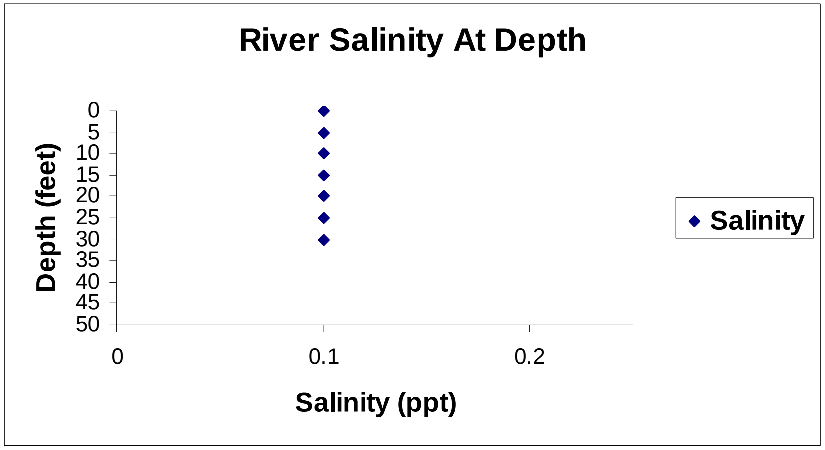

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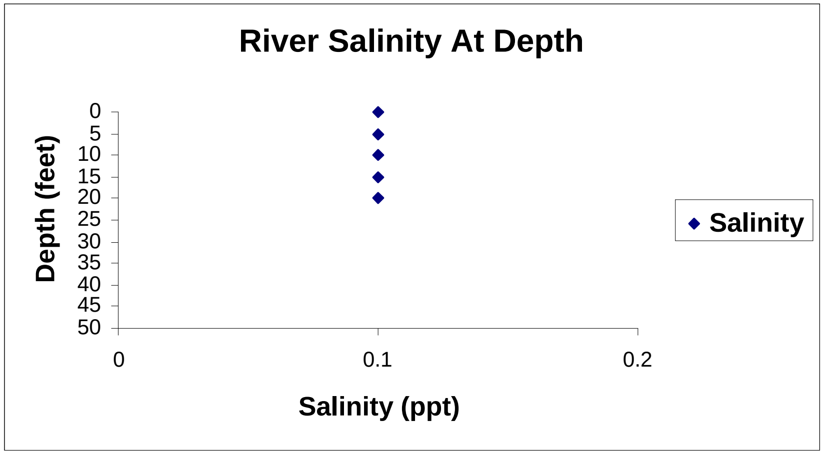

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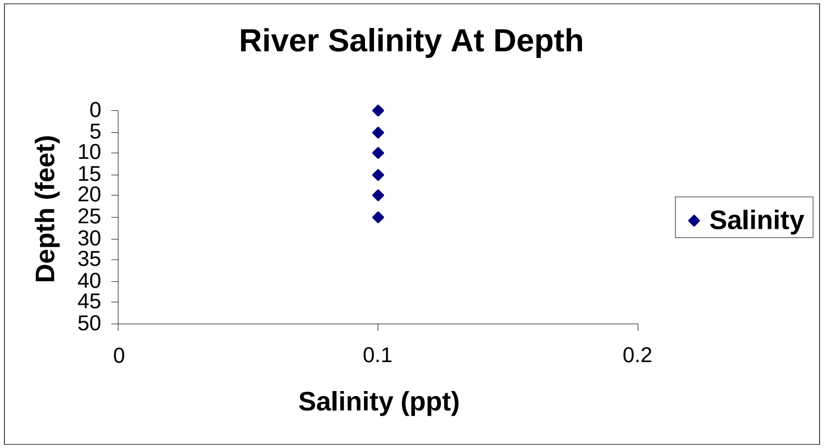

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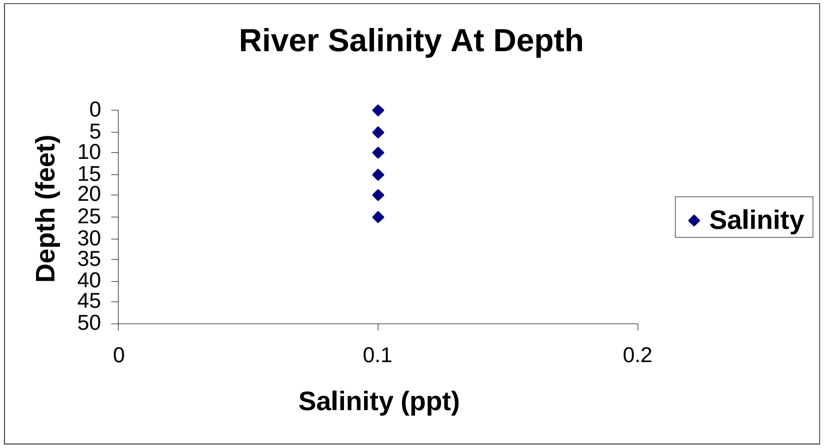

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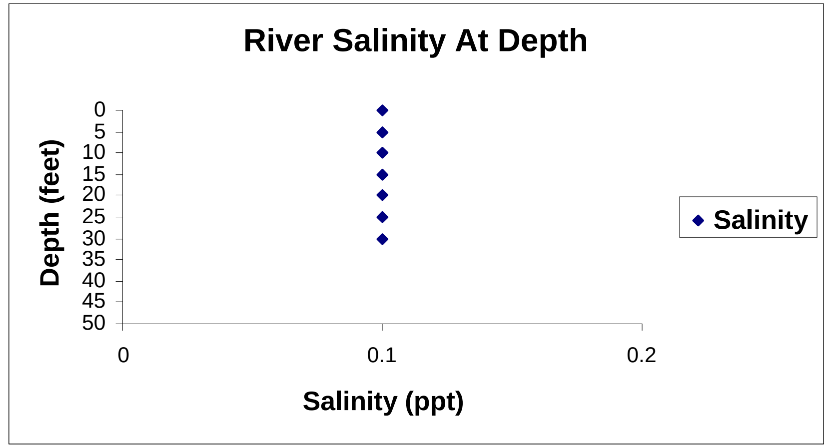

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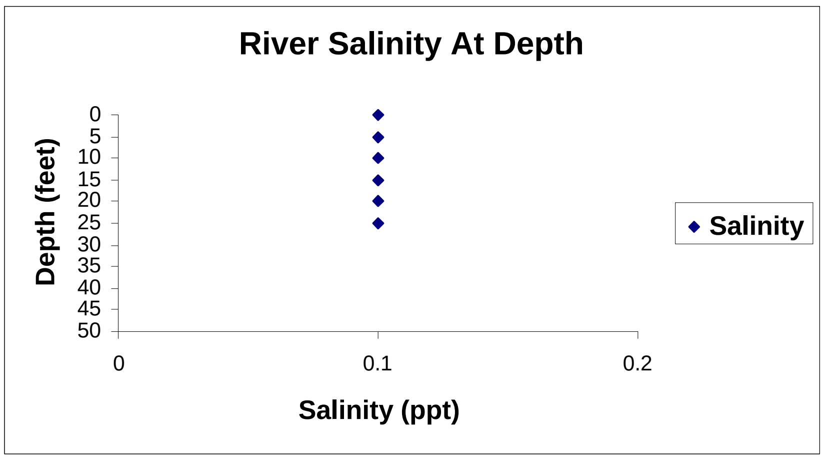

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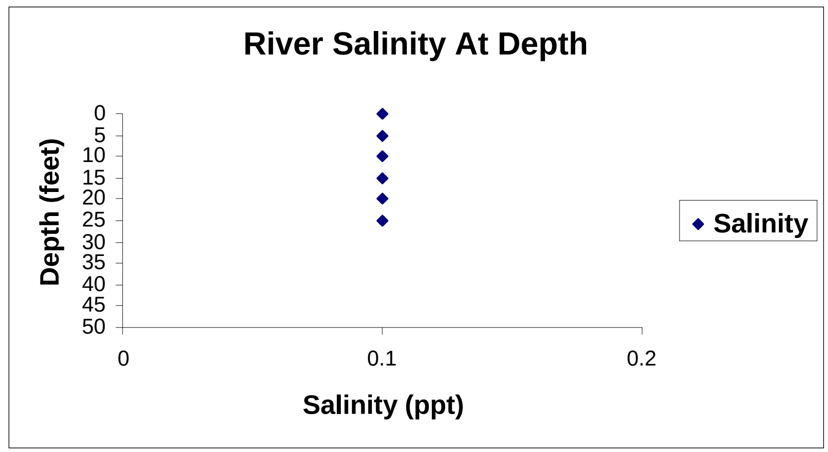

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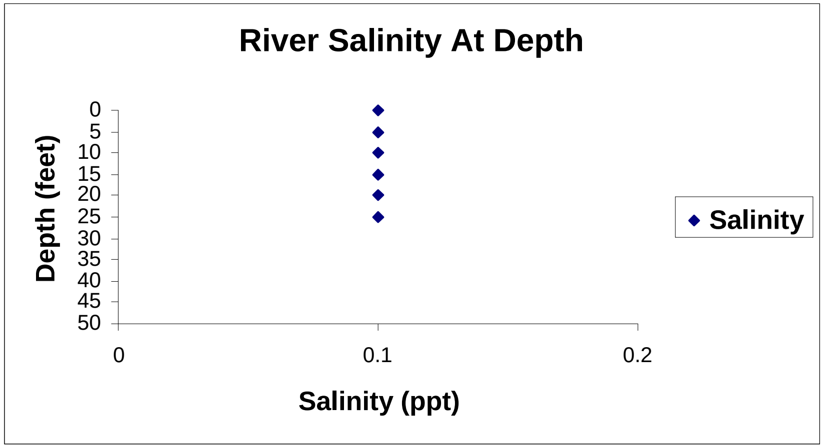

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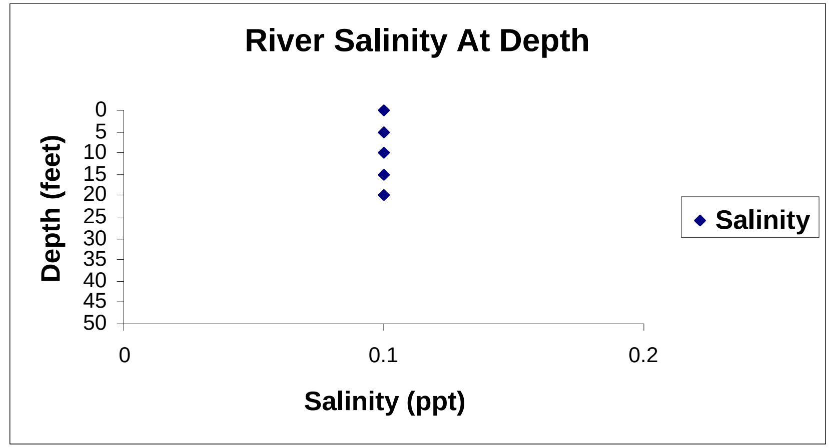

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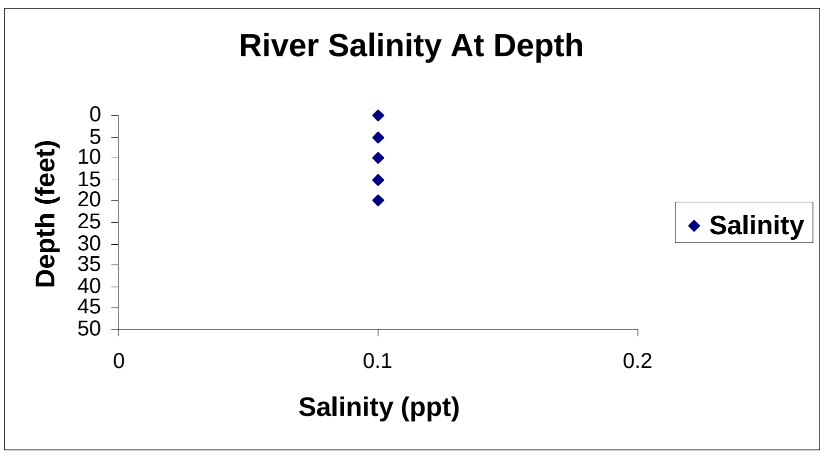

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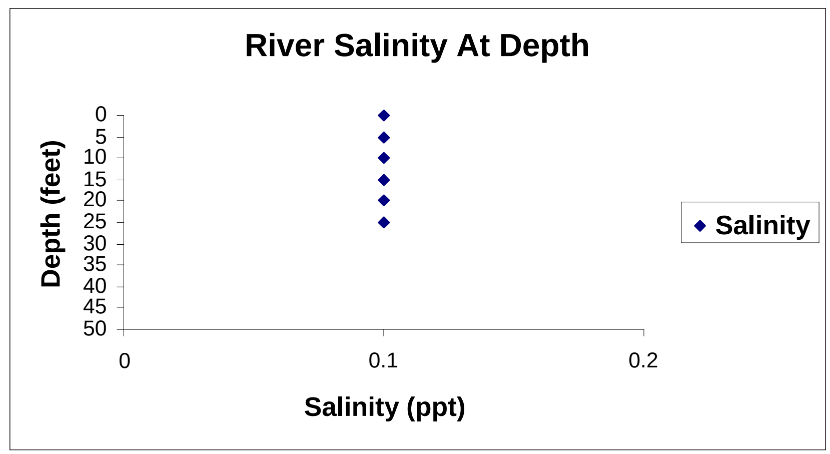

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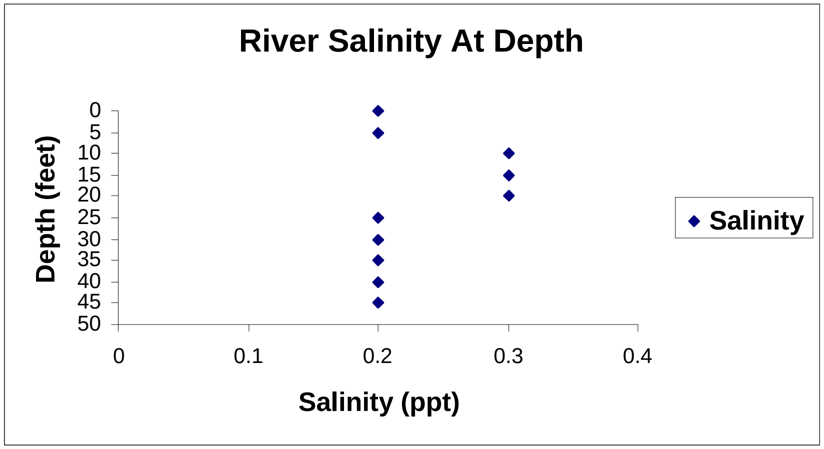

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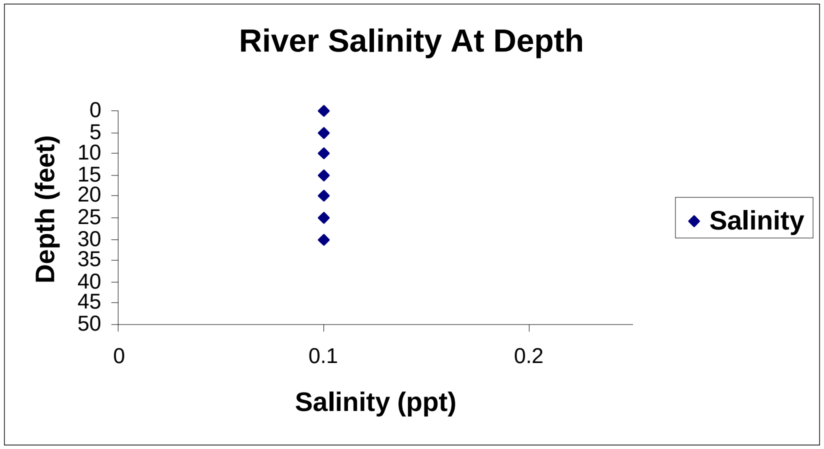

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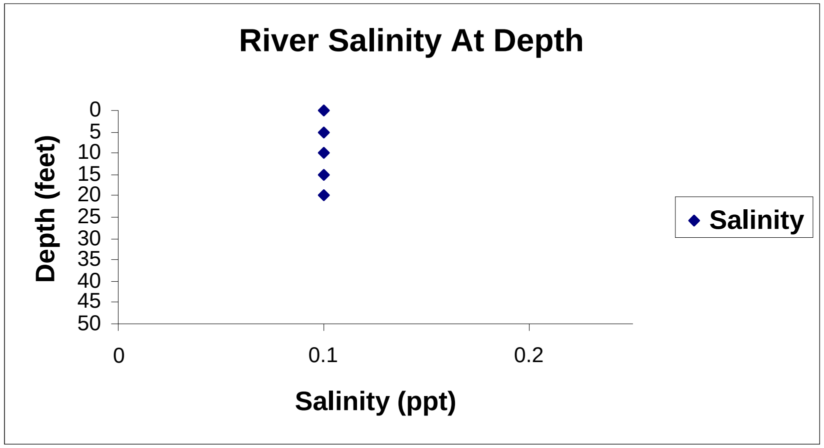

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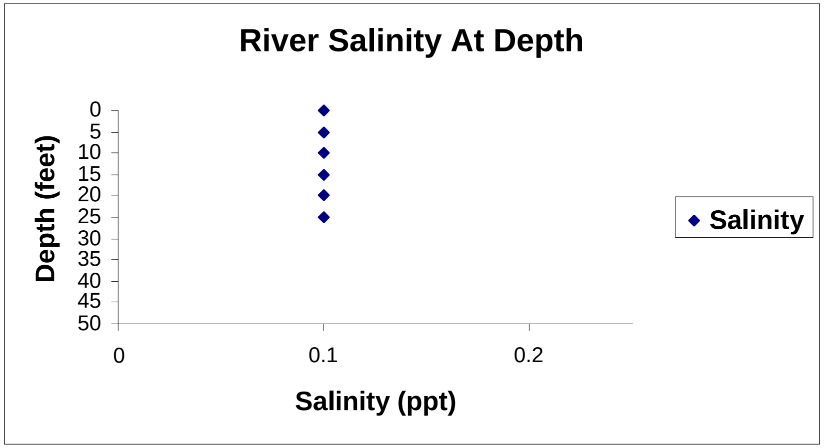

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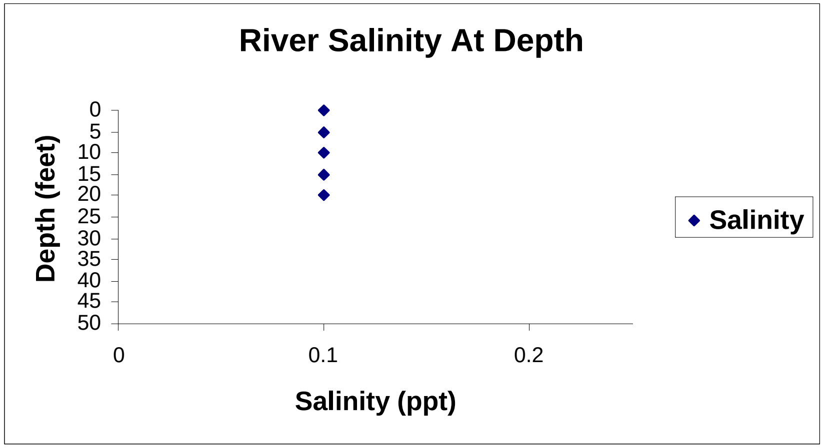

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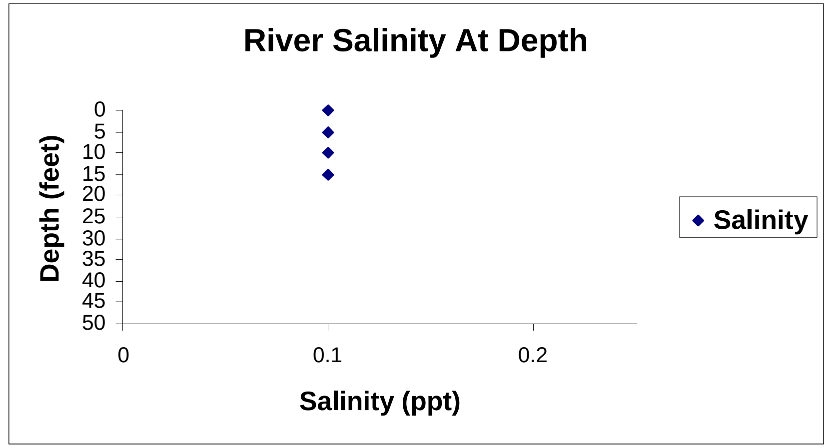

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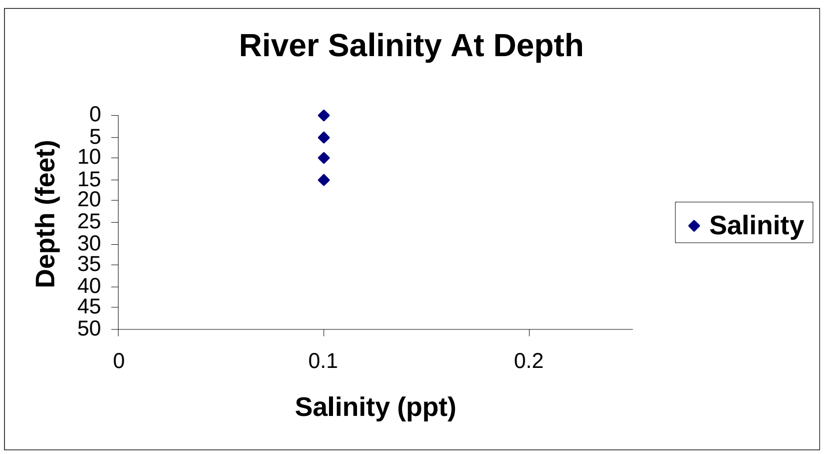

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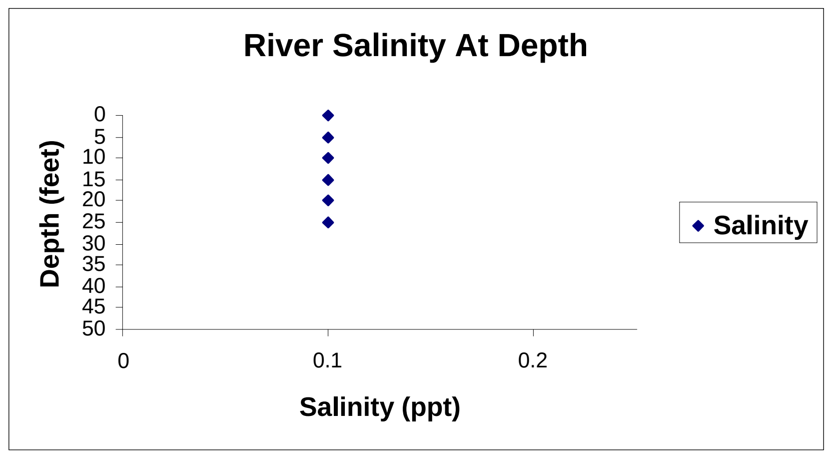

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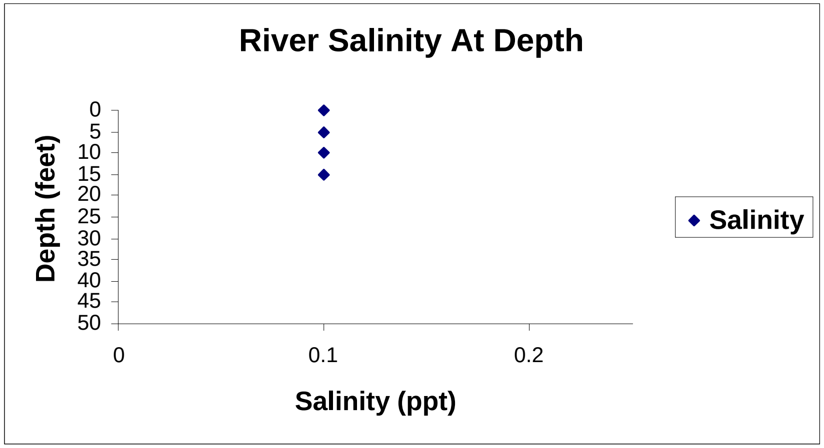

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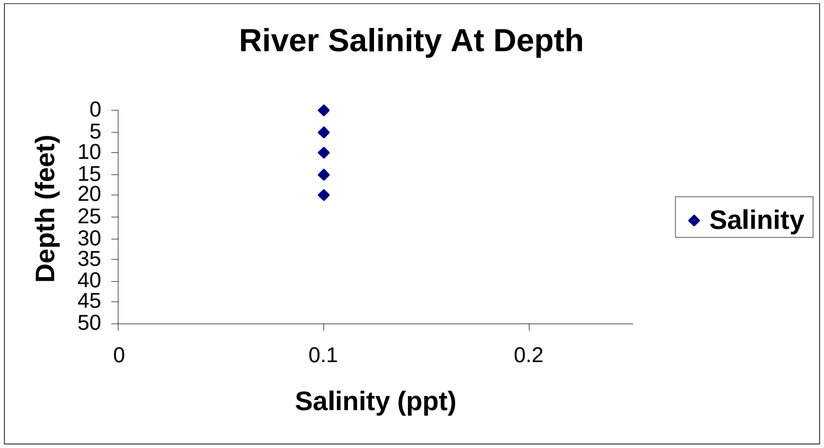

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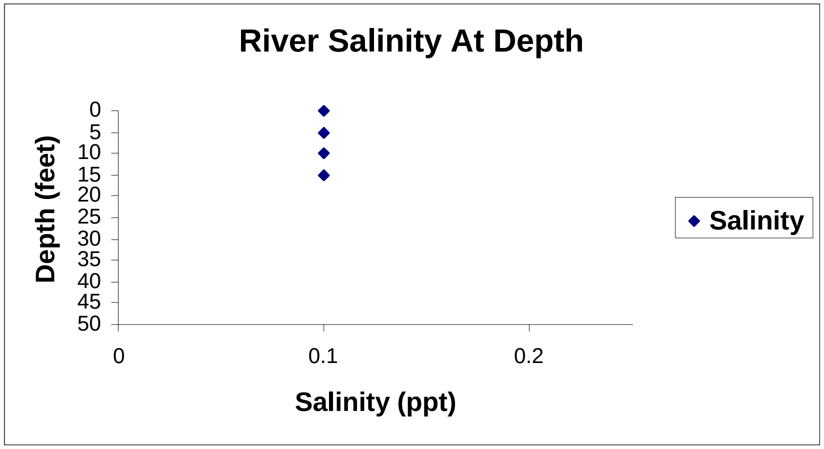

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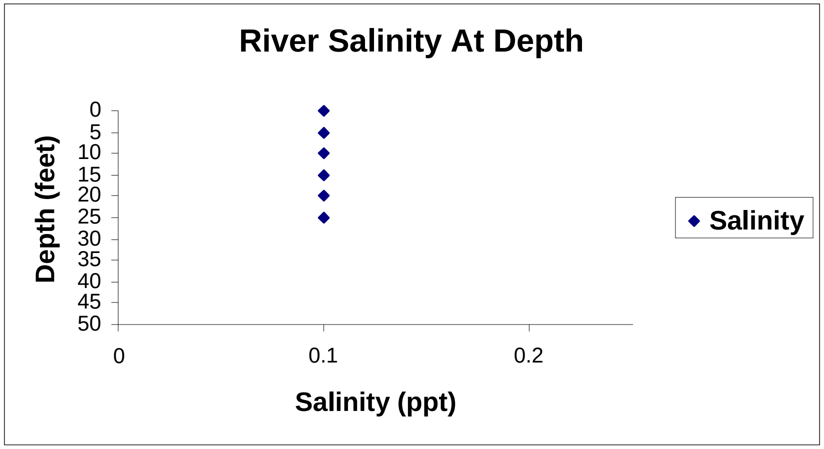

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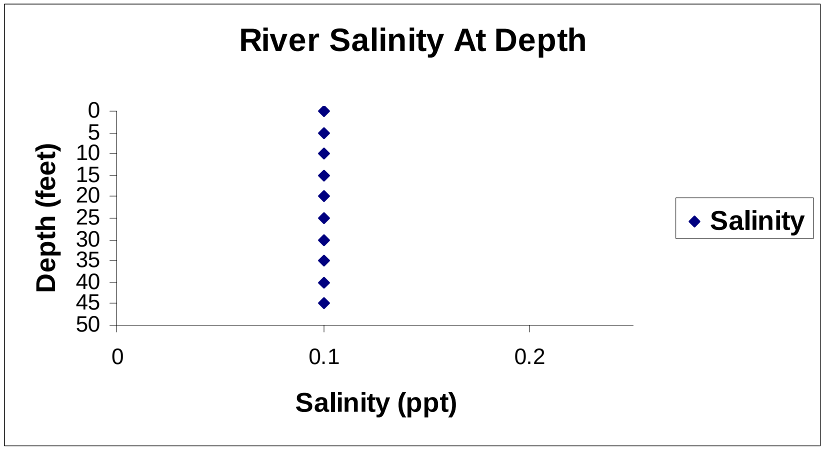

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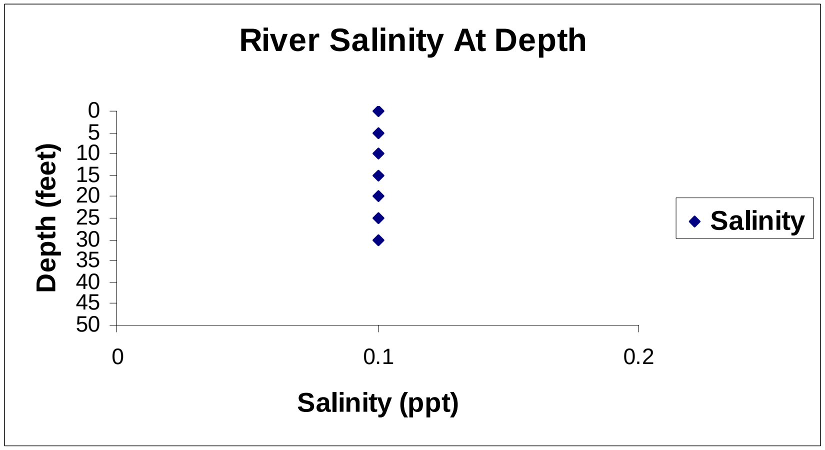

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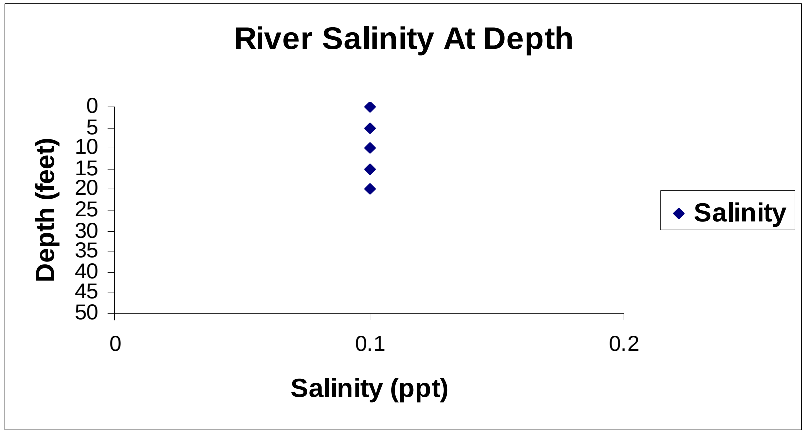

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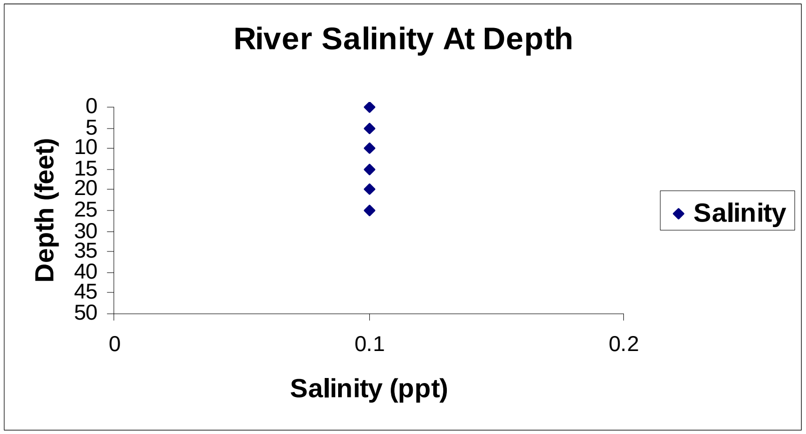

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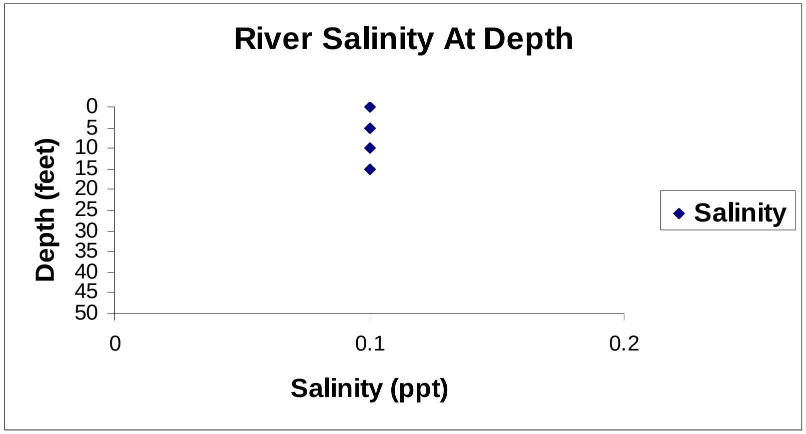

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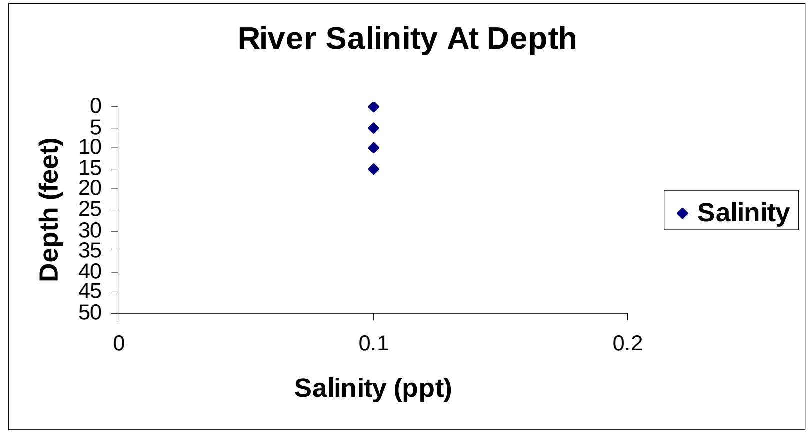

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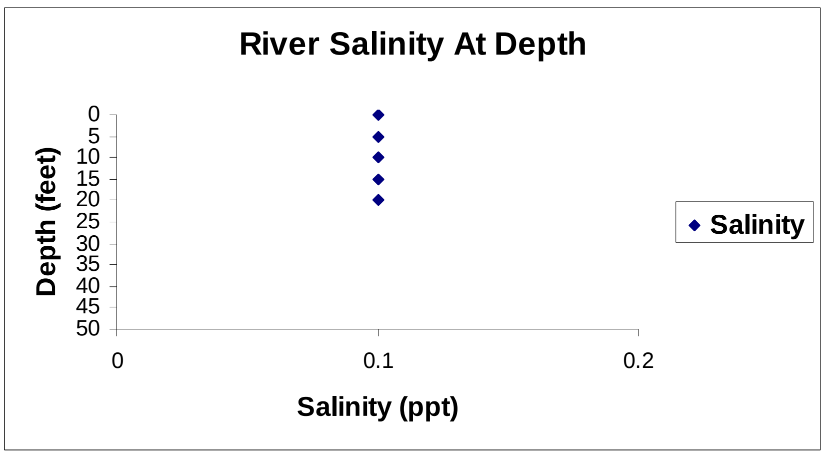

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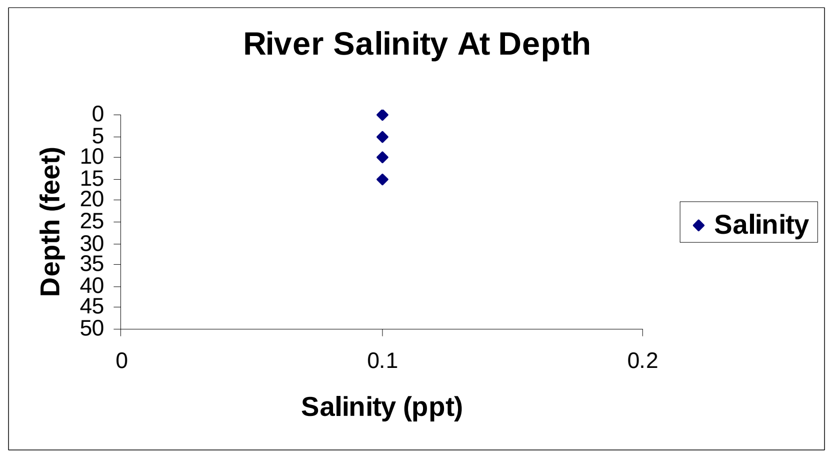

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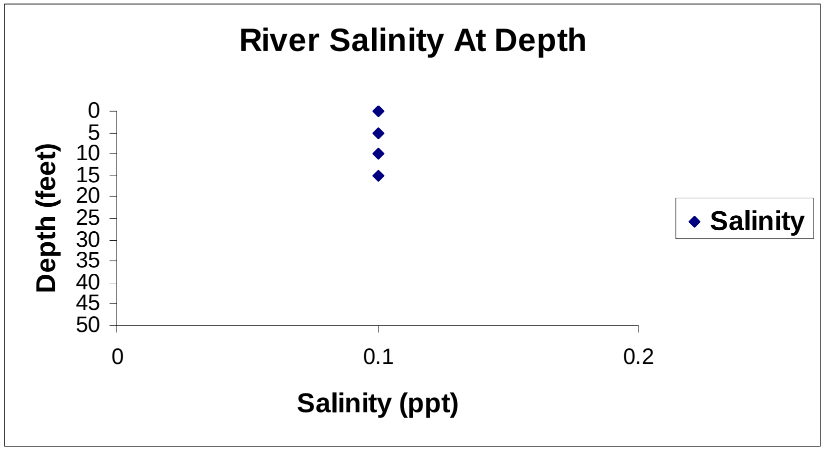

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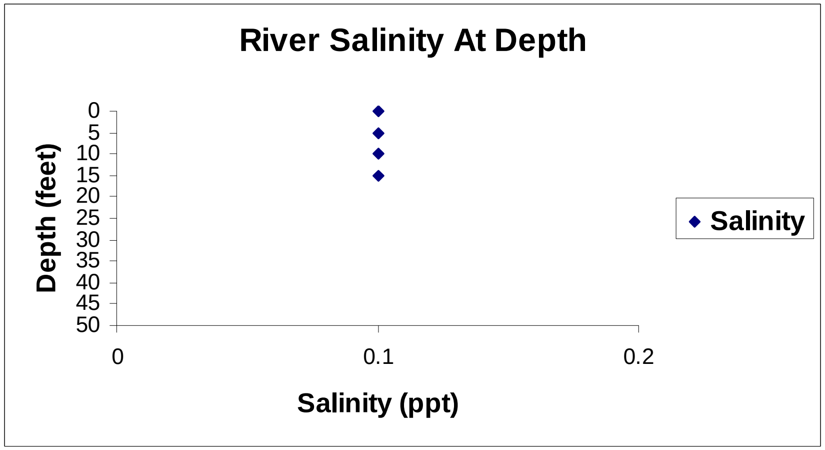

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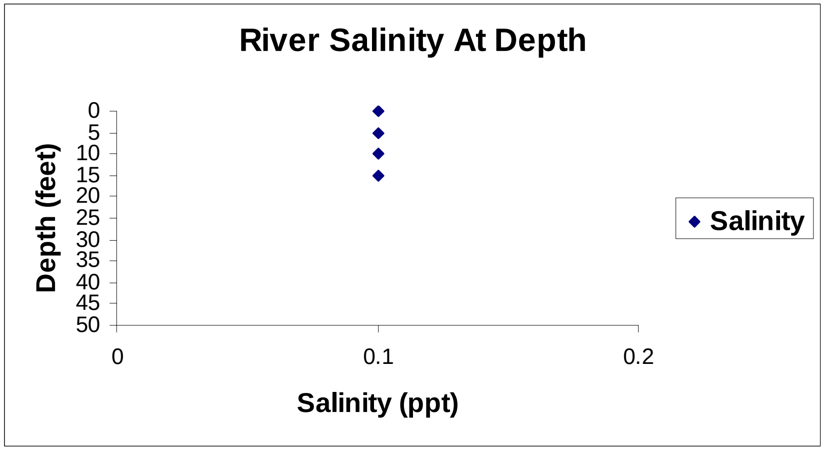

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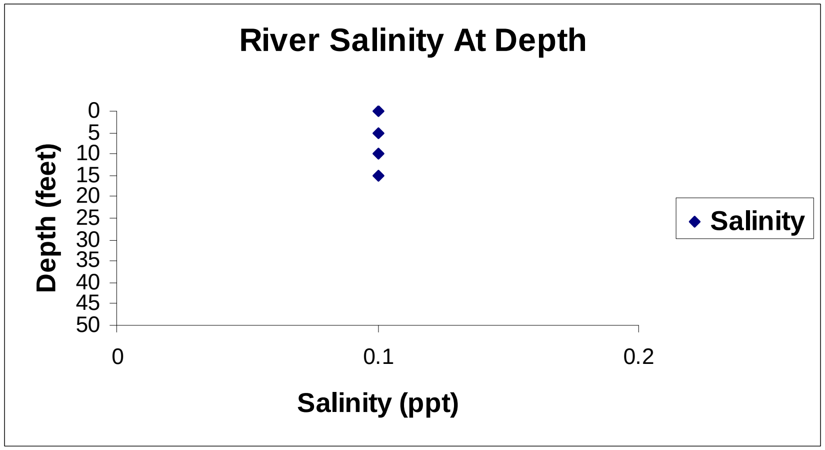

APPENDIX D

LIST OF SPECIES, COMMON NAMES AND AUTHORITIES FOR PLANTS SEEN IN OR NEAR POLYGONS AT SAMPLING STATIONS IN THE CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

List of Plant Species

A list of plant species used in text and tables or specifically noted in the field with accompanying authorities and common names follows. Both common and scientific names for vascular plants generally follow Kartesz and Meachum (2005). Some species have been updated to follow Weakley 2008. Species considered sensitive herbaceous species are marked with an asterisk (*). The list is cumulative for the project.

Acer rubrum L. Red Maple
Alnus serrulata (Ait.) Wild. Tag Alder
Alternanthera philoxeroides (Mart.) Griseb. Alligator-Weed
Amaranthus cannabinus (L.)Sauer Tidal-Marsh Amaranth
Apios americana Medik. Groundnut
Arundinaria gigantea (Walter)Muhl. River Cane
**Aster* sp. Probably *Symphyotrichum elliottii*.
Bidens cernua L. Bur-marigold
Bidens laevis (L.)B.S.P. Smooth Beggarticks
Bidens mitis (Michx.)Sherff. Small-fruit Beggarticks
Bidens sp. Beggarticks
**Boehmeria cylindrica* (L.) Sw. Small-Spike False Nettle
Bolboschoenus robustus (Pursh) J. Soják Salt-marsh Bulrush
**Boltonia asteroides* (L.) L'Hér. White Doll's-Daisy
Campsis radicans (L.) Seem. Ex Bureau Trumpet-Creeper
**Carex* L. Sedge
Carex albolutescens Schwein. Narrow-winged Sedge
Carex amphibole Steud. Eastern narrow-leaf Sedge
**Carex crinita* Lam. Fringed Sedge
**Carex crinita* var. *brevicrinis* Fern. Fringed Sedge
**Carex crus-corvi* Shuttlw. Ex Kunze Raven-Foot Sedge
Carex debilis Michx. White-Edge Sedge
Carex gigantea Rudge Giant Sedge
**Carex hyalinolepis* Steud. Shoreline Sedge
Carex leptalea Wahlenb. Bristly-stalk Sedge
**Carex lupulina* Muhl. Ex Willd. Hop Sedge
Carya aquatica (Michaux f.)Elliott, Water Hickory
**Chasmanthium latifolium* (Michx.) Yates Indian Wood-Oats
**Cicuta maculata* L. Spotted Water-Hemlock
**Cinna arundinacea* L. Sweet Wood-Reed
**Clematis crispa* L. Marsh Clematis
**Clematis ternifolia* DC. Sweet Autumn Clematis
**Commelina virginica* L. Virginia Dayflower
Cornus amomum P. Miller, Silky Dogwood
**Cyperus* L. Umbrella Sedge
**Decodon verticillatus* (L.) Ell. Swamp-Loosestrife
**Dulichium arundinaceum* (L.) Britt. Three-Way Sedge
Echinochloa walteri (Persh) Heller Barnyard Grass
**Elymus virginicus* L. Virginia Wild Rye
Erechtites hieraciifolius (L.)Raf. ex DC. Fireweed
**Eryngium aquaticum* L. Rattlesnake-Master
Eupatorium capillifoliuim (Lam.) Small Dog-fennel
Fraxinus caroliniana P. Mill. Carolina Ash
Fraxinus pennsylvanica Marsh Green Ash
Fraxinus profunda (Bush) Bush Pumpkin Ash
**Galium* L. Bedstraw
Hydrocotyle L. Marsh-Pennywort
**Hydrocotyle verticillata* Thunb. Whorled Marsh-Pennywort
**Hymenocallis crassifolia* Herbert Swamp Spider-Lily

Hypericum walteri (Gmelin) Gleason Marsh St. John's-wort
Impatiens capensis Meerb. Spotted Touch-Me-Not
Ipomoea L. Morning-Glory
Juncus effusus ssp. *solutus* (Fernald & Wiegand) Hämet-ahti Soft Rush
Leersia lenticularis Michx. Catchfly Cutgrass
**Leersia oryzoides* (L.) Swartz Rice Cutgrass
Leucothoe racemosa (L.) Gray Swamp Doghobble
Lilaeopsis chinensis (L.) Kuntze Eastern Grasswort
**Lobelia cardinalis* L. Cardinal-Flower
*Ludwigia decurrens*Walter Wingstem Water Primrose
**Ludwigia grandiflora* (M. Micheli) Greuter & Burdet Large-Flower Primrose-Willow
Ludwigia leptocarpa (Nutt.) Hara Water-willow
**Ludwigia palustris* (L.) Ell. Marsh Primrose-Willow
**Lycopus virginicus* L. Virginia Water-Horehound
**Mikania scandens* (L.) Willd. Climbing Hempvine
Morella cerifera (L.)Small Common Wax-myrtle
Murdannia keisak (Hassk.) Hand.-Maz. Wart-Removing-Herb
Nyssa aquatica L. Water Tupelo
Nyssa biflora Walt. Swamp Tupelo
Oenothera riparia Nuttall Riverbank Evening-Primrose (was *O. fruticosa* ssp. *glauca*)
**Orontium aquaticum* L. Goldenclub
Osmunda regalis var. *spectabilis* Gray Royal Fern
Packera glabella (Poir.) C. Jeffrey Cress-Leaf Groundsel
**Peltandra virginica* (L.) Schott Green Arrow-Arum
Persea palustris (Raf.) Sarg. Swamp Bay
**Phanopyrum gymnocarpon* (Ell.) Nash Savannah-Panic Grass
**Physostegia leptophylla* Small Slender-Leaf False Dragonhead
Pilea pumila (L.) Gray Canadian Clearweed
Platanthera flava (L.) Lindley Rein Orchid
Pluchea odorata (L.) Cass. Sweetscent
Polygonum arifolium L. Halberd-Leaf Tearthumb
**Polygonum hydropiper* L. Mild Water-Pepper
**Polygonum hydropiperoides* Michx. Swamp Smartweed
**Polygonum punctatum* Ell. Dotted Smartweed
**Polygonum virginianum* L. Jumpseed
**Pontederia cordata* L. Pickerelweed
Porella pinnata L Leafy Liverwort
Proserpinaca palustris L. Marsh Mermaidweed
Quercus lyrata Walter, Overcup Oak
Quercus michauxii Nuttall, Basket Oak
Rotala ramosoir (L.)Koch. Toothcup
**Rhynchospora corniculata* (Lam.) Gray Short-Bristle Horned Beak Sedge
**Rhynchospora inundata* (Oakes) Fern. Narrow-Fruit Horned Beak Sedge
Rosa palustris Marsh. Swamp Rose
**Rumex verticillatus* L. Swamp Dock
**Sagittaria lancifolia* L. Bull-Tongue Arrowhead
Sagittaria latifolia Wild. Wapato
**Saururus cernuus* L. Lizard's-Tail
**Scutellaria lateriflora* L. Mad Dog Skullcap
**Schoenoplectus americanus* (Pers.) Volk. Ex Schinz & R. Keller Chairmaker's Club-Rush
Schoenoplectus robustus see *Bolboschoenus robustus*
* *Schoenoplectus tabernaemontani* (K.C. Gmel.) Palla Soft-Stem Club-Rush
**Sium suave* Walt. Hemlock Water-Parsnip
Smilax rotundifolia L. Horsebrier
Solidago sempervirens var. *mexicana* (L.) Fern. Seaside Goldenrod
Spartina cynosuroides (L.) Roth Big Cord Grass

**Symphyotrichum elliottii* (Torr. & Gray) Nesom Marsh American-Aster
Symphyotrichum subulatum (Michx.) Nesom Seaside American-Aster
Symphyotrichum tenuifolium (L.) Nesom Perennial Saltmarsh American-Aster
Taxodium ascendens Brongn. Pond-Cypress
Toxicodendron radicans (L.) Kuntze Eastern Poison-Ivy
Toxicodendron vernix (L.) Kuntze Poison Sumac
**Triadenum walteri* (J.G. Gmel.) Gleason Greater Marsh-St. John's-Wort
**Typha latifolia* L. Broad-Leaf Cat-Tail
Typha angustifolia L. Narrow-Leaf Cat-Tail
Typha ×glauca Godr. (pro sp.)
Viburnum dentatum L. Southern Arrow-Wood
Woodwardia areolata (L.) T. Moore Netted Chain Fern
Woodwardia virginica (L.) E. Smith Virginia Chain Fern
**Zizania aquatica* L. Indian Wild Rice
**Zizaniopsis miliacea* (Michx.) Doell & Aschers. Marsh-Millet

Literature Cited

Kartesz, J.T., and C.A. Meacham. 2005. Synthesis of the North American Flora, Prepublication Version 2.0. Missouri Botanical Garden Press, St. Louis.

Weakley, A. S. 2008. Flora of the Carolinas, Virginia, Georgia, northern Flordia, and surrounding areas. Working Draft of 7 April 2008. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina at Chapel Hill. Chapel Hill, NC.

APPENDIX E

METADATA COVERING GIS/GPS FILES USED IN TEXT FIGURES IN SENSITIVE HERBACEOUS VEGETATION POLYGONS: 2008 ASSESSMENTS AT SEVEN STATIONS ESTABLISHED FOR THE WILMINGTON HARBOR MONITORING PROJECT IN THE CAPE FEAR RIVER ESTUARY, NORTH CAROLINA

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P3, INNER TOWN CREEK

FIGURE 8.41-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**13ben.shp 13ben.dbf 13ben.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**13pil.shp 13pil.dbf 13pil.shx**
DESCRIPTION OF LAYER:	Point depicting data collect platform piling
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P3, INNER TOWN CREEK

FIGURE 8.41-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**13poly.shp 13poly.dbf 13poly.shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2000 (13poly.ssf GPS file from CZR Incorporated)
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

FILE NAMES:	**13sub.shp 13sub.dbf 13sub.shx**
DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P3, INNER TOWN CREEK

FIGURE 8.41-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site9.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1" = 250' Resolution: 1100 DPI (23.1 microns)
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272' based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P3, INNER TOWN CREEK

FIGURE 8.41-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**13tra.shp 13tra.dbf 13tra.shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**Towncr07 .shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2007
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.9 and Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	7 Jan 2008
SOURCE:	David M. DuMond
SOURCE CONTACT:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P3, INNER TOWN CREEK

FIGURE 8.41-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**TC08PO .shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2008
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.9 and Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	14 Jan 2009
SOURCE:	David M. DuMond
SOURCE CONTACT:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

FILE NAMES:	**2outlpt8 .shp, .dbf, .shx**
DESCRIPTION OF LAYER:	points locating sensitive herbaceous plants, 2008
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points from points
SOFTWARE:	Pathfinder Office 2.9 and Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	14 Jan 2009
SOURCE:	David M. DuMond
SOURCE CONTACT:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P7, INDIAN CREEK

FIGURE 8.42-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**15ben.shp 15ben.dbf 15ben.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

FILE NAMES:	**15pil.shp 15pil.dbf 15pil.shx**
DESCRIPTION OF LAYER:	Point depicting data collect platform piling
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA
POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P7, INDIAN CREEK

FIGURE 8.42-1

CAPE FEAR RIVER ESTUARY,
WILMINGTON HARBOR MONITORING PROJECT,
NORTH CAROLINA

FILE NAMES:	**15sub.shp 15sub.dbf 15sub.shx**
DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P7, INDIAN CREEK

FIGURE 8.42-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site8.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1” = 250’ Resolution: 1100 DPI (23.1 microns)
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272’ based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P7, INDIAN CREEK

FIGURE 8.42-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**15tra.shp 15tra.dbf 15tra.shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**Indcr .shp, .dbf .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2002
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	6 February 2003
SOURCE:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P8, DOLLISONS LANDING

FIGURE 8.43-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**16ben.shp 16ben.dbf 16ben.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

FILE NAMES:	**16pil.shp 16pil.dbf 16pil.shx**
DESCRIPTION OF LAYER:	Point depicting data collect platform piling
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P8, DOLLISONS LANDING

FIGURE 8.43-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**Indcrpo3.shp, .dbf .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2008
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	4 August 2008
SOURCE:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

FILE NAMES:	**16sub.shp**	**16sub.dbf**	**16sub.shx**

DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P8, DOLLISONS LANDING

FIGURE 8.43-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site3.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1" = 250' Resolution: 1100 DPI (23.1 microns):
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272' based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P8, DOLLISONS LANDING

FIGURE 8.43-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**16tra.shp 16tra.dbf 16tra.shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P9, BLACK RIVER

FIGURE 8.44-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**17ben.shp 17ben.dbf 17ben.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

FILE NAMES:	**17pil.shp 17pil.dbf 17pil.shx**
DESCRIPTION OF LAYER:	Point depicting data collect platform piling
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P9, BLACK RIVER

FIGURE 8.44-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**17poly.shp 17poly.dbf 17poly.shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2000 (17poly.ssf GPS file from CZR Incorporated)
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

FILE NAMES:	**17sub.shp 17sub.dbf 17sub.shx**
DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P9, BLACK RIVER

FIGURE 8.44-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site4.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1” = 250’ Resolution: 1100 DPI (23.1 microns)
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272’ based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P9, BLACK RIVER

FIGURE 8.44-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**17tra.shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**briv.shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2005
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.9, ArcView 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	21 January, 2006
SOURCE:	David M. DuMond
SOURCE CONTACT:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P12, RAT ISLAND

FIGURE 8.45-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**Cam2.shp Came2.dbf Cam2.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**Ratpil2.shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Point depicting new location of piling, 2002
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.8 and Arcview 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	5 August 2002
SOURCE:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P12, RAT ISLAND

FIGURE 8.45-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**19poly.shp 19poly.dbf 19poly.shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2000 (19poly.ssf GPS file from CZR Incorporated)
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**19sub.shp 19sub.dbf 19sub.shx**
DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P12, RAT ISLAND

FIGURE 8.45-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site5.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1” = 250’ Resolution: 1100 DPI (23.1 microns)
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272’ based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P12, RAT ISLAND

FIGURE 8.45-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**19tra.shp 19tra.dbf 19tra.shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P13, FISHING CREEK

FIGURE 8.46-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**20ben.shp 20ben.dbf 20ben.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**20pil.shp 20pil.dbf 20pil.shx**
DESCRIPTION OF LAYER:	Point depicting data collect platform piling
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P13, FISHING CREEK

FIGURE 8.46-1

CAPE FEAR RIVER ESTUARY,
WILMINGTON HARBOR MONITORING PROJECT,
NORTH CAROLINA

FILE NAMES:	**20poly.shp 20poly.dbf 20poly.shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2000 (20poly.ssf GPS file from CZR Incorporated)
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

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FILE NAMES:	**20sub.shp 20sub.dbf 20sub.shx**
DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P13, FISHING CREEK

FIGURE 8.46-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site2b.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1” = 250’ Resolution: 1100 DPI (23.1 microns)
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272’ based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P13, FISHING CREEK

FIGURE 8.46-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**20tra.shp 20tra.dbf 20tra.shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**Fishcr07 .shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2007
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.9, Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	7 January 2008
SOURCE:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P13, FISHING CREEK

FIGURE 8.46-1

**CAPE FEAR RIVER ESTUARY,
WILMINGTON HARBOR MONITORING PROJECT,
NORTH CAROLINA**

FILE NAMES:	**Fishcr06, .shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2006
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.9, Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	23 January, 2007
SOURCE:	David M. DuMond
SOURCE CONTACT:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P14, PRINCE GEORGE CREEK

FIGURE 8.47-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**21ben.shp 21ben.dbf 21ben.shx**
DESCRIPTION OF LAYER:	Point depicting concrete benchmark
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

FILE NAMES:	**21pil.shp 21pil.dbf 21pil.shx**
DESCRIPTION OF LAYER:	Point depicting data collect platform piling
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Point
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P14, PRINCE GEORGE CREEK

FIGURE 8.47-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**21poly.shp 21poly.dbf 21poly.shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2000 (21poly.ssf GPS file from CZR Incorporated)
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**21sub.shp 21sub.dbf 21sub.shx**
DESCRIPTION OF LAYER:	Points depicting substation survey points
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P14, PRINCE GEORGE CREEK

FIGURE 8.47-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**site1.tif**
DESCRIPTION OF LAYER:	True color aerial photography was flown on March 25, 2000 at an altitude of 1500 feet.
SOURCE:	Wild RC20 Aerial Mapping Camera Scale: 1” = 250’ Resolution: 1100 DPI (23.1 microns)
DATA TYPE:	The image source consisted of color contact prints and diapositives were created and the negative film then digitally scanned on a Vexcell 4000 to create raw digital images to be rectified and produce digital orthophotos. This produced an original raw pixel size of .2272’ based on the scale of the negative film.
SOFTWARE:	Tif/Tfw file format
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	25 March 2000
SOURCE:	3Di, LLC Wilmington NC, Office
SOURCE CONTACT:	Scott C. Williams, PLS
SOURCE ADDRESS:	2704-A Exchange Drive Wilmington, NC 28405
SOURCE PHONE:	910/392-1496
SOURCE FAX:	910/392-7326

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P14, PRINCE GEORGE CREEK

FIGURE 8.47-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**21tra.shp 21tra.dbf 21tra.shx**
DESCRIPTION OF LAYER:	Points depicting belt transect markers
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Points
SOFTWARE:	Pathfinder Office 2.1 and Arcview version 3.2
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	20 December 2000
SOURCE:	CZR Incorporated
SOURCE CONTACT:	Samuel Cooper
SOURCE ADDRESS:	4709 College Acres, Suite 2 Wilmington, NC 28403
SOURCE PHONE:	910/392-9253
SOURCE FAX:	910/392-9139
FILE NAMES:	**Pringe07.shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2007
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.9, Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane 1983
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	8 January, 2007
SOURCE:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-30

METADATA

POSITIONS OF MONITORING STATION COMPONENTS AND SENSITIVE HERBACEOUS PLANT SPECIES POLYGONS WITHIN THE BELT TRANSECT AT MONITORING STATON P14, PRINCE GEORGE CREEK

FIGURE 8.47-1

CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

FILE NAMES:	**PGR08PO.shp, .dbf, .shx**
DESCRIPTION OF LAYER:	Polygon depicting sensitive herbaceous plants, 2008
SOURCE:	Trimble PRO XRS GPS Unit
DATA TYPE:	Polygon from points
SOFTWARE:	Pathfinder Office 2.9, Arcview 3.3
DATUM:	North American Datum (NAD) 1983
COORDINATE SYSTEM:	U.S. State Plane
REGION:	North Carolina 3200
UNITS OF MEASURE:	Feet
DATA COLLECTION:	4 January, 2008
SOURCE:	David M. DuMond
SOURCE ADDRESS:	1600 Hicks Road Broadway, NC 27505
SOURCE PHONE:	919/258-3032

APPENDIX F

AREAS AND LOCATIONS OF NEW YEAR 2008 SENSITIVE HERBACEOUS SPECIES POLYGONS AT SAMPLING STATIONS IN THE CAPE FEAR RIVER ESTUARY, WILMINGTON HARBOR MONITORING PROJECT, NORTH CAROLINA

Appendix F. Areas and locations of year 2008 sensitive herbaceous species polygons at sampling stations in the Cape Fear River Estuary, Wilmington Harbor Monitoring Project, North Carolina

Station Name/Number	Polygon Area (ft^2)	Point Number	Northing* (ft)	Easting* (ft)
Town Creek/ P3	Polygon 1 (266.78)	1	140243.951	2304213.3231
		2	140253.010	2304208.567
		3	140258.846	2304213.968
		4	140263.055	2304209.568
		5	140255.485	2304199.785
		6	140248.229	2304192.936
		7	140239.835	2304198.014
	Polygon 2 (21.21)	1	140270.730	2304226.200
		2	140279.501	2304231.257
		3	140280.024	2304226.721
	Outlier Points	1	140304.391	2304227.517
		2	140311.374	2304232.345
Indian Creek/P7	254.34	1	194616.062	2300205.160
		2	194626.765	2300215.932
		3	194638.931	2300201.503
		4	194623.459	2300194.217
Fishing Creek P13	1813.14	1	215476.999	2303576.850
		2	215471.860	2303577.919
		3	215456.413	2303582.640
		4	215453.940	2303587.555
		5	215442.840	2303593.882
		6	215432.193	2303591.098
		7	215434.977	2303589.716
		8	215435.252	2303589.111
		9	215453.848	2303584.224
		10	215449.283	2303575.735
		11	215474.936	2303568.212
		12	215455.757	2303561.241
		13	215474.963	2303568.216
		14	215491.590	2303567.240
		15	215510.513	2303544.529
		16	215528.778	2303543.796
		17	215545.674	2303525.504
		18	215553.445	2303534.849
		19	215530.054	2303558.251
		20	215505.442	2303576.003
		21	215502.554	2303580.498
		22	215498.541	2303582.169
		23	215496.447	2303572.720
		24	215491.186	2303576.427
		25	215482.189	2303584.865

Appendix F. (continued)

Prince George Creek./P14	4602.67	1	227250.236	2320208.686
		2	227244.040	2320215.961
		3	227232.494	2320223.228
		4	227228.480	2320228.327
		5	227224.481	2320223.511
		6	227216.853	2320234.592
		7	227204.741	2320238.191
		8	227205.244	2320255.769
		9	227219.192	2320255.178
		10	227216.753	2320260.684
		11	227204.257	2320268.816
		12	227216.193	2320284.327
		13	227203.498	2320286.560
		14	227203.257	2320291.255
		15	227215.899	2320292.193
		16	227224.225	2320283.487
		17	227232.025	2320300.390
		18	227233.535	2320281.009
		19	227241.647	2320275.491
		20	227259.761	2320279.712
		21	227261.018	2320280.919
		22	227279.818	2320277.656
		23	227274.532	2320299.537
		24	227292.683	2320303.937
		25	227302.842	2320286.456

*North Carolina State Coordinate System, Region 3200, North American Datum, 1983.